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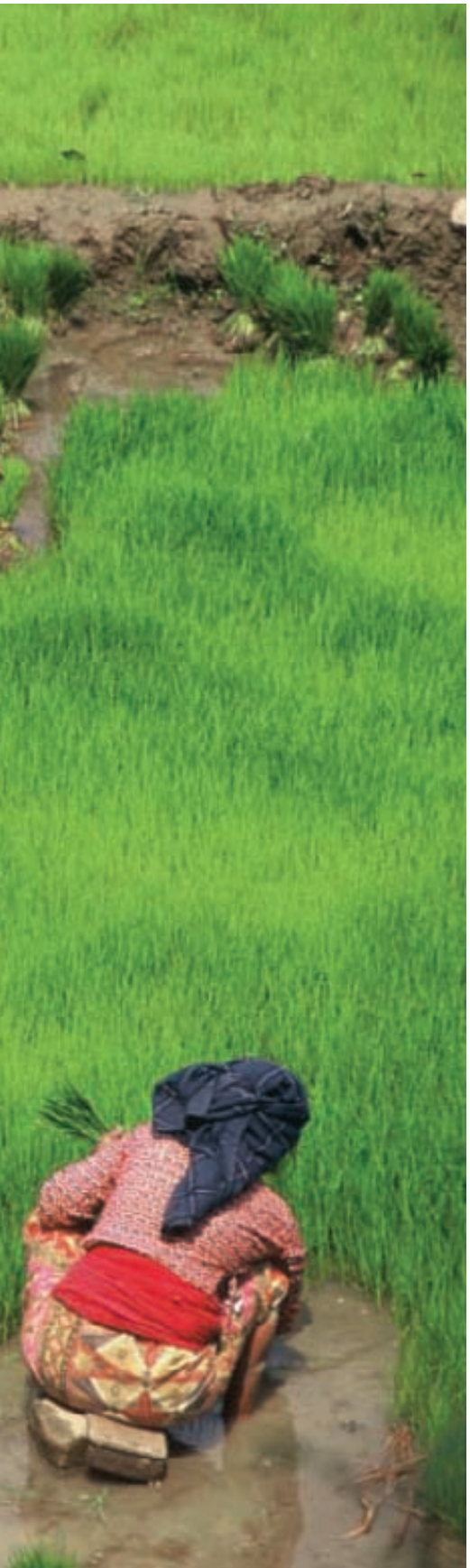
Common Ground

Solutions for reducing the human, economic and conservation costs of human wildlife conflict.



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Abbreviations and Acronyms

AREAS	Asian Rhino and Elephant Action Strategy
BKSDA	Government Agency for the Conservation of Natural Resources
CBNRM	Community Based Natural Resource Management
CITES	Convention on International Trade in Endangered Species of Wild Fauna & Flora
DNPWC	Department of National Parks and Wildlife Conservation
EIA	Environmental Impact Assessment
FAO	Food & Agriculture Organization
FFB	Fresh fruit branch
GEF	Global Environment Facility
GPTF	Game Products Trust Fund
HACSIS	Human Animal Conflict Self Insurance Scheme
HEC	Human Elephant Conflict
HWC	Human Wildlife Conflict
MET	Ministry of Environment & Tourism
NGO	Non Government Organisation
NTNC	National Trust for Nature Conservation
NR	Nepalese Rupees
PES	Payments for Environmental Services
PRAP	Poverty Reduction Action Programme
RSPO	Round Table on Sustainable Palm Oil
TAL	Terai Arc Landscape
TFCA	Transfrontier Conservation Area
UNDP	United Nations Development Programme
VDC	Village Development Committee
WTLCP	Western Terai Landscape Complex Project

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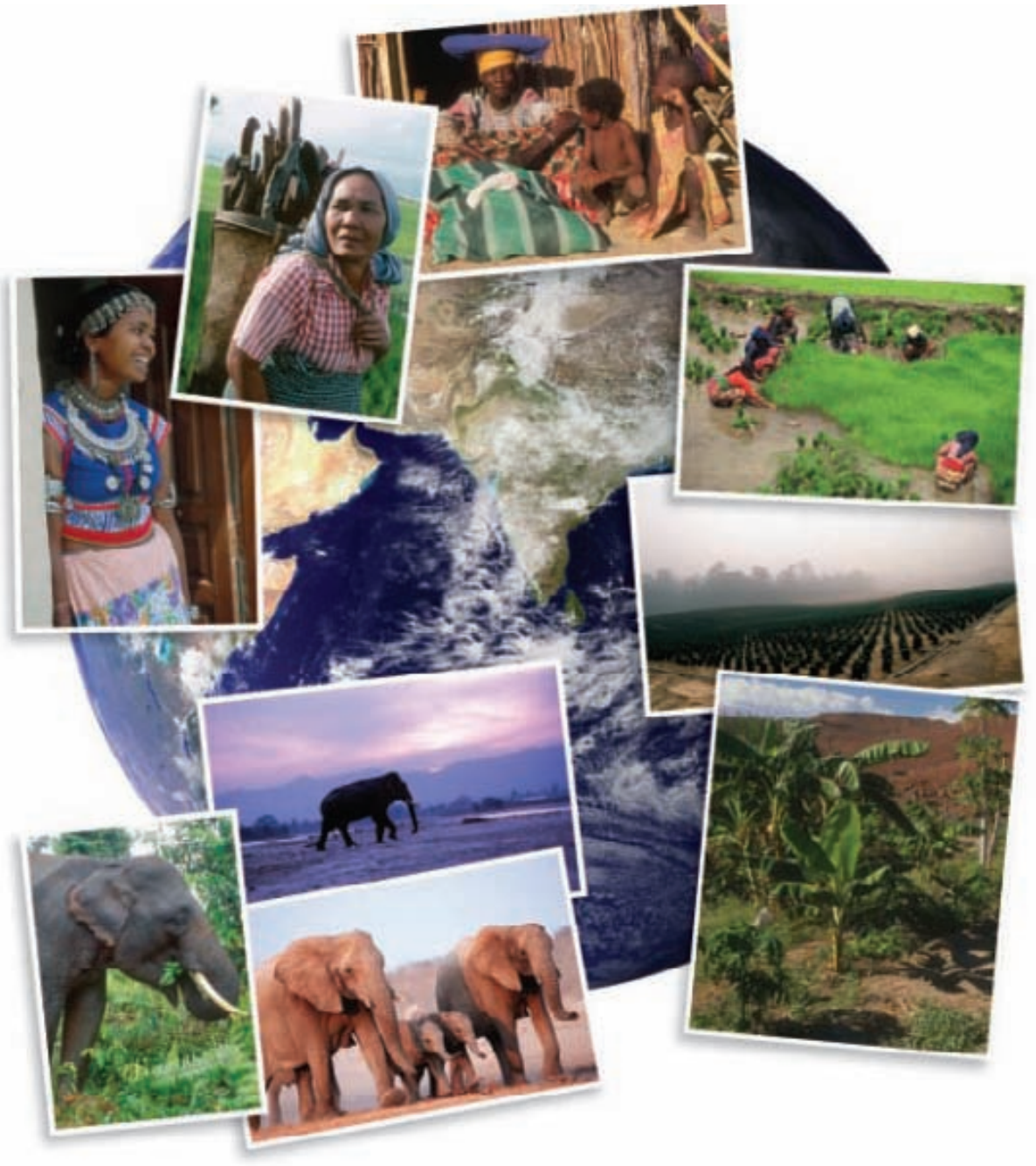

Forward

Dear Readers,

It is with great pleasure that WWF presents this report, which deals with the serious conflicts that occur between humans and wildlife. In today's world, where the frontiers of development are expanding ever further into wildlife habitat, people and animals are being forced to live closer than ever alongside one another, often with disastrous consequences. People can lose crops, livestock, property and even their lives. Wildlife populations in some areas have plummeted due to retaliatory killings after such attacks. It is absolutely essential to work together to find long-term solutions to this problem, both in terms of ensuring the security of local people's lives and livelihoods, and in safeguarding the biodiversity on which the health of our planet depends.

This report focuses on elephants as a flagship of these conflicts, and explores the problem through a series of case studies in three countries: Namibia, Nepal and Indonesia. In all three places, the people, the problem and the drivers of the situation are vastly different, and the case studies fully explore the breadth of the issues involved in each location. However there is one common theme in all of these case studies – solutions are available. The option of doing nothing is not an option. To be truly effective there needs to be a shift in approach - development needs to occur in a fully coordinated cross-sectoral manner. This includes the cooperation of different, often competing, ministries as well as the effective linking of all societal levels, from the individual community right up to international trade and consumption patterns. Innovative financial solutions and strategies for effective land-use planning are available, but need backing, support and development.

