Review of measures to minimize human tiger conflict (HTC)

(WNF, n.d.4)

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Master's Thesis for the Environment and Society Studies programme
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12-02-2019

Preface

In this document you will find the thesis "*Review of measures to minimize human tiger conflict (HTC)*", written for the master Environment and Society Studies at Radboud University. After contacting WNF, there appeared to be a demand for an overview of the effectiveness of several HTC reduction measures. Although much knowledge about HTC reduction measures was present in literature, an overview that could be used in practice was lacking. As wildlife conservation is one of my big interests, I decided to write my thesis about this.

During my thesis, I was supervised by Femke Hilderink on behalf of WNF. I would like to thank her for the pleasant guidance. I could go to her at any time and she was always open to questions, which was very nice for me to work with. In addition, she has high knowledge about the subject and provided me with constructive criticism which was very useful. In addition, Natascha Zwaal, also working for WNF, supervised me. Next to providing several pieces of feedback, she guided me more process wise, for which I would like to thank her. Also, several other WNF staff were very helpful, for example, by connecting me to some interviewees. They were all very kind and accessible and made my working experience at WNF very enjoyable.

In addition, during this research I was supervised by Duncan Liefferink on behalf of Radboud University. I would like to thank him for the pleasant supervision as well. He always took time to provide me with feedback and thought along with me when I was struggling with something.

I would also like to thank all respondents who I have interviewed. Without them, valuable information would have been missing.

Finally, I want to thank family and friends, with whom I could always talk about ideas and who were open to read my research to be able to give me advice with a fresh perspective.

I experienced writing my thesis as very pleasant and educational. The interesting subject and helpful support have been very valuable to me.

I wish you a lot of reading pleasure!

Lusanne Smink
Nijmegen, 12-02-2019

Abstract

This research investigates the successfulness of HTC reduction measures, which are required to reduce the increasing number of HTC. Their effectiveness, pro's, cons and requirements are investigated by evaluating on three assessment criteria: some basic aspects, the roles of actors involved and three success criteria: the impact on-, or relation with, safety of humans and livestock, conservation goals and local conditions. To complement literature findings, in-depth interviews have been conducted with people working for conservation organisations.
Although all measures possibly reduce HTC, with exception of dredging water channels, some have proven to be very effective in particular: education and training, land use planning, the management of wild prey and the instalment of response teams. However, other preventive, reactive and mitigative measures, based on local, social and ecological conditions are indispensable. For all measures, a good understanding of the local context is required because no strategy is appropriate anywhere, and actors must be intensively involved to secure a proper implementation and maintenance. Finally, a more flexible and opportunistic approach makes it possible to look more location specific at possibilities for reducing HTC in specific areas, in addition to the opportunities provided by the 'conventional' approach and measures for reducing HTC.

Keywords

Human-tiger conflict, tiger conservation, human-tiger conflict reduction, livestock loss, human safety, HTC reduction measures, interventions, governance

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List of abbreviations

CBAPU	-	Community Based Anti-Poaching Unit
CITES	-	Convention on International Trade in Endangered Species
HTC	-	Human tiger conflict
HWC	-	Human wildlife conflict
IUCN	-	International Union for Conservation of Nature and Natural Resources
KfW	-	'Kreditanstalt für Wiederaufbau' (German Development Bank)
NGO	-	Non-governmental organisation
WWF	-	World Wide Fund for Nature

1. Introduction

Between April 2014 and May 2017, 92 people were killed by tigers in India alone (The Guardian, 2017). Even though wild tigers are under threat of extinction (GTI, 2011), the number of human-tiger conflicts (HTCs), in this research seen as conflicts whereby tigers attack people or livestock (Dhungana et al., 2018), has increased over the past years (Anwar, Saralch & Kumar, 2015; The Guardian, 2017). In the Russian Far-East the number of conflicts between human and tiger has even doubled since 2010 (Kostyria, Fomenko, Solkin & Hilderink, 2018).
In the past decades, much habitat of tigers has been reduced. Human population is growing, and more pressure is placed on wildlife habitats (Bulte & Rondeau, 2005; Distefano, 2005; Madhusudan, 2003; Seidensticker, Christie & Jackson, 1999; Sillero-Zubiri & Laurenson, 2001). However, in some areas, conservation measures have ensured that the number of tigers started to increase. For example, in India *"… 30 years of serious official commitment leading to sporadic recovery of tiger populations."* (Karanth et al., 2003, p.141). This combination of diminishing tiger habitat and in some areas, although still to a limited extent, increasing tiger populations leads to increasing conflicts between humans and tigers (Brooks, 2014; The Guardian, 2017; Treves & Karanth, 2003). According to Nyhus, Osofsky, Ferraro, Madden and Fischer: *"… human conflict with wildlife is a significant – and growing – conservation problem around the world."* (2005, p. 107). HTC cause injuries, cost the lives of humans and livestock, cause economic losses and influence the livelihoods of local inhabitants (Bulte & Rondeau, 2005; Distefano, 2005; Goodrich, 2010; Kartika & Koopmans, 2013).

Furthermore, HTCs form an important threat for tiger conservation because when a HTC occurs, very often the tiger is killed in revenge (Dhungana, Savini, Karki & Bumrungsi, 2016; Inskip et al., 2013; Löe & Röskaft, 2004; Madhusudan, 2003; Woodroffe, Frank, Lindsey, ole Ranah & Romanach, 2007). In some regions, up to 50% of tiger mortality is a consequence of retaliatory killing (Inskip & Zimmermann, 2009). As Sillero-Zubiri and Laurenson note: "*Predation by carnivores on livestock is the root of a deeply ingrained hatred for carnivores throughout the world …"* (2001, p.4). Furthermore, Loveridge, Wang, Frank and Seidensticker note: *"Loss of human life or livelihood provides the impetus for people to attempt localized or sometimes wide-scale eradication of predators."* (2010, p. 164). Also, Dickman notes: "*Human–wildlife conflict is one of the most critical threats facing many wildlife species today"* (2010, p. 458). However, tigers provide important ecological services. As a top predator they are important for the maintenance of diverse ecosystems (Banikoi et al., 2017; Michalski, Boulhosa, Faria & Peres, 2006) and "*The presence of viable populations of wild tigers is an indicator of the integrity, sustainability, and health of larger ecosystems."* (GTI, 2011, p. ix).

Without proper measures taken to reduce HTC, the number of people and livestock killed by tigers might further increase (Goodrich, 2010; Gurung, Smith, McDougal, Karki & Barlow, 2008) and "… *successful conservation initiatives might be reversed as an angry public retaliates in response to increased HTC.*" (Goodrich, 2010, p. 308). Different measures exist to minimize HTC or its consequences. Among many other measures, farmers could make use of better fences to protect livestock from predation, people can make use of deterrent methods to chase tigers away, insurance programs could be set up to compensate for financial losses and people could be trained how to behave when encountering a tiger (Goodrich, 2010; Treves & Karanth, 2003).

The World Wide Fund for nature (WWF) is a nature conservation NGO that focuses on themes such as oceans, forests, rivers and lakes, climate change, food and wildlife (WWF, n.d.3). In order to protect wildlife, WWF, among many other things, supports programmes to manage HWC (human-wildlife conflicts) such as HTC. Thereby, the focus is placed on the prevention of conflicts, response to an ongoing conflict situation and mitigation of the impact when a conflict has occurred. However, the

exact contributions and restrictions of different measures to reduce HTC are unclear. Therefore, this research focuses on the different measures that are being taken to fight against HTC. The main question of this research is:

"To what extent are different measures to reduce human-tiger conflicts successful in avoiding and managing HTC?"

To answer this question, the following sub questions were formulated:

1. Which measures to reduce HTCs exist?
2. To what extent do HTC reduction measures increase human and livestock safety?
3. How do different HTC reduction measures influence (tiger) conservation goals?
4. How do different HTC reduction measures relate to local conditions, considering economic, legal and social aspects?
5. In what way can different actors contribute to the implementation and success of different HTC reduction measures?

Much literature on HTC reduction measures is available. However, a schematic overview of the different measures with their pros and cons, that also relates to local conditions is lacking. This makes it difficult for governments and NGOs like WWF to choose the most effective and appropriate measures to reduce HTC. Furthermore, because of the specificity of the local context from places where HTCs occur, most literature focuses on a specific area where HTC occurs. Only few attempts are made to investigate the effectiveness of HTC reduction interventions in general, but "*Because conflicts are relatively rare in any single location, coordinating efforts and standardizing data collection across sites and countries to allow analyses of a metadata set will be crucial to rapid identification and implementation of effective interventions*." (Goodrich, Seryodkin, Miquelle, Bereznuk, 2011, p.590). Further, a *"… protocol should be developed to provide guidelines for appropriate interventions."* (Goodrich et al., 2011, p.590). So, this research amplifies scientific literature by focusing on the pros and cons of different HTC reduction measures in general while taking into account different local contexts without demarcating and focusing on one specific area. Societally, this research is relevant because it offers insights in ways to reduce HTC. By providing an overview of the different available measures this research helps governments, local communities and other organisations like WWF to choose an appropriate set of measures to address HTC in a specific area. Thereby, a contribution to the reduction of HTC is provided whereby human and livestock safety can be increased, economic losses can be prevented livelihoods can be secured better (Thirgood, Woodroffe & Rabinowitz, 2005). Finally, a contribution to HTC reduction contributes to the conservation of tigers as well, which is of high societal importance as tigers fulfil important ecosystem services (Gurung et al., 2008).

This research starts with a theoretical framework about HTC reduction. First, an overview is provided of a comprehensive HTC reduction plan, after which the components this research focuses on are examined in more detail; the different HTC reduction measures and the roles of actors for their successful implementation. The theoretical framework ends in a conceptual model and operationalization of the different aspects that will be used in the evaluation of HTC reduction measures. Thereafter, the method will be discussed, in which the way of data collection and analysis will be discussed. Then, the results will be elaborated, in which the different HTC reduction measures will be evaluated individually. In the final chapter, the conclusion and discussion can be found. First, an answer on the main question will be provided in the conclusion, after which it will be discussed what, next to the effectiveness of individual measures, can be said about their potential to reduce

HTC in general. This, and a critical review on this research can be found in the discussion part. The research ends with some scientific and practical recommendations.

2. Theoretical framework

As indicated in the introduction, it is being investigated to what extent different measures successfully avoid and manage HTC. First, a general overview of HTC reduction will be provided. This is followed by a closer look at the specific aspects this research focuses on; the different measures and roles of actors that are required for HTC reduction. The chapter ends with an operationalizing of the indicators that will be used to investigate the effectiveness of HTC reduction measures.

2.1 Comprehensive HTC reduction plans

If humans, livestock and tigers have to share and live in the same area, which is currently increasingly the case, HTCs will continue to happen (Brooks, 2014). Therefore, ways to reduce and minimize the effects of HTC have to be found.

According to Brooks, the managing of conflicts consists of six elements, together shaping the '*safe approach'*: conflict understanding, prevention, mitigation, response, policy and monitoring (2015), which are all required to address HTC holistically. This comprehensive approach starts with a good understanding of the causes of HTC which is needed to arrive at appropriate solutions (Linkie, Dinata, Nofrianto & Leader-Williams, 2007; Nyhus & Tilson, 2010). A focus on the causes is also stressed by Pahl, Wyles and Thompson, stating that: "*Effective, acceptable solutions require a strong focus on the core causes…*" (2017, p. 697). Measures to reduce HTC can be grouped in various ways. A commonly used distinction, also used in this research, distinguishes between the 'stage' a measure focuses on; does it prevent, react to or mitigate a conflict (Bowen-Jones, 2012; Goodrich, 2010)? A combination of these different kinds of measures; preventive, reactive and mitigative, is necessary to fully address HTC (Brooks, 2014; Goodrich, 2010). Policy, the fifth element of the safe approach, is required for legislation and governmental plans (Brooks, 2015). However, to successfully reduce HTC it is important that non-governmental actors are involved as well; "*… too top-down institutional arrangements raises the risks of imposition which may be manifested by apathy, objections and non-cooperation by other actors."* (Fernandez, 2006, p.31). This also fits with the landscape approach which WWF strives for in her battle to reduce HTC. In this approach it is, next to the importance of looking at the overall picture, for example, to prevent displacement of the problem, required to involve different actors to reconcile different views and stand-points and to arrive at generally accepted solutions (Oosten, 2011; WWF, n.d.5). In order to deal with different actors in a well-founded way, governance plays an important role (Adger et al., 2003). In addition, governance is relevant for changes and interventions towards sustainability and the managing of HTC as these require actions being taken by, and cooperation between all different stakeholders to arrive at viable solutions (Fernandez, 2006; Messmer, 2009; Quist & Vergragt, 2004; Strengers & Maller, 2014). As this research focuses on the successfulness of HTC reduction measures, which are interventions themselves, in addition to policy also governance aspects and the roles of different actors in implementing HTC reduction measures will be included in this research. Finally, "*Monitoring is essential to judge the effectiveness of interventions."* (Treves, Wallace, Naughton-Treves & Morales, 2006, p. 391). The situation can be improved by evaluating and sharing experiences (Zhou et al., 2004), for example by addressing possible shortcomings.

For governance, three major institutional domains get distinguished: the civil society, the market and the state (Scott, 2004), which all need to be involved in HTC reduction. For example, the local community, part of the civil society, needs to be involved because they are part of the subject of HTC (Fernandez, 2006) and they are in many cases the appropriate actor to take ownership of HTC reduction measures. Market actors play, among others, a role in the development of HTC reduction measures (Le Bel, Chavernac & Stansfield, 2016). State actors play an important role because policy is

required to implement legislations and governmental plans (Brooks, 2015). Therefore, all these different actors need to be involved to successfully reduce HTC.

An overview of the different elements of a comprehensive HTC reduction plan are given in figure 1, As this research focusses on the effectiveness of HTC reduction measures, after a brief problem understanding, emphasis is placed on the different measures and roles of actors in HTC reduction. Due to the fact that monitoring increases the effectiveness of HTC reduction measures in general and is not linked to the effectiveness of certain measures in particular, monitoring is mainly left out of consideration in this research.

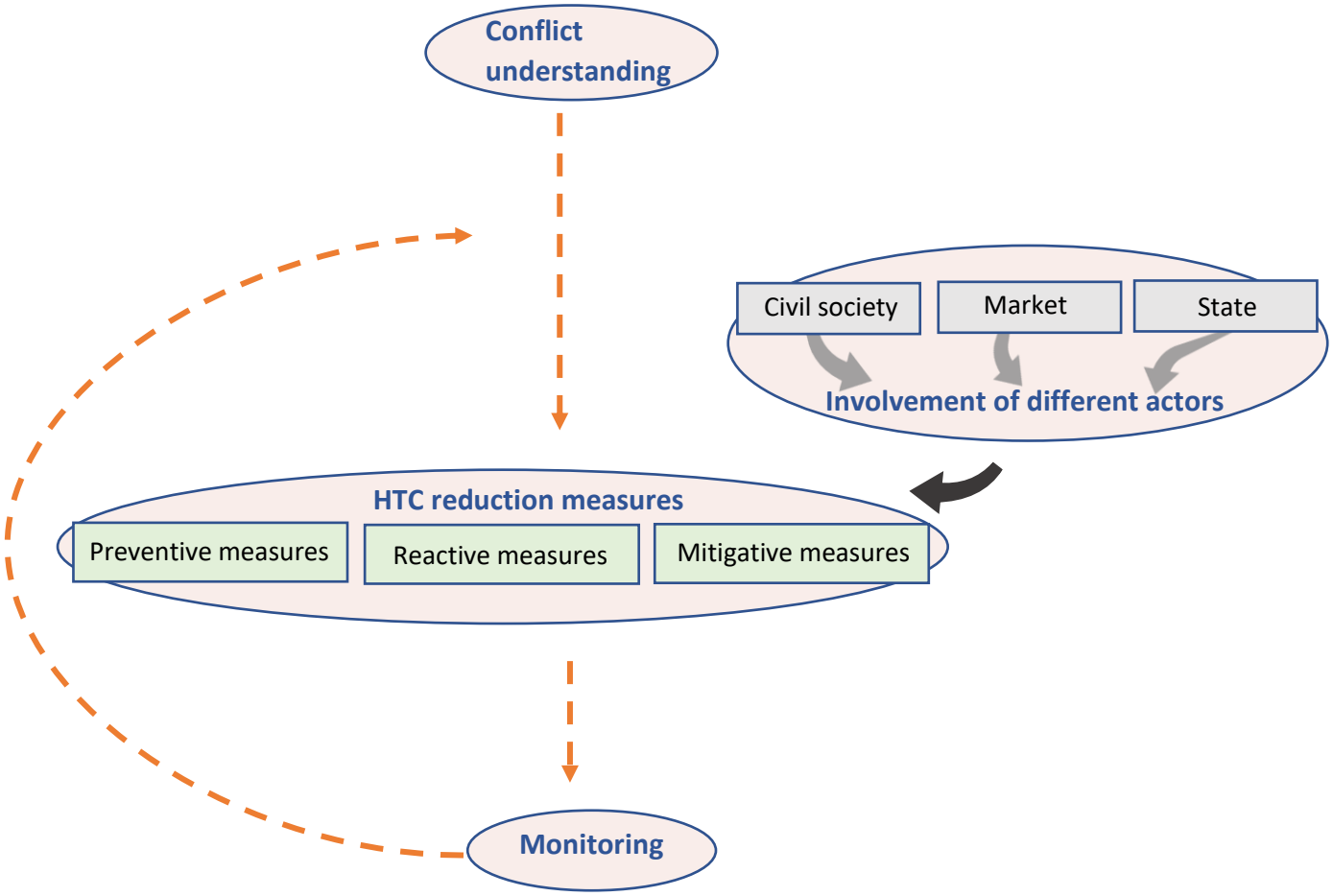

Figure 1: Comprehensive HTC reduction plan

2.2 Understanding of HTC

Naturally the diet of tigers consists of larger mammals, such as deer and oxen (Andheria, Karanth & Kumar, 2007), and people are not part of their prey (Pathak et al., 2013). However, tigers attack humans and livestock relatively often.

As already shortly noted, an important cause of HTC is the increasing competition on space and resources between tigers and human. Much habitat of the tiger is lost, degraded and/or fragmented (Distefano, 2005). Human population is growing, and more area is in use for human activities, for example by roads, agricultural activities and housing. Due to human population growth, also livestock quantities have increased, another reason for the decrease of tiger habitat (Distefano, 2005; Mollel, 2017). Significant amounts of space are needed for livestock grazing and the production of livestock feeds. Due to this decrease in tiger habitat, natural tiger prey densities have also been reduced

(Mishra et al., 2003). In addition, the placement of traps and snares and the poaching of wild prey have led to reduced prey densities (Aryal, 2005; Paltsyn, Spitsyn, Kuksin & Istomov, 2012). By this decrease of wild prey, livestock is becoming relatively easier for tigers to prey upon; they are often present in large amounts and they are sometimes easier to catch (Distefano, 2005). Furthermore, the injury of tigers, for example by tigers falling into a snare or a failed hunting attempt, increases the amount of HTC (Nyhus & Tilson, 2010) by the inability of these tigers to catch wild prey (Dhungana, 2016). Finally, in some areas the number of tigers has started to increase due to conservation measures. These factors all lead to more encounters as they "*… cause individual tigers to enter villages and/or attack domestic animals or people.*" (Goodrich, 2010, p.305). Consequently, without limiting these factors, conflicts between tigers and humans are expected to continue and further increase in future (Pathak et al., 2013).

The number of conflicts varies between areas where tigers are present (Thirgood, Woodroffe & Rabinowitz, 2005). For example, the Sundarbans, a mangrove forest in Bangladesh and India, is the region where HTC happens most often (Neumann-Denzau & Denzau, 2010). Within specific areas the amount of conflicts varies between seasons (Distefano, 2005). For example, in Russia HTCs happen more often during winter due to heavier climatic circumstances and a lower prey availability (Goodrich et al., 2011). Finally, diversities in quantities of conflicts can be declared by differences in husbandry practices. For example, areas where livestock is grazing freely, HTC is more likely to happen than in areas where livestock is kept in safe enclosures (Johnson, Vongkhamheng, Hedemark & Saithongdam, 2006).

To better understand the emergence of HTC it is important to look into deeper underlying social aspects of HTC. As Dickman notes: "*… human–wildlife conflicts are often manifestations of underlying human–human conflicts, such as between authorities and local people, or between people of different cultural backgrounds.*" (2010, p. 458). Furthermore, certain beliefs can contribute to the emergence of HTC and constitute reasons for implementing a measure or not. For example, in Tanzania the belief exists that certain ethnic groups train hyaenas to kill livestock of other farmers, showing that conflicts between wildlife could be heightened by relations between different groups of people (Dickman, 2010). Another example is the fact that Buddhism is against the killing of animals (Silva, 1998). This makes lethal control an unsuitable measure in Buddhist areas, regardless of the effectiveness of the measure.

2.3 Grouping of measures

Now, a closer look will be given to the different HTC reduction measures that are going to be investigated. Following the explanation of the grouping of measures, a list of HTC reduction measures will be given for preventive, reactive and mitigative measures. The specific conditions, pros and cons of each measure will be elaborated in-depth in the results.

Preventative measures are designed to stop or reduce a conflict before it occurs (Brooks, 2015; Goodrich, 2010). However, as Madhusudan notes: *"Still, there are no documented successes in preventing all possible conflict between humans and wildlife*." (2003, p.472). Therefore, also measures that focus on the moment a HTC is about to happen, or the time afterwards are needed. **Reactive measures** focus on the moment a HTC is about to happen or is already occurring (Brooks, 2015; F. Hilderink, personal communication, January 25, 2018). These measures are designed *"… to alleviate a specific, ongoing HTC incident …"* (Goodrich, 2010, p. 302). Finally, **mitigative measures** can be distinguished; they focus on the time after a HTC has occurred (Brooks, 2015). These measures are mainly designed to reduce the financial impact of HTC on people (F. Hilderink, personal communication May 2, 2018; Goodrich, 2010). ***Education*** and ***training*** play an overarching role in reducing HTC (Treves & Karanth, 2003). It can respond to the different aspects of HTC and knowledge

about HTC reduction measures can be spread. Therefore, education and training do not fit within one of the distinct categories.

2.3.1 Preventive measures

As already noted, preventive measures are designed to prevent and reduce HTC. ***Land use planning*** is a preventive measure (Treves & Karanth, 2003) that is used to divide land over different forms of land use. Tigers can be kept away from people and livestock by separating human and livestock from tiger habitat (Goodrich, 2010; Pettigrew et al., 2012). Goodrich notes: "… *hard agricultural edges bordering tiger habitat might reduce HTC if the agricultural lands (e.g. coffee or oil palm plantations) have no livestock and human activity is limited to people harvesting and maintaining crops during the day, preferably in groups."* (2010, p. 303). Furthermore, the closer the livestock live to humans and buildings, the less probable they will be attacked by a tiger (Treves & Karanth, 2003). Also, the ***management of wild prey*** contributes to the prevention of HTC (Brooks, 2015). For example, by habitat restoration or protection, the number of wild prey could increase so that tigers become less dependent on livestock. ***Reducing injuries to tigers*** helps to prevent HTC, because tigers that are injured will more likely become involved in HTC (Goodrich, 2010; Loveridge et al., 2010; Planet Doc Full Documentaries, 2016; WCS Russia, n.d.1). Also, ***fences*** and ***water channels*** are used to keep tigers away from people and livestock to prevent HTC (Barlow, Greenwood, Ahmad & Smith, 2010; Goodrich, 2010; Pettigrew et al., 2012; Treves & Karanth, 2003). Next to these, ***detecting devices*** and ***early warning systems*** can help preventing HTC to occur (Brooks, 2015). For example, with the use of infrared sensors it is possible to detect approaching predators (Shivik, 2006), allowing action to be taken before it ends up into a conflict. ***Herders*** tending livestock can actively avoid tiger habitat to prevent HTC (Goodrich, 2010). Also, ***guard animals***, like buffalo's (Goodrich, 2010) or dogs (Barlow et al., 2010) are used to protect livestock (Treves & Karanth, 2003), because they act defensively towards predators and alarm their handlers (Conover, 2001). ***Masks*** can be worn by people to deter tigers that are about to attack (Goodrich, 2010). Tigers preferably attack from behind (Schiller, Cullinane, Sawyer & Zietlow, 2007), so by humans wearing masks on the back of the head tigers see someone facing them making them less likely to attack (Sillero-Zubiri & Laurenson, 2001). Finally, the ***removal of vegetative cover*** helps prevent HTC, because tigers tend to avoid areas with a low density of vegetative cover (Goodrich, 2010).

2.3.2 Reactive measures

Reactive measures focus on the moment a HTC is about to happen or is already happening. These measures prevent actual escalation when a tiger approaches or stop an occurring conflict. ***Response teams*** can be called if someone encounters a tiger (F. Hilderink, personal communication, February 6, 2018) to respond to individual HTC situations (Brooks, 2015; Goodrich, 2015). These teams investigate if indeed a conflict involving a tiger has happened, use hazing techniques to scare a tiger away, monitor the situation after a HTC has occurred to determine whether the tiger is still in the area and take other measures, like capturing the tiger, if required. The capturing of a tiger could be needed, for example, to assess the tiger's physical condition, or, in case of recurring conflict involving the same tiger, to fit a radio collar to monitor the animal's movement (Goodrich, 2010, p. 307). Tigers that (repeatedly) attack humans or livestock can be ***translocated*** onsite, can be removed from the wild (Brooks, 2015) or can be ***lethally controlled*** (Goodrich, 2010; Treves & Naughton-Treves, 2005). Finally, ***deterrent measures***, such as sound and light signals, are used to scare tigers away (Treves & Karanth, 2003). For example, signal flares and fireworks (Goodrich, 2010) are used immediately preceding a conflict situation to deter a tiger.

2.3.3 Mitigative measures

If a HTC has happened, measures can be taken to reduce its consequences. To compensate for financial losses, ***compensation programs*** are set up (Goodrich, 2010). Financial compensation or in kind assistance can be given to *"… individuals or their families who have experienced wildlife damage to crops, livestock or property, or who have been injured, killed or physically threatened by wildlife."* (Nyhus et al., 2005, p. 108). For example, in India some jurisdictional authorities give the family of a person killed by a tiger financial compensation (Löe & Röskaft, 2004). Furthermore, ***insurance programs*** are set up so that people can insure themselves against damage caused by tigers (Goodrich, 2010). ***Incentive programs*** have been installed to provide "… *alternative sources of income, based on "conservation-friendly" practices, which often include improved livestock management practices.*" (Goodrich, 2010, pp. 304-305). An example is a Russian certification scheme for tiger friendly non-timber forest products. Based on a market-based mechanism, conservation goals and improved livelihood conditions are being pursued by certifying certain products (Svadlenak-Gomez et al., 2007).

In figure 2, an overview is given of the different HTC reduction measures that will be investigated in this research.

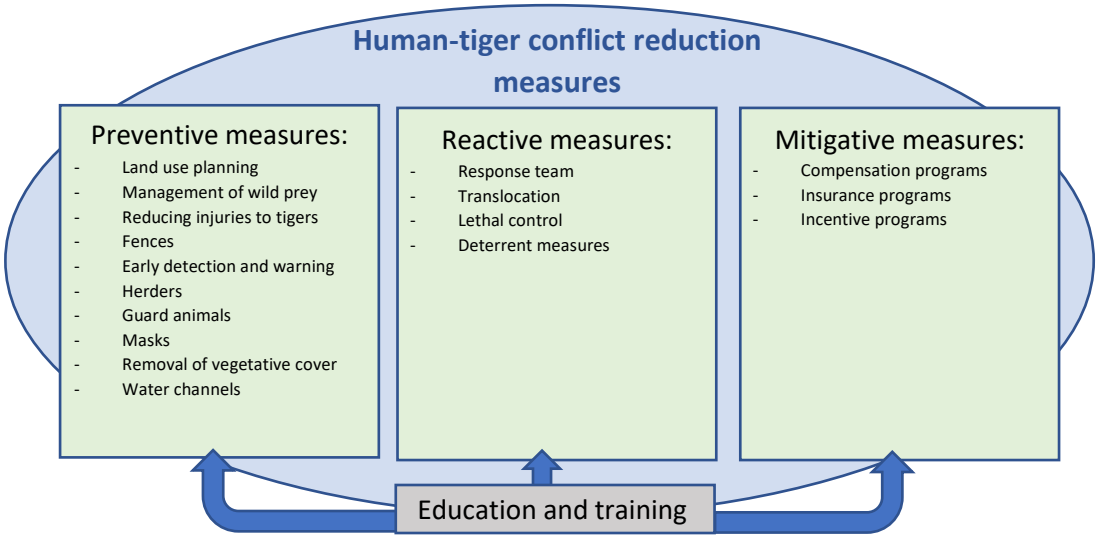

Figure 2: HTC reduction measures

2.4 Governance

To reduce HTC and successfully implement different kinds of HTC reduction measures, it is required that different actors get involved in HTC reduction (Redpath et al., 2004).