We know that species conservation programmes can and do reduce poverty, increase participation by women in society, improve governance structures, increase food security and, of course, deliver a sustainable environment for future generations. Yet around the world, billions of dollars are being spent to reduce poverty and promote economic development – often with inadequate attention to the link between sustainable development and a healthy environment. Modern species conservation is about conserving and managing a world for both species and people.

WWF's mission is "to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature." A species conservation approach that is integrated with human needs is fundamental to the fulfillment of this mission, and resolving human wildlife conflict gets to the absolute core of that aim. We hope that governments, industry and the global community at large can take on board the recommendations contained in the report, and work with us to make this mission a reality.

Dr. Susan Lieberman
Director
WWF-International Species Programme

Dr. David Reed
Director
WWF Macroeconomics Programme Office.

Summary Analysis

As the world's human population steadily expands, the places where wildlife can still thrive are not only continually shrinking but are also becoming increasingly more remote. It seems that there is no place left on Earth that humans won't enter - sometimes voluntarily, sometimes because they are driven from other places by armed conflicts, sometimes due to the loss of their traditional land rights or due to environmental catastrophes and sometimes simply due to human population increases. This leads inevitably to a growing number of confrontations around the world between humans and wild animals – a phenomenon termed 'Human Wildlife Conflict' (HWC). When wildlife lose their natural habitats and have reduced access to natural food sources, they eat agricultural crops, livestock, can destroy property and can injure or kill people. Animals are usually captured or killed by humans in retaliation. The problem is exacerbated by the fact that many of the people affected by HWC are some of the most impoverished on earth.

The process of climate change will exacerbate the existing loss of wildlife habitat in many vulnerable places, for example by worsening the already pressing problems of droughts and floods. Furthermore, climate change will alter the location and nature of the geographical environment, and wildlife will be forced to migrate to new areas as a way of adapting. As there are limited natural places left for wildlife to move to, this will likely bring wildlife into more densely populated human areas, and create additional situations of HWC.

Avoidance of human-wildlife conflict (HWC) can be seen as one important indicator of our ability to keep the world's environment in a healthy state, one that enables the majority of people to live a life free from poverty without jeopardizing the future environmental sustainability of our planet. There are various socioeconomic and ecological factors that create or aggravate conflicts between humans and wildlife; and there are also various technical, institutional and political means to avoid and mitigate them. Potential solutions, of course, are different in different places, depending on a huge variety of factors, such as the species of animals involved and the prevailing attitudes of the local people towards wildlife.

This report focuses on two spectacular species that compete with people for land, food and water: the African and the Asian Elephant. Aspects of the issue are considered at three different levels: a) the macro level of international and national policies, b) the meso level of regional (provincial) institutions and planning processes and c) the micro level of local communities and civil society organizations (3xM approach). Case studies were conducted in three countries, Namibia, Nepal and Indonesia, which illustrate HWC in three very different settings. Yet despite their clear differences, strong conclusions can be drawn from the analysis of all three areas, and sustainable, feasible solutions have been identified.

Elephant in the settlement boundary of Bahundangi village in Jhapa District, Nepal.

Human-Wildlife Conflict: The Problem

This analysis has demonstrated that HWC is a significant concern to the health and lives of local people, the security and sustainability of their livelihoods, to industry, to governments and to national economies. In all three countries, human injuries and deaths occur due to HWC - clearly the most catastrophic impact. However the economic impacts are also severe. In Namibia, a rough estimation of the combined costs of HWC to communal area farmers is US$1 million annually. HWC in one region of Namibia alone (Caprivi) results in a loss of US$770,000 to the National Economy of Namibia. In Riau, Indonesia, HWC and its prevention can cost individual oil palm companies as much as US$ 23,234 per year. In one study site in Nepal, the average damage by elephants is as much as 27% of the yearly income for each individual household. It is clear that solutions are urgently needed for this global problem that is increasing both in intensity and geographic scope.

Reducing Human Wildlife Conflict - appropriate land use planning

Firstly, and most importantly, the analysis of these three case studies has demonstrated conclusively that improved land-use planning processes and their strict implementation can substantially reduce HWC. Strong, coordinated, forward thinking planning for all land-use processes, and mechanisms to ensure current and potential future HWC is taken into account in all planning decisions, will save millions of dollars for national economies, substantially increase the livelihoods of communities living with wildlife, reduce the economic burden of HWC on agribusiness and most importantly, reduce the occurrences of human injury and death from wildlife.

So, how can proper land-use planning reduce HWC? By ensuring both humans and animals have the space they need, ensuring that key areas for wildlife (such as core habitats and corridors) are secured and by ensuring that land uses likely to generate HWC are kept far from, or buffered from, wildlife habitats. There are many land-uses that do not attract wildlife and can act as buffers between wildlife habitats and land-use types that conflict with wildlife.

The case studies in this report demonstrate the economic benefits of this kind of coordinated land-use planning. In **Namibia**, it has been shown that crop enterprises established in the vicinity of wildlife habitat could experience a 28-30% drop in net income, and crop enterprises established closer to wildlife habitat would experience a 60-85% drop in net income. Crop enterprises established directly in the vicinity of unfenced wildlife habitat could suffer a 120-202% drop in net income, making the enterprise entirely economically unviable as the costs of the enterprise are greater than any income it generates. The enterprise would be a drain on the national economy. This provides the strongest argument possible for land-use planning mechanisms that would ensure that new agricultural enterprises are established as far from wildlife habitat as possible, and that avoid government incentives that push people to settle near wildlife habitats.

Fresh elephant tracks next to a farmer's daytime hut in a sorghum field which was raided the night before. Sikaunga, Kwandu Conservancy, Namibia.

In **Nepal**, communities in an area with reasonably good land-use patterns experienced half the economic damage from HWC as two other areas with less effective land-use patterns. Looking more closely at the factors behind these differences, it became clear that the site with less conflict had far more forest cover in 'edge' habitats between wildlife and human used areas. The study revealed a direct positive relationship between the amount of deforested land and economic losses due to HWC, and a positive association between the fragmentation of forest habitats and economic losses due to crop loss. This means that greater economic losses are suffered when the remaining forest habitats are fragmented into lots of small pieces rather than existing as one large chunk. The level of habitat fragmentation was actually more influential in determining the amount of crop loss than the amount of forest coverage itself. This strongly indicates that the shape and distribution of forest cover is a crucial factor in influencing levels of HWC, and further reiterates the importance of effective land-use planning that ensures remaining forest areas are fragmented as little as possible.

In Riau, **Indonesia,** a simple geographic plotting of losses of human lives as well as captures and deaths of elephants due to HWC indicate that the vast majority of human and elephant deaths/captures occur in or around elephant pouch areas which have lost significant amounts of forests. Looking from a different perspective, the lack of effective land-use planning at an appropriate scale in Riau, has resulted not only in high levels of HWC and the near decimation of elephant populations (a decline of 80% in less than 25 years,) but will also likely result in the province being unable to capitalize on possibly its most important and valuable resource – its carbon rich peat swamp forests. If current trends continue, Riau will be left with just 6% of forest cover by 2015, and will thus have relinquished an enormous opportunity to generate economic benefits and development opportunities for its rural communities through globally exchanged carbon credits, whilst simultaneously stabilizing the global environment and conserving its unique and spectacular biodiversity.

What is needed for effective land use planning that reduces HWC?

The kind of macro level land-use planning that will be able to effectively reduce HWC necessitates a broad 'landscape' approach, collaboration of all sectors and players, as well as extremely strong enforcement.

This study has indicated that one of the most important factors for effective land-use planning is constructive **cooperation between all 'stakeholder ministries'**, generally including the ministries of environment, agriculture, forests, water, energy, and infrastructure. At the current time, it is often ministries of agriculture or forests that are responsible for deciding how and where various land-use activities will take place, and it is these decisions that ultimately determine how much HWC occurs. If they do not take HWC into account in their planning (and decide to allocate agricultural concessions directly adjacent to unfenced wildlife habitat for example), it is the environment ministry that is called in to solve the problem when HWC inevitably occurs. The environmental ministry must then find solutions to stem the problem that has been caused by another ministry, which is obviously extremely difficult. Environment ministries, conservationists or often simply the animals themselves, receive the blame and bad feeling for losses due to HWC. The only logical step is therefore to ensure that all sectors take current or potential future HWC into account in their planning and feasibility assessments, and ensure greater coordination and collaboration between all sectors. Unfortunately, to date in many developing countries this has been the exception rather than the rule.

However adequate land-use planning is not enough. Proper **implementation and effective enforcement** have to accompany the plans. This should happen in a way that does not exclude already poor people from development opportunities, but in a way that prevents inappropriate land-uses developing that will be to the detriment of both people and wildlife. The case study in Indonesia demonstrates what can happen when enforcement isn't applied. Although there is substantial waste land available in Riau and a government land-use plan that proposes that all new acacia plantations must be established on already degraded wastelands, 96% of all pulpwood plantations in one part of Riau replaced natural forests, and uncontrolled and rampant conversion of natural forest even in protected areas has meant that over the last 25 years, the forest cover in Riau has shrunk from 78% to 27%.

It is also clear from the case studies that HWC is affected not just by local, regional and national factors but that international policies, structures and drivers are also important – i.e**. macro, meso and micro levels all play a significant role**. In Namibia, International Agreements such as those between Europe and Africa giving preferential access to Namibia and other countries to the protected European beef markets, artificially enhance the economic viability of the livestock sector compared to other land-uses (such as wildlife), thus decreasing the perceived benefits of wildlife in contrast to other forms of lands-use and promoting the development of non-wildlife industries that often create or exacerbate HWC. In Indonesia the growing global demand for palm oil as a 'bio-fuel' is creating a secure economic environment for increasing oil palm expansion in Riau. 29% of Riau's natural forest has already been converted into palm oil plantations, and oil palm is the crop which causes more conflict with elephants than any other. In Nepal, the transboundary nature of elephant movements means that effective HWC management can only occur through a collaborative transboundary approach. Therefore it is clear that reduction and management of HWC can only be successful if micro, meso and macro levels are not treated in isolation but integrated through appropriate policy and implementation frameworks.

In conclusion, the only truly sustainable solution to reducing HWC is a land-use and development planning system that takes HWC into account, is based on public consultation, good technical feasibility studies and environmental assessments, and links all the different levels. This kind of system would not only be beneficial for the reduction of HWC (and the subsequent reduction of costs to local communities, industry and governments) but would also provide a more cohesive and positive general structure for national development that is far less likely to cause unforeseen problems and conflicts.

This kind of cooperative, holistic approach will create the necessary driving force and mechanism for countries to successfully achieve the globally agreed "Millennium Development Goals" as well as the individual sustainable development goals of each country.

Living with human wildlife conflict – economic solutions

Whilst effective land-use planning can dramatically reduce HWC, there will always be some conflict between humans and wildlife, and in today's world economic solutions to this conflict are required. Where these kind of solutions don't readily exist, and local communities have no way of benefiting from wildlife or from the ecosystems in which they live, there is an extremely low tolerance of wildlife and wildlife related losses. This can be seen in Riau, Indonesia, where despite the fact that economic losses from crop destruction to local communities are relatively low (excluding all situations in which injury or loss of human life has occurred), cases of retaliatory killings of elephants, including capture and removal by the government, are so high they have led to a dramatic decline in the elephant population. In these scenarios, wildlife will be marginalized and eventually disappear, and the long-term benefits that can be generated from the presence and utilization of wildlife will be lost.

The various case studies in this report identify economic solutions that are applicable for each different situation, and a summary of those is included below.

Community Based Natural Resource Management (CBNRM)

In situations of relatively low population density, strong and supportive government and good community governance structures, the devolution of power to the lowest societal level offers a solution. This option is practiced in Namibia, whereby local communities organized into groups called 'conservancies' are given rights over wildlife (and other assets) on their land, and therefore both the costs and benefits of living with wildlife are internalized by the community. The economic analysis in this study demonstrates that conservancies generate more income from wildlife than they incur from HWC damage, and therefore the strategy of devolution of power to community level is an economically sound method of mitigating HWC.

Community Based Resource Management has also been developed in Nepal with success. Local communities in and around forests are supported to form legally mandated User Groups who are assigned rights and responsibilities for the management of the forests, and for the sustainable use of the resources they contain. These forests are of critical importance to local people providing products such as fuel, fodder, housing, agricultural tools, household implements and medicine. Forest foods are also an important supplement in times of hardship. Furthermore, local communities also receive direct livelihood benefits from wildlife conservation through tourism and protected area revenue-sharing.

The benefits of this approach in Nepal were demonstrated by the difference between two sites which had received strong assistance from government and NGOs in conservation and community development, and another site which had not. As would be expected, respondents from the two assisted sites had a strong belief in sustainable community-based natural resource management as long-term strategic solution, including political decentralization, community forestry, tourism development and better integration of women. They also firmly rejected the notion of reducing elephant populations to reduce HWC. In the other site, respondents agreed overall with the notion of reducing elephant populations to reduce Human Elephant Conflict (HEC), and 80% of respondents believed there had been an increase in retaliatory killing of elephants (>90% of respondents in the other two sites did not think this was the case in their area). This strongly demonstrates the importance of CBNRM and community engagement in resolving HWC, and indicates that participatory conservation and development activities will lead to enhanced tolerance for elephants and conservation.

It should be noted that this solution is not applicable in all situations. The benefits generated from wildlife in Namibia that are used to offset HWC losses are often either related to tourism or trophy hunting. There will be locations that are not either picturesque or accessible enough for tourism, and in several cultures (such as Nepal) trophy hunting of species such as elephants would not be appropriate for religious or other reasons. In addition, the communities involved need to be resident, and organized, with potential for the establishment of strong internal governance systems. In Riau, Indonesia, many of the communities are immigrants, forcibly moved to Riau from other islands by the government, or more recently immigrating into Riau to take advantage of the oil palm boom. They have no internal governance systems or historic link to the land, making the establishment of conservancies and devolution of land rights much more difficult.

Compensation / insurance

Compensation or insurance for animal-induced damage is another, complementary solution that is widely accepted. In Namibia, the government does not pay compensation, but community-based insurance systems exist for damage done to livestock. The Nepalese government pays compensation in areas around national parks. Insurance schemes for crop and livestock losses may be a potentially valuable but largely unexplored field for the private sector; it has worked in developed countries and has the potential to work in developing countries also.

PES - Elephants

Payment for Environmental Services (PES) is a concept that has recently gained popularity in the international development/conservation community. Environmental (or Ecosystem) Services are the multiple benefits that people receive from nature, such as water purification and flood control by wetlands. PES schemes reward those whose lands provide these services with subsidies or market payments from those who benefit. A simplified framework for calculating payments for biodiversity conservation, in this case paying people to live with elephants, could take the following format:

1. Estimate the direct costs of managing the elephants (e.g. costs of plans, rangers, enforcement etc. for several alternatives)
2. Estimate the indirect costs of damage caused by elephants (e.g. loss of products, infrastructure etc)
3. Estimate the opportunity costs to farmers of living with the elephants, under different elephant management regimes (e.g. land they may not crop, crops they may lose, etc)
4. Estimate what funds can be made from elephants (e.g. tourism, trophy hunting, sale of tusks, hides and meat – where relevant and legal)
5. Estimate the benefits that will be derived from the maintenance of forest as elephant habitat (eg. use of non-timber forest products, sustainable use of species other than elephants etc.)

1+2+3 – 4+5 = these are the global biodiversity costs for maintaining elephants

The greater difficulty lies in the implementation of a PES scheme. Decisions need to be made about who pays in, who receives the money, and who takes responsibility for a just distribution. One possibility is that PES could occur through a biodiversity fund into which the international community would pay, with international conservation organizations in collaboration with local governments taking responsibility for implementation. Another possibility would be to charge some kind of stipend or tax on the agricultural industries most responsible for HWC (such as the oil palm industry in Indonesia) and use those funds to input into the scheme.

PES - carbon

Payment for the environmental service of sequestering carbon, discussed in the case of Indonesia, is also a possibility, if it is set up so that the funds benefit local communities. This could happen within the framework of a better connected landscape with wildlife corridors that would consist of community-managed agroforestry systems with carbon as one product; or it could happen within the avoided deforestation system (REDD) that is already accepted. Some of the unsolved problems here are how to pay the up-front costs and how to make the system permanent.

Wildlife Friendly Products

Another possibility is the development of a certification scheme for 'wildlife-friendly products', benefiting farmers who produce oil palms or other crops in an elephant-friendly manner, by ensuring a higher price for their products in American, European and big city niche-markets.

Urbanization

Given its high population density, Nepal and many other places may have already reached the limits of their environmental carrying capacity. The rural areas cannot support more human inhabitants without seriously jeopardizing the environment and the services it provides. The best solution to HWC in these cases might be to reduce human pressures on wilderness areas through a well-planned and implemented process of urbanization or other voluntary relocation. This would include the establishment of small and middle-sized rural centers with economies built on products from the surrounding rural areas. In urban centers where people are further away from animals, it might be easier to create the tolerance needed to keep the remaining biodiversity in harmony with the human endeavors for improving livelihoods.