Governance is a way of governing whereby boundaries between public and private sectors have become blurred. By governance, it is not solely the government that regulates in a top-down manner. Instead, different institutions and actors form autonomous self-governing networks, whereby power dependencies between the actors exist, and regulate in a bottom-up way (Kemp, Parto & Gibson, 2005; Stoker, 1998). Besides the contributions these actors can generate on their own, they are to some extent dependent on each other.

This bottom up approach is required for sustainability issues, making governance relevant for a transition towards sustainability (Kemp, Parto & Gibson, 2005). As Adger et al note: *"… institutional diversity is necessary to tackle complex environmental issues …"* (2003, p. 1101). Further, different actors such as the state, companies and local communities are interdependent for sustainability as they are all part of the problem and can only reach a solution together (Kemp, Parto & Gibson, 2005). Zooming in at the managing of HTC, a small aspect of a transition towards sustainability (UNDP, n.d.), the involvement of different actors is still required. As Treves et al. note: *"Social scientists and the*

methods they have developed for participatory planning, measuring perceptions, and understanding socioeconomic practices are essential for the design and implementation of politically viable HWC co-management projects." (2006, p. 392). Also, Redpath et al. state: "*The successful resolution of human-wildlife conflicts requires the participation of local communities and other stakeholder groups in formulating management decisions."* (2004, p.1). For example, to foster successful regulation or spatial plans that get support from the public and of which the implementation gets accepted, different actors need to be involved in decision making (Börzel & Risse, 2010). Not only actions by different actors is needed, also actions and cooperation at different levels is required, as the following statement further emphasizes: "*The trade in tiger parts often transcends national boundaries, as do the drivers of habitat loss. International links require international action and regional cooperation.*" (Dinerstein et al., 2007, p.512). Further, actors complement each other, for example by NGOs supporting national governments (Dinerstein et al., 2007) by offering knowledge. Consequently, to reduce HTC actors should take action both themselves and in cooperation (WILDLABS.NET, n.d.2).

As this research investigates the roles of actors by which they can contribute to the success of HTC reduction measures, the three institutional domains will be further discussed individually in their relation to the management of HTC. For each actor, specific roles are given that will be used to investigate the way by which an actor can contribute to the success of a HTC reduction measure.

2.4.1 The civil society

The civil society includes, among others, local communities and NGOs (Beer, Bartley & Roberts, 2012). To start, local communities should be involved in HTC management to create support for the reduction of HTC while conserving tiger populations. HTC subverts local support for conservation goals (Tweheyo, Hill & Obua, 2005), as it causes negative and hostile attitudes towards tigers and provokes people to kill tigers (Sillero-Zubiri & Laurenson, 2001). Research to the interaction between people and tigers in the Sundarbans has shown that around a quarter of the respondents did not want to conserve tigers because the presence of these animals felt as a threat to them (Reza, Feeroz & Islam, 2002). Also, Okello notes: "… *lack of community involvement in wildlife conservation were major sources of local resentment.*" (2005, p.19). Consequently, with a good understanding of the problem and incorporation of the local community, hostility towards tigers can be reduced and support to take measures against HTC enhanced.

Second, it is essential to involve local communities and local human interests in HTC reduction strategies (Gurung et al., 2008; Goodrich, 2010, Kolipaka, 2018) because every HTC concerns people from local communities (Sillero-Zubiri & Laurenson, 2001). Without involving local communities, the problem could escalate. As Madden notes: *"If protected area authorities fail to address the needs of the local people or to work with them to address such conflict adequately, the conflict intensifies, becoming not only conflict between humans and wildlife, but also between humans about wildlife."* (2004, p. 248).

Thirdly, as indicated in paragraph 2.2, some human activities, for example the placement of snares, contribute to the emergence of HTC. Solving complex issues, such as the reduction of HTC, requires that individuals make connections between the problem and their own behaviour and practices (Pahl, Wyles & Thompson, 2017), for which involvement of the local community is needed.

Focussing on the implementation of HTC reduction measures, local communities and NGOs can fulfil several roles to contribute to HTC reduction. First, several measures to reduce HTC can or should be owned and implemented by local communities or NGOs. For example, fences can be owned individually, and NGOs can provide education and training themselves (WWF India, n.d.2). Ownership of HTC reduction measures is therefore a possible role by which the civil society can contribute to the

reduction of HTC. Beyond, local communities can offer labour, for example by being responsible for the building or maintenance of fences (Osborn & Parker, 2003). NGOs further contribute to the implementation of HTC reduction measures by offering knowledge and financial resources (Dinerstein et al., 2007). By offering these resources, NGOs mainly stimulate or assist other actors to implement measures to reduce HTC. For example, regarding land use planning "*WWF Indonesia has … provide technical input to Indonesian spatial planners."* (Bhagabati et al., 2014, p. 154). Financial resources can include for example, "*… the nongovernmental costs of supporting park management, anti-poaching efforts, monitoring, research, and habitat restoration*." (Dinerstein et al., 2007, p.510). Very often, financial assistance from NGO's is coming from Western countries while more project-based and to the field contributions comes from local offices in the countries where HTC occurs (Clarke, 2006; Miller, Agrawal & Roberts, 2013). Finally, NGOs influence on policies by agenda-setting (Gemmill & Bamidele-Izu, 2002) and advocating for regulation (WWF, n.d.1).

2.4.2 The market

The involvement of market actors is also required for a reduction in HTCs. For market actors such as farmers, the reduction of HTC is important as it can increase their yield (Thirgood, Woodroffe & Rabinowitz, 2005). Further, companies can make a profit by developing and producing HTC reduction measures. In addition to the fact that many tigers are killed because they are seen as a threat to livestock and people, tigers are killed for trade (Le Bel, Chavernac & Stansfield, 2016). Nearly every part of a tiger has a high economic value, which stimulates the (illegal) hunting and trading of tigers (Nowell, 2000). However, because the illegal trading of tigers is a very complicated problem in itself, this research leaves the trading of tiger parts out of consideration and focuses on the role that market actors can play to contribute to the success of the described HTC reduction measures.
Market actors can contribute to the successful implementation of HTC reduction measures in different ways. To start, market actors are required to manage HTC by developing and innovating technologies for HTC reduction measures such as early warning systems. For example, the mobile phone market enables people to inform each other very quickly when a tiger has been seen or when a conflict has happened (Le Bel, Chavernac & Stansfield, 2016).
In addition to developing HTC reduction measures, market actors such as businesses are needed for the production of these measures. By trying to keep prices of measures as low as possible, market actors make HTC reduction measures affordable for a large public. This is important because HTC often happens in low-income areas where people are financially dependent on their livestock (Johnson et al., 2006; Tamang & Baral, 2008; WILDLABS.NET, 2017) and the natural resources around them (Inskip et al., 2013). If more producers exist and compete, market forces ensure an efficient use of resources and prices are kept low as possible (Griffith, 2001).
Furthermore, some HTC reduction measures require on-going labour in terms of part- or full-time jobs. For example, response teams function on well-trained employees and labour is needed for the guarding of livestock and maintenance of fences (Graham & Ochieng, 2008). In exchange for labour, income can be generated making a measure operating in a market-based way.
Going beyond, market-based mechanisms can stimulate the implementation of HTC reduction measures as people are stimulated to take measures to reduce HTC if they see something in return by doing so. Farmers are more willing to protect livestock that provides some income for them, such as in the production of milk. For example, in a region where cows did not generate income for farmers while goats and buffaloes did, people were more willing to take HTC reduction measures like herding to protect their goat and buffalo's than their cows. As Kolipaka notes: "*The lack of revenue reduced people's use of preventive measures…*" (2018, p. 64).
Finally, market actors can take ownership of a measures. For example, (independent) insurance companies can be responsible for the providing of insurance.

2.4.3 The state

State actors are also required for HTC reduction. As state actors include large areas, they can *"… maintain public order and facilitate collective action*." (Stoker, 1998, p. 17) and contribute to HTC reduction on a large scale.

First, governmental actors are authorized to impose binding regulation; they are the only ones who can exercise legitimate coercive power (Stoker, 1998). Due to the rapid decline of tigers "… *high-level political will on the part of tiger-range countries and countries that permit traffic in tiger parts …*" is needed for the conservation of tigers (Dinnerstein et al., 2007, p.511). Even though the hunting and trade of tigers occurs, all countries where tigers still live in the wild have national regulation to protect tigers against the illegal hunting and trade. Furthermore, the international trade of tigers or products from tigers is prohibited by the Convention on International Trade in Endangered Species (CITES) (IFAW, n.d.). Thereby, it is shown that most state actors are willing to impose binding regulation to protect the tiger. Although governmental authorities can exercise coercive power, other actors must be involved as well. As support is required for regulation to be successful, other actors need to be involved (Kaufmann, Kraay & Mastruzzi 2011).

Secondly, state actors can contribute to HTC reduction by developing spatial plans as they are to a large extent responsible for land use planning (Nelson, 1977). By doing so, governmental authorities are essential for wide scale zoning plans and they influence the size of protected habitat for tigers, for example. By the installation of National Parks and other protected areas, state actors can also take ownership of a measure (Gurung et al., 2008), a third way in which state actors can reduce HTC while protecting the tiger.

Finally, state actors can contribute to HTC reduction measures financially (Nyhus et al., 2005). For example, by providing subsidies for compensation governmental authorities contribute to the implementation of compensation programs.

In figure 3, a summarized overview is given of the different roles that actors can perform to contribute to HTC reduction measures.

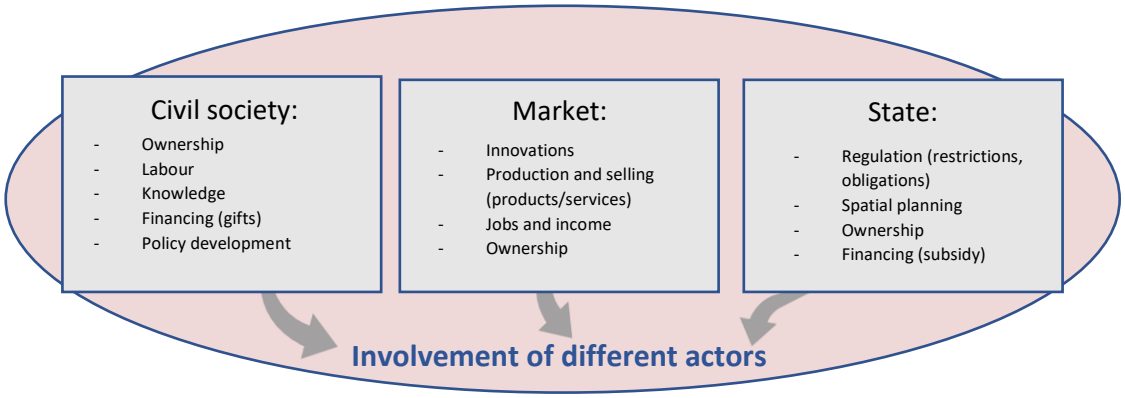

Figure 3: Roles of different actors to reduce HTC

2.5 Combining measures and actors

For the successful implementation of the different measures described in paragraph 2.3, the involvement of all different actors described in paragraph 2.4, is required. For example, the preventive measure land use planning requires regulation and planning by state and support and possible movements of local inhabitants that are part of the civil society. Early detection and warning systems, another preventive measure, require production and developments by market actors, that can be (financially) supported by NGOs, while the devices are often owned by local villagers. The reactive measure lethal control should be allowed and possibly executed by state actors and

accepted by the civil society. Also, mitigative measures require the involvement of different actors; insurance programs function in a market-based way by insurance companies but can be (partially) governmental.
Some of the described roles of actors may seem overlapping, for example the ownership of a HTC reduction measure. However, different actors are suitable for, in this case ownership of different measures. For example, masks are often owned individually while response teams are operating and 'owned' on a larger scale.
In figure 4, a combination of the elaborated components that this research focuses on is given.

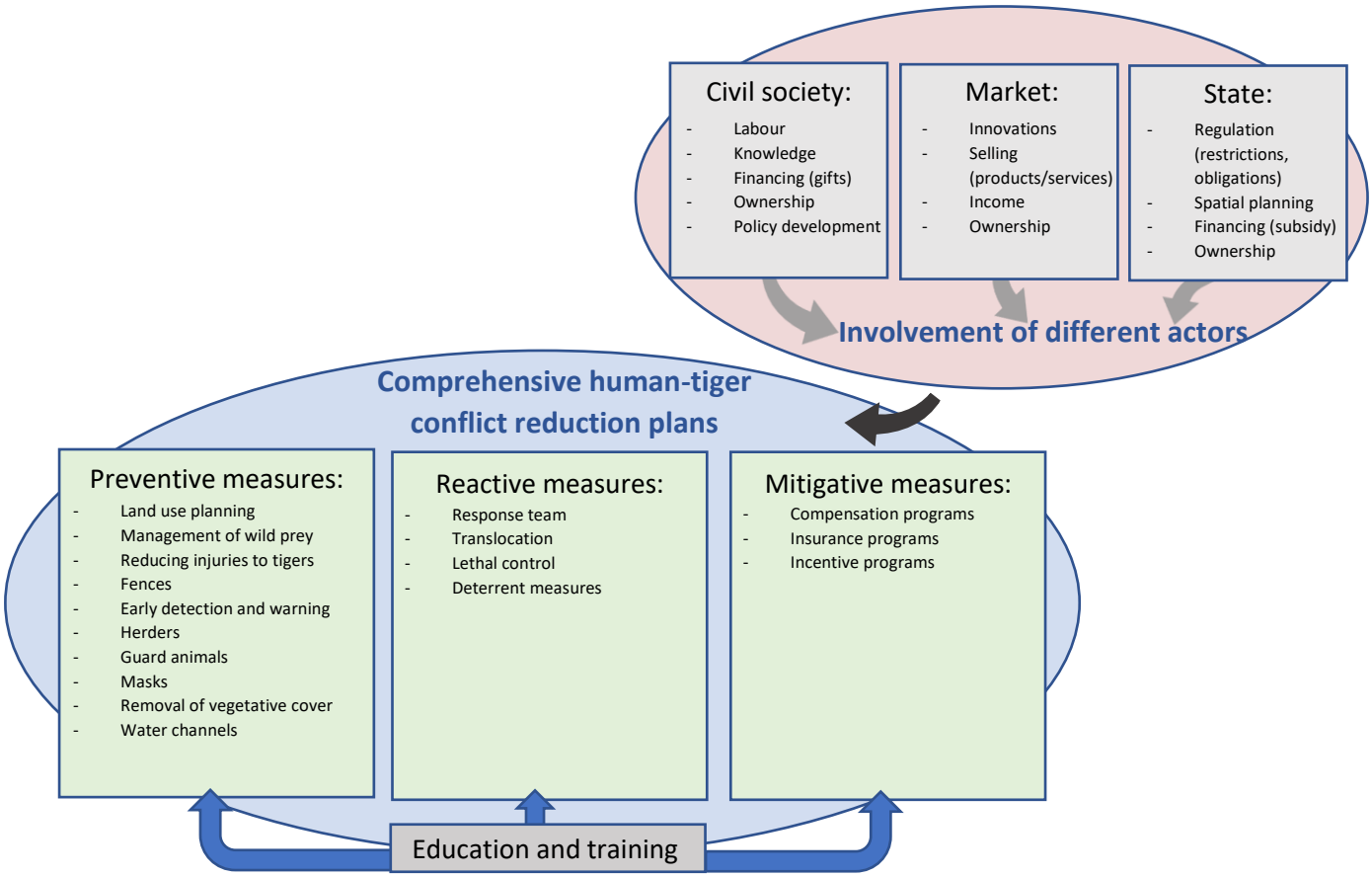

Figure 4: Comprehensive HTC reduction plans

2.6 Assessment criteria HTC reduction measures

In order to make an overview of the pros, cons and (local) preconditions of individual measures, several assessment criteria are used. For each measure, three types of assessment criteria are used which will be successively explained in more detail: for each measure some basic aspects are given, the roles of actors involved are discussed and three success criteria are evaluated.
To get a general understanding of each measure it is required to show a number of basic aspects. This includes among others the scale on which a measure operates, the costs that must be incurred and the workload that a measure requires (see paragraph 3.4 for an operationalisation of these different aspects). By evaluating this more practical aspects, the requirements of each measure can be better identified.
Due to the fact that governance and specific roles of the different actors are not required for each individual measure to be successful, it is not appropriate to design indicators for this that can be used to investigate the effectiveness of individual HTC reduction measures. However, as already noted, governance is required to effectively reduce HTC at large. Consequently, to investigate the required

activities for each measure and to be able to make a general conclusion about HTC reduction that takes the required larger aspects in consideration, the roles of different actors are shown for each measure focussing on the described roles in paragraph 2.4
The success criteria are operationalized in different aspects and focus on the way each measure relates to aspects of *human and livestock safety, conservation goals* and *local conditions*. To be able to assess these different variables, several indicators are given.

First, measures against HTC aim to increase human and livestock safety. Therefore, it can be investigated whether a measure reduces the number of humans or livestock killed or attacked by tigers (Barlow et al., 2010). Attention must be given to the fact that some HTC reduction measures possibly displace the problem. Although these measures increase the safety of some people or livestock, they do not lead to an absolute reduction of HTC.
HTC also leads to financial losses. Therefore, the 'safety' or well-being of people increases when the impact of HTC is reduced, for example, by compensating for financial losses (Goodrich, 2010; Nyhus et al., 2005).

Secondly, the impact of different measures on conservation goals needs to be considered as well. The number and variety of plants and animals are an indicator for a biodiverse environment (Lindenmayer, Margules & Botkin, 2000). Tigers need a species-rich habitat and, as a top predator species, contribute to maintaining this (Banikoi et al., 2017; Sergio, Newton, Marchesi & Pedrini, 2006; WNF, n.d.1). Therefore, an indicator is included suggesting whether a measure reduces, helps to maintain or increases the number of tigers or other animal species (Lindenmayer, Margules & Botkin, 2000). Some measures influence the vegetation of an area, so the impact on plants is investigated as well. Does a measure reduce, maintain of increases the amount and diversity of vegetation?
Due to the fact that many tigers are killed in retaliation, the influence a measure has on human-tiger relations can be used as indicator. If a measure improves human-tiger relations, the chance of retaliation killing reduces whereby the measure contributes to tiger conservation (Karanth & Gopal, 2005; Nyhus et al., 2005). Due to difficulties with measuring human-tiger relations, focus is placed on possible improvement or deterioration of human-tiger relations. Besides the real threats that tigers can cause, the perceived risk also provokes retaliatory behaviour towards tigers (Inskip, Fahad, Tully, Roberts & MacMillan, 2014; Nyhus & Tilson, 2004). Therefore, a reduction in the fear and perceived risks of tigers are positive for the conservation of tigers (Inskip et al., 2013) and will be used as an indicator as well.

Finally, the extent to which a measure fits the local conditions will be investigated. This also partially reflects some of the governance aspects as this success factor is more about the social context and actors that are, or can be, involved. As this category already indicates, it is very local dependent. It is not feasible to include all aspects concerning local contexts in the habitat of tigers in this research, as these can vary wildly. Therefore, some important aspects for the success of HTC reduction measures have been chosen to focus on within the following categories; the required resources, socio-political, cultural and physical environment.
For some measures, a certain amount of knowledge, money, and/or other resources are required. If local inhabitants don't have these resources, a measure can't be implemented (Woodroffe et al., 2007). Therefore, it is investigated what kind and amount of resources are required for each measure.
To implement a measure the required activities should be allowed by state (Goodrich, 2010). So, for each measure possible legal requirements will be given to investigate whether a measure fits with the existing legal framework. Also, HTC reduction measures should be in line with local daily

practices. For example, herding of livestock is only appropriate in areas where livestock is grazing freely. Further, it is important that measures and actions taken to reduce HTC fit with local beliefs, values and norms (Dickman, 2010; Kolipaka, 2018). Without acknowledging and reconciling the several points of view, beliefs, demands and obligations of the ones involved, it could be difficult or even impossible to implement a measure (Adger et al., 2003; Lynam, Jong, Sheil, Kusumanto & Evans, 2007). For example, if religious beliefs are against the killing of animals, the preventive measure lethal control won't be an appropriate measure in that area. Further, it is investigated whether a measure fits with the natural environment. For example, electric fences require a bare (made) area and are not appropriate in areas with heavy snow due to electrical leakage (Palmer, Payne, Wingard & George, 1985).

The different variables are schematically shown in table 1. For each variable, different indicators are given. Due to the fact that the appropriateness of the different HTC reduction measures is very context dependent, the indicators are chosen in such a way that room is left for contextual differences in application.

Variable	**Indicator**
Existing HTC reduction measures	- Preventive measures - Reactive measures - Mitigating measures
Success factors HTC reduction measures	
Human and livestock safety	- The measure reduces the number of people injured and/or killed by tigers - The measure reduces the number of livestock injured and/or killed by tigers - The measure reduces the financial impacts of HTC
Conservation goals	- The measure causes no damage to existing animal populations - The measure causes no damage to existing plant populations - The measure has a positive effect on human perceptions and attitudes towards tigers - The measure reduces the perceived threats of tigers
Local conditions	- Inhabitants are able to make use of the measure; knowledge and other necessary resources are available - The measure fits within the existing legal framework - The measure fits within local belief systems and norms - The measure is in line with local daily practices - The measure fits with local climatic and vegetative conditions

Table 1: Operationalization successfulness measures to reduce HTC

In addition to an evaluation of the successfulness of individual HTC reduction measures, a broader analysis examines how HTCs can be reduced in a general sense in chapter 5. By combining the elements of a comprehensive HTC reduction plan (shown in figure 1) and the successfulness of individual measures it is possible to draw an overarching conclusion about the extent to which different measures are able to reduce HTC in general.

3. Methodology

In this chapter, the used method will be illustrated. First the research approach is going to be described. Then, the study area will be illustrated. Finally, the data collection and data analysis will be discussed in depth.

3.1 Research approach

This research aims to investigate the effectiveness of different HTC reduction measures, taking into account their contextual dependencies. Since people see and value tigers in various ways and the efficiency of a HTC reduction measure depends on local beliefs and circumstances, it is not assumed that there is one single reality; different realities exist and are being interpreted locally. For example, tigers are not seen as something good, bad, dangerous or something else per se. In some areas, tigers are seen as a threat to local inhabitants while in other areas they are highly appreciated. Furthermore, some measures are highly appropriate to reduce HTC in some areas but are regarded as meaningless in other areas because they do not fit with local beliefs, for example. From an ontological point of view, this fits with a constructivist view (Creswell, 2014; Guba & Lincoln, 1994; Young & Collin, 2004).

As it is assumed that reality is socially constructed, 'reality' can be found by talking with different people. Therefore, this research made use of data triangulation by a combination of literature review and in-depth interviews. Questions for the interviews were not thought out beforehand but were more precisely formulated based on answers given during the interview. This means that there was an important interaction between the interviewee and the researcher as findings were partly the result of this interaction by formulating questions based on the answers the interviewee provided, fitting with a transactional and subjectivist epistemological point of view. Although it is impossible to disregard own beliefs and values completely, objectivity and internal reliability were pursued by avoiding subjective questions (Madill, Jordan & Shirley, 2000) as: "*What do you think about… ?*" and focussing on fact issues such as: *"Which actors are involved with …?"*.

Furthermore, only a limited selection of people was interviewed, who were all working for nature conservation organisations (see paragraph 3.3.2). Since HTC and its reduction is very local dependent, this does not generate a perfect representation of the actors involved, decreasing the external validity. Therefore, replication of this research could possibly lead to a different focus on some subjects. Due to the fact that this research emphasises the conditions that make a HTC reduction measure effective in some cases and does not aim for a generalised conclusion about the effectiveness of HTC reduction measure everywhere, this is not considered problematic.

3.2 Study area

HTCs occur in almost all areas where both human and tigers are present (Nyhus & Tilson, 2010). Therefore, this research focuses on the entire area where tigers live in the wild. As already noted and shown in figure 5, the habitat of tigers is highly reduced; it is estimated that the area where tigers still live is only around 7% of its original habitat (Sanderson et al., 2010; WNF, n.d.2). Currently, as table 2 shows, tigers still live in the wild in 13 countries: India, Russia, Indonesia, Malaysia, Nepal, Thailand, Bangladesh, Bhutan, China, Vietnam, Laos, Cambodia and Myanmar (WWF, 2016), although it is not totally sure whether tigers are still present in the last four countries.

In all these countries HTC occurs, although the total amount of conflicts highly differs between different areas. This has among other things, to do with cultural differences between countries, tiger and population densities and the availability of suitable tiger habitats. HTC happens more often in areas where human settlements and villages are surrounded by tiger habitat, while the change of HTC is lower in heavily used areas (Distefano, 2005). As Johnson et al., note: *"Tiger abundance was significantly lower where human population and disturbance were greater."* (2006, p. 421).

Consequently, it was chosen that this research focuses on the rural areas mainly, as these are the places where HTC mostly occur.

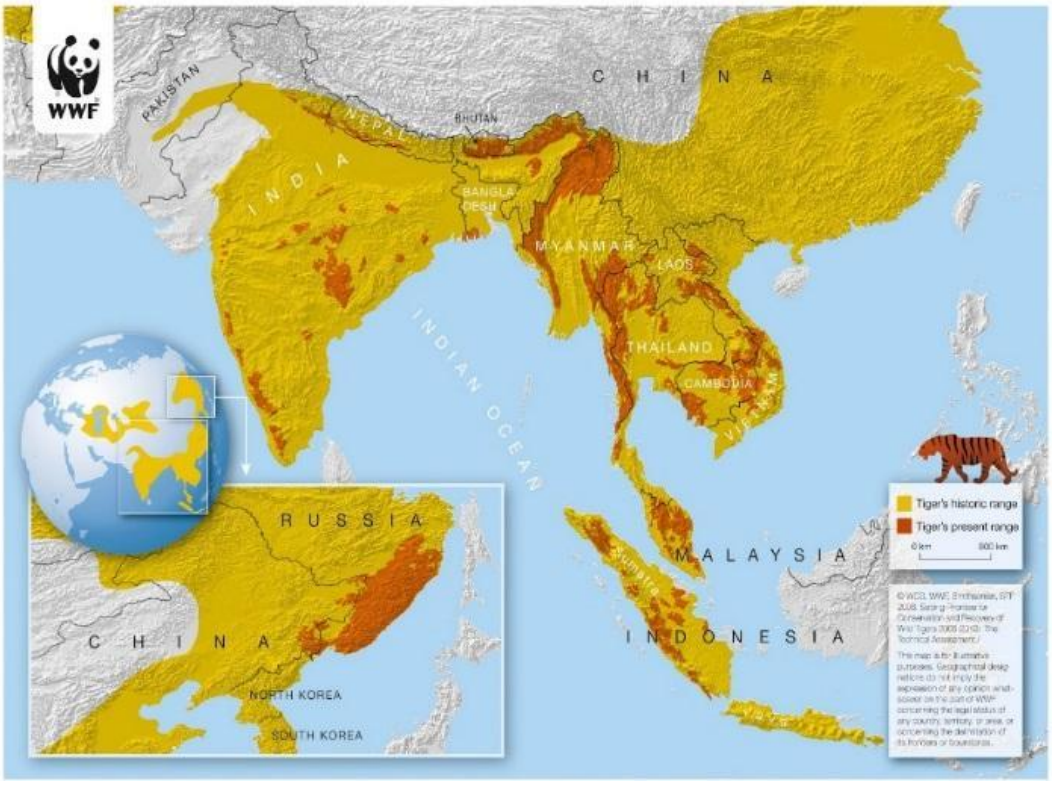

Figure 5: Living area of tigers (source: WILDLABS.NET, 2017)

Country	Number of tigers
India	2226
Russia	433
Indonesia	371
Malaysia	250
Nepal	198
Thailand	189
Bangladesh	106
Bhutan	103
China	>7
Vietnam	<5
Laos	2
Cambodia	0
Myanmar	No recent data
Total	*3890*

Table 2: Number of tigers per country (WWF, 2016)

3.3 Data collection

Two ways of data collection were used; extensive literature review was done and interviews were conducted. To collect information about the different existing HTC reduction measures, literature review was done. To get more information about these different measures, a combination of literature review and in-depth interviews were used. With literature review, general information about different HTC reduction measures and their effectivity was be obtained. By interviewing people, this data was complemented by, and compared to local and practise based empirical data. By

this data triangulation, both the reliability and internal validity were increased (Golafshani, 2003; Hussein, 2015; Meijer, Verloop & Beijaard, 2002).
The different forms of data collection will now be further discussed separately.