Despite the need for economic solutions, it must be emphasized that a cost-benefit analysis of HWC solutions in purely financial terms addresses only part of the issue. HWC generally occurs with most severity in areas where people are impoverished and vulnerable. For these communities the distribution of income is more important than the absolute amount of income generated. For example, a group of elephants can destroy the crops of an entire village in one night – with catastrophic impacts for that village that exceed the monetary value of the damage done. Yet government decisions about land-use planning or governance of resources are often driven only by overall income figures, ignoring both poverty impacts and environmental externalities like HWC.

Furthermore, it must be emphasized that there are not only direct monetary benefits from measures or policy changes designed to reduce HWC - there are also many indirect and hidden advantages. CBNRM as an example, seen as a measure to cope with HWC, contributes not only to reducing and managing the conflict by generating monetary income, but also helps to make communities better informed and educated, socially integrated and empowered citizens- definitely an important contribution to a more stable and democratic society.

Living with Human Wildlife Conflict - Field based solutions

There are a number of practical field based solutions that can limit the damage done both to humans and human property, and to wildlife. These solutions aim to prevent wildlife entering crops or areas of human habituation through a variety of methods. Every site needs a tailor-made response, as most tools and techniques show remarkable differences in success when used in different topographical or social scenarios. What people see as solution in one place, they may resist in another. What works in one place, may have the opposite effect somewhere else.

Trenches and 'flying elephant squads' (teams of tamed elephants used to chase wild elephants away from fields) in southern Asia have proved successful, fences and smoke bombs treated with chilli peppers are working well in Africa. Electric fencing can function well, but requires substantial maintenance. Guarding the fields, making noise, and using fire crackers are methods used everywhere with varying success, although their use may put farmers into dangerous situations. Each case study in this report outlines the cost of techniques used, their efficacy and any implementation or other problems.

The intelligence of elephants means that they can quickly become adapted to techniques used to keep them out of fields, and either find ways round them or ignore them. Keeping elephants away once the frontier between wildlife habitat and crop land has been established is a difficult and ever changing challenge. As such, the focus of governments must clearly be on decreasing HWC through the land-use planning processes discussed earlier.

Conclusion

Human wildlife conflict is a severe and growing problem in today's world. Unlike many environmental issues of our time, it involves not only the impoverishment of human communities but direct human injury and death. On the biodiversity side, it can cause dramatic population declines and potential extinctions, as is currently the concern for the Sumatran elephant in Indonesia. The increasing human population, combined with climate change and the alternative movements of both humans and wildlife that it will generate, mean that HWC is likely to increase rapidly in the coming years.

However there are solutions readily available, both to reduce conflict, and to manage and live with conflict where it can't be reduced. Appropriate land-use planning MUST be developed in those countries where HWC is a pressing issue – the potential to save money, lives and wildlife purely through a more intelligent planning approach cannot be ignored.

In those places where HWC can not be reduced, economic and field based solutions exist to ensure it can be managed.

It is now the responsibility of all sectors of government, the agricultural and forestry industry and the international community at large to ensure that the available solutions to this pressing problem are implemented without delay.

Recommendations for governments

1) All ministries with relevance to land and land-use planning should develop a coordinated planning system with clear procedures for taking environmental considerations, and in particular, current and potential future HWC, into account in land-use decisions.
2) Fully independent Environmental Impact Assessments, which assess the potential for creating or exacerbating HWC should be conducted for all new developments.
3) Attention should be paid to addressing drivers of conflict at all levels (micro, meso macro) including international agreements and markets. Structures must be set up to articulate all these levels through appropriate policy and implementation frameworks.
4) HWC costs, including the costs of HWC mitigation measures, must be included in prospecting budgets for agricultural developments when considering their economic merit against other forms of land-use.
5) Incentives should be given - at least in the 'kick off' phase - for innovative financial approaches that prevent and mitigate HWC such as insurance schemes, PES, carbon sequestration, wildlife-friendly products etc.

A group of school children in a protected-forest buffer-zone community in the Terai, Nepal.

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Human-Wildlife Conflict: Namibia

Human-Wildlife Conflict in Namibia

Abstract

Human wildlife conflict is one of the most pervasive environmental problems of the current day, threatening both wildlife and some of the most impoverished human communities on earth. Managing HWC requires the harmonization of both environmental and human development goals, and is essential to secure a sustainable future for both people and wildlife. This study analyses the causes, economic basis and long term solutions for resolving HWC in Namibia, for the joint benefit of both humans and wildlife.

The study reveals that government policies giving landholders rights over wildlife on their land, and therefore enable them to internalize both the costs and benefits of living with wildlife, is an economically sound method of mitigating human wildlife conflict (HWC) in Namibia; i.e. the economic benefits derived from living with wildlife are greater than those incurred from wildilfe related damage. However in order to be successful, such an approach requires appropriate economic incentives for living with wildlife, devolution of decision-making authority to local communities, and appropriate skills and information for developing specific management interventions in the field.

For the long term sustainable management of conflicts, HWC considerations need to be incorporated into land-use planning processes and viability assessments for all development projects, and HWC must be prioritised in all sectors, not just the environment sector. Without such planning, agricultural enterprises are likely to be established in areas where they will suffer high levels of HWC (for example, next to unfenced game reserves). This can lead to losses in net income for agricultural enterprises ranging from 3% to 202%, in some cases thus making the enterprise economically non-viable. Increased HWC can reduce the contribution of an agricultural enterprise to the National Economy by anything from 29% to the point that the enterprise becomes a drain on the National Economy. Current levels of HWC in the Caprivi area of Namibia alone result in a loss of US$770,000 to the National Economy from crop damage and livestock predation. The combined costs of HWC to communal area farmers in Kunene, North of Etosha and Caprivi combined is around US$1 million annually.

In addition, the study found that policies at regional (provincial), national and international levels all have a strong impact on HWC, and thus need to take HWC into account. The study demonstrates that an approach taking into account all the above factors to reduce and manage HWC will contribute strongly to improved livelihoods for local communities, reduce costs to the agricultural industry, the government and to the National Economy, and simultaneously secure healthy wildlife populations in the long term.

Water pump destroyed by elephants in Torra Conservancy, Kuene Region.

1. Introduction and Background

Human Wildlife Conflict (HWC) occurs when wild animals injure, destroy or damage human life or property and are killed, injured, captured or otherwise harmed as a result – i.e. both humans and animals suffer from the interaction with each other. HWC involves both the destruction of crops by herbivores, the predation on livestock by predators and the destruction of critical infrastructure such as houses or water sources by large animals such as elephants. People can be killed or injured by wild animals while trying to protect their land, livestock or family. These clashes can occur in areas of large-scale agriculture as well as in areas of small-scale subsistence agriculture, where a night raid by elephants or hippos can easily destroy the livelihood of a poor family.

As human populations expand ever further into wildlife habitat, HWC is expanding in both geographical scope and intensity, causing a significant threat to human lives and livelihoods and threatening the survival of many species around the world. Resolving this escalating problem requires the harmonization of both environmental and human development goals, and finding creative solutions to ensure human communities and wildlife can live together not in conflict but in a relationship of mutual benefit.

This case study deals with HWC in Namibia, south western Africa, and focuses on two particular areas where HWC is most severe - the north-eastern region of Caprivi and the north-western area of Kunene. It examines the dynamics of HWC, the root causes of the conflict and identifies opportunities and positive models for preventing and/or mitigating HWC in the future.

Namibia is a country of particular interest due to its policy of devolving rights over wildlife to landholders. In the late 1960s, the Namibian government gave the use rights over wildlife on their land to white freehold farmers, and a wildlife industry was developed around sport hunting, culling for meat and photographic tourism. Wildlife populations increased as a result. In the 1990s, black communal landholders were given the same rights over wildlife on their communal lands, provided they formed a collective common property resource management unit called a conservancy. These community-based natural resource management (CBNRM) activities spread rapidly and proved very effective. Conservancies benefited from improved governance and other structures, increased empowerment, increased skills and capacity, greater livelihood diversification options and increased income. In 2005 the total income to conservancies in Namibia was around US$2.9 million (C. Weaver, *Pers. Comm.)*. As a result of the increased commitment to conservation that this generated in local communities, wildlife populations experienced significant increases, particularly large mammals such as black rhino, elephant, lion, leopard, cheetah, giraffe and springbok (NACSO 2004, Stander 2006). The devolvement of power over wildlife to the local landholders and communities has shown that wildlife is an economically viable form of land-use for Namibia, provided the right incentives are given and the right policies are in place.

Although the human population is quite low in Namibia compared to other southern and eastern African countries, it is increasing. This increase combined with the burgeoning wildlife populations in the country and the fact that both humans and wildlife concentrate around the scarcest resource in Namibia – water – means that incidents of HWC are increasing, and solutions are urgently needed to ensure the current commitment to conservation and wildlife as a land-use is not degraded.

Sorghum field which has been raided by elephants. Kwandu Conservancy, East Caprivi, Namibia.

2. Description of the Problem

HWC incidents in Namibia comprise of damage to crops, livestock, and small infrastructure, mostly around waterholes, but also the killing or removal of problems animals and most significantly, human injury and death. Carnivores cause most trouble as a group, whilst elephants cause most incidents as a single species. Both live permanently on communal and freehold land where they regularly come into contact with people. A total of 3,194 problem incidents were reported country wide in conservancies during 2005. The species involved were as follows: elephants (23%), hyena (17%), jackal (10%), leopard (10%), cheetah (9%), bushpig (6%), hippopotamus (5%), crocodile (5%), various antelope (5%), lion (4%), baboon (2%), porcupine (2%) and caracal (1%) (Stander, 2005). However there is considerable regional variation in Namibia in terms of the species involved - spotted hyenas, lions and leopards are important throughout the northern regions, while problems with cheetah occur mainly in the west, and with wild dogs in the North-East. HWC for most wildlife species is not seasonal with the exception of elephants (Stander, 2005). In Caprivi, elephant conflict occurs mostly in the late wet season when crops are maturing.

There is also considerable geographical variation in the intensity of HWC in Namibia. The frequency of HWC in Kunene region (expressed as a ratio of the number of incidents per 100km^2) is 2.8 compared to 41.3 in Caprivi (Stander, 2005). Caprivi has the highest frequency in the country largely due to the increasing elephant population and higher human population densities than areas such as Kunene. The human population is higher in semi-humid Caprivi due to the greater availability of water than the more arid Kunene area. Proximity to protected areas also appears to be important. In 2003 the greatest number of problem animal incident reports from conservancies came from 3 conservancies adjacent to protected areas: the Kwandu (488 reports) and Mayuni Conservancies (269) which are both adjacent to Bwabwata National Park, and the Ehirovipuka Conservancy (204) near Etosha National Park. Conflict is also exacerbated when settlements are placed across areas frequently used by elephants. For example, in conservancies such as Kwandu and Mayni, settlements were placed in well-used elephant paths to and from the Kwando River leading to increased threat to people and higher likelihood of crop damage (Cumming and Jones, 2005).

HWC in Namibia also varies geographically in the type of damage inflicted (Cummings and Jones, 2005). In Caprivi, elephants provide a physical threat to people and destroy crops. In the more arid Kunene, elephants also pose a threat to people, and some damage to crops, but the main form of damage is to fences and infrastructure for water provision; elephants damage wind pumps and rip up pipes in search of clean water. Larger groups of elephants can consume almost the entire contents of a reservoir, forcing people to cover the costs of pumping more water for themselves and their livestock. Elephants can also occasionally kill livestock at water points. An indication of the number of HWC incidents by type is provided in table 1 below.

Table 1:
The number of incidents of human wildlife conflict caused by all species in Namibian conservancies using the Event Book system over the last three years. *(Source: NASCO, 2006).*

	2003	2004	2005
Human Attacks	17	14	15
Livestock Attacks	1733	1684	2658
Crop Damage	1098	1084	1470
Other Damage	171	154	139

Note: This data reflects incidents in only those conservancies using the 'Event Book' monitoring system and thus do not reflect all such incidents in the country. The Event Book is a simple colour-coded, image-based monitoring system for use by conservancy game guards.

Data on HWC incidents is gathered by the Ministry of Environment and Tourism (MET) and through the Event Book System by the community guards of the conservancies. The two systems report remarkably different figures, raising the question how much of the documented increase in HWC is due to better monitoring and how much is real. In fact, when data from the Event Book system was corrected for sampling effort, it appeared that HWC was actually stable between 2001 and 2004, although there has perhaps been a real and sudden increase in HWC over 2004 and 2005 (Stander, 2005). Irrespective of the true extent of the increase in HWC incidents, the perception on the part of all stakeholders is that HWC is increasing, and this is of importance in itself.

The increase in HWC has created greater political will within the MET to resolve the problem, with the MET Permanent Secretary observing in 2005 that "MET offices across Namibia have reported intensifying problems and incident reports relating to human wildlife conflict. Measures are urgently required to mitigate the conflict and increase the benefits of living alongside wildlife" (MET, 2005).

Unlike many countries where retaliatory killing and removal of problem animals is a major threat to the species concerned, in Namibia HWC does not appear to have a negative impact on the main species involved at the current time, with the possible exception of the wild dog (Stander, 2005). This is mainly due to the commitment to conservation of Namibian land holders (including local communities) as well as comparatively low human population densities. However this situation could change if HWC is not adequately dealt with and frustration with HWC related losses leads to increasingly negative attitudes towards wildlife.

3. Economic Analysis of HWC

The existing information about economic losses through HWC in Namibia is neither exhaustive nor consistent. The physical and monetary extent of HWC damage is extremely difficult to measure, and data is highly variable temporally, spatially and depending on the sources and methods used. Some manipulation is required to derive average values with validity. Bearing this in mind however, the following economic conclusions can be reached for Caprivi (based on the analysis by Barnes and Nhuleipo, 2005). All figures in US dollars, based on an exchange rate of 6.98 Namibian dollars to one US dollar.

- The average annual value of crop damage for each crop-producing household is US$37 (this is a blended average, including both dryland and floodplain crop producers).
- The average annual value of livestock losses per livestock producing household is US$38.

These values represent the average amounts by which rural household gross incomes are reduced by HWC. The total average annual value of losses due to wildlife (including both crops and livestock) is US$75 per household, which represents 7% of total household cash income[1] (total annual household *cash* income is around US$1,080). As a rough estimation, the combined costs of HWC to communal area farmers in Namibia (Kunene, North of Etosha and Caprivi) is around US$1 million annually.

However the most important point to note is that that across Caprivi the levels of HWC suffered by different households and agricultural enterprises vary greatly. Some enterprises experience hardly any HWC at all, and others experience extremely high levels. This depends on how close the enterprise is to wildlife habitat or corridors used by wildlife. The average levels of HWC referred to above are calculated for the entire region, and therefore mask the huge variations between those enterprises with extremely high HWC and those with very little. Some useful deductions can be made by using economic modelling exercises to compare the average levels of HWC with what could be expected for a particular agricultural enterprise which was situated close to wildlife habitat, and therefore was suffering higher than average levels of HWC:

1 The cash income estimate does not include home-consumed income. There are currently no estimates of total household income that take both home-consumed and cash income into account.

- Agricultural enterprises (both crops and livestock) established in the general vicinity of wildlife habitat or wildlife corridors can be expected to incur twice as much HWC than is experienced on average by all enterprises across Caprivi. Enterprises suffering a doubled level of HWC would suffer an additional drop of 3% in net income for a livestock enterprise (a loss of US$89 per in net income for each household), a 28% drop in net income for a floodplain crop enterprise (a loss of around US$37 in net income per household), and a 30% drop in net income for a dryplain crop enterprise (a loss of around US$97 in net income for every household).

- Agricultural enterprises established close to wildlife habitat could experience 3 times the average level of HWC in Caprivi, which would result in a 14% drop in net income for a livestock enterprise (a loss of US$358 in net income per household), a 60% drop in net income for a dryland crop enterprise (a loss of US$193 in net income per household), and an 86% drop in net income for a floodplain crop enterprise (a loss of US$114 in net income in each household).

- Agricultural developments established directly adjacent to unfenced wildlife habitat could experience levels of HWC that are 5 times greater the average levels of HWC experienced across Caprivi. This would result in a drop of 28% in net income for a livestock enterprise (a loss of US$719 in net income for every household), a 120% drop in net income for a dryland crop enterprise and a 202% drop in net income for a floodplain crop enterprise, making the enterprises entirely economically unviable.