3.3.1 Literature review

An important part of this research was based on a literature review. Thereby, different existing measures to reduce HTC were investigated.

In order to get a better understanding and broad overview of HWC, and specifically HTC, firstly literature was sought about the causes of these conflicts. Furthermore, general literature was sought about ways to deal with these conflicts. Therefore, searching terms as '*causes of HWC/HTC', 'Human-wildlife conflict management', 'perceptions HWC/HTC'* and *'social aspects wildlife conflicts'* were used.

To answer the first sub question, a literature review was conducted to investigate which HTC reduction measures exist. With sources such as Google Scholar, searching terms as '*human tiger conflict', 'human tiger conflict reduction measures', 'strategies against human-tiger conflict', 'preventing human-tiger conflict'* and '*mitigating human-tiger conflict'* were used. To possibly find additional literature, also searching terms as '*human-wildlife conflict reduction measures'* were included, whereby possible links with HTC reduction measures were made. Additional literature and reports from WWF were also used. WWF has a lot of studies and data available that have something to do with HTC. Even though not all of this information is published, it provided useful information for this research. An example is the report '*Human Tiger Conflict: A SAFE Strategy for the tiger range'.* Based on a combination of these results, a list of different existing measures was made. To create a schematic overview, the measures were categorised in different subgroups, depending on the aspect the measure focus on. A distinction was made between preventive, mitigating and reactive measures.

To increase the objectivity and reliability of this research, the 'successfulness' of different aspects of HTC reduction measures was operationalized in different variables and indicators (Raffelsberger, Dembélé, Neubauer, Gottardis & Gronemeyer, 2002; Sekaran & Bougie, 2016), as already shown in the theoretical framework. The different indicators are represented in the sub questions. So, subsequently, the found HTC reduction measures were further investigated individually to answer the following sub questions.

To answer the second sub question, which is about human and livestock safety, searching terms as '*effectiveness *measure* against HTC', 'protect human/livestock from tigers',* '*diminishing the amount of HTC'* and *'*measure* reduces number of human deaths/livestock losses'* were used. Thereby, it was researched whether, and possibly to what extent, each measure helps to decrease the number of people and livestock attacked by tigers.

To answer the third sub question, which is about the influence different measures have on conservation goals, an analysis was made of the possible impact of each measure on tiger and other animal or plant populations. As a result of implementing a measure, are animals killed or disturbed? Should plants be removed? Could diseases be introduced or spread more easily, for example, by using guard animals? Therefore, searching terms as *'impact of *measure* on (tiger) conservation/plant populations/animal populations'* were used.

The fourth sub question, which is about the extent to which measures fits within the local context, was answered by looking at the areas where HTC occurs and the requirements that are needed to implement a measure. Does a measure fit with the existing legal framework or are modifications

necessary? Should residents have specific knowledge to make use of a measure? What costs should be made and by who? These, and other aspects were examined to determine whether different measures fit within the local context and to understand general conditions that contribute to an effective implementation. To get insights in this, searching terms such as *'legal requirements for implementing *measure*', 'local beliefs towards tiger conservation', 'costs/required maintenance for *measure*'* were used. Due to the fact that aspects such as beliefs and values are extremely local dependent, it was decided that it is beyond the scope of this research to include all different local beliefs and value. However, to ensure alignment with local beliefs these aspects need to be considered before any measure is implemented anywhere.

The fifth sub question was answered by investigating the roles that different actors can perform to contribute to the success of HTC reduction measures. For this, it was first investigated which actions are required to implement a measure, and by whom. Beyond, possible contributions were taken into account as much as possible. Via Google Scholar, searching terms as *'ownership *measure*', 'actors involved *measure*', 'role of local communities for *measure*'* were used. In addition, secondary literature was sought on websites of governments and NGO's. On NGO websites such as the ones of WWF, the role of NGO's in the implementation of different HTC reduction measures was investigated. For example, the searching term *'HTC'* was used at the website of WWF India to look deeper into the strategy of WWF against HTC and their role in this.

3.3.2 Interviews

In addition to literature study, interviews were conducted to further discuss and complement the different aspects that were found in the literature review. The interviews were mainly used to fill knowledge gaps from the literature review, as focus was placed on the aspects that were not found in literature. Therefore, only a part of each interview was on forehand thought out in topic points (see appendix 2) and much space was left for the interviewee to answer and appoint the things he/she had knowledge about and/or experience with, and for the interviewer to deepen the aspects that were missing. This made the interview process flexible and the interviews semi-structured (Bryman, 2015).

For the interviews, different kind of experts were questioned. In order to get a general overview, which is in the aim of this research, the interviews were conducted with experts from different countries. Due to long geographical distances between interviewer and interviewees, the interviews were conducted online, mainly through Skype. However, thereby only respondents with access to working internet, a computer or phone to use and a good understanding of the English language could be questioned. This made it, within the possibilities of this research, not possible to interview local inhabitants. It is very difficult to get in contact with them without going there, they do not always have access to internet and also language barriers could impede the possibility to interview local inhabitants. By interviewing other experts, such as WWF staff and tiger scientists, a good understanding was gained of the local circumstances. However, account must be taken of the fact that they possibly not exactly know the local conditions and cultural aspects of a specific area. Besides, it is important to take in mind that, for example, WWF staff possibly value tigers and other conservation related aspects different than local inhabitants. So, by investigating the local context 'through' people who not necessarily originate from, or live in, the investigated area where HTC occurs, the validity of this research was diminished (Golafshani, 2003). Further, no people working for governmental organisations were interviewed. Experiences with WNF showed that this regularly takes a lot of time and their involvement with HTC reduction is not always evident. Due to time limitations and the focus of this research on HTC reduction measures, it was decided to interview only experts that are undoubtedly involved with HTC reduction. Finally, it is hard to come in touch

with local market actors and, although they produce HTC reduction measures, they are not necessarily involved in HTC reduction. However, meetings with two developers of early detection and warning systems were included in this research; other market actors were not interviewed for this research.

In table 3 an anonymous overview of the expertise of each interviewee is given.

Respondent	**Function**
Respondent 1	Communities expert, WWF Myanmar
Respondent 2	Tiger expert, WWF Russia
Respondent 3	Project coordinator of the tiger conservation programme, IUCN/KfW France
Respondent 4	Conservation director, WWF Bhutan
Respondent 5	Scientist, with experience in human-tiger interactions in India
Respondent 6	Landscape coordinator, WWF India
Respondent 7	Programme manager, WWF India

Table 3: Description of the respondents

3.4 Data analysis

To evaluate the successfulness of different HTC reduction measures, the measures described in paragraph 2.3 will be subsequently discussed. As already pointed out, three assessment criteria were evaluated for each measure: some basic aspects will be shown, the roles of actors involved will be discussed and the three success criteria, that focus on human and livestock safety, conservation goals and local conditions will be evaluated.

The evaluation starts with a general introduction of the measure, followed by the way in which the measure contributes to human and livestock safety. Afterwards, the way in which a measure relates to conservation goals will be discussed. Then the costs that have to be made and the actors involved will be discussed. Hereafter, the required workload and possibly other relevant conditions that don't fit within one of the other categories will be discussed. Due to the fact that local conditions can vary greatly, and it was not possible to include all possible circumstances in this research, the criteria for local conditions were reflected in some basic aspects. For example, the actors involved can be found under 'actors', the required monetary resources under 'costs' and local belief requirements under 'other conditions'. By doing so, it is possible for NGO's, policy makers and other actors that are involved in HTC reduction to evaluate themselves whether a measure meets their local conditions or not.

For each measure a schematic overview of the scale, costs, actors, required workload and other conditions is provided, which are operationalised as follow:

Scale: The scale is about the geographical scope for which a measure offers some form of protection. This is divided into *small* (individual level/individual fields), *medium* (a village/several fields) and *large* (several villages/ fields on a landscape level).

Costs: The costs are divided in both setup and maintenance costs. The costs are all converted to US Dollar and vary between *low* ($0-$1000), *medium* ($1.000-$30.000) and *high* ($30.000+).

Actors: This category is about the different roles actors can or have to play in order to implement a measure. Which actor is/can be responsible for the implementation? Which actor(s) are assigned to maintain a measure and take responsibility for this? A distinction is made between the actors *state*, *market* and *civil society* (*community* and *NGOs).*

Workload: The required workload of different measures differs in intensity for both instalment and maintenance. The financial costs for this are already included in the section on 'costs', so this factor is mainly about man-hours. Workload can vary between *low* (monthly till none), *moderate* (weekly till monthly) and *intense* (daily till weekly).

Other conditions: In addition to the already discussed aspects, there are sometimes other conditions that are relevant for the success of a measure. Aspects that don't fit under the previously defined categories can be discussed here, such as the requirement of dedicated people for response teams or an area with free livestock grazing for herders.

Finally, for each measure, the main advantages and disadvantages are schematically shown. Focus was placed on the three assessment criteria; some basis aspects such as the costs and required workload, the roles of actors involved and the three success criteria, divided into the impact a measure has on the safety of people and livestock, the influence a measure has on conservation goals and the local conditions that a measure requires.

4. Results

In this chapter, the different measures, described in paragraph 2.3, will be consecutively discussed in depth. First, education and training will be discussed, followed by the different preventive, reactive and mitigative measures.

4.1 Education and training

A measure that focusses on the social side of HTC is education. With education, knowledge about for example tiger biology, the importance of tiger conservation and reducing injuries to tigers (Barlow et al., 2010; Respondent 4, personal communication, June 14, 2018), the moment when predation is more likely to occur (Karlsson & Johansson, 2010), different HTC reduction measures and how to react when encountering a tiger (Conrad, 1992; Goodrich, 2010) can be enhanced (see table 4). This reduces HTC (Karlsson & Johansson, 2010; Miller, Linnell, Athreya & Sen, 2017), as a good problem understanding, a link with people's own behaviour and knowledge about possible actions people can take all reduce the chance of HTC and make people able to adequately react to a conflict (Pahl, Wyles & Thompson, 2017). Especially by educating children, this measure is effective in the long run (Respondent 3, personal communication, June 11, 2018).

People's perception of tigers and the degree of already present knowledge determines the extent to which education is relevant. Educational activities and consultations with local inhabitants are mainly relevant in areas where people see tigers as a threat and knowledge about tiger conservation and HTC is low (Kolipaka, 2018; Respondent 1, personal communication, May 31, 2018). To align the content of the education with local beliefs, cultural aspects need to be taken into account (Respondent 3, personal communication, June 11, 2018). By investigating the prevalent knowledge level and local culture, the education can respond to that subjects knowledge about is lacking, or to the things that are of great value to local inhabitants.

Different ways of education can be used; education campaigns, radio programs, television programs, school programs, street drama, camps, religious leaders and famous artists can all be used to spread knowledge (Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018; Respondent 5, personal communication, June 18, 2018; Treves & Karanth, 2003).

Topics education can focus on to reduce HTC
• Importance of tiger conservation
• Reducing injuries to tigers
• How to react when encountering a tiger
• The existence and use of different HTC reduction measures

Table 4: Topics education can focus on to reduce HTC

Human and livestock safety:

The behaviour of people when encountering a tiger can determine whether it will end in an attack or not (Löe& Röskaft, 2004). Goodrich notes: *"Human behavior during an encounter with a tiger can prevent attack, so teaching people about how to respond when confronted with tigers is important"* (2010, p. 307). As figure 6 shows, most attacks on people are provoked. Therefore, education and training about how to behave when encountering a tiger reduces the chance of a tiger attacking a human (Goodrich, 2010; Löe & Röskaft, 2004; Treves & Karanth, 2003). For example, tigers prefer to attack from behind so facing a tiger can reduce the chance of attack.

Going beyond, with education and training knowledge can be spread about other HTC reduction measures, which can further increase human and livestock safety. For example, if farmers have more knowledge about good management practices, they can protect their livestock better.

It is very hard to investigate the absolute effectiveness of education. For example, to what extent has

the provided information led to an actual change in mind and behaviour? (Respondent 3, personal communication, June 11, 2018). Is the (change in) behaviour possibly related to other factors than the education? Despite some difficulties with determining the exact effectiveness of education, it is still regarded as one of the most effective measures to safe human lives; according to Barlow et al., more human lives can be saved by educating people than by, for example, translocating tigers, fencing or the wearing of masks (Barlow et al., 2010).

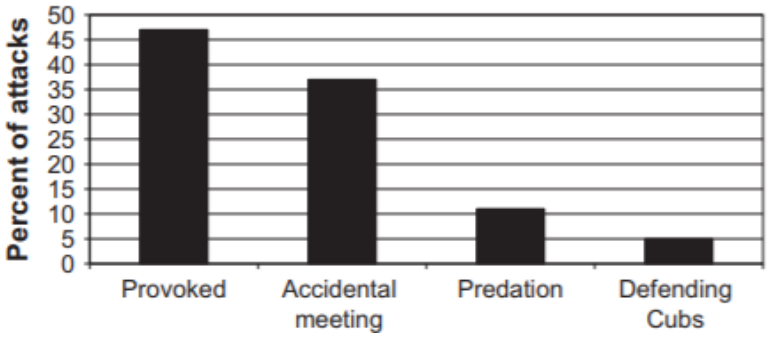

Figure 6: Causes of tiger attacks on people in the Russian Far East between January 2000 and February 2009 (Goodrich et al., 2011, p. 587)

Conservation of tigers and other animal and plant species:

Education offers important possibilities for conservation. As respondent 3 notes: "*So, this is also a way to do awareness and also a way to reach illiterate people and make conservation popular.*" (personal communication, June 11, 2018). Tigers that are, sometimes not on purpose, injured by people are more likely to get involved in HTC. To reduce these (unintended) injuries, for example caused by snares, education is important (Goodrich, 2010; Respondent 4, personal communication, June 14, 2018). With education the attitude of people towards tigers can be ameliorated and the perceived risks of HTC can be reduced (Gore & Knuth, 2009). Thereby, the amount of retaliatory killing on tigers can be reduced (Barlow et al., 2010). Further, as Goodrich note: *"… people should be taught about laws regarding tiger conservation."* (2010, p. 307). Then, their support for conserving tigers will be further enhanced.

Education can also be positive for other animal species. For example, conflicts with leopards happen often in India, Nepal and Bhutan (Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018). More knowledge about animal conservation and conflicts with these animals could also contribute to the reduction of other HWC. Consequently, with education and training tigers as well as other animal species can be protected, and also plant populations and habitat can be saved.

Costs:

Due to the different forms education can take, it is hard to give a specific cost indication. According to Barlow et al., the costs for reducing HTC by educating forest users and local inhabitants in the Sundarbans will be around $46.000 a year. Although setting up education programs can be quite expensive, education does not have to be an expensive measure (Kolipaka, 2018) as, for example, information about tiger conservation can be integrated in songs or street drama (Respondent 4, personal communication, June 14, 2018).

Actors:

The actors involved in education mainly depend on the media that is chosen. For radio or television programs, support from the media industry is required. For educational programs at schools, both governmental actors and NGOs can play a role (Respondent 4, personal communication, June 14, 2018). Governmental actors are able to include several subjects in educational programs. NGOs can, besides providing education themselves (WWF India, n.d.1; Respondent 2, personal communication,

June 4, 2018; WWF Russia, 2017) assist or offer financial recourses for other forms of education (Respondent 6, personal communication, June 29, 2018). For example, in Russia, both the hunting department and WWF are occupied with education at schools (Respondent 2, personal communication, June 4, 2018). Local inhabitants play a role through the subject they choose for street drama, for example. Finally, religious leaders can play a role by spreading certain messages among local people, for example, by emphasizing that spirits disapprove the disruption of wildlife (Respondent 5, personal communication, June 18, 2018).

Workload:

The required workload for education depends, as is the case for the costs and actors involved, on the way in which the education is provided. For example, if information is spread by religious leaders or if related subjects are integrated in local street drama, the additional time that is required is relatively minimal. Religious leaders can incorporate HTC related items in their messages (Respondent 5, personal communication, June 18, 2018) and local street artist have to find other subjects otherwise. However, to implement education about HTC in school programs, much more work is required; an education program must be designed and adopted by schools, and teachers or other people such as volunteers, who are willing to provide these education by themselves, must be trained and free up time for providing the education. As knowledge is forgotten relatively easily, education is in all cases a measure that needs to be provided repeatedly (Hoekstra, 2005). Therefore, the required workload varies from moderate to high.

Measure	Scale	Costs	Actors	Workload	Other conditions
Education and training	Medium-Large	Low-High	- State: incorporating subjects leading to a reduction in HTC in education - Market: incorporating subjects leading to a reduction in HTC in, for example, radio and television programs - Civil society: incorporating subjects leading to a reduction in HTC in, for example, street drama or messages by religious leaders NGOs: providing education about subjects leading to a reduction in HTC, providing financial resources for other forms of education	Moderate-Intense	- Requires dedicated people - Knowledge about tiger conservation, HTC reduction measures or other ways to reduce HTC should be limited among local inhabitants

Table 5: Characteristics of education and training

Measure	Advantages	Disadvantages
Education and training	• Enhances general knowledge about tiger conservation • Long-term strategy for reducing HTC • Content and way of education can be chosen locally, fitting with the circumstances	• Hard to measure the direct effect on HTC reduction

Table 6: Identified advantages and disadvantages of education and training

4.2 Preventive measures

4.2.1 Land use planning

"Land use planning (LUP) is an iterative process between stakeholders aiming at the negotiation and decision for a sustainable land use as well as initiating and monitoring its implementation." (Baruah, Bandyopadhyay & Reza, 2014, p. 292). Land use planning can take different forms and is aimed at minimizing the overlap of resource-use and change of encounters with tigers (Goodrisch, 2010;). By

zoning, people and livestock can be separated from tiger habitats and breeding areas (Goodrich, 2010; Respondent 5, personal communication, June 18, 2018). This can be done by the installation of protected areas like ***National Parks,*** surrounded by buffer zones where land use is to some extent restricted (Mwalyosi, 1991; Shafer, 1999) (see textbox 1). Veeramani, Jayson and Easa advise to separate people from tiger habitat, by ***resettling*** villagers from inside forest areas (1996).
Different forms of land use planning are closely related and can easily overlap, and are therefore not discussed separately. For example, zoning can lead to the resettling of people and the instalment of National Parks.

Human and livestock safety:
An important reason for HTC to occur is the competition between human and tigers for space (Inskip & Zimmermann, 2009). As figure 7 shows, people in a close distance from the forest are more often attacked by tigers. By land use planning, the geographical overlap of human and livestock and tigers can be reduced. If properly designed and executed, land use planning generates benefits for both people and wildlife. By reducing the chance of encounters between tigers and human or livestock, the safety of both human and livestock is enhanced and the amount of HTC reduced (Karanth & Gopal, 2005; Linnell et al., 2005; Löe & Röskaft, 2004; Respondent 5, personal communication, June 18, 2018; Respondent 7, personal communication, June 29, 2018; Songhurst, McCulloch & Coulson, 2016). For example, voluntary resettlement, an extreme form of zoning, "*… has been employed over 30 years in India to move human settlements out of lion and tiger habitat, leading to a substantial reduction in conflict …*" (Treves & Karanth, 2003, p. 1496). Furthermore, the relocation of people should be completely voluntary and preferably benefit the people, for example, through better access to socioeconomic opportunities (Madhusudan, 2003; Treves & Karanth, 2003).
HWCs, including HTCs, occur mostly at the edges of protected areas. However, measures like zoning and relocation do not deal with HTC occurring at the edges of protected areas (Karanth & Gopal, 2005). By proper decision making and implementation it should be prevented that the problem is just relocated by, for example, zoning (Treves & Karanth, 2003).

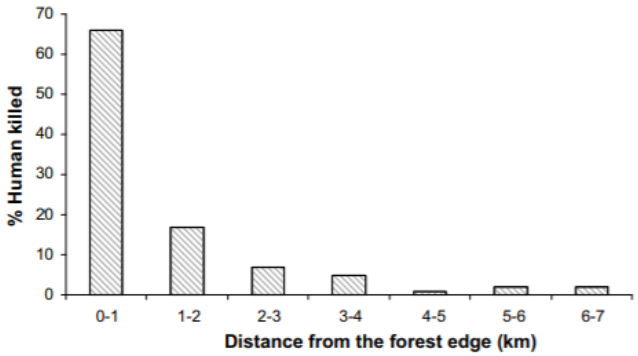

Figure 7: Percentage of humans killed in relation to forest edge in and adjacent to Chitwan National Park, 1979–2006. (Gurung et al., 2008, p.3073)

Conservation of tigers and other animal and plant species:
Land use planning is a critical tool for reducing habitat fragmentation due to humans occupying wildlife habitat in a scattered way, making it a critical measure for the recovery of tiger and other wildlife populations that face habitat fragmentation as one of their biggest threats (Karanth & Gopal, 2005; Meijaard et al., 2005). It contributes in keeping areas free from human development and secures space for wildlife, plants and other ecological functions. Thereby land use planning contributes to conservational outcomes. For example, after voluntary resettlement carnivore populations have started to increase (Treves & Karanth, 2003). Further, National Parks offer protection to tiger habitat and important tiger corridors and contribute to anti-poaching activities

(Respondent 3, personal communication, June 11, 2018; Respondent 5, personal communication, June 18, 2018).

Costs:

Land-use planning can be extremely costly to implement (Nelson, Bidwell and Sillero-Zubiri , 2003). For example, the costs for relocating whole villages do easily exceed $10.000,-. The instalment of National Parks is also expensive. Besides the costs for instalment, ongoing management costs have to be made. However, by doing so people, livestock and wildlife are protected in the long-run. Thereby, land use planning might be less expensive than it seems at first. Depending on the scale for which plans are being designed, costs can vary highly. However, by increasing the scale of land use plans, and thereby probably the costs, a more landscape wide strategy can be achieved. This enhances the social and ecological benefits, for example, because including a larger area can prevent the displacement of HTC. If long-term social and economic costs of dealing with HTC are taken in mind, land use planning is a relative cost-effective way to reduce HTC (Karanth & Gopal, 2005).

Actors:

Successful land use planning requires the involvement of many different actors (Respondent 1, personal communication, May 31, 2018). State actors like the government have, among others, the capabilities to declare specific areas as protected (Athreya, Odden, Linnell, Krishnaswamy & Karanth, 2013; WWF, n.d.4), take ownership of these areas (Respondent 5, personal communication, June 18, 2018), prohibit machine access to certain areas and impose restrictions on harvesting (Meijaard et al., 2005). In order to make these regulations successful, proper implementation is required. For example, factors such as collaboration, leadership and the organizational culture can prevent National Parks from becoming a paper park; areas that are by legislation *"… assigned for protection but receive little or no resources for implementation*" (Figueiredo, 2007, p. ii). Furthermore, support for the regulations is required. For example, support from local inhabitants is needed to prevent illegal hunting in protected areas (Respondent 3, personal communication, June 11, 2018).
Market actors are affected by regulations and must be involved in land use planning to consider and integrate their interests. Furthermore, market actors, such as the harvesting industry, are an important land user themselves (Houghton, 1999) that benefit from healthy ecosystems. By considering long-term goals and taking effects of different activities in mind, proper land-use planning could generate long-term benefits (Gardingen et al., 2003), which can also benefit market actors. For example, proper land use planning can prevent problems like overharvesting, a problem that induces dramatic consequences for people, tigers, prey species and other wildlife.
NGOs can assist state actors by providing information and financial support for land use planning (Respondent 1, personal communication, May 31, 2018; WWF Russia, 2017). In Sumatra, Indonesia, the district and provincial governments are designing plans that include zoning decisions and concessions for economic activities, for which WWF provides additional information (WWF, n.d.4). Furthermore, *"… it's important that communities are being involved in decision making and in defining the different management tools…"* (Respondent 1, personal communication, May 31, 2018). Local citizens are the ones that are affected and have high level knowledge about the area (Respondent 1, personal communication, May 31, 2018). Furthermore, as Madden notes:

> … planning in consultation with the locally affected communities will enhance the likelihood of success. Where indigenous or other local peoples engage in traditions and practices that contribute to coexistence with wildlife, HWC policies and programs should be designed to build on and support, rather than override, existing local traditions and practices of coexistence. (2008, p. 204-205)

Currently, the support for relocations seems to increase, as Karanth and Gopal note: *"… there seems to be an incipient local demand for relocations, driven by changing social traditions and economic aspirations of the local people*." (2005, p. 385). However, tolerance and support for relocation differs between countries and areas as, for example, respondent 4 notes:

> In Bhutan the case is slightly different because there were people living or even before the protected area were demarcated. So, they cannot remove the people from the protected area system. So, within protected areas you have people in Bhutan, so they have the right to stay there. (personal communication, June 14, 2018).

Workload:

Land use planning requires intensive research as many local conditions have to be considered in decision making. For example, relocations are particularly relevant for people living in important tiger habitats or corridors that are connecting tiger populations (Karanth & Gopal, 2005), because at these places the chance of encountering with tigers, and possibilities to generate ecological benefits by land use planning are highest (Moller, 2017). Furthermore, the location of, for example, residential areas and roads should be strategically and case specific chosen. In some regions it is desirable to build roads in a straight line, making the total distance and cost lowest. However, in other areas it is desirable to build roads around certain areas if, for example, ecological benefits from doing so outweigh the negative environmental consequences from a longer road which is even more expensive to construct (Meijaard et al., 2005). When land use plans are developed, proper implementation is of high importance. The process must be carried out with caution and high accuracy, and the involved actors must remain involved during the process. For example, "*If the relocation process is not transparent, incentive-driven and fair, it can lead to hardship and resentments*." (Karanth & Gopal, 2005, 384).

Consequently, successful land use planning requires extensive research to balance social, ecological and economic aspects and taking place specific conditions into account (Linnell, 2005; Meijaard et al., 2005).

Textbox 1: Buffer zones

Nepal maintains an extensive buffer zone management system:

> Between 1996 and 2010 Government of Nepal demarcated buffer zones of 12 protected areas covering a total area of 5602.67 square kilometer in 83 VDCs and two Municipalities of 27 districts where benefiting human population is over 0.9 million. In the buffer zone management programme emphasis has been given on the natural resource management where need of eco-friendly land use practices and peoples participation in conservation for long term sustainability are encouraged. (Bhusal, 2012, p. 34).

As shown in figure 8, land use is divided into different areas and buffer zones surround National Parks. Before the buffer zones were installed, little support for National Parks was present. National Parks were seen as a governmental conservation plan and people felt removed without being involved in the process. Although buffer zones belong to the National Parks, support is strengthened by creating separate buffer zone management committees for which communities elect the chair person. As respondent 3 further notes:

> … before the buffer-zone system, communities didn't see the national park as a good thing, because they saw that, ok, it's a government wildlife, a government initiative and we're not part of it and, and they were relocated from the core area out, to, to the periphery. So they had to find a, a way to make people happy on, I mean to get people support for conservation, so this is why the buffer-zone system was created. (Personal communication, June 11, 2018).

Buffer zones aims to function as a buffer for both people and wildlife; wildlife habitat is protected while people can live there and use the area which reinforces local support, for example, by allowing, but restricting, the collection of wood (Bhusal, 2014; Respondent 3, personal communication, June 11, 2018). It is possible that people and wildlife live close to each other in the buffer zones. To reduce HTC in these areas, additional measures are required. In some cases this is done by fencing entire villages. By doing so, wildlife is still able to disburse in the surrounding area while people and livestock are protected (see also paragraph 4.2.4).

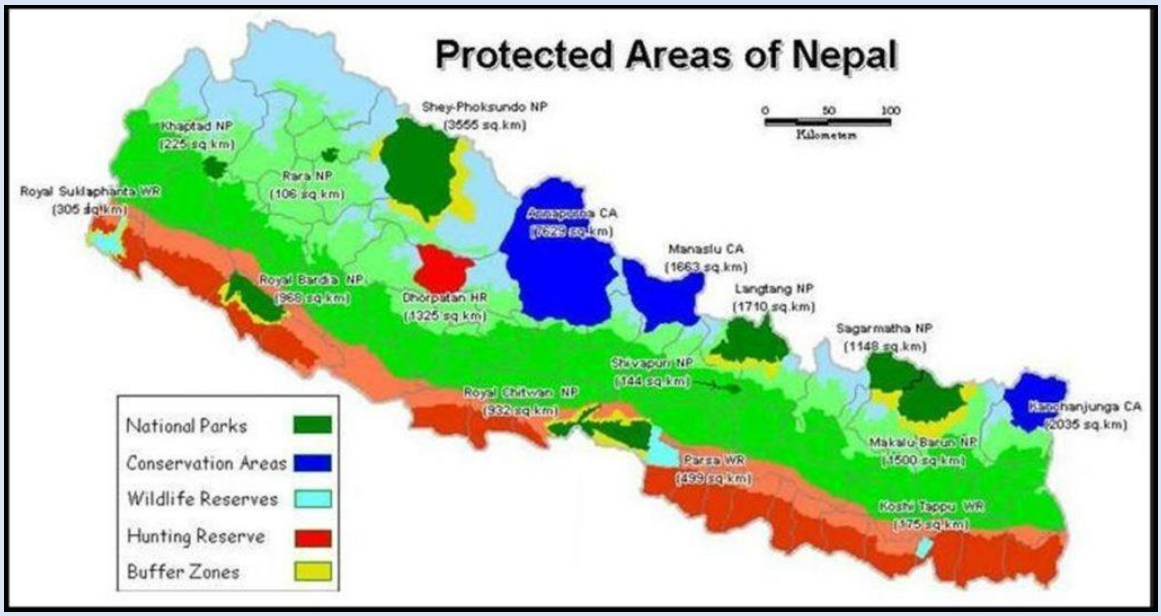

Figure 8: Protected areas of Nepal (Expeditions Nepal, n.d.)

Measure	Scale	Costs	Actors	Workload	Other conditions
Land use planning	Large	High	- State: developing land use plans, regulation, ownership of National Parks - Market: market activities can be affected by land use plans - Civil society: subject of matter, offering knowledge NGOs: providing knowledge and financial resources	Intense	- Requires open and transparent processes - Requires large-scale planning for which several actors must cooperate - Requires political will and high local support

Table 7: Characteristics of land use planning

Measure	Advantages	Disadvantages
Land use planning	• Long-term strategy for reducing HTC • Creates benefits for both the protection of people and livestock as well as for wildlife conservation	• Requires extensive investigation of the area

Table 8: Identified advantages and disadvantages of land use planning

4.2.2 Management of (wild) prey

As already noted, humans are increasingly occupying habitat of tigers and other wildlife and hunt for different animals, whereby the availability of tiger prey is reduced. Since it becomes more difficult for tigers to find sufficient wild prey, tigers are more often forced to enter residential area and intersect with, and prey on livestock and, although to a more limited extent, humans (Respondent 4, personal communication, June 14, 2018; Respondent 6, personal communication, June 29, 2018; WCS Russia, n.d.1).

Tiger prey can be made available in different ways. First, the ***living area of tigers can be enlarged or improved*** (Respondent 1, personal communication, May 31, 2018; Respondent 6, personal communication, June 29, 2018). This can be done by reducing competition between livestock and wild herbivores and by habitat protection and restoration (Goodrich, 2010). In the paragraph about land use planning, paragraph 4.2.1 this is discussed in more depth.
Second, in areas where people do not kill livestock themselves, feral and unwanted ***livestock surplus could be left behind*** in the wild so that tigers can prey on them (Kolipaka, 2018). Currently, this is done in India by local Hindu groups, who believe that a cow is sacred and it is a sin to eat beef, which is also being reinforced by state actors:

> The ruling right-wing Hindu party is in power for nearly two decades ... Their stay in power allowed them to impose an informal ban on cow slaughter and prohibition on the sale of cows to abattoirs. In 2015, the same Hindu right-wing party became a majority government in India. Respondents viewed that since the new government came into power, the informal prohibitions on cows also extended to buffalos. Further, the enforcement of prohibitions by local vigilante groups has become more stringent. (Kolipaka, 2018, p. 62)

In periods of stress whereby villagers are not able to take care of their livestock, for example due to droughts or sickness of animals, they let the animals free to roam in the forests.
Thirdly, ***tiger prey can be fed***. In Russia, this is done in winter periods when it is hard for prey animals to find enough food. By feeding, for example, wild deer and boar, more of these animals can survive the winter whereby the availability of wild prey for tigers increases (Respondent 2, personal communication, June 4, 2018; WNF, 2018). However, in for example Bhutan, the proportion of prey and other feed that wildlife can eat is not very seasonal making the feeding of tiger prey less appropriate (Respondent 4, personal communication, June 14, 2018) because then a constant

feeding is required which significantly increases the costs and workload. In addition, if it is aimed that tigers cope with natural fluctuations, although in the end this may not be realistic in the current human dominated world, winter feeding is not appropriate (Respondent 5, personal communication, June 18, 2018).
Further, several human-related actions influence prey densities. For example, in areas with a close distance to villages and roads and high proximity of snares, prey density is often lower and the amount of HTC higher (Soh et al., 2014). In addition, many hunting activities, like the wrong use of hunting equipment, overhunting and the placement of snares and traps decrease wildlife populations and are non-selective, causing considerable amounts of unintended mortality (Lindsey, Romanach, Tambling, Chartier & Groom, 2011). Therefore, ***anti-poaching efforts***, such as the reduction of snares, can lead to an increased amount of wild prey (Respondent 2, personal communication, June 4, 2018). This could be achieved, for example, by education (see paragraph 4.1) and the reduction of tiger injuries (see paragraph 4.2.3), so this paragraph will not go further into this.
Finally, governments and conservation organisations like NGOs can **reintroduce tiger prey animals** to the wild (Respondent 6, personal communication, June 29, 2018; Seddon, Armstrong & Maloney, 2007; Zeng, Jiang & Li, 2007). By breeding programs, animals are bred in captivity after which they can be released in the wild to form new populations (Zhou et al., 2004). For the persistence of a reintroduced animal population, it is required that the population includes a rich genetic variety and consists of enough individuals to be reproductive in the long term (Zeng, Jiang & Li, 2007). However, data about the reintroduction of tiger prey can hardly be found and more research is needed (Zhou et al., 2004). Therefore, this paragraph will not go into this in more detail. In table 9, an overview of different ways of managing the amount of wild prey is provided.

Ways to manage the amount of wild prey
• Habitat restoration and protection
• Leaving surplus livestock in the wild
• Winter feeding
• Anti-poaching efforts
• Reintroduction of prey animals

Table 9: Different ways of managing the amount of wild prey

<u>Human and livestock safety:</u>
The extent to which the management of wild prey contributes to the safety of humans and livestock is disputed in literature. According to Bhattarai and Fischer (2014) and Inskip and Zimmermann (2009) a low prey availability correlates with a high level of attacks on people and livestock. Also, Khorozyan, Ghoddousi, Soofi and Waltert note *"…livestock predation by big cats can be reliably determined and predicted by biomass of wild prey species. Predation rates significantly increase when prey biomass decreases below certain minimum thresholds…"* (2015, p.274). In contrast, Dhungana et al. notes: "*Neither human casualties nor livestock depredation were correlated with density of wild prey."* (2018, p. 59) and *"… even if livestock are readily available, tigers may kill livestock whenever an opportunity arises, regardless of the availability of wild prey*." (2018, p. 62). Also, Kolipaka notes: *"… when livestock were available, all tigers killed more of such animals even when wild prey was available*." (2018, p. 114).
So, to prevent tigers from killing livestock or humans, a minimum threshold of tiger prey must be available (Goodrich, 2010; Woodroffe et al., 2007). If this minimum of tiger prey isn't available, tigers are highly motivated to prey upon humans or livestock, which also limits the effectiveness of other HTC reduction measures (Karlsson & Johansson, 2010). However, if this minimum of tiger prey is available, HTC will not be dissolved completely; it depends on several factors, such as the degree to

which livestock is protected, to what extent tigers will prey upon wildlife or livestock as tigers prey on the easiest available prey (Respondent 5, personal communication, June 18, 2018).

Conservation of tigers and other animal and plant species:

Preventing tigers from getting access to livestock may have negative implications for their survival in areas with low wild prey densities. For example, *"… when the prey densities are low it's very difficult for tiger to really multiply…."* (Respondent 4, personal communication, June 14, 2018). Therefore, it is critically important for the conservation of tigers to ensure sufficient and viable wild prey populations when addressing HTC (Hayward, Jedrzejewski & Jedrzejewska, 2012). This is also indicated by the Woodroffe et al.,: "*… preventing wild carnivores from killing livestock will only contribute to their conservation if alternative, wild, prey are available to them.*" (2007, p. 1258). So, to both reduce HTC and protect tiger populations it is required to increase or maintain the number of wild prey available, possibly in combination with a reduced access to livestock (Goodrich, 2010; Loveridge et al., 2010).

Leaving behind livestock in the wild has different ecological consequences. The 'danger' is the fact that this action could lead to a modification in the hunting behaviour of tigers, as tigers may become more likely to attack on livestock through learning behaviour (Nyhus & Tilson, 2010). Further, abandoned livestock leads to higher levels of competition for food with present wild animal species. This can lead to overgrazing and the displacement of wild herbivores, leading to a poorer ecosystem.

Costs:

The costs related to the management of wild prey can vary highly. For example, for the instalment and management of protected areas or the feeding of wild prey, costs can easily transcend thousands of dollars. On the other hand, no costs have to be made for leaving behind livestock surplus in the wild; by avoiding veterinarian costs, costs can even be saved (Kolipaka, 2018).

Actors:

Different strategies to manage the amount of tiger prey require different actors to be involved. For the installation of protected areas, an actor as the state can be supportive and needed by developing and implementing legislation and law enforcement that protect the habitat of tigers (Goodrich, 2010), for which NGO's can be pushing and supportive (Respondent 4, personal communication, June 14, 2018). Furthermore, it is important to involve the local community in this because they live in many (protected) areas where tigers are present (Respondent 1, personal communication, May 31, 2018).

For the leaving of livestock in the wild, individual farmers are needed to do this. It is required that farmers have livestock that is of no value for them, like feral or unwanted livestock, which they do not want to kill themselves (Respondent 3, personal communication, June 11, 2018; S. Kolipaka, personal communication, February 14, 2018).

If tiger prey is fed, local communities, NGOs and governmental authorities play an important role. For example, WWF Russia supplies food during winter periods with heavy snow which is every few days spread out by local inhabitants or managers and rangers of hunting estates (F. Hilderink, personal communication, July 4, 2018; Respondent 2, personal communication, June 4, 2018; WNF, 2018).

Workload:

Furthermore, the required workload for managing wild prey depends on the strategy that is chosen for doing so. For example, the installation of protected areas requires lots of work, which has already been put forward when discussing zoning. On the other hand, leaving livestock behind in the wild requires almost no action. Further, the feeding of wild prey requires some regular feeding once in a couple of days.

Other conditions:
For all types of managing the amount of wild prey, it must be taken in mind that the interaction between tigers and their prey is very complex. For example, the life stage of a tiger influences the preference of the life stage of the prey (Respondent 5, personal communication, June 18, 2018). Furthermore, the vegetation in an area influences the animals that tigers prey upon. For example, in densely vegetated areas the visibility is small, making small deer such as chital that also have group vigilance very difficult to prey upon. Therefore, the existing ecosystem must be very well investigated to understand tiger interactions, what animal their main prey is and their need and lack for prey animals in general to decide carefully how, and what prey should be made available for tigers (Respondent 5, personal communication, June 18, 2018; Respondent 6, personal communication, June 29, 2018). So, it is important that actions to increase the amount of prey will be site specific (Goodrich, 2010).

Measure	Scale	Costs	Actors	Workload	Other conditions
Management of (wild) prey	Large	Low-High	- Sate: regulation, providing feed for tiger prey - Civil society: leaving behind livestock surplus NGOs: providing feed for tiger prey	Low-Intense	- For leaving livestock in the wild, farmers should have unwanted livestock that is of no value for them

Table 10: Characteristics of the management of wild prey

Measure	Advantages	Disadvantages
Management of (wild) prey	• Inextricably linked to and required for the conservation of tigers	• Even with large availability of wild prey, tigers may still prey on livestock and people if this is easier to them

Table 11: Identified advantages and disadvantages of the management of wild prey

4.2.3 Reducing injuries to tigers

As already noted, injured tigers experience more difficulty catching wild prey, causing them to prey upon livestock more often (WCS Russia, n.d.1). This induces tigers to enter human settlements which increases the chance and amount of HTC.

The amount of tiger injuries can be reduced in various ways. As already noted, ***education*** is a way by which the attitude towards tigers can be ameliorated and retaliatory behaviour and the injury of tigers can be reduced. By doing so, fear and anger towards tigers can be converted into respect. ***Anti-poaching*** activities such as ***snare and trap removal*** and ***patrolling*** are other ways to prevent the injury of tigers (Goodrich, 2010; Respondent 4, personal communication, June 14, 2018). Many tigers get injured by a falling into snares or traps, possibly provoked by retaliatory behaviour of humans. The removal of snares and traps can therefore reduce injuries of tigers. Patrols can monitor an area to, among others, detect and reduce illegal activities (WWF, n.d.6) such as illegal hunting and the illegal placement of snares and traps.
In most cases, a combination of measures is required to effectively reduce injuries to tigers; education and anti-poaching activities can be used to address the core causes behind the injury of tigers while patrolling and snare and trap removal can be used to address the problem more on site. An overview of different ways to reduce injuries to tigers is given in table 12. More specific information about education can be found in paragraph 4.1, and will therefore not be included here.

Ways to reduce injuries to tigers
• Education
• Anti-poaching
• Snare and trap removal
• Patrolling

Table 12: Different ways to reduce injuries to tigers

Human and livestock safety:

As figure 9 shows, more than 60% of the investigated tigers involved in HTC suffer from injuries caused by human activities. Tigers get very often wounded by snares, traps and gunshots that are not necessarily aimed at them (WCS Russia, n.d.1). For example, in Sumatra tigers get stuck in snares that are placed to catch wild pigs (Goodrich, 2010).

Most tigers that get involved in HTC are injured or ill (Nyhus & Tilson, 2010). Out of four translocated tigers in the Russian Far East, three had a bad physical condition (Goodrich & Miquelle, 2005). Also, Gurung et al., concluded that 56% of the investigated human-killing tigers were injured (2008). These animals attacked humans, dogs and livestock as they were, due to injury or disease, not able to catch wild prey. So, by reducing tiger injuries, a major cause of HTC is countered, the safety of both people and livestock is increased and the amount of HTC can be reduced.

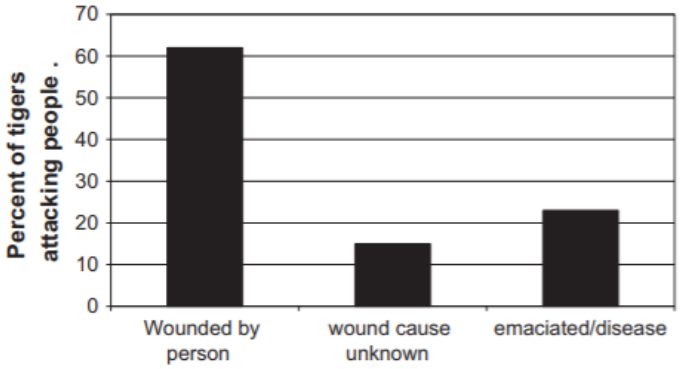

Figure 9: Physical characteristics of tigers that attacked people in the Russian Far East between January 2000 and February 2009 (Goodrich et al., 2011, p. 587)

Conservation of tigers and other animal and plant species:

As it speaks for itself, a reduction in the injuries to tigers contributes to the conservation of tigers. As more tigers can be saved (Respondent 4, personal communication, June 14, 2018). Other animal species can also experience benefits. For example, many other animals than tigers are being saved by the removal of snares and traps because they do also fall into them (Goodrich, 2010; Kumar & Chandel, 2014; Respondent 4, personal communication, June 14, 2018; Respondent 5, personal communication, June 18, 2018). Also, if injuries to tigers are reduced by spreading knowledge about the importance of tigers and their conservation, other animals can be saved as well. People become more aware of ecosystem services and the importance of the existence of different species, as discussed in paragraph 4.1.

Reducing injuries to tigers has no direct influence on plant species. However, by the important ecosystem services that tigers fulfil, this measure positively influences and contributes to the balancing of the entire ecosystem.

Costs:

The costs of reducing tiger injuries depends on the action being taken. In most cases, wages are the main costs that must be incurred. Education, patrolling and snare and trap removal require action

undertaken by people, and no or only minimal material investments. The extent to which costs can rise is unknown, but in the long-term costs will be at least $1.000,-, as the monthly wages of two or three people already exceed this amount of money (Respondent 3, personal communication, June 11, 2018; Bureau Wibaut, 2012).

Actors:

State actors are important for reducing tiger injuries by their power to impose regulations. For example, in India The Wildlife (Protection) Act, 1971, imposed several restrictions and prohibitions on the use of traps and snares (The Ministry of Environment, Forest and Climate Change, 1993). In addition, it is prohibited to kill any wildlife in many areas (Respondent 5, personal communication, June 18, 2018). Governmental actors further contribute to the reduction of tiger injuries by initiating anti-poaching and patrolling activities (Ranthambore National Park, 2017). Also, NGOs can carry anti-poaching activities and patrolling themselves; WWF provides rangers who are involved in patrolling (WWF, n.d.6). Local inhabitants play a role by organising education and anti-poaching activities themselves, for which governmental actors and NGOs can be supportive by providing financial and material resources.

In textbox 2 an example of a voluntary anti-poaching unit is given.

Textbox 2: Nepalese Anti-poaching unit

In Nepal, a voluntary anti-poaching unit is active, called the CBAPU (Community Based Anti-Poaching Unit). One of their main activities is awareness raising. Local people are being informed about conservation by offering school programs, theatre and street drama (Respondent 3, personal communication, June 11, 2018). In areas where poaching occurs relatively often, the CBAPU organises spontaneous patrolling to reduce illegal poaching on site (WWF Nepal, 2012). Further, the CBAPU focuses on law enforcement and "*The Government of Nepal has officially honored the role of CBAPU and made it a major stakeholder in conservation…*" (WWF Nepal, 2018b).

The CBAPU consists of youth from the community taking part of the association voluntarily, which offers several benefits: *"… people know them, they can speak the local language and they understand the context, so they can be closer to the people actually. And it also engage the youth in conservation*." (Respondent 3, personal communication, June 11, 2018). However, it is hard to engage volunteers in the long run, as people need to earn a livelihood. Furthermore, the materials required for the activities led by the CBAPU are provided by National Park and NGO's. The CBAPU is therefore highly dependent on outside actors, making long-term existence vulnerable and challenging (Respondent 3, personal communication, June 11, 2018).

Figure 10: More than 4.000 youth came together to celebrate the sixth CBAPU Day (WWF Nepal, 2015)

Workload:
The reduction of tiger injuries requires intensive work. As already noted, this measure is based on actions being taken by people. Structural education, snare and trap removal, patrolling or other anti-poaching activities require frequent activities, making word load moderate till intense.

Other conditions:
Many local inhabitants are for their livelihood to some extent dependent on wildlife, even though the hunting for this may be illegal. Therefore, alternative livelihoods should be available to prevent the reduction of wildlife hunting from contributing to undesirable situations, such as increased poverty (Respondent 5, personal communication, June 18, 2018).

Measure	Scale	Costs	Actors	Workload	Other conditions
Reducing injuries to tigers	Large	Medium-?	- State: regulation, initiate anti-poaching and patrolling activities, providing (financial) resources - Civil society: organising education and anti-poaching activities NGOs: providing (financial) resources	Moderate-Intense	- Knowledge about negative consequences of injuring tigers is required - Fear and anger towards tigers must be converted into respect

Table 13: Characteristics of the management of wild prey

Measure	Advantages	Disadvantages
Management of (wild) prey	• Increases human and livestock safety while contributing to tiger conservation	• If people are dependent on wildlife for their livelihood and no alternative livelihoods are available or provided, it can lead to other unwanted situations like increased poverty

Table 14: Identified advantages and disadvantages of the management of wild prey

4.2.4 Fences

By fencing, tigers are excluded from specific areas by physical barriers. Different types of fences can be used, for example, stone walls, electric fences and barriers made of wooden poles, wire mesh, barbed wire or nylon netting (Karanth, 2011; Muruthi, 2005; Respondent 3, personal communication, June 11, 2018; Veeramani, Jayson & Easa, 1996). Each type of fencing has its own characteristics, for example in costs, effectivity and maintenance. To choose between different types of fencing it is, next to these characteristics, important to keep in mind the physical properties of tigers and the different animal species that live in the area. For example, if it is aimed to protect livestock from tigers in an area where also elephants and rhinos live, a fence should be constructed in such a way that it prevents also these animals from destroying it (Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018).

First of all, fences can be made from large ***stone walls*** or ***wooden walls***. However, tigers are good jumpers and can easily climb (Barlow et al., 2010), causing fences to be several meters high (Tigers of India, n.d.). Fences built from stone walls or wooden walls are therefore not appropriate to keep out tigers (Ogra & Badola, 2008).
Furthermore, ***electric fences*** are being used. By giving an electric shock to tigers when touching the wire, tigers avoid touching the wires and won't use the wires for climbing, for example. In addition, electrified fences prevent tigers from crossing the wires if they are placed so close together that tigers cannot cross without touching them. To prevent tigers from crawling or digging underneath an electric fence, the bottom should be well-secured, possibly by placing the bottom wire close to the ground (Conover, 2001). Due to electrical leakage, electric fences are not appropriate in areas with

heavy snow (Palmer et al., 1985). If designed properly, animals tend to be very aware of electric fences and don't adapt to it easily because an electric shock is very different to any stimulus animals normally encounter in the wild (Fernando et al., 2008, p. 14). To decelerate animals from getting used to it, electric fences can be placed temporarily during harvesting seasons only. Further, this brings the advantage that wildlife can use the area for a longer period of time, offering ecological benefits (S. Pilapitiya, personal communication, April 24, 2018).
Another type of fence is made of ***nylon***. Advantageous is that this type of fencing is cheaper to construct than electric fencing and is less risky for wildlife than, for example, barbed wire fencing that can easily injure wildlife (Respondent 3, personal communication, June 11, 2018). In addition, these fences can be constructed, removed, and partly temporarily untied for crossing easily (Respondent 6, personal communication, June 29, 2018). Thereby, this type of fencing is, for example, successful for the capture of tigers that need to be translocated. By temporarily placing a nylon fence, the area where a tiger is located can be narrowed and people can be hold away, after which the tiger can be caught for translocation (Respondent 6, personal communication, June 29, 2018; Respondent 7, personal communication, June 29, 2018).

Figure 11: Nylon net fencing used in the Sundarbans (Mallick, n.d., p.7)

Concrete fencing is also a way by which tigers can be excluded from specific places. However, concrete fencing is extremely expensive. One kilometre of concrete fencing costs about $60.000, making it unpayable in many areas (Respondent 3, personal communication, June 11, 2018). Further, concrete fencing disables the transmission of wildlife and plant species, making it undesirable from a conservation perspective.
Further, ***wire mesh fences*** are being used. This type of fencing is also expensive to construct and not very effective to prevent animals from crossing (Pérez & Pacheco, 2006), for example, because animals can use the wires to climb over the fence.
Finally, fences are made of ***barbed wire***. This type of fencing is relatively cheap but not very effective to prevent animals from crossing, as the following statement shows:

> The barbed wire fence which separates the park and the village boundary was least effective for any kind of animals and crops. These were destroyed and damaged in many places both by animals and communities facilitating trespassing for crop damage and illegal resource extraction. (Thapa, 2010, p.1301)

Going beyond, animals get stuck in barbed wires causing fence mortalities (Harrington & Conover, 2006). This makes barbed wire fences not desirable from a conservational perspective. Even local people, for example in Nepal, don't prefer to use barbed wire fencing because of this risk for animals (Respondent 3, personal communication, June 11, 2018).

Types of fencing	
• Stone walls	- Ineffective to prevent tigers from crossing
• Wooden walls	- Ineffective to prevent tigers from crossing
• Electric fencing	- Expensive to construct - Effective to prevent larger animals from crossing
• Nylon fencing	- Cheap type of fencing - Easy to construct and replace
• Concrete fencing	- Expensive to construct - Obstructs the crossing of wildlife and plant species
• Wire mesh fencing	- Expensive to construct - Not very effective to prevent animals from crossing
• Barbed wire fencing	- Can be broken down relatively easily - Animals can get stuck in it causing fence mortalities

Table 15: Different types of fences

As can be seen from table 15, electric and nylon fencing are the most promising ways of fencing for reducing HTC, and are similarly effective if proper maintained (Barlow et al., 2010). Therefore, only these types of fencing will be further discussed in this paragraph.

Human and livestock safety:

According to Barlow et al., fencing is one of the least effective measures to save human lives because it only prevents HTC in or close to villages (2010), the places where HTC occurs least (Respondent 3, personal communication, June 11, 2018). Currently, electrified fences are not always well designed. For example, in some cases only a few wires are placed on a very low height. Thereby, tigers can easily jump over the fence, and if tigers make no contact with the ground they can avoid getting an electric shock and can even use the wires to climb over them (G. Polet, personal communication, May 29, 2018). Therefore, the design of fences is of high importance, as the following statement shows: "*If they are properly designed, constructed and maintained, fences can be completely effective in preventing conflict between people and wild animals*." (Muruthi, 2005, p. 5). For example, proper constructed and maintained nylon fencing has proved to be very effective to reduce the presence of tigers in villages and the number of people killed by tigers in the Sundarbans (Mukherjee & Mathur, 2012).

By limiting tiger presence, fences are also effective to increase the safety of livestock. Usually, tigers prey upon livestock under free ranging conditions (Karanth, 2011). Keeping livestock in safe enclosures, for example by fencing, reduces HTC (Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018), as Pettigrew et al. note: "*Fenced enclosures for holding livestock at night have been effective in preventing attacks by tigers and other carnivores …*" (2012, 221).

In beyond, fences offer protection for humans and livestock from other animals than tigers (Pettigrew et al., 2012). If the physical properties of other damaging wildlife species, for example elephants, are taken into consideration, fences provide protection at a higher level by preventing conflict with multiple species. However, the effectivity of this depends on the animal species and design of the fence. For example, fencing didn't prove to be effective to prevent human-leopard conflict (Respondent 3, personal communication, June 11, 2018).

To increase the scale of protection that fences provide, the construction of fences has to be coordinated. If an individual farmer protects his livestock by fences, and other farmers in that area take no protective measures, it is likely that the tiger, and thus the conflict, will only replace. So, to increase the scale of protection, every individual farmers or household should construct fences or a whole area has to be fenced, to prevent displacement of the problem. Furthermore, by fencing

entire villages both people and livestock can be protected at the same time. However, in practice, livestock is in many cases allowed to graze (freely) in the forests as farmers don't have enough land themselves, by which the potential of fences cannot be fully used (Respondent 3, personal communication, June 11, 2018).
Finally, the presence of fences reduces the risk perception of people; people living close to a fence feel more safe (Respondent 3, personal communication, June 11, 2018). Although this does not reduce HTC in itself, it contributes to the well-being of people.

Conservation of tigers and other animal and plant species:
A disadvantage of fences is the possible impact on ecosystem structures, for example by obstructing animal movement, causing overuse of a specific area or by blocking migration routes or critical water sources (Hayward & Kerley, 2009; Respondent 3, personal communication, June 11, 2018). Hayward and Kerley even note: "*… fences may ultimately prove to be as much a threat to biodiversity as the threats they are meant to exclude …*" (2009, p.1).
To prevent fences from becoming a threat to conservation, the location of fences should be carefully chosen and the possible impacts has to be well-considered, possibly by environmental assessments (Hayward & Kerley, 2009; Jachowski, Slotow & Millspaugh, 2014). For example, if animals have to migrate through an area, the location of the fence should be chosen in such a way that it will not restrict this movement.
Further, the design of fences influences the impact on biodiversity. For example, "*… a non-electrified bottom strand wire could be incorporated to keep small fauna from the electric strands.*" (Hayward & Kerley, 2009, p. 6). Deterrent measures like flags could be integrated in the design of fences to increase the visibility of fences and thereby prevent animals from getting too close or get stuck in it.
Advantageous of fencing is that it reduces illegal livestock grazing (Respondent 3, personal communication, June 11, 2018). This makes the management of the use and monitoring of areas easier (Barlow et al., 2010), allowing areas to be managed more sustainable.

Costs:
Despite the possibilities for reducing HTC by fences, if well designed and maintained, "*The major factor limiting the wider use of wildlife fences is their cost."* (Muruthi, 2005, p. 5). Although the actual costs differ between countries *"… the key issue is that it is expensive and it requires continued maintenance.*" (Hayward & Kerley, 2009, p.8). To reduce the costs of electric fences, they could be powered by solar energy, which is also more sustainable. According to Barlow et al. (2010), electric fences are one of the most expensive measures. The setup costs for electric fences in the Sundarbans will be around $360.000 while maintenance costs will be around $36.000 a year. To reduce the costs of electric fences, they could be powered by solar energy, which is also more sustainable. For that same area, nylon fences are much cheaper: setup costs will be around $22.500 and maintenance costs around $11.250 a year (Barlow et al., 2010). However, nylon fences must be replaced more often, namely every few years (Mallick, n.d.). Despite the high costs for fencing, if costs are compared with costs for other HTC reduction measures such as compensation programs, fencing may be more cost effective in the long-run (Hayward & Kerley, 2009).