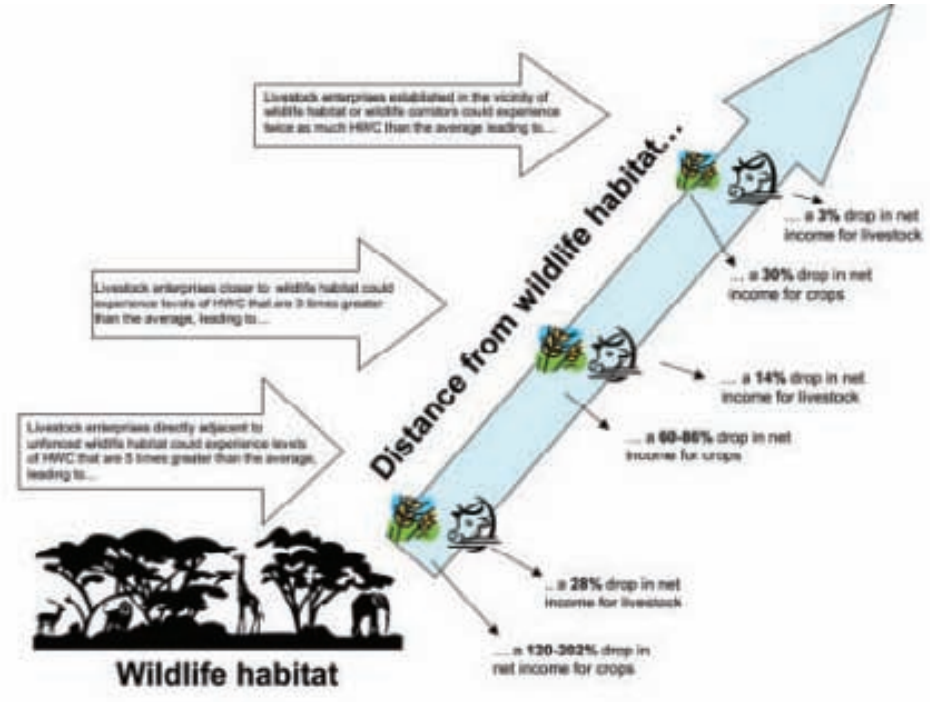

Figure 1:
Economic value of HWC losses for crop enterprises at various distances from wildlife habitat

It is interesting to note from the above analysis that elevated levels of HWC have a greater impact on crop based enterprises than they do on livestock based enterprises. Net income drops very significantly for crop enterprises with two or three times the average level of HWC, and crop enterprises with five times the average level of HWC are not economically viable. However livestock enterprises can withstand five times the average level of HWC, only seeing a reduction in net income of 28%.

In terms of the contribution that crop and livestock enterprises make to the national economy, a floodplain crop enterprise experiencing twice as much HWC than the regional average would contribute 29% less to the national economy. The same enterprise experiencing three times more HWC than the regional average would contribute 86% less to the national economy. If an enterprise were to experience 5 times more incidents of HWC than the regional average,

it would be a severe drain on the national economy. Current levels of HWC in Caprivi alone result in a loss US$770,000 to the National Economy of Namibia – US$294,000 from crop damage, and US$476,000 from livestock predation.

This analysis clearly shows that it is in the economic interest of rural communities, agricultural enterprises, all government departments and the National economy of Namibia, to develop appropriate land-use planning that ensures future agricultural enterprises are established in areas as far away from wildlife habitats and corridors as possible. This will ensure lower levels of HWC, greater net profits for agricultural enterprises, and greater contribution of those agricultural enterprises to the National Economy of Namibia.

This analysis does not account for the differential impacts of HWC according to the status of the individual households. Elephant damage to the crops of poor small producers will have a higher impact than similar damage to the crops of a more wealthy family with larger crop lands. In a society of low incomes (with no security mechanisms in place), reductions in net income of 30-40% can be life-threatening. Very probably, it is the social networks that ensure in many cases that families experiencing very high levels of HWC don't starve. Crop damage will also have a higher impact on families affected during drought years. Furthermore, not all crops would necessarily be sold, and many people in Caprivi depend upon crops for consumption. This means that crop losses to elephants therefore have important implications for household food security.

It is difficult to place a value on the most significant and catastrophic impact of HWC – human injury or loss of life. In Caprivi the number of injuries and deaths has risen from one in 2001 to seven in 2005.

Table 2:
Costs of various levels of wildlife damage on household crop and livestock production activities in Caprivi (all values in US dollars).

		Average level of HWC	Twice the average level of HWC	Three times the average level of HWC	Five times average level of HWC
Caprivi floodplain crops enterprise	Gross income	318	279	202	49
	Net income (profit)	133	96	19	-136
	Net income drop (%)		28%	86%	202%
	Profit/investment (%)*	24%	17%	3%	Negative
	Value added to Gross National Income (GNI) **	79	56 (a drop of 29% from base value)	11 (a drop of 86% from base value)	-80
	Loss in gross national income/household for floodplain crops = 23				
	Aggregate loss in GNI for Caprivi for floodplain crops = 302,579				
Caprivi dryland crops enterprise	Gross income	612	516	321	-66
	Net income (profit)	322	225	129	-66
	Net income drop (%)		30%	60%	120%
	Profit/investment (%)*	43%	30%	17%	Negative
Caprivi livestock enterprise	Gross income	2,997	2,907	2,547	1,828
	Net income (profit)	2,590	2,501	2,232	1,871
	Net income drop (%)		3%	14%	28%
	Profit/investment (%) *	31%	30%	27%	22%
	Aggregate loss in GNI for Caprivi for livestock*** = 491,690				

* Annual private profit as a proportion of initial capital costs – a crude measure of return on investment
** The annual net contribution of the activity to the gross national income (GNI), measured in economic prices – a different measure from private profit
*** Aggretate value, calculated using GNI loss values for similar enterprises in Ngamiland, Botswanna and the rural household population for Caprivi.

A similar pattern is seen in conservancies. Table 3 shows the net benefits that communities derive from wildlife through CBNRM. Conservancies experiencing levels of HWC that are twice as high as the regional average would have net incomes reduced by 36-49%, reducing net income for the community by US$46,454 - 59,726. Conservancies experiencing four times the average level of HWC have net incomes that are 73-97% lower, and experience a reduction in net community income of US$92,909 - 199,454. Conservancies experiencing levels of HWC that are more than 4 times higher than the average would be completely economically unviable, as the losses due to HWC would be greater than the economic benefits derived from wildlife. It is interesting to note that the drop in net income that a conservancy would experience as a result of increased HWC varies between conservancies based on the amount of wildlife the conservancy has. Mayuni Conservancy, with a rich stock of wildlife, can withstand up to four times the average level of HWC and still generate more income than it suffers in losses. Salambala conservancy, with poor wildlife resources, cannot withstand even a twice the average levels of HWC without the net income of the conservancy going into the red.

However this analysis does show that, on average, the amount of HWC experienced by conservancies is lower than the costs that the conservancy suffers as a result of HWC. This is an important finding that demonstrates that the Namibian government policy of promoting a system of CBNRM where wildlife can pay for itself and communities can internalise both the costs and benefits from wildlife appears to be economically sound. This can also be seen when looking at the contribution conservancies make to the national economy. Although a doubling of average HWC levels reduces the contribution of conservancies to the gross national income substantially, economic viability is retained even under conditions of HWC up to four times higher than the average.

Table 3:
Costs of various levels of wildlife damage to crops and livestock in two community-based conservancies in Caprivi (all values in US Dollars).

		Average level of HWC	Twice the average level of HWC	Four times the average level of HWC	Eight times the average level of HWC
Mayuni conservancy	Gross income	230,032	193,308	96,855	-119,052
	Net income (profit)	74,702	37,977	-21,751	-141,205
	Community income*	164,309	104,583	44,855	-74,600
	Community Income drop	-	36%	73%	145%
	Community Internal Rate of Return (IRR)**	220%	123%	38%	Negative
	Value added to Gross National Income (GNI)***	192,898	139,811	86,722	-19,456
Salambala conservancy	Gross income	171,582	125,128	54,934	
	Net income (profit)	30,006	-16,448	-40,186	
	Community income*	95,544	49,089	2,635	
	Community Income drop		49%	97%	
	Community IRR**	40%	0.6%	Negative	
	Value added to GNI***	117,920	76,629	35,338	

* Community income is a measure of total annual net benefits to community members in the conservancy, including conservancy net income (profit), salaries and wages, conservancy dividends

** Internal rate of return (IRR) to the community's investment in the conservancy over ten years – a relatively sophisticated measure of return on investment

*** The annual net contribution of the conservancy to the gross national income (GNI), measured in economic prices.

Whilst it is relatively easy to assess the relative costs and benefits of living with wildlife to the conservancy as a whole, it is difficult to provide an analysis at the individual household level. Not all conservancies make direct payments to households and many of the benefits to households stem from social projects and are thus intangible (such as empowerment and capacity building). However it is clear that although some households within a conservancy experience much higher levels of HWC than others, the income generated by wildlife through conservancies does not always preferentially reach the households most affected by HWC. As a result although HWC costs are not more than between 35-50% of the benefits that wildlife brings to the conservancy as a whole, the benefits reaching certain individual households subject to severe HWC are insufficient to off-set losses caused by wildlife. It is therefore necessary to develop local mechanisms to ensure that benefits from wildlife reach the households that are most affected by HWC. Options for doing so are discussed in section 5 below.

4. The Policy Environment and HWC: Dynamics, Drivers and Solutions

This section considers the various drivers of HWC, or factors that exacerbate HWC, at the three levels – micro, meso and macro.