Actors:
Fences can be owned by different stakeholders, such as private organizations, governments or individual inhabitants. The actors involved depend on the area that a fence aims to protect. For the protection of a herd of livestock, an individual owned fence is appropriate. If a fence is used to catch a tiger, a response team is often involved. In Nepal, whole villages are fenced, protecting entire communities and preventing livestock from grazing freely. To create a shared responsibility for the fence and its maintenance, a more collaborate owning is required. By giving ownership to the local

community and communicating the utility of fences, the change of successful maintenance can be enhanced (Respondent 4, personal communication, June 14, 2018). The costs of fences can be shared by the households whereby the amount of contribution depends on the size of land that is owned. Instead of providing money, also labour could be provided whereby one day of work equals a certain amount of money. By doing so, people are directly involved in the construction and maintenance of a fence (Respondent 3, personal communication, June 11, 2018). In buffer zones (see paragraph 4.2.1) maintenance can be done by guards from both the related National Park and the local community, whereby costs are shared and jobs are created (Respondent 3, personal communication, June 11, 2018). Fence guarders can play a role by checking the condition of a fence and take action if the fence is broken down or if a tiger has crossed it (Fernando et al., 2008). However, fence guarders face a risk themselves as they get sometimes attacked by wild animals while doing their job (Banikoi, 2017).

An advantage of collaborative fences is the fact that these fences often enclose a large area. For these fences strategic locations can be chosen, whereby a maximum of people and livestock is protected with as few fences as possible (Respondent 4, personal communication, June 14, 2018). Also, fences can be maintained in cooperation between NGOs, state and private actors (Respondent 3, personal communication, June 11, 2018; Respondent 6, personal communication, June 29, 2018). However, as is the case for the other measures, association with governmental actors often slows down the process (Hayward & Kerley, 2009). In addition, fences owned by the government are often less effective than private and company owned fences due to weaker maintenance, as research to the effectiveness of electric fencing for reducing human elephant conflict in India has shown. The percentage of private or company owned electric fences that were in operation were four times higher than government owned fences (Fernando et al., 2008). In Bhutan, the government is constructing fences themselves, while local communities are responsible for the maintenance. In some areas, people do not take care of this maintenance while this way of managing fences proved to be successful in other areas (Respondent 4, personal communication, June 14, 2018). In some cases in India, structural nylon fences at the areas where communities interfere with the forests, installed and maintained by collaboration between NGO's, state actors and local communities, have been very effective in preventing tigers from crossing. However, in other areas, success with structural nylon fencing was lacking as there was no proper maintenance without intensive community collaboration.

To minimize the costs for fencing, the market is an important actor as well, as they produce and sell fences. In Bhutan, local fabrication has highly reduced the costs of electrified fencing and the government is currently active in the installation of fences (Respondent 4, personal communication, June 14, 2018).

Anyhow, it is important that fences are implemented with community support in the design, execution and maintenance in order to secure proper maintained fences for which actors feel responsible, and to ameliorate people's attitudes towards tiger conservation (Fernando et al., 2008; Osborn & Parker, 2003; Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018).

Workload:

The installation and maintenance of fences take a lot of work. First, the area around a fence needs preparation and maintenance. For example, if it is chosen to install an electric fence, vegetation should be removed to prevent leakage from plants touching the wires. If a fence is built, good maintenance is of crucial importance; if a fence is broken somewhere, which could, in many cases, be easily done by rhinos and elephants (Banikoi et al., 2017; Respondent 3, personal communication, June 11, 2018), tigers are able to enter the fenced area making the rest of the fence fruitless. If a

tiger gets inside a fenced area, the chance of multiple livestock deaths even increases (Pettigrew et al., 2012, p. 221). In many cases, the maintenance of fences is not appropriate as people are not aware of the necessity of doing so (Respondent 3, personal communication, June 11, 2018). In addition, maintenance can be expensive (Hemson, 2004) and very time consuming: "*Good maintenance requires daily inspection of fence for wire breaks, loosening, current leakage from objects or plants touching the wires, replacing damaged posts, inspection of batteries, powering energizer etc.*" (Fernando et al., 2008, p. 15).

Other conditions:
Detecting devices can be used to increase the effectivity of fences. If, for example, tigers are radio collared, the habitat and walkways of tigers can be mapped. By constructing fences at the edges of, or even outside these areas, the chance of tigers crossing the fence will be reduced (S. Pilapitiya, personal communication, April 24, 2018). Furthermore, sensor networks can play a role by indicating the place where a fence is broken. Without such technologies, it can be extremely hard to find the breakage due to the length of fences (Wijesinghe, Siriwardena & Dias, 2013; J. de Looze, personal communication, January 11, 2018). So, if electrified fencing is combined with early warning systems, which will be discussed in more depth in paragraph 4.2.5, the effectivity of fences could be enhanced by enabling easier and faster action taken.

Measure	Scale	Costs	Actors	Workload	Other conditions
Fences	Small - Large	High	- State: installation and maintenance, ownership - Market: production, selling and lowering the costs for fencing - Civil society: individual or community based installation and maintenance, ownership NGO's: installation and maintenance, ownership, providing financial resources	Intense	- Requires extensive research about ecosystem structures - Presence and properties of potential fence destroying and conflict-causing animals must be taken into account - Requires ongoing maintenance - Ownership and responsibilities must be well defined to secure a proper maintenance

Table 16: Characteristics of fences

Measure	Advantages	Disadvantages
Fences	• Nylon fences can be easily constructed and removed • Reduces illegal livestock grazing • Can be used to keep out multiple species of wildlife • Makes people feel safer	• High costs • Possibly limits animal movement

Table 17: Identified advantages and disadvantages of fences

4.2.5 Early detection and warning

With detecting devices, approaching animals can be detected at an early stage to prevent HTC. Different technologies exist for this. For example, infrared sensors are used to detect approaching predators before crossing a fence (Shivik, 2006). In Canada, thermal cameras are used to detect wildlife on a highway. If an animal is on the road, warning signals are given to passing drivers (TranBC, n.d.).

Human and livestock safety:
If approaching tigers are detected, action can be taken before a tiger attacks on people or livestock. To actually reduce HTC, the dealing with detecting devices must be managed well, for example by connecting the technologies to early warning systems. This can be, for example, a siren system

installed at one of the households in a village. If a tiger is observed, inhabitants can contact, for example by calling, the one that serves the siren to turn it off when required. People in the village will hear this and can go into their homes (Respondent 3, personal communication, June 11, 2018). Desirably, a response team will be called to come on the spot, investigate the situation and take action in an appropriate way (Respondent 3, personal communication, June 11, 2018). A proper handling with the tiger is required to increase the safety of livestock by a detecting and warning system, as livestock will not protect itself by hearing an alarm. Livestock safety can be further enhanced by connecting an early warning system to electric fences. With future technologies it will be possible to automatically determine and indicate where an electric fence is broken. This enables immediate action being taken, increasing the safety of the by electric fences protected livestock (T. van Dam, personal communication, January 11, 2018).

Conservation of tigers and other animal and plant species:
The detection of tigers has no ecological consequences in itself. The consequences for tigers and other animal or plant species depend on the action being taken after detection and warning. Therefore, a closer look must be given to the consequences of the measure that is taken in prosecution.

Costs:
Technological developments can lower the costs of detecting and warning systems. For example, the range that detecting devices can reach determines how many are needed to cover a certain area. Currently, detecting and warning devices are being further developed, among others, aiming at minimalizing the costs to make them affordable to people in low income areas (J. de Looze, personal communication, January 11, 2018; L. de Groot, personal communication, January 11, 2018). If more producers exist and compete, market forces ensure an efficient use of resources and prices are kept low as possible (Griffith, 2001). As developments are still going on, it is not known what the costs of different detecting devices exactly will be.
Warning systems can be integrated to detecting devices to prevent them from being controlled manually. Although this still requires costly one-off technological investments in the beginning, which is not affordable in all low-income areas where HTC takes place (Karanth, 2011), it can lower the costs in the long run by reducing structural labour costs. Not all warning systems require high investment costs. For example, one loud siren can be enough to warn a whole village of tiger presence (Respondent 3, personal communication, June 11, 2018), making costs, especially when being shared, relatively low.

Actors:
To start, market actors are required for the production and development of detecting and warning technologies (L. de Groot, personal communication, January 11, 2018; T. van Dam, personal communication, January 11, 2018). Up to now, no technologies have been developed that allow devices to automatically distinguish between different animal species, irrespective of the amount of light, in a cost-effective way. For this, technologies are being developed, for example by the Shuttleworth Foundation Arribada Initiative (A. Davies, personal communication, January 11, 2018). Camera traps are already able to identify specific animal species, but do not work in poor lighting conditions and are not cost effective. Infrared technologies have these properties but cannot distinguish between different animal species yet. Therefore, Arribada is developing thermophile sensors, a technology that combines these methods to automatically recognize specific animal species, irrespective of the amount of light, in a cost-effective way (WILDLABS.NET, n.d.1).
Besides, by combining the collaring of animals with detection technologies, further developments could make possible to monitor the animal movement and alarm people when a tiger is approaching

(Respondent 4, personal communication, June 14, 2018). So, market investments and developments could make the usage of this measure feasible and affordable for people in low income areas (Wibaut, Wijesinghe, Siriwardena & Dias, 2013). NGOs can be supportive in this; for example, WWF has organised the Human Wildlife Conflict Tech Challenge. The submitted idea with the most potential for reducing HWC was rewarded with financial support to further develop the idea and technologies (WNF, 2017). In addition, NGOs can, for example, assist state actors in the placement of camera traps (Respondent 6, personal communication, June 29, 2018).
For a well-functioning detecting and warning system, close interaction with local communities is necessary. Otherwise, establishment proved to be hard (Respondent 2, personal communication, June 4, 2018) and they are the people where it is about and who are right on spot if an approaching tiger is detected. Community involvement is further important to prevent the stealing of detecting and warning equipment. If people see the usefulness of these technologies and possibly feel responsible for it, for example by shared ownership, people will be less likely to steal it (T. van Dam, personal communication, January 11, 2018).

Workload:
Currently, most detecting and warning systems require manual activity, for example to turn off an alarm system or to identify a detected animal species. Constant human availability is required for this. If it becomes possible to detect just one specific animal species automatically, the usage of detecting devices requires less work and becomes more attractive to local inhabitants. Then, notifications can be given only when the intended animal is approaching and only minimal work is required (A. Davies, personal communication, January 11, 2018). Ideally, only minimal maintenance for repair is then required.
As already noted, people can safeguard themselves after perceiving a warning, but detection and alarm systems do not increase the safety of humans and livestock in itself; for this, further action is necessary. This requires consideration of the amount of work that other measures entail, which can be found in the concerning paragraphs in this chapter.

Measure	Scale	Costs	Actors	Workload	Other conditions
Early detection and warning	Small-Large	Low-High	- State: deploy technologies such as camera traps - Market: production, selling, develop and improve detecting and warning technologies - Civil society: ownership, respond to a detected tiger/alarm NGOs: contribute to the development and deployment of technologies	Low-Intense	- Requires close interaction with the local community

Table 18: Characteristics of early detection and warning

Measure	Advantages	Disadvantages
Early detection and warning	• Potentially a self-acting system that requires no physical adjustments in the environment • Contributes to the monitoring of animal presence	• (currently) Requires large investments

Table 19: Identified advantages and disadvantages of early detection and warning

4.2.6 Herders

A traditional measure to reduce HTCs is by safeguarding livestock in presence of a herder. By putting farmers themselves at work to reduce HTCs, this measure gives people a sense of empowerment

(Fernando et al., 2008). Herding is appropriate in areas where livestock is grazing freely. For example in Russia, where livestock is hold mostly inside of enclosures, this measure is not relevant (Respondent 2, personal communication, June 4, 2018).

Human and livestock safety:
This measure mainly focusses on the safety of livestock and to a lesser degree on human safety. The safety of humans could even be reduced because people are placed in a situation with a relative chance to encounter a tiger (Respondent 3, personal communication, June 11, 2018). However, safeguarding free grazing livestock by herders can highly reduce tiger predation on livestock (Anwar, Saralch & Kumar, 2015; Goodrich, 2010; Karanth, 2011; Respondent 4, personal communication, June 14, 2018; Woodroffe et al., 2007). As herders decide where the livestock is grazing, areas can be chosen with a (relatively) low chance of encountering a tiger (Kolipaka, Persoon, Longh & Srivastava, 2015; Respondent 4, personal communication, June 14, 2018).

Conservation of tigers and other animal and plant species:
Herding practices require no physical adjustments in the environment, which allows predators to remain part of the ecological system (Marker, Dickman & Macdonald, 2005). Besides the fact that plants get consumed by the grazing livestock, which is also the case without herders, the tending of livestock by a herder has little influence on existing plant and wildlife populations. Although on a small scale, more suitable places for livestock grazing can be chosen by herding livestock which allowing more sustainable grazing management.

Costs:
The costs for livestock herding include the daily labour costs of the herder (Respondent 4, personal communication, June 14, 2018). This makes herding attractive in places where labour is available and inexpensive (Karanth, 2011). As the presence of one herder is sufficient to guard one herd of livestock, costs will be low; for example, in Nepal guarders of a fence were paid around $55,- a month (Respondent 3, personal communication, June 11, 2018). Due to the fact that a herder is required daily, the costs for a herder have to be made continuously and will not decrease over time.

Actors:
For herding to be relevant, it is required that the free grazing of livestock is happening and thus allowed. Thereby, state actors play a role. As Roy notes: "*The government policies have a great influencing factor in livestock farmers' choice towards free range grazing …"* (2009, p. 88). Furthermore, this 'higher level' involvement is needed to make free grazing and herding practices successful, as the following statement shows: "*… there is an urgent need for proper enabling policies and guidelines at government of India as well as state government levels. Such measures will lead to better utilization of the available natural resources and its further improvement …"* (Roy, 2009, p. 88). Livestock herding can be organized at different levels; from individual farmers to entire farmer or village societies. Often, the actor performing this measure is the individual farmer, as farmers become the herder themselves (Respondent 4, personal communication, June 14, 2018). If labour is cheap, farmers can also decide to hire someone to herd their livestock. Herding can also be organized communally, but this "*… requires cohesion among the farmers and a central authority which can penalize those who do not comply with their guard duties*." (Fernando et al., 2008, p. 5).

Workload:
The herding of livestock is a labour-intensive job that requires the continuous presence of a herder (Respondent 4, personal communication, June 14, 2018), making the required workload intense.

Measure	Scale	Costs	Actors	Workload	Other conditions
Herders	Small-Medium	Low	- State: regulating the free grazing of livestock - Market: providing herders - Civil society: herding practices are often performed by farmers	Intense	- Only relevant in areas with free grazing livestock - Regulations and guidelines for the free grazing of livestock are required to secure a sustainable grazing management

Table 20: Characteristics of herding

Measure	Advantages	Disadvantages
Herding	• Gives farmers sense of empowerment	• Focusses on the protection of livestock only • Decreases safety of people by enlarging the chance of encountering between tigers and people

Table 21: Identified advantages and disadvantages of herding

4.2.7 Guard animals

Different animal species have the property to be protective and repel predators. Guard animals are therefore being used to protect people and livestock, and prevent HTC.
Depending on the predating animal species, different guarding animals can be used. Dogs are a common used guard animal. However, they are not very appropriate to ward of tigers because tigers readily prey on them (Respondent 2, personal communication, June 4, 2018; Respondent 4, personal communication, June 14, 2018). Thereby, the presence of dogs could further attract tigers instead of keeping them away (Goodrich, 2010). Buffalos are also used as guard animals. They act defensively towards predators, but as is the case for dogs, tigers sometimes kill buffalos (Goodrich, 2010; Khorozyan et al., 2015) although they prefer smaller prey (Dhungana et al., 2018). Donkeys and lamas can also protect livestock. These animals are effective to deter coyotes or other small animals, but they have not proved to be effective to repel other carnivores like tigers (Treves & Karanth, 2003).

Human and livestock safety:
Due to the fact that tigers hunt on many different animals, it is difficult to find a species that can protect humans and livestock by deterring tigers. Therefore, the usage of guard animals is not very helpful to increase the safety of humans and livestock directly (Respondent 2, personal communication, June 4, 2018).
However, a function by which dogs can play a role for the reduction of HTC is by alerting people to a forthcoming or present predator (Khan, 2009; Woodroffe et al., 2007). Research in the Sundarbans has shown that in 92% dogs were able to detect the presence of any close and sizeable animal. In 62%, they were able to distinguish a tiger from other animal species (Khan, 2009, p. 44). By alarming, dogs can increase the safety of both human and livestock. For example, if a tiger is approaching a herd of livestock, a dog can warn his owner so that action can be taken before the tiger comes to attack. Furthermore, dogs can increase the safety of a herder by supporting the herder in guarding practices (Respondent 4, personal communication, June 14, 2018), and warning them for approaching tigers. Further, the safety of honey gatherers, working in countries such as Nepal and Inia, can be highly increased by using guard dogs. For these people, it is extremely hard to notice an approaching tiger themselves because they work with smoke most of the time. Therefore, the use of guard dogs is in particular advantageous for them (Khan, 2009).
Due to the limited possibilities to increase the safety of humans and livestock by other animals than dogs, the following aspects will be considered with respect to the usage of guard dogs.

Conservation of tigers and other animal and plant species:

As is the case for herding, an advantage is that no physical adjustments in the habitat are required (Marker, Dickman & Macdonald, 2005). However, an important negative consequence of the usage of guard dogs is that these dogs possibly *"… carry infectious diseases that have the potential to substantially reduce the viability of wild carnivore populations ..."* (Woodroffe et al., 2007, p. 1257). In many areas, farmers abandon their dogs in the wild. For example, if they don't want to feed the dogs when guard dogs are periodically not needed, or when the dogs give birth and the farmers are not able or don't want to hold and take care of all the puppies, farmers abandon dogs in the wild. These abandoned dogs readily spread diseases like rabies and canine distemper, harming tigers and other wildlife. Furthermore, these semi-wild dogs chase and injure animal species like deer and the red panda, and prey on other tiger prey species (Respondent 4, personal communication, June 14, 2018). Besides these negative influences on wildlife, the spread of diseases poses a risk for people. As Totton et al., note: "*More than 20,000 people die of rabies every year in India, and the majority of victims acquire the disease from the bite of a rabid stray dog*." (2010, p.51).

Guidelines for people how to take care of their guard dogs and a proper vaccination and neutering program can both prevent these risks and increase the effectiveness of guard dogs (Bommel & Johnson, 2012; F. Hilderink, personal communication, July 25, 2018; Respondent 4, personal communication, June 14, 2018).

A positive consequence of the use of guard dogs is that it can ameliorate the attitude of human humans toward tigers. As, Khan notes: *"Use of domestic dogs in the Sundarbans could not only reduce human deaths but, in the long-term, change the hostile attitude of many people towards the tiger and improve local support for tiger conservation*." (2009, p. 46). Also, Woodroffe et al. note: "*… domestic dogs reduce livestock depredation, and, by extension, reduce the numbers of predators killed by livestock farmers."* (2007, p. 1257). Thereby, possible negative consequences on conservation could be countered to some extent if the use of guard dogs reduces retaliatory killing.

Costs:

The costs for using guard animals are relatively low and require no major investments. A farmer must buy an animal, like a dog, and take care of it. According to Barlow et al., the usage of guard dogs is one of the most cost-effective measures to reduce the number of people killed by tigers (2010). For a region like the Sundarbans, set up costs will be around $18.000,- after which it will only cost about $4.000,- a year, making it one of the cheapest measures (Barlow et al., 2010).

However, possible negative consequences of guard dogs, such as the spread of diseases, can lead to high indirect costs; costs that are not solely borne by the individual owner. Very often, sick dogs are abandoned to avoid veterinary costs (Acharya & Dhakal, 2015). In India, stray dogs became such a big problem that a programme for the vaccination and neutering of stray dogs had to be set up (Totton et al., 2010). However, this is not an easy task; dogs get semi-wild and especially in rural areas it is difficult to catch dogs for treatment (Respondent 6, personal communication, June 29, 2018). Thereby, the indirect costs of this measure can increase considerably. However, proper guidelines for dog owners could avoid these extreme costs by preventing that the usage of guard dogs leads to the problem of stray dogs on such a high level. So, to both reduce possible negative ecological consequences and extreme costs, good care of the guard dogs is required which can be fostered by proper guidelines.

Actors:

Initially, the actors involved for the usage of guard dogs are individuals from the local community, who buy, own and take care of the animal. However, as already spoken about, if people abandon their dogs also other actors have to be involved to prevent negative consequences like the spread of diseases. Then, NGO's and governmental actors play a role by, for example, sterilization, vaccination

and education programs to reduce the number of abandoned dogs and spread of diseases (Acharya & Dhakal, 2015; Respondent 6, personal communication, June 29, 2018; Totton et al., 2010).

Workload:
Owners of guard animals have to take care of the animals, for which daily care is needed (Farnworth, Blaszak, Hiby & Waran, 2012). Furthermore, minor training is required for dogs to become a guard animal. It is important that the dog is raised by the livestock to create a strong bond between the dog and the livestock. When the dog gets older, some obedience training is required (Andelt, 1999).

Other aspects:
If guard dogs get combined with fencing, the costs for fencing can be diminished. Fences appropriate to keep dogs and livestock in are cheaper to construct and maintain than fences that keep off tigers out (Conover, 2001). The guard dog can then be used to prevent tigers from entering a fenced area and prey on livestock unnoticed.

Measure	Scale	Costs	Actors	Workload	Other conditions
Guard animals	Small	Low	- Civil society: ownership - State and NGOs: sterilization, vaccination and education programs	Intense	- Guidelines for people how to take care of their guard dogs are required to prevent negative ecological consequences and extreme costs

Table 22: Characteristics of guard animals

Measure	Advantages	Disadvantages
Guard animals	• Relatively cheap • People are being warned of tiger presence	• Dogs can easily spread diseases like rabies and canine distemper, harming human, tiger and other wildlife populations • Animals used a guard are possible tiger prey and can thus attract tigers

Table 23: Identified advantages and disadvantages of guard animals

4.2.8 Masks

As already noted, tigers prefer to attack prey from behind and avoid frontal attack. Thereby, face-like masks or masks with large eye spots can be worn individually by people on the back of the head (see figure 12) to give tigers the impression that they're being watched to reduce the chance of attack (Anwar, Saralch & Kumar, 2015; Goodrich, 2010; Karanth & Gopal, 2005; Nowel & Jackson, 1996; Sillero-Zubiri, Sukumar & Treves, 2007).

Figure 12: People wearing masks to scare of tigers (Mukherjee & Mathur, 2012, p. 11)

Human and livestock safety:
The wearing of masks is a measure that focusses on the safety of people. Little and contradictory data about the effectiveness of wearing face masks is available, so it is unclear if, and to what extent the wearing of masks contributes to the reduction of tiger attacks on human. Although it is expected that the number of HTC can be reduced by wearing a mask (Barlow et al., 2010), it has not proved to be effective in the Sundarbans (Mukherjee & Mathur, 2012; Respondent 6, personal communication, June 29, 2018). However, according to Zimmermann et al., no attacks were reported on people wearing face masks in the Sundarbans (2010, p. 140), but it is unknown whether this has to do with other aspects. Furthermore, it is unknown whether people exhibit more risky behaviour because of a reduced risk perception by wearing a mask. Instead of reducing HTC, this could possibly lead to undesirable and opposite outcomes.
To protect livestock as well, this measure should, for example, be combined with herding. Then, the livestock is protected by presence of a herder and the safety of the herder is increased by wearing a mask.

Conservation of tigers and other animal and plant species:
The wearing of masks does not influence animal species or plant populations, as no adjustments to the environment and ecosystems have to be made.

Costs:
Masks are relatively cheap. According to Barlow et al. the setup and maintenance costs for masks are very low (2010); the production of masks costs only a few dollars (Beissel, 1996). For an entire region like the Sundarbans, the setup costs of this measure would be about $20.000 and maintenance costs about $2.000 a year, making it one of the cheapest measures (Barlow et al., 2010).

Actors:
For this measure, farmers or other individuals have to buy or make and wear a mask by themselves. For people to do so, there has to be a relative chance of encountering a tiger. For example, in Russia this chance is extremely low making this measure not appropriate. As respondent 2 stated about the wearing of masks: "… *most of people use nothing on the forest because the possibility to meet tigers on the forests is very low, because of the density is low*..." (personal communication, June 4, 2018).
Market actors can play a role in the production and selling of masks.

Workload:
Masks requires no extensive work or maintenance. Once a mask is made, it can be used for a period from a couple of months up to several years (Beissel, 1996). Thereby, wearing a mask is a simple and straightforward measure to implement.

Measure	Scale	Costs	Actors	Workload	Other conditions
Masks	Small	Low	- Market: production and selling - Civil society: individual ownership and use	Low	- Only relevant in regions with a relative chance of encounter with a tiger

Table 24: Characteristics of masks

Measure	Advantages	Disadvantages
Masks	• Cheap measure that requires almost no maintenance, knowledge, technology and investments • Easy to combine with other measures	• Offers only limited protection to people on individual level

Table 25: Identified advantages and disadvantages of masks

4.2.9 Removal of vegetative cover

Tigers prefer to hunt in a densely vegetated area. They are too big and heavy to run long distances, so for hunting, tigers hide between plants and sneak close enough to their prey until they are able to catch it (Pathak et al., 2013; Tigers of India, n.d.; WNF, n.d.5). Therefore, depredation conflicts happen more often in areas with dense tree cover (Soh et al., 2014) and the removal of vegetative cover can contribute to the reduction of HTC.

Human and livestock safety:

By clearing an area from vegetative cover, the visibility of approaching tigers is increased (Seiler & Helldin, 2006). As a result, people have a better view of what is happening around their house and action can be taken more quickly if a tiger is approaching, increasing the safety of people and livestock.

Further, the removal of vegetative cover can be used to demotivate tigers to cross a specific area and thereby reduce HTC (Goodrich, 2010; Treves et al., 2004). However, it is unclear how wide a bare area has to be in order to prevent tigers from crossing it. Probably, this area is very large because tigers can easily overpass several kilometres (Respondent 3, personal communication, June 11, 2018; Respondent 6, personal communication, June 29, 2018).

The extent to which the removal of vegetation prevents tigers from attacking humans and livestock is unclear, but not expected to be high (Respondent 3, personal communication, June 11, 2018; Respondent 6, personal communication, June 29, 2018).

Conservation of tigers and other animal and plant species:

The removal of vegetation generates negative ecological consequences; it further decreases the already scarce habitat of wildlife. Consequently, the large-scale removal of vegetative cover is not desirable from an ecological perspective (Sunquist, 1981). Also, as elaborated in paragraph 4.2.2, the reduction of prey available for tigers could increase the amount of HTC. So, by diminishing habitat and food available to prey animals, the number of prey available for tigers diminishes (Respondent 6, personal communication, June 29, 2018) whereby the removal of vegetative cover could instead of reducing HTC could lead to opposite outcomes.

Costs:

Since it is unclear how wide the bare area has to be in order to prevent tigers from attacking human and livestock, it is unclear what the costs will be of doing so. Possibly, this measure can be profitable for the actor takes care of the removal of vegetative cover, because they can use and sell the harvested vegetation.

Actors:

The creation of a bare area should be approved by the state. For example, in some ‘core areas’ which are highly protected, it is prohibited to clear anything (Respondent 3, personal communication, June 11, 2018). Thereby, governmental authorities perform a decisive role by regulation. If the removal of vegetative cover is allowed, both market actors and the civil society play a role by clearing the area and collecting the resources it provides. If vegetative cover is cleared on a small scale, for example by only clearing some meters of vegetative cover around a house, local inhabitants are the important actor by doing this themselves.

Workload:

If an area is cleared, it requires some regular maintenance to keep the area clear. This is something that can be done by market actors and local inhabitants. For example, a cleared area becomes very accessible and seductive for livestock to graze, so farmers’ livestock could be used for keeping the area bare. Normally, tigers don’t show hunting behaviour in open areas with short vegetation.

However, if vegetation gets high enough for tigers to hide themselves, tigers will use the area for hunting (Khan & Chivers, 2007). Therefore, to prevent tigers from attacking livestock, the bared made area should be well managed (Respondent 3, personal communication, June 11, 2018).