Micro level

One of the factors that prevents adequate management of HWC is lack of devolution of full decision making regarding problem animals to the local institutions that need to be able to react when a problem occurs. Farmers are legally allowed to kill animals that threaten their lives or livestock while the threat is actually occurring, although if the animal is a protected species such as a big cat, wild dog or crocodile, the killing has to be reported to the MET within 10[2] days. Non protected wildlife that threatens crops may be killed if the fields are fenced, but specially protected species such as elephants, rhinos and hippos may only be killed without a permit if threatening human life.

In non-life threatening situations, a HWC causing elephant, may only be killed once the Minister of Environment and Tourism has declared it to be a 'problem animal.' The animal may then be destroyed either by MET or by a professional hunter. The idea of using a professional hunter is so that in the case of a conservancy, the shot animal can bring some income and help offset losses caused by the animal. However the process is too protracted to be effective, taking anything from a few weeks to six months for a problem animal to be declared by the Minister – by which time the animal will likely have moved on, possibly even into another country (Jones, 2002).

Communities in Caprivi are increasingly starting to view wildlife as belonging to the conservancy rather than to the state (Jones and Butterfield, 2001). As a result they expect the conservancy to deal with problems caused by the conservancy's animals. The fact that conservancies do not have the authority to shoot an elephant if necessary and have to wait for permission from MET for the elephant to be destroyed is undermining the support of the conservancies by their members. It is therefore recommended that the authority to identify a problem animal and authorise its lethal removal is decentralised to the lowest levels, thus enabling a quick reaction in the field and ensuring the correct animal is removed. Whilst elephant populations remain at sustainable levels, and the conservancy sees elephants as a valuable asset, it is highly unlikely that offtake of seriously problem causing animals will have any impact on the population. The draft national policy on HWC Management makes provision for this authority to be devolved to MET regional offices and conservancies that have HWC management plans.

Another problem faced by conservancies is lack of secure land tenure. Although the National Land Policy makes provision for groups of people such as cooperatives and conservancies to become land holders, this approach is not strongly backed up by the legislation that

[2] Nature Conservation Ordinance 4 of 1975 (GRN 1975)

followed – the Communal Land Reform Act. When conservancies develop local land-use plans and zone specific areas for wildlife and tourism, it becomes difficult for them to exclude other people from outside the conservancy from moving into these zoned areas. If outsiders move their livestock into areas zoned by conservancies for wildlife, conflict with predators in these areas is likely to ensue. Without support from government levels above, enforcement of management plans and zoning can be extremely problematic. However one example of a conservancy in Caprivi demonstrates how effective appropriate zoning can be. Mayuni conservancy recorded a dramatic decline in crop damage after the implementation of its zoning plan which moved people away from the floodplain areas much used by wildlife (NASCO 2006). The local Chief was a driving force behind this process – something which is key to the success of any community plan. The MET has now taken up this approach as crucial in its draft national policy on HWC management.

Meso level

The major problem at the meso level is that Regional planning bodies and those responsible for land allocation do not take potential HWC into account when making decisions about land allocation. Plans are made without considering whether there are existing uses of the land based on wildlife, or whether proposed agricultural developments will increase levels of HWC. Insufficient consideration is given to the economic benefits of different land-uses and to the optimum use of land given the prevailing environmental conditions.

For example, the government recently designated a large block of land for smallholder agricultural just west of Kaudom Game Reserve in Kavango Region. The reserve is unfenced and there is considerable movement of wildlife (particularly of elephants) westward during the wet season. These farms that will be directly adjacent to unfenced wildlife habitat and in the path of known elephant movement, can expect levels of HWC that are five times higher than average. As can be seen from the economic analysis above, this level of HWC could lead to a 120% drop in net income, thus making the agricultural enterprise commercially unviable and a drain on the national economy. Furthermore, the negative impact of HWC on wildlife within the reserve will diminish the opportunity to develop economically viable wildlife and tourism enterprises using the Kaudom Game Reserve as a core wildlife area and tourism attraction (Jones and Kakujaha-Matundu, 2005). The impacts on wildlife in the game reserve as a result of the increased conflict are unquantifiable, but are likely to be particularly severe for wild dog. The area is one of the last strongholds of the wild dog in Namibia, but the animals are not contained within the park, and the increased conflict with new livestock farmers could considerably reduce their numbers.

In order to avoid inappropriate land-use planning such as this, it is critical that the government bodies with a remit for land-use planning at all levels take current and potential future HWC into account in their decision making. An integrated multi-agency approach to land-use planning in this case could have investigated the best economic uses of the land and carried out a cost-benefit analysis of various options. For example, the cost of developing farming activities would need to take into account the likely costs of repairing fences and water installations damaged by elephants, crop losses to elephants and livestock losses to predators. It would also need to take into account the value of the wildlife likely to be killed as a result of HWC in the absence of any system (such as a conservancy) to return income from such animals to the community. This approach, used overall in land-use planning decision making, will ensure increased potential for income generation from wildlife, increased economic success for new agriculture developments and increased contributions to the National Economy.

Macro level – National and regional (provincial)

Namibia's National land and water policies also do not adequately cover HWC issues and in some cases serve to exacerbate the problem:

- The Ministry of Lands and Resettlement does not consider HWC issues prominently in its land-use planning approaches if at all. Land-use planning appears to be driven by the desire to promote crop farming and livestock as land uses, without necessarily considering their

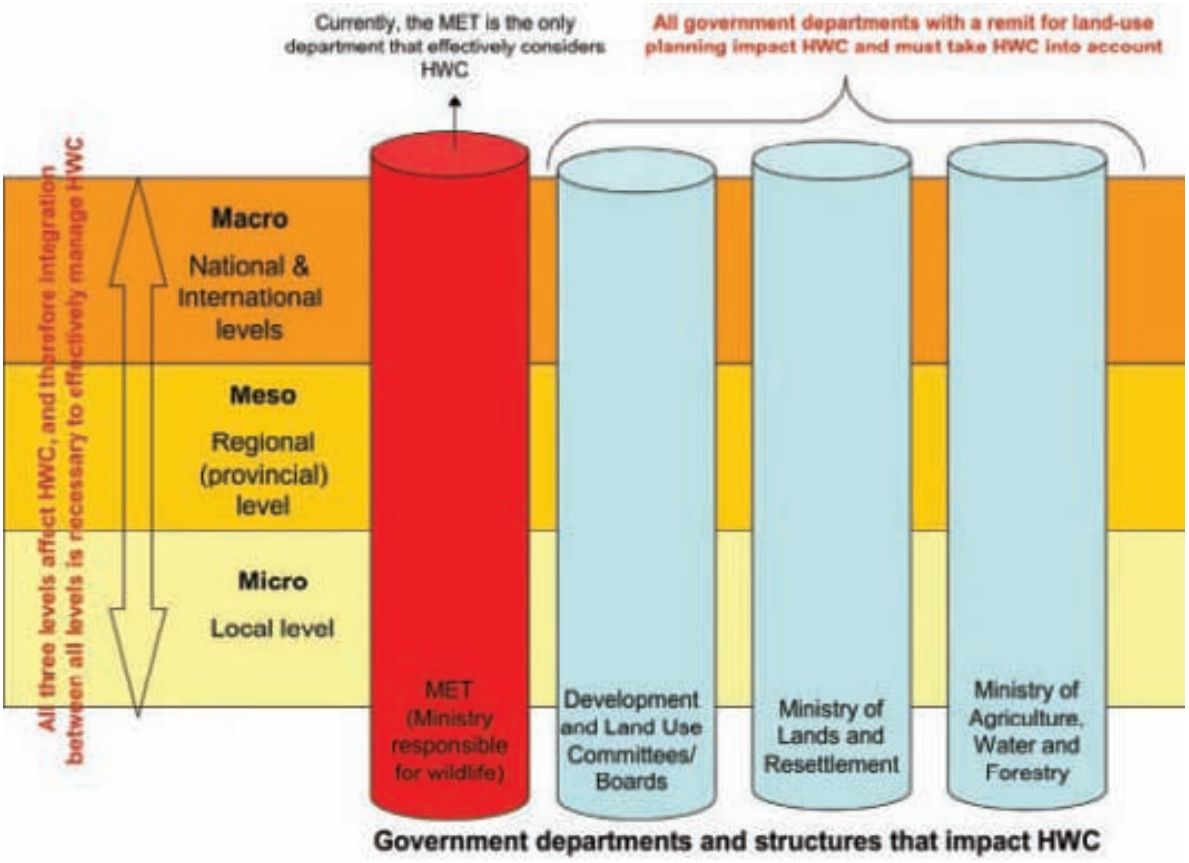

Figure 2:
Visualisation of the various institutions and levels at which HWC must be considered.

impact on the existing use of land for wildlife in conservancies and without considering the most economic forms of land-uses based on land capability and climatic conditions. For example, the economic potential of wildlife management in drylands is mostly ignored.