Other aspects:
Despite the limited possibilities of this measure, it could offer some benefits if it is combined with other measures. For example, if land-use planners have decided that the area around human settlements may be harvested, economic benefits for the harvesting industry can go together with increased safety for local inhabitants. Another example is that a drawback of fencing is that it is difficult and costly to construct and maintain fences in an area with a dense vegetation (see paragraph 4.2.4). Therefore, the removal of vegetative cover in places where fences will be constructed enhances the effectiveness of fences, for example by preventing electric leakage from plants touching the wires. Furthermore, fences require intensive maintenance which is made easier with better access around the fence by removed vegetation (Fernando et al., 2008). Also, early warning systems profit from the removal of vegetative cover because approaching tigers can be detected more easily if vegetative cover is removed (see paragraph 4.2.5).

Measure	Scale	Costs	Actors	Workload	Other conditions
Removal of vegetative cover	Unknown	Unknown	- State: regulation - Market: clearing an area - Civil society: clearing an area	Moderate	- The removal of vegetative cover must be allowed by state

Table 26: Characteristics of the removal of vegetative cover

Measure	Advantages	Disadvantages
Removal of vegetative cover	• Increases the visibility of approaching predators • Easily combined with other measures to increase their effectivity	• Reduces the already scarce habitat of tigers and other wildlife • A bare area has to be relatively wide to actually prevent tigers from hunting

Table 27: Identified advantages and disadvantages of the removal of vegetative cover

4.2.10 Water channels
Water channels are being used as a way to prevent HWC. However, tigers are very good swimmers that can easily swim up to several kilometres and can also kill prey in the water (Bear, 1966; Garner, 2013). In the Sundarbans, tigers even swim from India to Bangladesh through the ocean (Montgomery, 2004). Although water channels partially prevent the attraction of tigers by keeping out tiger prey such as deer and boar (Respondent 3, personal communication, June 11, 2018), it is very hard to keep of tigers by water channels and the effects of water channels to reduce HTC are limited. In a cost-effective way, dredging water channels has even less impact than doing nothing. Going beyond, to save human lives, dredging water channels is not supposed to be effective (Barlow et al., 2010; Mukherjee & Mathur, 2012). Instead, closer proximity to rivers is associated with a higher risk for HTC (Soh et al., 2014).
So, because of these limited possibilities of dredging water channels to keep out tigers, this measure is not recommended for reducing HTC and will not be further discussed in this research.

4.3 Reactive measures
4.3.1 Response teams
Tiger response teams play an overarching role in the management of HTC. Teams of trained personal can respond to individual conflicts with a high level of knowledge and expertise. The teams include, among others, rangers who have knowledge about the capture process, veterinarians who provide

medical assistance, for example, to immobilize a tiger (Respondent 2, personal communication, June 4, 2018), members of a National Park and members of the army (Respondent 3, personal communication, June 11, 2018). The goal of these teams is to reduce attacks on people and livestock while minimizing the deaths of tigers (Goodrich, 2010).
Detailed protocols help response teams in decision making, to react in an appropriate way to each HTC (Goodrich, 2010). These protocols should be place specific, for example, because regulation about how to deal with tigers differs per country.
After a response team has investigated a conflict, different actions can be taken depending on the conflict. Among others, response teams can give medical treatment to the injured person (Barlow et al., 2010), chase an animal away by using deterrent measures (Respondent 3, personal communication, June 11, 2018) or translocate a tiger to another place in the wild or to a place in captivity if the tiger is wounded or too young to live in the wild itself. Furthermore, response teams can place camera traps to determine tiger presence (Goodrich, 2010; Respondent 2, personal communication, June 4, 2018), assist people in getting compensation and they can play a role in law enforcement and education (Goodrich, 2010). The application of lethal control by response teams has not been found as they don't kill tigers (respondent 2, personal communication, June 4, 2018), but because of their high expertise they might be able to apply this if required.

Human and livestock safety:
Response teams increase the safety of humans; it's one of the most effective ways to reduce the number of human deaths from HTC (Barlow et al., 2010). Response teams are also effective to increase the safety of livestock because it makes it possible to respond quickly to approached tigers. The effectivity of response teams can be increased by presence of a rehabilitation centre for tigers (Respondent 2, personal communication, June 4, 2018; Respondent 4, personal communication, June 14, 2018). Then, tigers that are temporarily not able to take care of themselves can be rehabilitated in these centres. Thereby, HTC can be reduced because, as already discussed in paragraph 4.2.3, injured tigers are more often involved in HTC by their inability to catch prey, for example.

Conservation of tigers and other animal and plant species:
For the conservation of tigers and other wildlife, response teams are one of most desirable measures to reduce HTC. By the installation of response teams, many tigers are saved (Barlow et al., 2010). Without the ability to call response teams, people often kill tigers themselves after a conflict had happened (Respondent 2, personal communication, June 4, 2018). The number of tigers saved can be further enhanced if rehabilitation centres are present; if response teams work together with rehabilitation centres, which are often privately owned (Respondent 2, personal communication, June 4, 2018), more tigers can be saved by bringing injured animals to these centres. Furthermore, no other animal or plant species experience negative consequences of response teams.

Costs:
According to Barlow et al., response teams are one of the most cost-effective ways to reduce HTC (2010). The reduction of HTC in the Sundarbans by response teams will cost yearly around $20.000 (Barlow et al., 2010). This is comparable with other regions, like in Russia, where costs are estimated to be around $20.000-25.000 a year (Respondent 2, personal communication, June 4, 2018).

Actors:
If a HTC had happened, a response team has to be called directly by local inhabitants or via a governmental department (Respondent 2, personal communication, June 4, 2018; Respondent 3, personal communication, June 11, 2018). As already noticed, response teams consist of a diverse team of experts. Thereby, different actors are involved. For example, people working for the government, NGOs, a veterinarian, the army or National Parks members could be involved in the

teams (Respondent 3, personal communication, June 11, 2018; Respondent 6, personal communication, June 29, 2018).
In addition, local inhabitants can assist the response teams, for example, by helping with the erection of temporary fences (Respondent 6, personal communication, June 29, 2018; Respondent 7, personal communication, June 29, 2018).
For the financing and instalment of response teams different actors can play a role. In Russia, the government and NGOs are both crucial for the existence of response teams. Their dependency is also highlighted by respondent 2: *"… if we or them stop to pay for the response team, I think it will be stopped."* (personal communication, June 4, 2018). Also, in Bhutan both NGOs and governmental actors play a role for the installation of response teams. There, NGOs like WWF play an important role by offering knowledge and financial resources. Governmental actors are also required for financial support and are further responsible for the real implementation and field activities. For example, in areas where depredation on livestock is high, the government of Bhutan is planning to install response teams (Respondent 4, personal communication, June 14, 2018).

Workload:
For a well-functioning response team, members of the team should be available on a daily basis. As already noted, it is important that HTCs are dealt with quickly. Traces and evidence disappear soon and to determine, for example, whether a conflict was accidental or provoked by people, immediate investigation and a fast procedure are required (Nowell & Jackson, 1996).
After calling, the team often arrives within a few hours Respondent 2, personal communication, June 4, 2018; Respondent 6, personal communication, June 29, 2018)). Then, the conflict will be investigated after which it can be decided what to do (Respondent 6, personal communication, June 29, 2018). Depending on the action that is taken, a certain amount of work is required, which can take quite long. For example, only the capturing of a tiger can take around two till seven days (Respondent 6, personal communication, June 29, 2018).

Measure	Scale	Costs	Actors	Workload	Other conditions
Response teams	Large	Medium	- State: regulation, membership of response teams, providing financial resources - Market: providing jobs, veterinary assessment of the tiger - Civil society: inform response teams after a HTC had happened, assist with actions being undertaken NGOs: membership of response teams, providing expertise and financial resources	Intense	- Requires dedicated and educated team members - Local people should have recognition and knowledge about the existence and functioning of response teams

Table 28: Characteristics of response teams

Measure	Advantages	Disadvantages
Response team	• Very effective to increase human and livestock safety • Tigers are being saved • No negative consequences for other animal species than tigers and their habitat • Every conflict can be responded on individual basis	

Table 29: Identified advantages and disadvantages of response teams

4.3.2 Translocation

Tigers involved in HTC can be translocated to locations where HTC is less likely to occur (Loveridge et al., 2010). This could be a location where tigers live in captivity or a site where no or less human activity takes place. However, it can be very hard to identify the tiger that was involved in a conflict, especially if the tiger was not injured and did not enter a human settlement (Sangay & Vernes, 2008; Woodroffe, Thirgood & Rabinowitz, 2005). Despite, "*The proper identification of 'problem animals' is essential for the success of the exercise*." (Fernando et al., 2008, p. 23).
Translocation is not appropriate for all tigers. For example, tigers that *"… lacked the wariness of people that most tigers display …*" are less suitable for translocation in the wild (Goodrich & Miquelle, 2005, p. 546). In most cases, translocation is viable for healthy tigers that have not attacked on people (Lamichhane et al., 2017). 'Problem tigers', tigers that repeatedly, or more often than their conspecifics, come into conflict with humans (Loveridge et al., 2010) or tigers that are unable to survive in the wild by themselves, can be translocated or removed from the wild to prevent the repeating of HTC (Goodrich, 2010; Respondent 6, personal communication, June 29, 2018; Respondent 7, personal communication, June 29, 2018).

<u>Human and livestock safety:</u>
Both human and livestock safety can be increased by the translocation of tigers. According to Löe and Röskaft, it's one of the most effective measures to reduce HTC, because it highly reduces the chance of encounter between tigers and humans or livestock (2004). For translocation, it is required that a suitable substitute habitat with good living conditions for a tiger is found (Goodrich, 2010). However, this can be difficult because suitable habitats for tigers with low conflict potential are very scarce (Barlow et al., 2010; Fernando et al., 2008; Woodroffe, Thirgood & Rabinowitz, 2005) and become even scarcer by human population growth (Bulte & Rondeau, 2005; Joshi et al., 2016; WWF, n.d.2). Even if a suitable place on site is found, success is not always guaranteed. Translocated animals could return to their old habitat (Loveridge et al., 2010) or the translocation may simply relocate the problem. For example, in some cases the translocated tigers *"… moved to areas with high human activity.*" (Goodrich & Miquelle, 2005, p. 456). To prevent defaults like this, the behaviour of the translocated tiger should be taken in mind, for example, by collaring and tracking translocated tigers. If the characteristics of the area, the tiger and its habitat are well understood and taken into account, translocation can increase the safety of both humans and livestock, as many translocations have also led to successful outcomes. In Russia, for example, several successful translocations had taken place where tigers successfully established themselves in the new habitat and did not get into conflict again (Goodrich & Miquelle, 2005; Kostyria et al., 2018), contributing to the safety of both people and livestock.

<u>Conservation of tigers and other animal and plant species:</u>
Although not in all cases, translocation can negatively influence tiger conservation goals. As Woodroffe, Thirgood and Rabinowitz note: *"Most problem tigers that undergo capture and handling are injured in the process…"*. (2005, p. 382). This is not solely hindering the individual tigers, as tigers injured by humans will be involved in HTC more quickly. By proper equipment to capture and transport tigers and by offering rehabilitation for tigers that are, or get, injured during the process, tigers are able to return in the wild in a healthy condition. This reduces the chance that the tiger will get involved in HTC again (Goodrich, 2010; Kostyria et al., 2018).
Not all tigers are equally suitable for translocation, so characteristics like age, sex and physical condition have to be considered before translocating a tiger. For example, young tigers are better suited for translocation than older tigers because young ones are less tied to a strict territory (Goodrich, 2010). Female tigers should get priority to remain in the wild because of their importance to population persistence by their ability to get cubs (Goodrich, 2010). Injured tigers have more

trouble taking care of themselves which causes them to be more quickly involved in a conflict. This makes most of them not suitable for relocation in the wild (Karanth, 2011), and translocating these animals can cause negative conservational outcomes.
As is the case for human and livestock safety, even by taking into account the characteristics of the area, the tiger and its habitat success is not guaranteed from a conservational perspective (Woodroffe, Thirgood & Rabinowitz, 2005). If a tiger is translocated in the wild, the tiger must compete with other animals for space and prey. Due to the fact that tigers are territorial, this could lead to the elimination of the translocated tiger or a tiger from the original tiger population. So, even the translocation of tigers to a protected area with a relatively low population density and high prey density is not always with success, as it is hard for tigers to get their own territory (Goodrich & Miquelle, 2005).
Translocation of tigers to a place removed from the wild is also not without problems because "*Wild tigers do not adapt well to life in captivity…"* (Woodroffe, Thirgood & Rabinowitz, 2005). A suitable place with proper holding facilities has to be found (Goodrich, 2010), which is due to the increasing number of tigers involved in a HTC increasingly difficult to find. For example, the capacity of zoos to hold tigers is not infinite and has reached its maximum in some places already (Woodroffe, Thirgood & Rabinowitz, 2005).
Consequently, the removal of tigers from a habitat, if this is done both for translocation or lethal control, could upset the ecosystem and cause dramatic chances in the population of other species (Ministry of Agriculture and Forests Bhutan, 2018). Furthermore, tigers can get harmed or even die from translocation (Massei, Quy, Gurney & Cowan, 2010) whereby consequences for tiger populations would be comparable with killing tigers (Treves & Karanth, 2003). Therefore, to remove tigers from a habitat without damaging the remaining ecosystem including its populations, a very adequate understanding of the tigers' interactions with its environment is essential (Muruthi, 2005). For example, by eliminating a top predator, how is unsustainable growth of other animal populations prevented? This kind of aspects need to be considered before translocating a tiger. If the tiger is suitable for translocation and a proper, strategic location is available, translocation can contribute to the conservation of tigers. For example, translocating tigers can contribute to the re-establishment of subpopulations and the increase of small tiger populations (Kostyria et al., 2018, p. 31).

Costs:
For the translocation of tigers, several costs must be made. First, a team has to be set up which investigates the situation and take responsibility of the translocation. This could be a response team, which is discussed in paragraph 4.3.1. Secondly, proper translocation equipment must be purchased. According to Barlow et al., the costs for translocation in the Sundarbans will be around $36.000 a year. If a tiger has to be translocated to a place in captivity, the costs will increase considerably. For example, one month food for one tiger costs around $1.500,-. To keep a rehabilitation centre running, yearly costs will be around $150.000,- (WNF, n.d.3).

Actors:
In most areas the translocation of tigers is socially accepted because no tigers have to be killed for this measure (Karanth, 2011). Actors that play a crucial role for the translocation of tigers are the state and civil society. First of all, the translocation of tigers must be allowed by state. The state has to give permission for the capture of tigers, the location where they will be released has to be approved and if tigers are held in captivity, also permission by the state is needed. Local inhabitants are needed to inform the team responsible for translocation when a conflict had happened and can, for example, assist them in erecting temporal fences for tiger capture (Respondent 6, personal communication, June 29, 2018). The team responsible for translocation could be a collaboration between state actors and NGOs like WWF (Kostyria et al., 2018; Respondent 6, personal

communication, June 29, 2018) or WCS (WCS Russia, n.d.3), who can also assist in research and financial support (WCS Russia, n.d.2; WWF Nepal, 2018a). Further, a veterinarian is required to assess the tigers' condition, before it is translocated (Respondent 6, personal communication, June 29, 2018).
Market actors play a role by developing, producing and selling the equipment required for translocating tigers. For example, collaboration between an engineer and WWF leaded to the development of a much lighter cage. This makes translocation easier and less harmful, as people often have to carry the cage, including the weight of a tiger, in the forests through mud and other heavy circumstances themselves (Respondent 6, personal communication, June 29, 2018; Respondent 7, personal communication, June 29, 2018). Furthermore, market actors play a role by developing technologies that automatically report when a tiger enters the cage (Respondent 6, personal communication, June 29, 2018).

Workload:
The relocation of tigers requires, as already noted, a high understanding of the tigers' interaction with its environment. Therefore, extensive and site-specific research is needed (Goodrich, 2010). As discussed in paragraph 4.3.1, a team should be continuously available for the moment a HTC happens. The team must come as soon as possible to the place of conflict to research the situation and decide what to do. Further, the actual relocation of a tiger should be done very accurately, to prevent the tiger from being injured during the process. The final amount of work highly depends on the specific case. For example, in some cases capturing a tiger can take several days. Further, if it is decided to translocate a tiger to a place where it will live in captivity, the daily activities for taking care of the tiger(s) must be considered as well.

Measure	Scale	Costs	Actors	Workload	Other conditions
Translocation	Large	High	- State: regulation, members of teams who are responsible for translocation process - Market: developing, producing and selling equipment for translocation, veterinary assessment of the tiger - Civil society: inform and assist teams when HTC has happened NGOs: members of teams who are responsible for translocation process, contribute to developing equipment for translocation	Intense	- Physical characteristics and condition of the tiger must allow translocation - Requires a suitable place with a low conflict potential for tigers to live on site or, if needed, in captivity

Table 30: Characteristics of translocation

Measure	Advantages	Disadvantages
Translocation	• Very effective to increase human and livestock safety	• Requires a high understanding of the tigers' interactions with its environment, and even than it remains challenging to not harm or disadvantage the translocated tiger

Table 31: Identified advantages and disadvantages of translocation

4.3.3 Lethal control

Another way to remove a tiger from the wild is through lethal control, a measure whereby the animal is killed. This can be necessary in extreme cases were no other measure is appropriate, for example, because a tiger is time after time involved in a conflict and is not suitable for translocation (Goodrich, 2010; Treves & Karanth, 2003; Woodroffe, Thirgood & Rabinowitz, 2005). However, as is already

mentioned, it can be very hard to identify the tiger that was involved in a conflict (Karanth, 2011; Muruthi, 2005; Woodroffe, Thirgood & Rabinowitz, 2005).

Human and livestock safety:

In first instance, lethal control is a reactive measure. A conflict has already taken place so both livestock or human are killed or injured and a tiger is being killed. Thereby, both property and wildlife are lost whereby "… *selective lethal control can frustrate both agriculturists and conservationists …*" (Treves & Naughton-Treves, 2005, p. 103). However, by eliminating problem tigers future conflicts can be prevented.

The extent to which lethal control increases the safety of humans and livestock is disputed. If it is possible to only remove the 'problem' tigers, lethal control may be a useful measure to reduce HTC (Treves & Karanth, 2003). According to Barlow et al., lethal control is one of the most effective measures to save human lives (2010).

In contrast, Treves, Krofel and McManus concluded about livestock safety that "*Non-lethal methods were more effective than lethal methods in preventing carnivore predation on livestock…"* (2016, p. 380). Conflicts may happen in the same areas, even after the removal individual problem animals (Treves, Krofel & McManus, 2016). This has possibly to do with the fact that other tigers will enter the vacated area and make it their territory (Nugraha & Sugardjito, 2009). Further, in some cases lethal control applied to bears led to an increase of livestock predation. As Peebles, Wielgus, Maletzke and Swanson note in their research about cougars: *"…increased young male immigration, social disruption of cougar populations, and associated changes in space use by cougars - caused by increased hunting resulted in the increased complaints and livestock depredations."* (2013, p.1).

Conservation of tigers and other animal and plant species:

By lethal control, tigers are removed from the wild which reduces the already critical low number of tigers. This makes lethal control atrocious to conservationists (Barlow et al., 2010; Goodrich, 2010; Nugraha & Sugardjito, 2009; Woodroffe, Thirgood & Rabinowitz, 2005). As it is very hard to identify the tiger that became into conflict, often multiple tigers, of which some were not involved in a conflict, and other animals are being killed before the intended tiger is found (Karanth, 2011; Treves & Karanth, 2003). Often, population reduction leads to an increased birth rate (Muruthi, 2005), but this does not seem to happen fast enough to stabilize tiger populations, considering their large decline in numbers (Kostyria et al., 2018).

In order to minimize the negative consequences, it is desirable that the execution of lethal control is performed by properly trained staff (Muruthi, 2005). These teams can identify individual problem animals to selectively kill them. To further reduce the ecological impact of lethal control, it can be decided to kill only the tigers that have killed at least two people, as research in both the Sundarbans and Nepal has shown that only half of the tigers that kill people do this more than once (Barlow, 2009). However, by doing so, action is being undertaken after a second person is killed or injured. This could possibly lead to resistance from the community, so a thoughtful consideration has to be made.

A positive consequence of lethal control is that the removal of problem animals can prevent a deteriorated attitude towards tigers. As Madden notes:

> … consider a community that is repeatedly harassed by an old tiger that can no longer hunt wild prey. If the community lacks the means to eliminate or correct the problem, an otherwise tolerant community may turn against the protected area authorities and develop a negative attitude toward all tigers in the area, arbitrarily retaliating against the population of tigers, rather than targeting the one that caused the initial conflict. (2008, p. 201).

Costs:
According to McManus, Dickman, Gaynor, Smuts and MacDonald: "*… non-lethal methods of human–wildlife conflict mitigation can reduce depredation and can be economically advantageous compared to lethal methods of predator control*." (2015, p. 687). After investigating a conflict situation, the tiger has to be killed and no further or maintenance costs have to be incurred. The costs for lethal control are medium; to reduce HTC in the Sundarbans by lethal control, costs will be around 20.000 a year (Barlow et al., 2010).

Actors:
As is the case for translocation, local inhabitants are the ones who can inform teams about a conflict that has occurred. Although practically not necessary, it is desirable that a team of well-trained personnel is responsible for the execution of lethal control. For example, a failed killing attempt, whereby the tiger only gets injured, can cause HTC. To prevent this, the killing of a tiger must be performed properly (Madden, 2008).
By investigating HTC situations individually, response teams, as discussed in paragraph 4.3.1, can decide in which cases it is appropriate to apply lethal control. The actual killing of a tiger has to be done by someone who has a permit to do so. This could be a veterinarian or someone from the army, by which a problem tiger was killed in Nepal, for example (Lamichhane et al., 2017).
According to Karanth and Gopal, the killing of 'problem tigers "*… has been widely accepted and practised by local people…"* in India (2005, p.381). However, the opposite is currently more often found. Formerly, lethal control was a common way to reduce HTC, but since tiger populations have decreased tremendously popularity of lethal control decreased. For example, in countries where tigers are present, governments have imposed regulation against the killing of tigers making the state an important actor (Respondent 4, personal communication, June 14, 2018; Respondent 5, personal communication, June 18, 2018; Saif, Rahman & MacMillan, 2016; WWF, 2012). Going beyond, due to religious beliefs, as also indicated in paragraph 2.2, in many areas like India and Bhutan, the killing of animals and tigers is not allowed and accepted (Kolipaka et al., 2015; Respondent 4, personal communication, June 14, 2018; Respondent 5, personal communication, June 18, 2018). Also, urban advocacy groups often oppose the killing of tigers (Woodroffe, Thirgood & Rabinowitz, 2005, p. 381). Thereby, possibilities to apply lethal control are constrained (Massei et al., 2010) and little literature about the legally organized killing of tigers is available.

Workload:
Lethal control is a measure that should not be done on a regular basis. Extensive research is needed, to precisely decide in which exceptional cases it can be appropriate to kill a tiger (Goodrich, 2010; Treves & Karanth, 2003). When it is decided to kill a tiger, the resulting required action is relatively inexpensive in terms of time. As already noted, after investigating the situation and killing a tiger, no further action or maintenance is required.
If only the cases that lethal control gets applied are considered, workload will be low as these include some exceptional cases only. However, if investigating each HTC situation is included, as this is required before knowing if lethal control should be applied, the required workload is much higher.

Measure	Scale	Costs	Actors	Workload	Other conditions
Lethal control	Large	Medium	- State: regulation, applying lethal control - Market: applying lethal control by veterinarians - Civil society: inform teams after a HTC has happened	Low-Moderate	- The killing of tigers should be allowed and accepted - The killing of tigers has to be done by well-dedicated people

Table 32: Characteristics of lethal control

Measure	Advantages	Disadvantages
Lethal control	• Highly reduces human deaths • Removes possible repeat offenders	• Diminishes the number of tigers • Requires high understanding of the tigers' interaction with its environment

Table 33: Identified advantages and disadvantages of lethal control

4.3.4 Deterrent measures

Different deterrent measures can be used to scare tigers away. Their effectivity highly depends on the way stimuli are provided. Treves and Karanth state: *"… note the great potential of these devices if stimuli vary unpredictably and if the devices are triggered by the behaviour immediately preceding conflict with humans*" (2003, p. 1495).

To start with, ***sound and visual signals*** can be used to deter tigers. For example, sound and light signals are combined to scare tigers away by lighting off fire crackers. To protect livestock flags can be used, probably in combination with fencing. However, flags are constantly present, so tigers get used to it easily. Thereby, this measure has little potential to be effective in the long-term (Treves & Karanth, 2003). ***Chemicals*** or ***taste aversion*** that cause an aversive reaction can also be used to deter tigers. It is impossible to make a direct connection between predatory behaviour and the ingestion of chemicals (Treves & Karanth, 2003). For example, chemicals can be inserted on carcasses. However, this way of deterrence has regularly unpredictable and unintended negative consequences for other species than tigers (Anwar, Saralch & Kumar, 2015; Treves & Karanth, 2003). For example, for the survival of tigers it is needed that they also prey on animals that are not inserted with chemicals. In combination with the fact that tigers also prey on non-inserted animals, this way of deterrence is not very effective to stop an upcoming, or prevent future HTC. Finally, ***rubber bullets*** can be used to chase tigers away. However, this is not recommended because the use of it is dangerous (Goodrich, 2010) and stray bullets possibly injure tigers and other non-targeted individuals. In table 34 an overview of different deterrence and some of their characteristics is given.

Ways to deter tigers	
• Sound signals	- Effective if stimuli vary unpredictable and is triggered by the behaviour directly preceding HTC
• Visual signals	- Effective if stimuli vary unpredictable and is triggered by the behaviour directly preceding HTC
• Chemicals and taste aversion	- Generates unpredictable and unintended negative consequences for non-target species - Stimuli cannot consequently precede predatory behaviour
• Rubber bullets	- Dangerous in use

Table 34: Different ways to deter tigers

Due to the limited or negative effects of the use of chemicals and rubber bullets, this paragraph will focus on the use of sound and visual signals.

<u>Human and livestock safety:</u>

As noted, deterrent measures can be used to increase the safety of livestock and people if the stimulus is unpredictable and is triggered by the behaviour directly preceding HTC. Research into the effectiveness of continuous present scarecrows for deterring predators like lions and hyenas indicated that the usage of this could increase the number of conflicts, instead of reducing them. Possibly, animals get attracted by the visual movement (Woodroffe, Frank, Lindsey, ole Ranah & Romanach, 2006), but it is not certain whether this also applies for tigers.

In practice, livestock is not always being watched and the moment directly preceding a HTC is often

not observed, making it difficult to provide unpredictable stimuli that precedes a conflict (Goodrich, 2010). Different technologies can provide a solution for this, for example by automatically detecting the presence of tigers. Therefore, it is useful to combine detecting devices (see paragraph 4.2.5) with deterrent measures. Deterrent measures can also be used by herders. Then, the herder can chase an approaching tiger away to increase the safety of the livestock and himself. Although some deterrent measures can easily be used individually, it is required that the use and effects of deterrent measures are considered on a broader scale to prevent displacement of the problem. As Karlsson and Johansson note about the individual use of deterrent measures: *"… predators may focus on neighbouring farms instead, which would not reduce total depredation numbers*." (2010, p. 170).

Conservation of tigers and other animal and plant species:
The consequences for tigers and other animal and plant species depend on the way that is used to deter tigers. Sound and visual signals can affect non-target species, for example, by scaring away other animals than tigers. Also, light signals can influence plant species (Kami, Lorrain, Hornitschek & Fankhauser, 2010). However, if the signals are only provided occasionally when a tiger is about to attack, these effects are neglectable.

Costs:
The costs for deterrent measures can be low. For example, fire crackers are relatively cheap and affordable for individual farmers (Respondent 4, personal communication, June 14, 2018). In some cases, controlling deterrent measures requires no additional activities and costs, as, for example, a herder can carry a deterrent measure. In other cases, the controlling of deterrent measures is regulated more commonly. For example, a person in a watchtower can watch over an area to control the deterrent measure when a tiger is approaching and about to attack (Respondent 4, personal communication, June 14, 2018). Then, continuous labour costs have to be incurred as well. Deterrent measures could also be controlled automatically. However, this increases the investments costs substantially (Goodrich, 2010), as these technologies should be combined with detection systems which are very expensive.

Actors:
To start, market actors play a role in the production and selling of deterrent measures. Most deterrent measures are individually owned as they have a limited reach. Individual farmers can buy and use deterrent measures themselves (Respondent 4, personal communication, June 14, 2018). For more communal use of deterrent measures, labour should be provided by someone watching an area. State actors can contribute to this financially, for example, by providing loan for this (Respondent 4, personal communication, June 14, 2018). If deterrent measures are automatically controlled and combined with detecting technologies, community-based ownership is more obvious, and costs can be shared. Then, the actors and roles described in paragraph 4.2.5 also account here.

Workload:
The workload required for deterrent measures depends on the way the deterrence is regulated: is it served manually or automatically? If it is chosen to control deterrent measures manually, daily and ongoing observation is required to take action at the moment a tiger is about to attack (Respondent 4, personal communication, June 14, 2018). Automatically regulated deterrent measures require less workload; this only requires regular maintenance to check and probably repair the system (see paragraph 4.2.5).

Measure	Scale	Costs	Actors	Workload	Other conditions
Deterrent measures	Small-Medium	Low-high	- State: providing financial resources	Moderate-intense	- Stimuli must be unpredictable and triggered by the behaviour immediately preceding HTC

			- Market: production and selling - Civil society: individual or community-based ownership		

Table 35: Characteristics of deterrent measures

Measure	Advantages	Disadvantages
Deterrent measures	• Relatively cheap and easy for herders to use to increase the safety of the herder and his livestock	• Requires intensive work (if manually regulated) or intensive investment and knowledge expertise (if automatically regulated) • Without coordinating the use of deterrent measures above individual level, it possibly leads to the displacement of HTC

Table 36: Identified advantages and disadvantages of deterrent measures

4.4 Mitigative measures

4.4.1 Compensation programs

Financial resources or in kind assistance can be provided to people who have been confronted with HTC to compensate for damage as a result of HTC (Nyhus & Tilson, 2004). Thereby, consequences of HTC are mitigated.

Human and livestock safety:

By this measure, the financial impacts for the ones involved in HTC are reduced. Thereby, this measure increases the 'safety' of people in a material way; it makes people able to deal with the consequences of HTC more easily. For example, if livestock is killed by tigers, farmers can purchase new animals with the obtained compensation.

Compensation programs for the losses of human lives are more often successful than compensation programs for the losses of livestock, "… *because attacks on humans are rare in most areas and claims are more easily verified*." (Goodrich, 2010, p.304). The success of compensation programs for livestock depredation can be enhanced by setting different requirements on the compensation (Goodrich, 2010). For example, if compensation is only given to farmers that take different measures to protect their livestock, like fencing or limiting grazing during certain times or in specific areas, farmers are stimulated to prevent HTC themselves and the number of applications for compensation can be reduced. Without these requirements, compensation could lead to less risk-aversive behaviour increasing the chance of HTC to occur (Nyhus et al., 2003).

Conservation of tigers and other animal and plant species:

Compensation programs do not directly increase the number of wildlife or plant species or the amount of wildlife habitat. However, by the increased ability to deal with the consequences of HTC, compensation programs indirectly contribute to conservation goals. Compensation programs reduce the killing of tigers in retaliation by improving the local acceptance of tigers (Fernando et al., 2008; Goodrich, 2010; Okello, 2005). According to Nyhus et al., a fast handling and payment "… *can help victims to get over their anger or urge to retaliate …*" (2003, p.38) and it "… *can temper the anger of wildlife damage victims and reduce retaliation against animals or conservation authorities …*" (2003, p.40).

Costs:

The success of compensation programs partly depend on the amount of money that is provided as

compensation. If compensation is high and is only available for conflicts involving tigers, compensation programs can lead to false claims and failure (Ferdinand et al., 2008; Goodrich, 2010; Löe & Röskaft, 2004). As Kolipaka notes: "*In Gir forests the local pastoralists tolerated lions killing their buffalos because they earned more money from the local park management's compensation scheme."* (2018, p. 64). On the other hand, low pay out costs could miss the ameliorated human attitudes towards tigers and may also result in a lack of conflict notification.
It is not straightforward to decide which amount of compensation is appropriate (Owen, 2013). For example, should compensation be given for the value a young animal has when being killed, or for the value the animal would have when being mature? Should compensation transcend the market value to compensate for the cases that are not verified? Should there be a compensation for the trauma or time being taken by a conflict? If a human is killed, how would one value this in monetary terms? These are all questions that need to be considered when setting up a compensation program (Nyhus et al., 2003).
The actual costs for compensation programs highly depend on the amount of money that is given as compensation but are generally relatively high. The amount of compensation differs between states (Fernando et al., 2008) and should be place specifically chosen by taking local conditions and interests into account. For example, in Nepal compensation for someone who is injured by wildlife will vary between $270,- and $2.700,-, depending on the severity of the injuries. Compensation for the family of a person killed by wildlife can rise to about $14.500,- (Mandal, 2017). Despite, compensation is still too low in Nepal for people to be satisfied with it (Respondent 3, personal communication, June 11, 2018).
Disadvantageous of compensation programs is the fact that it requires a constant influx of money. Thereby, this measure is financially dependent on donors and hard to sustain on the long-run (Respondent 2, personal communication, June 4, 2018; Respondent 5, personal communication, June 18, 2018; Treves, 2009), a problem that could be avoided by insurance programs (see paragraph 4.4.2).

Actors:
Governments and NGOs play a crucial role by financing compensation programs (Nyhus et al., 2003; Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018; Respondent 6, personal communication, June 29, 2018). However, as already noted, compensation programs need a permanent influx of money. Therefore, some NGOs, like WWF Russia, do not support this measure. As Respondent 2 notes: *"… if the government doesn't have money for this then we have, we have money ... But it does not work, we can't have money for the, hundred years."* (personal communication, June 4, 2018). Also, governments are not always supporting compensation programs. If they do, success is not guaranteed because government corruption causes various compensation programs to fail (Goodrich, 2010; Nyhus et al., 2003).
A team of trained personnel has to verify every reported conflict, creating jobs and labour. To decrease fraud and increase trust and transparency, it is desirable that verification is carried out by experts who work independently from the organization distributing thee compensation (Nyhus et al., 2003). For example, in Bhutan verification is done by people working for the forestry sector (Respondent 4, personal communication, June 14, 2018).
Local communities play a role in the design of compensation programs. By community involvement, support for and knowledge about the compensation programs can be created (Nyhus et al., 2003), which is important as local inhabitants are the recipients of compensation.

Workload:
As is the case for other measures, like response teams, compensation programs require extensive research after a HTC had happened, and it can be hard to verify a claim because it sometimes difficult

to prove that a tiger was involved (Goodrich, 2010; Respondent 3, personal communication, June 11, 2018; Respondent 4, personal communication, June 14, 2018). Verification is even one of the most critical compensation challenges according to Nyhus, Fischer, Madden and Osofsky who note: "*Spoor and other evidence of predation can disappear quickly. Even when investigation ensues immediately, the true cause of death may never be found.*" (2003, p.38). Therefore, it is required that notifications of HTC are dealt with quickly. In addition, a slow handling and payment process, which is sometimes difficult to prevent in rural areas (Goodrich, 2010), can prevent people from reporting conflicts (Löe & Röskaft, 2004; Respondent 4, personal communication, June 14, 2018). Ideally, verification takes place within only a couple of days (Nyhus et al., 2003), so a team should be available on a daily basis. In practice a fast handling is not always realized (Goodrich, 2010; Madhusudan, 2003; Respondent 4, personal communication, June 14, 2018). For example, "*In one area of India, it reportedly takes months before anyone officially verifies an attack-if at all.*" (Nyhus et al., 2003, p.38) and also respondent 3 notes: "*So, the people I met who asked for compensation, they, they didn't receive it or it was too low or too long, so they were not really happy with it …"* (personal communication, June 11, 2018). Going beyond, Veeramani, Jayson and Easa (1996) state that only 20% of the compensation claims relating attacked livestock, and only 14% of the claims that concern humans involved in a conflict was disbursed.

Other aspects:

It is important that compensation programs are generally accessible. For example, in Nepal people have to go to town to apply for compensation, which not everyone is able to due to lack of money or transport (Respondent 3, personal communication, June 11, 2018). This makes the program not well adapted to the local conditions and compensation that is not equally accessible can even contribute to inequality (Treves, 2009).

Further, compensation for other causes of death, such as other depredating species than tigers is desirable. Otherwise, conflicts between recipients of compensation and those who verify a claim can easily come about, especially if the cause of conflict is questionable (Nyhus et al., 2003). In addition, by a lack of compensation for damage caused by other animals than tigers, tigers can still be killed when people target, in retaliation, on other wildlife through poisoning or traps, for example (Anwar, Saralch & Kumar, 2015; Goodrich, 2010).

An additional advantage of compensation programs is the fact that they stimulate people to report attacks by possibly gaining a benefit from doing so (Löe & Röskaft, 2004). Thereby, HTCs can be monitored more easily.

Measure	Scale	Costs	Actors	Workload	Other conditions
Compensation programs	Large	High	- State: ownership, providing financial resources - Market: providing jobs - Civil society: participation in the design, recipients of compensation NGOs: providing financial resources	Intense	- To prevent people from showing less risky behaviour, requirements for obtaining conservation must be determined - Compensation should also be available for other depredating species than tigers to ensure the relationship between farmers and experts who verify a claim and reduce retaliatory killing - A fast handling is required to satisfy people with compensation and reduce retaliatory killing - The organisation that is disbursing the compensation should be separated from the organisation verifying the claims to increase trust and transparency

					- Compensation should be easily and equally accessible for local people

Table 37: Characteristics of compensation programs

Measure	Advantages	Disadvantages
Compensation programs	• Can increases tolerance towards tigers • Creates stimulus to report attacks making monitoring of HTC more easily	• Financially hard to sustain in the long run • If compensation is not equally accessible, it can increase inequality

Table 38: Identified advantages and disadvantages of compensation programs

4.4.2 Insurance programs

Insurance programs are partially comparable with compensation programs; for both measures financial aid is given to compensate for losses due to HTC. The difference lies in the way by which the compensation is financed (Fernando et al., 2008). Therefore, this paragraph focuses on the costs, the actors that are involved and the workload that is required for insurance programs. More information about the way this measure contributes to the safety of humans and livestock, the ecological consequences, the workload required and other requirements can be found in paragraph 4.4.1.

Costs:

By insurance programs, people have to insure themselves before getting a compensation (Goodrich, 2010; Respondent 2, personal communication, June 4, 2018). Thereby, insurance programs create a revenue model by which the compensation can be financed. This makes insurance programs better able to persist on the long run than compensation programs (Nyhus et al., 2003).

The success of insurance companies can vary highly; some of them make a profit while others make a loss. This has, among others, to do with the number of people that insure themselves and with the amount of compensation that must be paid out. As is the case for compensation programs, it is very hard to decide which amount of money is accurate to compensate for losses due to HTC (Pol, 2005) and must be location specifically chosen. The total costs for insurance programs are comparable with the costs for compensation programs, as both measures offer a comparable amount of financial compensation for losses due to HTC.

Actors:

Insurance can be made obligatory by governmental actors. For example, in some areas in India people have to get insurance before they are allowed to enter the forests (Respondent 6, personal communication, June 29, 2018). Insurance companies and banks, which can be (partially) governmental, play a crucial role by offering insurance (Townsend, 1995) aim to prevent losses and ideally generate profit. If different insurance companies exist and compete, it will be tried to keep prices of insurance low. To minimize expenses, insurance companies stimulate private actors to prevent HTC, for example, by only offering compensation to farmers that has taken measures to prevent HTC (Goodrich, 2010).

Also, governmental and community-based insurance programs exist (Respondent 4, personal communication, June 14, 2018), for which financial support is provided. For example, in Nepal, WWF and the National Trust for Nature Conservation installed a community-based insurance system whereby the money is managed by the community itself. The money for insurance is very low, while the financial compensation is ninety per cent of the loss. This makes the program very accessible for local people which are sometimes poor or don't have access to transport (Respondent 3, personal communication, June 11, 2018).

Other aspects:

Due to the fact that people must insure themselves to get insurance, insurance programs are not accessible to all. For example, people with very low income may not be able to take insurance. Insurance programs can therefore contribute to inequality (Townsend, 1995), even more than compensation programs, as a larger portion of poorer people might not be able to afford insurance than compensation. To minimize this, it is important to keep the insurance as affordable and accessible as possible.

Measure	Scale	Costs	Actors	Workload	Other conditions
Insurance programs	Large	Low	- State: regulation, ownership, providing financial resources - Market: providing jobs, ownership - Civil society: ownership, users of insurance NGOs: providing assistance and financial resources	Intense	- Insurance should also be available for other depredating species than tigers or causes of death to reduce retaliation killing and to ameliorate relationship between farmers and experts who has to verify a claim - A fast handling is required to satisfy people with insurance and reduce retaliatory killing - The organisation that is disbursing the insurance should be separated from the organisation verifying the claims to increase trust and transparency - Insurance should be easily accessible for local people

Table 39: Characteristics of insurance programs

Measure	Advantages	Disadvantages
Insurance programs	• Can increases tolerance towards tigers • By (partly) creating its own income model, it is better persistent for the long-term • Creates stimulus to report attacks making monitoring of HTC more easily	• Can increase inequality

Table 40: Identified advantages and disadvantages of insurance programs

4.4.3 Incentive programs

Incentive programs, for example certification programs, can stimulate people to work in a way that has less negative impact on tiger populations and is less prone to HTC. Little data about incentive programs to reduce HTC could be found in practice (Respondent 2, personal communication, June 4, 2018; Respondent 3, personal communication, June 11, 2018) and literature, but to contribute to the little existent data available it is, as complete as possible, integrated in this research.

Human and livestock safety:

In order to save human lives, alternative sources of income can be provided for the ones doing jobs that face high risks for HTC (Pettigrew et al., 2012). This can be stimulated by, for example, certification schemes; certifications can be given to products or services that meet certain requirements for worker safety, wages and living conditions (Auld, Gulbrandsen & McDermott, 2008). By doing so, the chance of HTC can be reduced while working conditions can be improved. Incentive programs that are used for the conservation of snow leopards have resulted in positive outcomes for people as well by leading in some places to higher local income (Goodrich, 2010). Also, tourism, which is possibly increased by tiger presence and the associated protected areas, provides livelihood for local inhabitants (Respondent 6, personal communication, June 29, 2018). However,

due to the many types of incentive programs and little data about them, it is unclear to what extent incentive programs can increase human and livestock safety.

Conservation of tigers and other animal and plant species:
By integrating ecological aspects in the design of incentive programs, positive ecological outcomes can be generated. For example, certifications can be given to products that are produced under 'conservation-friendly' circumstances, for example, by improved livestock management practices (Goodrich, 2010). Further, incentive programs that are used for the conservation of snow leopards resulted in an increased density of wild prey (Goodrich, 2010). Thereby, ecological consequences possibly transcend tiger conservation; it can lead to the protection of different animal species and entire habitats. However, as is the case for increasing human and livestock safety, it is due to the limited data available unclear to what extent incentive programs contribute to conservation goals.

Costs:
No specific information about the costs for incentive programs was found.

Actors:
Incentive programs are mainly focused on market forces, so market actors play an important role. In many cases, a change of the practices of market actors is needed. Governments and NGO's can contribute to incentive programs financially; many programs are in the beginning paid by external inputs (Treves, 2009) such as subsidies. In the course of time, some become self-sustaining (Goodrich, 2010). Four examples of possible incentive programs and the roles of possible corresponding actors will be discussed.
First, certification programs can provide a stimulus for changing market practices to make them safer or more conservation friendly. For example, a green label can be provided to producers of electric wires that make sure who is buying their products, don't sell wires with very high capacity and take other measures that could contribute to a reduction of HTC (Respondent 5, personal communication, June 18, 2018). For this, it is required that market actors are willing to install incentive programs (Treves, 2009) and have an attitude and (work) environment that is open for change.
In Nepal, an example of an incentive program was found by buffer zone committees providing a soft-loan to people that want to start an income generating activity. The money for this is given by an NGO to the buffer zone committee. By doing so, the community is managing the money and activities that take place, and local people are encouraged to start income generation activities they want to do themselves. For example, if someone wants to start goat farming or offer night stay when living close to a National park, they can apply for a soft loan to get money for starting this (Respondent 3, personal communication, June 11, 2018).
Another example can be made from the production of honey. As already noted, honey collectors are at relatively high risk of HTC, and dozens of them die every year due to tiger attacks (Respondent 6, personal communication, June 29, 2018). In India, the government, in collaboration with WWF, installed fenced camps with boxes for bees to produce honey. Thereby, a safe working environment for honey collectors is created, and their livelihood is secured (Respondent 6, personal communication, June 29, 2018).
A final example can be made from a project by which solar street light is provided by WWF in areas that were not electrified (Respondent 7, personal communication, June 29, 2018). By this light, which is initially paid and installed by the WWF, people can better oversea the area and can more safely walk as the light deters wildlife (Respondent 6, personal communication, June 29, 2018; Respondent 7, personal communication, June 29, 2018). By connecting the energy that is generated by the solar panels with individual households, people are stimulated to take responsibility of the panels, and thereby the street lights, creating a self-governance system whereby the role of WWF largely

disappears. As people get something in return, for example light in their house, people are willing to take care of the required maintenance. As respondent 6 notes about someone who receives part of the energy produced: "… *now it's her responsibility, if she continuous to get these services she has actually to maintain these lights and now these batteries, they're actually hosted inside the houses, to see the security that it doesn't get stolen*." (personal communication, June 29, 2018). In addition, as people can be more productive at home by receiving electricity; children can start studying and adults can start making products and opening shops at home. Thereby people are less dependent on the forests and have less time to go into the forests, reducing HTC even more (Respondent 6, personal communication, June 29, 2018; Respondent 7, personal communication, June 29, 2018).

Workload:

No specific information about the workload needed for incentive programs was found, and is highly dependent on the program that is implemented.

Measure	Scale	Costs	Actors	Workload	Other conditions
Incentive programs	Unknown	Unknown	- State: setting up incentive programs, providing (financial) resources - Market: changing activities - Civil society: manage incentive programs NGO's: setting up incentive programs, providing (financial) resources	Unknown	- Requires an attitude and (work) environment that is open for change

Table 41: Characteristics of incentive programs

Measure	Advantages	Disadvantages
Incentive programs	• Could provide an internal stimulus for actors to contribute to reducing HTC and tiger conservation, by seeing something in return	• In many cases dependent on market forces and external inputs

Table 42: Identified advantages and disadvantages of incentive programs

5. Conclusion and discussion

In this chapter, an answer to the main research question will be given. In addition, the evaluation of HTC reduction will be discussed from a broader level; next to the successfulness of individual measures, what is required to reduce HTC in general? After this, a comparison will be made between literature and interview results, and it will be discussed how possible differences could be explained. Then, a critical reflection on the way of data collection and analysing will be provided. The section ends with some recommendations for both further research and for more practical applications in the reduction of HTC.

5.1 Conclusions

With the obtained results, the following question: *"To what extent are different measures to reduce human-tiger conflicts successful in avoiding and managing HTC?"* can be answered.

To reduce HTC in an effective, long-term way, it is required that, while actors get intensively involved, different measures get combined and are place specifically chosen. Depending on environmental and social factors, a particular set of measures is appropriate to reduce HTC in an area; no single strategy to reduce HTC exists. However, something can be said over the way a well-considered set of measures can be chosen.

Despite the fact that the appropriateness of different measures is highly context dependent, some conclusions can be made about the effectiveness of different measures in general (see appendix 1 for an overview of all measures).
First of all, land use planning, the management of wild prey, education and training and the presence of response teams are for any area highly recommended to reduce HTC in the long-term and on a large scale, as they reduce HTC most integrally. Although these measures face relatively high costs and an intensive workload, these measures are very effective in reducing HTC. These measures tackle the core causes of HTC; an increasing competition between human and tigers for space and an ignorance of people about how to deal effectively with HTC. In addition, these measures can highly increase the safety of humans and livestock, contribute to conservation goals and easily fit within different contexts. By land use planning, space for both people and tigers can be secured. The management of wild prey is unavoidable if tiger populations are going to be maintained. There has to be a considerable amount of prey animals for tigers to survive. The main advantage of education is the fact that it fights against HTC in a structural way. By teaching people about HTC and ways to reduce this, a bottom-up approach is used which is, by increasing people's awareness and knowledge, sustainable to be effective on the long-term. Response teams consisting of trained experts can, in a skilful way, respond to HTC situations at the individual level, for example, by translocating a tiger if required and suitable. Thereby, different interests and factors can be balanced to react to each case in the most appropriate way. Challenging is the fact that all these measures require actions being taken by, and cooperation between different actors. For this, coordination between and commitment of the different actors is essential.
Remarkably, a mitigative measure is not included in these highly recommended measures. In practice, compensation programs, insurance programs and incentive programs offer several difficulties and their contributions are limited; they mainly provide financial compensation for the ones involved in a HTC. To reduce HTC, none of these individual measures were regarded as essential. Despite, insurance programs are, although to a lower extent, recommended to deal with the consequences of HTC more easily. In contrast to compensation programs, insurance programs are sustainable for the long run by creating an independent income model and they stimulate people to take HTC reduction measures themselves.
Next to the abovementioned highly recommended and highest recommended mitigative measure,

more preventive and reactive measures are required to deal with HTC in a sufficient way. However, some of the measures are not recommended at all. Due the physical characteristics of tigers, water channels and fences made from stone or wooden walls are not effective in keeping tigers out to increase the safety of people and/or livestock, whereby these measures are not recommended to reduce HTC. The remaining measures discussed in this research are all appropriate to reduce HTC. Their appropriateness is, however, to a higher degree location dependent, making them in general terms less strongly recommended. For example, fences and herders can reduce HTC in areas where livestock is grazing freely. Guard animals are relevant for people having livestock or people going into the forests themselves. Masks are also relevant for people who go into the forests but will only be worn if there is a considerable chance of encountering a tiger. Early detection and warning systems can be used if common support, for example to realize financing, is present. Deterrent measures can also be used by people who go into the forests themselves, or in combination with fences or early detection and warning systems. The removal of vegetative cover can increase the visibility of approaching predators locally, so that tigers are more easily detected. Translocation and applying lethal control can be very effective in specific cases, but are not recommended in general, for example because these measures are, or can relatively easily influence tiger populations negatively. Insurance programs are financially very hard to maintain on the long-run. Finally, the contributions of incentive programs to reduce HTC are to a large extent still unknown.

Besides the different pros, cons and effectiveness of each individual measure, synergies can be sought for when measures get combined. For example, the wearing of masks by herders is a relatively simple and cheap way to increase the safety of herders. If the amount of wild prey is increased, fences can prevent a rising number of tigers from predating on livestock. The removal of vegetative cover can increase the effectivity of fences by preventing electrical leakage and preventing tigers from using plants to climb over the fence. Measures such as education, compensation and insurance programs can decrease retaliatory killing and thereby reduce the amount of injuries to tigers. A search for these synergies is, taking local conditions into consideration, highly recommended as they can transcend the individual contributions and possibly lower the costs that would have to be made separately.

As is the case for all measures, the implementation can take different forms and must be adapted to the location, taking local conditions into consideration. Actors can contribute to HTC reduction in different ways. Although different actors have various possibilities to contribute to the success of HTC reduction measures, something can be said about their roles in general. Governmental authorities have, among others, the exclusive authority to impose binding regulation and prohibit or allow certain activities, which is, for example, required for land use planning and applying lethal control. Most measures for which the state can be supportive operate on a large scale, which is possible due to their jurisdiction over a particular territory. On the one hand this offers the benefit that a large area can be incorporated, but on the other hand, as this territory involves many other actors, state actors always have to involve other actors in HTC reduction to create support for their activities. For measures that operate on a small scale, such as the wearing of masks and the use of deterrent measures, the state is not a necessary actor to be involved.
The role of market actors in reducing HTC is more limited, but not less important; market actors are often required for the production and innovation of several HTC reduction measures. Notably, most of the measures in which market actors are involved focus mainly on increasing human and livestock safety. For example, measures such as fences, masks, clearing of vegetative cover and deterrent measures do increase human and livestock safety but do not offer major contributions for the conservation of wildlife and their habitat. As market actors want to make a profit, they focus on measures that offer opportunities that people want to pay for, which is people's own and their

livestock's safety.
Notably, the civil society must, or can, play a contributing role in each HTC reduction measure examined. As local inhabitants are the ones 'in the field' of places where HTC occurs, they are in most cases first aware of a conflict. Thereby, an important role for them is to inform other actors about an occurred conflict. In addition, local inhabitants have to implement and take ownership of many HTC reduction measures themselves. For measures operating on a small scale, such as herders and the wearing of masks, local inhabitants are often the ones that have to take ownership. For measures operating on a larger scale, the civil society is more complementary required by informing and providing support for other actors involved. NGOs generally provide a supportive role by providing knowledge or financial resources. The measures in which NGO's can be supportive, such as education and training, land use planning, the management of wild prey, reducing injuries to tigers, response teams etcetera, provide high contributions to conservational outcomes. This is in accordance with the role of NGO's, as they generally focus on social issues that are beyond the individual level, such as wildlife conservation.

Despite the contributions that individual actors can provide, different actors have to be involved in the design, implementation and maintenance of a measure.
First, this is important because the different actors have distinct authorizations and possibilities to handle. Although no specific roles of actors are related to the success of HTC reduction measures, actors are both dependent on, and complementary to each other making the involvement of different actors essential. For example, for translocating tigers, state actors are indispensable by providing regulations about the translocation of tigers, while market actors are required for the development and production of suitable equipment, and local inhabitants have to call the designated team to inform them about an occurred conflict. Thereby, all actors are required for the success of this measure. Especially for measures that are effective on a large scale, such as land use planning and response teams, actors are dependent on each other and can't implement these measures successfully on their own. In addition, even measures that do not require the involvement of different actors, have in most cases proven to be more effective if different actors get involved. For example, fences that are collaboratively installed and owned have shown more success than fences installed and owned by one actor only. The measures that are effective on a small scale, such as herders, guard dogs, and masks, don't require the involvement of different actors and can be successfully implemented individually. However, their reach and effectivity is also limited.
Second, different actors must be involved because support for a measure can be created by involving different actors. This prevents the counteracting or destruction of measures and stimulates proper maintenance, which is decisive for the success of many measures. For example, in many cases fences have proven to be effective only in places with a high involvement of different actors, as otherwise no one takes care of the maintenance which is crucial for its success. In addition, many requirements for different measures concern the involvement of, or relationships between different actors. For example, land use planning and response teams require close interaction between different actors, such as governmental actors and local inhabitants. For compensation and insurance programs, a certain level of trust between actors is required. For response teams, translocation and lethal control a certain level of collaboration is required, so that the right people get informed and are able to take action in a proper way.

By a combination of measures based on place specific conditions, involvement of different actors and by taking a general and overarching perspective, possible trade-offs and displacement of the problem can, and has to be prevented to successfully reduce HTC. For example, by taking an entire area or village into consideration, fencing by only one farmer causing tigers to prey upon the neighbour's livestock can be prevented. Going beyond, by managing the amount of wild prey without considering

the core causes of the low number of prey animals, like a reduced habitat, the increasing of prey will not lead to tiger prey populations that will survive in the long run. Therefore, also habitat must be secured, for example by land use planning.

So, although land use planning, the management of wild prey, education and training and the presence of response teams are highly recommended to reduce HTC, other preventive, reactive and mitigative measures based on both local, social and ecological conditions are indispensable. In combination with a landscape wide overarching approach by which different actors are intensely involved, HTC can be structurally reduced. In figure 13, the conclusions are schematically shown.

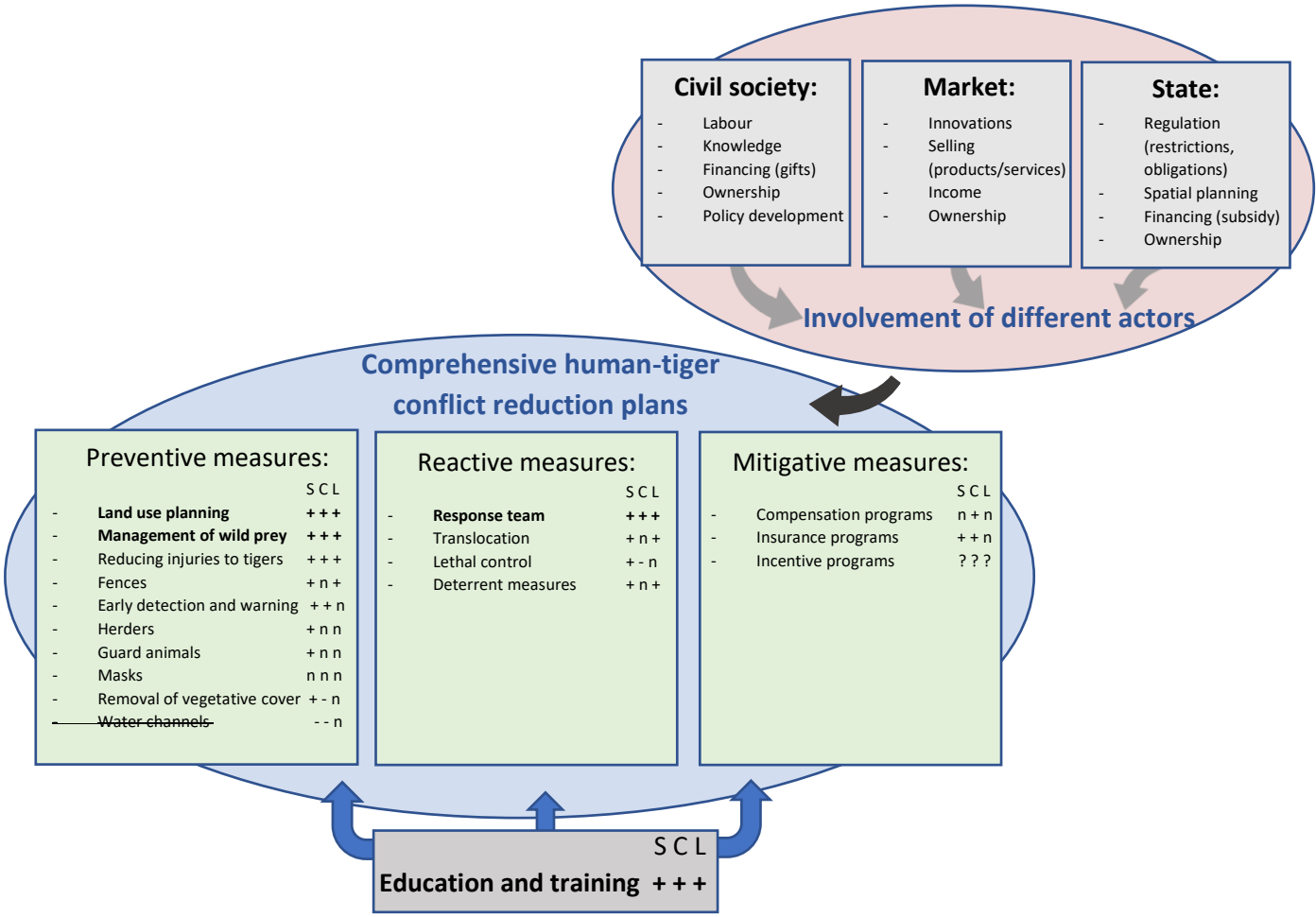

Figure 13: Evaluation of the measure- and actor related elements of a comprehensive HTC reduction plan

S = contribution to human and livestock safety
C = contribution to conservation goals
L = the extent at which a measure fits within different contexts
+ = high contributions/fits easily in different contexts due to no or few area-bound requirements
n = some contributions/fits relatively easily in different contexts due to some area-bound requirements
- = no or negative contribution/fits hard in different contexts due to many area-bound requirements
Bold = highly recommended for all areas
Normal = recommended, depending on context
~~Lined~~ = nowhere recommended

5.2 The evaluation of measures from a broader perspective

In addition to regarding the opportunities and limitations that individual measures provide, it is relevant to regard the reduction of HTC from a broader perspective, as in the end it is aimed to reduce HTC in general. Although the different elements of a comprehensive HTC reduction plan, such

as a combination of preventive, mitigative and reactive measures and the involvement of different actors are required to reduce HTC holistically, some examples show that HTC can also be reduced differently. For example, in a region in India, the rock art present has been used to protect the tiger and reduce HTC. As people saw the rock art as heritage, they were willing to conserve it, including the area around it. So, by requesting religious leaders, who are close to and trusted by the local community, to spread the message about conserving the rock art and the areas around it, people were stimulated to protect the area in which tigers are living as well. This can reduce HTC by indirectly protecting tiger habitat and their prey as religious leaders stimulate people to respect the area and not disturb the animals that live there (Respondent 5, personal communication, June 18, 2018). As this example shows, in some cases HTC can be reduced without the need of implementing a comprehensive HTC reduction plan consisting of different kind of measures in which several actors are involved.

However, for this, as is the case for other HTC reduction measures, a very good understanding of the local context is required as this strategy won't be appropriate for all regions where HTC occurs (Respondent 5, personal communication, June 18, 2018). To arrive at these non-standard strategies that can successfully reduce HTC in specific cases, a more opportunistic approach is required.

In addition, in understanding HTC, account must be taken of the motivation for reducing HTC and other related issues such as the protection of tigers. If only the presence of tigers is aimed at, a different approach is required then when it is aimed at having a viable tiger population. For example, in the first case it could be important that tigers can safely cross whereas in the second case the area must be suitable for reproduction and the population must consist of a genetically robust mix of male and female tigers. These different goals and motivations also require a different set of HTC reduction measures (Respondent 5, personal communication, June 18, 2018). Also, in areas where people see tigers only as a threat to them, measures that are directly aimed at the conservation of tigers won't get support. In this case, for example, the conservation of tigers by the preservation of stone art can be more suitable (Respondent 5, personal communication, June 18, 2018). Therefore, in addition to conflict understanding, goals and underlying motivations must be considered extensively to arrive at a suitable HTC reduction plan.

So, instead of aiming to arrive at some general conclusions about the way in which different actors and measures can contribute to reduce HTC in general, a more flexible and opportunistic approach is necessary. This would make it possible to look more place-specifically at the possibilities for reducing HTC in specific areas, and opportunities can be taken that are more easily overlooked by the conventional point of view in which it is, for example, desired to reduce HTC by a combination of preventive, reactive and mitigative measures to address 'all' aspects of HTC. Therefore, if the aim is to reduce HTC in a specific area, starting with extensively investigating that area is recommended. Then, people, such as people working for governments and NGO's, that aim to reduce HTC, can adequately respond to the 'out of the ordinary' possibilities that a specific area provides, and, in addition, locally applied use can be made of the elements of a more 'standard' comprehensive HTC reduction plan, as described in this research. In the end, if all strategies and measures for reducing HTC are added up, you will have a comprehensive HTC reduction plan containing preventive, reactive and mitigative measures in which all different actors are involved, but by using these elements as a starting point and forcing to use all of them for each specific area, certain possibilities/opportunities to successfully reduce HTC are too easily overlooked. By this, it must be taken in mind that the goal is to reduce the amount of HTC. If, however, the goal is to increase awareness for tiger conservation, which is sustainable for dealing with HTC in the long-run, measures like education remain indispensable wherever.

5.3 Comparing literature with interview results

As emphasized in literature, a combination of preventive, reactive and mitigative measures is required to reduce HTC in general, as all types of measures are required to address all aspects of HTC. This was also indicated by the interview results; no measure can solve HTC by itself and it is required to deal with the different aspects of HTC to reduce it comprehensively. However, a distinction can be made in the importance of different measures; mitigative measures seem less important than preventive and reactive measures. This is also indicated by Miller et al. who stated the following: *"… conservation authorities and practitioners could more proactively prevent conflicts, which would reduce the need for conflict mitigation in the first place*." (2017, p. 25). Although mitigative measures do contribute to the reduction of HTC, their role seems less indispensable. This could be explained by the fact that, besides minimizing the financial consequences of HTC, most mitigative measures aim to ameliorate human tiger relations, which is also done by some of the non-mitigative measures. If strategically chosen, lots of the contributions that mitigative measures provide for the reduction of HTC can be taken on by preventive and reactive measures. For example, by educating people about HTC, their fear and retaliation towards tigers can be reduced. Also, preventive and reactive measures such as fencing, herding and response teams ameliorate human-tiger relations, for example by making people feel safer, by giving them the feeling that they can (actively) do something against HTC and by lowering people's desire to retaliate.

Most literature and interview results correspondent with each other. Both results show that a broader set of measures can be achieved if the capabilities of different actors get combined. In addition, the measures that require the involvement of many different actors, like land use planning and education, are the measures that reduce HTC by counteracting the core problems. This makes them effective on a large scale and in the long term, which is why it is of high importance to integrate them in comprehensive HTC reduction plans. Going beyond, as indicated in the theoretical framework, Western NGO's do often provide financial resources, while more Eastern NGO's are responsible for field work contributions. This was also evident from the interview results, as both respondent 1 and 4 highlighted this. Further, most conclusions about the effectiveness of different measures that were found in literature correspond with the results found during the interviews. For example, the importance and effectivity of response teams were highlighted in both.
Also, some differences between literature and interview results can be found. An example is the effectiveness of the removal of vegetative cover. In literature it is said that this could reduce HTC. However, none of the respondents indicated this as an effective way to reduce HTC. This possibly has to do with the fact that no example of the clearing of vegetative cover with the purpose of HTC reduction was found in practice.
Another difference can be found in the way in which the involvement of different actors is looked at. According to literature, the involvement of different actors is of high importance to comprehensively reduce HTC (Adger et al., 2003, Börzel & Risse, 2010). However, the respondents gave more attention to the fact that a need to include all different actors could obstruct the implementation of HTC reduction measures. The involvement of different actors can drastically slow the implementation and can decrease the effectivity of a measure. An example can be made from compensation programs. If governmental actors are involved to disburse compensation, pay-outs often take more time. This highly decreases the effectivity of compensation. Consequently, governmental involvement in compensation programs is only supportive if these actors are really committed in doing this. This difference in results can be explained by the fact that a difference exists between the 'presence' and the real 'involvement' of an actor. Beyond being present, involved actors must show a high level of support and commitment to contribute to the effectiveness of a measure. Only then do actors take care of the necessary work and maintenance, which is of high importance for the success of a

measure. In addition to the commitment required for compensation programs, an example can be made from fences. Fences reduce HTC only if properly maintained and if support exists to prevent people from destroying the fences. As also respondent 5 notes about the importance of a bottom-up approach and involving different actors:

> As WWF or as local, whatever, park manager, you can never resolve these conflicts, because this is one man or one organisation against the whole community. The conflicts is too large in scale, you cannot address them, so you have to, so you have to create a system within the people who can actually manage these conflicts. (Personal communication, June 18, 2018).

As is the case for deciding which measures are most appropriate in a specific area, the way of bringing actors together must be place specifically chosen. For example:

> … in Myanmar there is a long history of conflict between the indigenous people and the government, or also there is a civil war or an armed conflict in the past, then you have to be very careful in bringing the stakeholders together … (Respondent 1, personal communication, May 31, 2018).

So, although in practice the involvement of different actors provokes a more complicated implementation in the short run, it is a requirement to successfully reduce HTC in the long term.

5.4 Reflecting data collection and analysis

As already noted, this research made use of in-depth interviews to further deepen HTC reduction measures. Due to limits in time, the interviews were all conducted with people working for a conservation related organisation with whom contact was made relatively easily; experiences of WWF showed that it could be very hard to come in touch with governmental agencies and due to distance and language barriers also local inhabitants were not interviewed for this research. As a consequence of this, the focus on and importance of the way in which a measure relates to conservational outcomes is possibly enhanced. By also interviewing respondents working for a governmental organisation or people from local communities, the reliability and internal validity of this research could be enhanced. In addition, if data regarding more different countries was used, the reliability and external validity could be further improved. For example, little literature about cost specificities of different measures was found. Most results about the costs of measures are obtained from the research by Barlow et al. (2010), in which focus is placed on the Sundarbans. However, the costs for a measure differ between areas. If more research that also focusses on other places was available, a more general and reliable conclusion about the different properties of the measures could be drawn, as the success of measures is highly location and context dependent (Respondent 5, personal communication, June 18, 2018).

Nevertheless, it is not regarded as problematic that the interviewees were not completely representative. The goal of this research was to provide a practically applicable overview of the effectiveness of different HTC reduction measures and the possible (local) requirements for the success of a measure. It was not aimed to obtain conclusions that can be generalized to the entire region where HTC occurs, as this won't be appropriate regarding the context dependencies of HTC and its solution. Therefore, the consequences of a non-representative interviewee group do not significantly decrease the value of the results. To point this out, the fact that the appropriateness of different measures and strategies must be considered on a very site-specific basis is regularly emphasized. If it is aimed to investigate the way in which HTC can be reduced in a specific area, it is due to the high local dependency of HTC and its reduction indispensable to interview local inhabitants and other actors involved as well.

Although it was strived to receive complete objective and reliable results, interaction between

interviewer and interviewee is inevitable. For example, realities and meaning can be different for interviewee and interviewer (Scheurich, 1995). Especially during the later interviews, it was observed that the motivation for reducing HTC could have several implications for the chosen strategy and the goals that are pursued. Further, respondent 3 noted that in some areas local people should see a picture of tigers and leopards before knowing which animal it is about, as they use the same word for both animal species (Personal communication, June 11, 2018). Although it is expected that the nature conservationists who were interviewed for this research mean with the word tiger only the animal species tiger, other clarifications could prevent misconceptions like this. By starting the interviews more broadly aimed at obtaining a shared understanding, for example by asking how the interviewee defines and sees a concept as human safety, and what their precise motivation for reducing HTC is, interpretation of results by the interviewer could have been made more objective. The way of data collection, a combination of literature study and interviews, was aimed at arriving at reliable results by being able to verify certain findings as described in the methodology. This has also proven to be the case, as conflicting and possibly inaccurate results have been found. For example, one of the respondents has indicated that ten kilometres of nylon net fencing costs around $45.000,-, while another respondent has indicated that ten kilometres of electric fencing costs around $5000,-. This doesn't seem plausible as all other findings indicate that electric fences are more expensive than nylon fencing. By using different sources of information and interviewing several respondents, misconceptions like this could be identified and further investigated or omitted if more accurate information was lacking, as was the case with the price of fences, to increase the reliability of the results.

Social aspects are, due to their complexness and the scope of this research, to a large extent left out of consideration in this research. Focus was placed on actors involved, the available resources, the existing legal framework, local belief systems and norms, daily practices and climatic and vegetative conditions. By keeping this aspects relatively common, it is possible to apply them broadly by indicating what has to be met to investigate locally whether a measure fits within the existing local circumstances. However, the aspects only partly constitute the perceptions of conflict, which are of high importance for its reduction (Chakraborty & Mondal, 2013; Manfredo & Dayer, 2004). Different views exist about the ideal situation; how many tigers and space for wildlife is desirable differs per area, for example. Going beyond, the importance of aspects such as safety, conservation and poverty is given different priority between different areas (Adams et al., 2004), differences that should be recognized to successfully reduce HTC. As these perceptions vary extensively, it was beyond the scope of this research to include them entirely, limiting the completeness of this research. Consequently, before applying the results of this research in practice, it is required that extensive site-specific research towards the problem understanding and social context is done. Only then, the results of this research can be used in a way in which account is taken of the local circumstances, which is required to successfully reduce HTC.
Besides, due to the scope of this research, not all measures that possibly reduce HTC were included in this research. For example, more options for education, fencing, the management of wild prey and the deterrence of tigers could be conceived. Going beyond, Barlow et al. (2010) included, for example, the wearing of fiberglass headgear and the use of electrified dummies as measures to reduce HTC. Due to their limited effectivity and lack of more research about these measures, it was decided to not include them in this research. Lack of these aspects limits the completeness of this research. However, each respondents was asked if certain aspects were missing, and no additional measures were mentioned. Therefore, decisions made about which measures to include in this research are assumed to be accurate.

The three assessment criteria that this research focuses on; some basic aspects, the actors involved and the three success criteria, seemed to be adequate for evaluating the success of HTC reduction measures. Besides a few specific aspects that have been placed under 'other conditions', which is inescapable due to the wide multiformity that HTC reduction measures can take, all results on the success of a measure could be divided among these criteria. Moreover, the measures that were regarded successful according to literature and interview results were also, in total, positively assessed on the three used assessment criteria.

Despite some limitations, this research contributes to the existing literature about HTC. This research amplifies literature by discussing several HTC reduction measures without focussing on one specific area. An overview is created that can be practically used if it is planned to take HTC reduction measures. Thereby, this research can contribute to the reduction of HTC.

5.5 Recommendations

Although extensive literature about HTC reduction is available, some recommendations can be made for further research. To start with, most existing literature that is about measures to reduce HTC focusses on possible measures in one specific area. Thereby, literature can be amplified by research that focuses on a specific measure that is compared in different areas. By doing so, more knowledge about factors leading to the success or failure of a measure can be generated. Also, more general conclusions about, for example, the costs of a measure could then be drawn.
Going beyond, more ex-post research is desirable. By monitoring and evaluating the results of a measure, more deliberate choices can be made in the future.
To obtain more information about the uncommon 'measures' or strategies for reducing HTC, which is relevant due to the high context dependency of HTC reduction strategies, more site-specific research is needed. This should specifically focus on the local context by, for example, interviewing local people and investigating what possibilities specific areas provide for reducing HTC.
Further, for some of the specific measures that were included in this research, further research is recommended. Currently, little is known about the effectivity of reintroducing prey for HTC reduction. Therefore, more research into its effectivity and requirements is recommended. Also, sufficient research about the effectiveness of the wearing of masks for the reduction of HTC is lacking. Due to the fact that it is expected that the wearing of masks reduces HTC, more research about this measure is recommended. Incentive programs are another measure that requires further research. From both literature and interview results, concrete information about different forms of incentive programs, their effectiveness, related actors, etcetera were not found.

As NGO, WWF can contribute to the reduction of HTC in several ways. As the results show, many measures benefit from NGOs providing knowledge and financial resources. In almost all countries where tigers live WWF is already occupied with this to reduce HTC. To maximise their contribution, a good conflict understanding is required to choose each strategy locally. Although social and cultural aspects and the fact that conservation is looked at different in many places are already integrated in the choice between, and implementation of HTC reduction measures, the contributions can be broadened by more extensively taking these aspects in account in the very beginning. Then, local conditions will be used as starting point, instead of a set of requirements within which a measure must fit. For example, by involving religious leaders in conservational activities, something that is currently not being done extensively, support for conservation can be strengthened considerably by staying close to the beliefs and priorities of local people.
For WWF, as is the case for other actors involved with HTC reduction, it is recommended to focus on land use planning, the management of wild prey, education and training and the creation of response teams, which is also in line with WWF's landscape approach by reducing HTC most integrally. These

measures have to be complemented by other, place specifically chosen HTC reduction measures. Other actors must continue to be involved intensively to secure the fitting with local conditions, a decent implementation and proper maintenance of measures, which are all required to successively and structurally reduce HTC.

Finally, a more opportunistic and site-specific attitude based on comprehensive initial research in searching for HTC reduction strategies is generally recommended. Next to the contributions that 'standard' measures and strategies to reduce HTC can provide, a more open, bold and 'out of the box' way of thinking can result in novel and innovative strategies that can be locally very successful in reducing HTC.

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Appendix 1: Overview of the different characteristics, requirements, pros and cons of each HTC reduction measure

Measure	Scale	Costs	Actors	Workload	Other conditions	Advantages	Disadvantages
Education and training (p. 27)	Medium-Large	Low-High	- State: incorporating subjects leading to a reduction in HTC in education - Market: incorporating subjects leading to a reduction in HTC in, for example, radio and television programs - Civil society: incorporating subjects leading to a reduction in HTC in, for example, street drama or messages by religious leaders NGOs: providing education about subjects leading to a reduction in HTC, providing financial resources for other forms of education	Moderate-Intense	- Requires dedicated people - Knowledge about tiger conservation, HTC reduction measures or other ways to reduce HTC should be limited among local inhabitants	- Enhances general knowledge about tiger conservation - Long-term strategy for reducing HTC - Content and way of education can be chosen locally, fitting with the circumstances	- Hard to measure the direct effect on HTC reduction
Land use planning (p. 30)	Large	High	- State: developing land use plans, regulation, ownership of National Parks - Market: market activities can be affected by land use plans - Civil society: subject of matter, offering knowledge NGOs: providing knowledge and financial resources	Intense	- Requires open and transparent processes - Requires large-scale planning for which several actors must cooperate - Requires political will and high local support	- Long-term strategy for reducing HTC - Creates benefits for both the protection of people and livestock as well as for wildlife conservation	- Requires extensive investigation of the area
Management of (wild) prey (p. 34)	Large	Low-High	- Sate: regulation, providing feed for tiger prey - Civil society: leaving behind livestock surplus NGOs: providing feed for tiger prey	Low-Intense	- For leaving livestock in the wild, farmers should have unwanted livestock that is of no value for them	- Inextricably linked to and required for the conservation of tigers	- Even with large availability of wild prey, tigers may still prey on livestock and people if this is easier to them
Reducing injuries to tigers (p. 37)	Large	Medium-?	- State: regulation, initiate anti-poaching and patrolling activities, providing (financial) resources - Civil society: organising education and anti-poaching activities NGOs: providing (financial) resources	Moderate-Intense	- Knowledge about negative consequences of injuring tigers is required - Fear and anger towards tigers must be converted into respect	- Increases human and livestock safety while contributing to tiger conservation	- If people are dependent on wildlife for their livelihood and no alternative livelihoods are available or provided, it can lead to other unwanted situations like increased poverty
Fences (p. 40)	Small - Large	High	- State: installation and maintenance, ownership - Market: production, selling and lowering the costs for fencing - Civil society: individual or community based installation and maintenance, ownership	Intense	- Requires extensive research about ecosystem structures - Presence and properties of potential fence destroying and conflict-causing animals must be taken into account - Requires ongoing maintenance	- Nylon fences can be easily constructed and removed - Reduces illegal livestock grazing	- High costs - Possibly limits animal movement

			NGO's: installation and maintenance, ownership, providing financial resources		- Ownership and responsibilities must be well defined to secure a proper maintenance	- Can be used to keep out multiple species of wildlife - Makes people feel safer	
Early detection and warning (p. 45)	Small-Large	Low-High	- State: deploy technologies such as camera traps - Market: production, selling, develop and improve detecting and warning technologies - Civil society: ownership, respond to a detected tiger/alarm NGOs: contribute to the development and deployment of technologies	Low-Intense	- Requires close interaction with the local community	- Potentially a self-acting system that requires no physical adjustments in the environment - Contributes to the monitoring of animal presence	- (currently) Requires large investments
Herders (p. 47)	Small-Medium	Low	- State: regulating the free grazing of livestock - Market: providing herders - Civil society: herding practices are often performed by farmers	Intense	- Only relevant in areas with free grazing livestock - Regulations and guidelines for the free grazing of livestock are required to secure a sustainable grazing management	- Gives farmers sense of empowerment	- Focusses on the protection of livestock only - Decreases safety of people by enlarging the chance of encountering between tigers and people
Guard animals (p. 49)	Small	Low	- Civil society: ownership - State and NGOs: sterilization, vaccination and education programs	Intense	- Guidelines for people how to take care of their guard dogs are required to prevent negative ecological consequences and extreme costs	- Relatively cheap - People are being warned of tiger presence	- Dogs can easily spread diseases like rabies and canine distemper, harming human, tiger and other wildlife populations - Animals used a guard are possible tiger prey and can thus attract tigers
Masks (p. 51)	Small	Low	- Market: production and selling - Civil society: individual ownership and use	Low	- Only relevant in regions with a relative chance of encounter with a tiger	- Cheap measure that requires almost no maintenance, knowledge, technology and investments - Easy to combine with other measures	- Offers only limited protection to people on individual level
Removal of vegetative cover (p. 53)	Unknown	Unknown	- State: regulation - Market: clearing an area - Civil society: clearing an area	Moderate	- The removal of vegetative cover must be allowed by state	- Increases the visibility of approaching predators - Easily combined with other measures to increase their effectivity	- Reduces the already scarce habitat of tigers and other wildlife - A bare area has to be relatively wide to actually prevent tigers from hunting

Response teams (p. 54)	Large	Medium	- State: regulation, membership of response teams, providing financial resources - Market: providing jobs, veterinary assessment of the tiger - Civil society: inform response teams after a HTC had happened, assist with actions being undertaken NGOs: membership of response teams, providing expertise and financial support	Intense	- Requires dedicated and educated team members - Local people should have recognition and knowledge about the existence and functioning of response teams	- Very effective to increase human and livestock safety - Tigers are being saved - No negative consequences for other animal species than tigers and their habitat - Every conflict can be responded on individual basis	
Translocation (p. 57)	Large	High	- State: regulation, members of teams who are responsible for translocation process - Market: developing, producing and selling equipment for translocation, veterinary assessment of the tiger - Civil society: inform and assist teams when HTC has happened NGOs: members of teams who are responsible for translocation process, contribute to developing equipment for translocation	Intense	- Physical characteristics and condition of the tiger must allow translocation - Requires a suitable place with a low conflict potential for tigers to live on site or, if needed, in captivity	- Very effective to increase human and livestock safety	- Requires a high understanding of the tigers' interactions with its environment, and even than it remains challenging to not harm or disadvantage the translocated tiger
Lethal control (p. 59)	Large	Medium	- State: regulation, applying lethal control - Market: applying lethal control by veterinarians - Civil society: inform teams after a HTC has happened	Low-Moderate	- The killing of tigers should be allowed and accepted - The killing of tigers has to be done by well-dedicated people	- Highly reduces human deaths - Removes possible repeat offenders	- Diminishes the number of tigers - Requires high understanding of the tigers' interaction with its environment
Deterrent measures (p. 62)	Small-Medium	Low-high	- State: providing financial resources - Market: production and selling - Civil society: individual or community-based ownership	Moderate-intense	- Stimuli must be unpredictable and triggered by the behaviour immediately preceding HTC	- Relatively cheap and easy for herders to use to increase the safety of the herder and his livestock	- Requires intensive work (if manually regulated) or intensive investment and knowledge expertise (if automatically regulated) - Without coordinating the use of deterrent measures above individual level, it possibly leads to the displacement of HTC
Compensation programs (p. 64)	Large	High	- State: ownership, providing financial resources - Market: providing jobs - Civil society: participation in the design, recipients of compensation NGOs: providing	Intense	- To prevent people from showing less risky behaviour, requirements for obtaining conservation must be determined - Compensation should also be available for other depredating	- Can increases tolerance towards tigers - Creates stimulus to report attacks making monitoring of HTC more easily	- Financially hard to sustain in the long run - If compensation is not equally accessible, it can increase inequality

			financial resources		species than tigers to ensure the relationship between farmers and experts who verify a claim and reduce retaliatory killing - A fast handling is required to satisfy people with compensation and reduce retaliatory killing - To increase trust and transparency the organisation that is disbursing the compensation should be separated from the organisation verifying the claims - Compensation should be easily and equally accessible for local people		
Insurance programs (p. 67)	Large	Low	- State: regulation, ownership, providing financial resources - Market: providing jobs, ownership - Civil society: ownership, users of insurance NGOs: providing assistance and financial resources	Intense	- Insurance should also be available for other depredating species than tigers or causes of death to reduce retaliation killing and to ameliorate relationship between farmers and experts who has to verify a claim - A fast handling is required to satisfy people with compensation and reduce retaliatory killing - To increase trust and transparency the organisation that is disbursing the insurance should be separated from the organisation verifying the claims - Insurance should be easily accessible for local people	- Can increases tolerance towards tigers - By (partly) creating its own income model, it is better persistent for the long-term - Creates stimulus to report attacks making monitoring of HTC more easily	- Can increase inequality
Incentive programs (p. 68)	Unknown	Unknown	- State: setting up incentive programs, providing (financial) resources - Market: changing activities - Civil society: manage incentive programs NGO's: setting up incentive programs, providing (financial) resources	Unknown	- Requires an attitude and (work) environment that is open for change	- Could provide an internal stimulus for actors to contribute to reducing HTC and tiger conservation, by seeing something in return	- In many cases dependent on market forces and external inputs

Appendix 2: Interview structure

Interview

- Intro
    - Introduction
    - Work experience
        - Areas
        - Measures
        - Field work
        - Etc.
- Main part
    - Measures
        - Land use planning
            - Costs?
        - Removal of vegetative cover
            - Costs?
            - How wide?
        - Fences
            - Experience with different forms of ownership?
        - Herders
            - Support?
        - Guard animals
        - Management of wild prey
            - Costs?
            - Long term effectivity?
        - Reducing injuries to tigers
            - Costs?
            - Knowledge?
        - Early detection and warning
            - Costs?
        - Deterrent (sound and light)
            - Costs?
            - Options?
        - Masks
            - How to set up?
            - Availability in different areas?
        - Education and training
            - Who is responsible?
            - What about political support?
        - Translocation
        - Response team
            - Who is responsible?
            - Interaction with local community? (Experience, requirements)
        - Compensation programs
            - Experience with creation?
            - Necessary interaction between actors?
        - Insurance programs

            - Experience?
            - Initiator?
        - Incentive programs
            - Costs?
            - Options?
            - Experience?
    - Actors
        - What role(s) do different parties play?
        - What is experience with interactions?
        - Place bounded differences?
            - Support
            - Knowledge
            - Money
            - Beliefs
- Closing
    - Other comments