- National Development Policies, whilst including the promotion of environmental and ecological sustainability as a strategy, and whilst recognising the contribution of CBNRM to national development goals, do not directly consider or address HWC. In fact, establishing more land under irrigated high-value crops is seen as one contributing measure to national development, despite the fact that this is likely to lead to more HWC in some areas.
- In the extremely dry northwest, where elephants regularly damage water installations, water authorities refer local residents to the MET if the damage was caused by wildlife. However the MET does not pay compensation for HWC losses and damage. Although communities that have formed successful conservancies and are generating sufficient income can use funds generated by elephants to address water-related problems caused by elephants, better integration with water committees would be of considerable advantage.

However a number of new or draft policies are aiming to improve the situation.

- A new Policy on Tourism and Wildlife Concessions on State Land will enable the Minister to reserve concessions in protected areas for a community resident in the area or adjacent to it. This would offset the losses suffered by the community from HWC. There is also a draft policy on Protected Areas and Resident People which promotes the development of cooperative management of protected areas between MET and residents/neighbours and the development of compatible forms of land-use adjacent to protected areas based on the CBNRM approach.
- The Environmental Act requires Environmental Impact Assessments (EIAs) for all development projects. If these EIAs required an assessment of the potential for a development project to increase or create new HWC, they would effectively provide a mechanism to ensure that development proceeded in a manner that protected the economic potential of wildlife and reduced the potential for agriculture and other enterprises to experience losses as a result of HWC.

- The government's Poverty Reduction Action Program (PRAP) recommends the strengthening of CBNRM and conservancies. The PRAP also recommends promotion of high-value tourism focused on wildlife.
- The MET is expected to approve a new HWC management policy that will provide incentives for farmers to live with wildlife and bear the costs.

The most important overriding issue is the lack of a national land-use and development planning system that takes HWC into account, is based on public consultation, good technical feasibility studies and environmental assessments and links the different levels. The following steps are recommended to provide such integration (adapted from Jones and Kakujaha-Matundu, 2005):

- Relevant ministries should develop a coordinated planning system that encompasses land-use planning, physical planning and development planning at national and regional levels, establishes clear procedures for taking environmental considerations into account in land-use decisions (e.g. Environmental Impact Assessments) and which also identifies the roles of key stakeholders at different levels.
- National and regional Land-Use and Environmental Boards should be established to administer and coordinate national and regional land use planning systems.
- Training programmes should be developed for regional council and land board members covering basic environmental principles, the economic potential of different land-uses, Environmental Impact Assessments and Environmental Management Plans, as well as principles of CBNRM.
- Regional Councils, Land boards and traditional authorities should be involved in the development of regional and local level HWC management plants with MET, other relevant ministries, conservancies and other stakeholders such as NGOs.

Local childrenm Sikaunga village, Kwandu Conservancy, East Caprivi, Namibia.

Table 4:
Key Features of Namibian Policies and Legislation Relevant to HWC

Policy/legislation	Relevance to HWC	Recommendations
Local level land-use planning	• Provides the micro level framework for land-use planning that will minimise conflicts (such as moving settlements out of elephant corridors.)	1. Conservancies need the appropriate group tenure rights that would enable them to enforce their land-use zoning with the full backing of the various government authorities at regional and national levels.
Conservancy policy and legislation	• Provides the institutional framework for devolving rights over wildlife and tourism to rural communities that form conservancies. A conservancy must have designated boundaries, defined membership, a legal constitution, a representative committee, and plan for equitable distribution of benefits. • Conservancies provide the institutional mechanism at community level for channeling benefits that can offset HWC losses, for implementing prevention measures, and for interacting with the meso and macro levels.	1. Provide stronger rights over wildlife to conservancies including decision-making over problem animals 2. Assist conservancies to target benefits derived from wildlife to those households most affected by HWC
Draft Environmental Act	• Will mandate EIA screening for all development projects. Should enable HWC to be considered in the planning and implementation of agricultural and other rural development projects.	All other sectors need to be fully aware of the provisions of the Act and their responsibility to include HWC in Environmental and Social Assessments.
Community Based Tourism (CBT) Policy	• Provides the framework for government support for community-based tourism (CBT). • Allows conservancies to get concession rights for 'lodge' development. Crucial for increasing financial and other benefits that can help to offset HWC losses.	Intent to give tourism concessions to conservancies must be included in legislation.
Draft tourism policy and legislation	• Provides the framework for national tourism development. • Crucial for increasing financial and other benefits that can help to offset HWC losses.	1. CBT should be defined 2. Role of communities should be defined vis a vis the government and private sector. 3. Principles of CBT policy should be incorporated. 4. Control of tourism (e.g. planning, zoning and regulations) should be devolved to conservancies.
Draft policy on protected areas and neighbours	[a] Provides a framework for relationships between protected areas (PAs) and neighbours (including people resident in parks). • Promotes benefits to neighbours from PAs and provides for co-management arrangements with regard to HWC on park borders and other issues.	1. Role of conservancies as neighbours should be emphasised. 2. Park staff should develop joint HWC management plans and co-management agreements with neighbours, particularly conservancies
Forestry policy and legislation	• Provides institutional framework for giving communities rights over forest resources. The arrangement is similar to that which exists for conservancies. Compatible with conservancy approach and provides rights over a wider range of resources. • Community forest committees could also provide useful institutions for addressing HWC and interacting across sectors and levels.	1. Community forest management plans should also address HWC
Land policy and legislation	• Land Policy provides for categories of land holder that includes conservancies, but legislation does not clearly provide for groups such as conservancies to gain secure land tenure. This undermines the ability of conservancies to enforce their land use zoning plans, and can lead to increased HWC where people ignore this zoning • Communal Land Reform Act provides that Land Boards have to take conservancy management plans into account when allocating land for leases for commercial activities. • Land Boards and traditional leaders rarely consider HWC in allocating residential and agricultural land	1. Provisions for secure and exclusive group tenure should be explicitly incorporated in legislation 2. Traditional Authorities and Land Boards should take HWC into account when allocating and approving land allocations for agricultural and residential purposes. 3. Provide information and training to Communal Land Boards on conservancies, HWC and Environmental Assessments.

Water policy and legislation	• Provides framework for cost recovery for water provision including transfer of management, operation and maintenance of water points and installations to communities. • The approach means that local people have to pay for any repairs required due to damage by elephants.	1. As with the #Khoadi //hoas Conservancy case study, conservancies in the NW can do much to prevent and mitigate the damage to water installations 2. Conservancies should develop practical integration with water committees in particular regarding protection of water points and other forms of funding support such as provision of diesel for pumping water where elephants drink regularly
National Agricultural Policy	• Provides framework for Agricultural development. Calls for community empowerment and group tenure. • Past subsidies to livestock being phased out.	1. Needs legislation on group tenure over rangelands (see Land Policy and legislation) 2. Carry out research on effects of past subsidies and new subsidies under the Affirmative Action Loan Scheme
Decentralisation policy	• Framework for devolution of functions to regional councils. Provides for Regional and local governance structures and development committees to carry out development and land use planning.	1. Regional Councils and development committees need to take HWC into account in agricultural and rural development planning 2.Promote positive links between conservancies and regional and local governance structures and development committees 3. Provide information and training to Regional Councils and development committees on HWC, mitigation and prevention measures and environmental assessments.

Macro level - International

International agreements seemingly unrelated to HWC can actually prove to have a significant and important influence – either as drivers of the problem, or as part of the solution.

Special rules of the Coutonou livestock protocol give access for Namibia and other countries to the protected European beef markets, artificially enhancing the economic viability of the livestock sector in Namibia compared to other industries. Similarly, livestock sectors in southern African countries have received substantial domestic subsidies. In contrast, wildlife use activities, and investment in wildlife production, have tended to receive no subsidization in Southern Africa, and in fact the bureaucratic processes involved in wildlife management (such as delays and inefficiencies in the requisite government permit allocations) further reduce the competitive advantage of wildlife as a land-use relative to livestock. This all serves to decrease the perceived benefits of wildlife in contrast to other forms of land-use, thus promoting the development of non-wildlife industries that often create or exacerbate HWC. More detailed study on the effects of taxes/subsidies and trade restrictions/trade advantages, in both the livestock and natural resources/wildlife sectors, is urgently required in order to inform policy development and reform.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulates international trade in wildlife. While the southern African countries suffer from an overpopulation of elephants, the animals are highly endangered in the other areas of the continent and in Asia, particularly in areas where controls on illegal poaching of elephants are inadequate. Due to the potential threat that an uncontrolled international market for ivory would pose for more threatened populations, the international trade in elephant ivory and other products is tightly regulated by CITES. CITES does not regulate domestic trade or wildlife management within Namibia, however the internal markets for elephant products in Namibia are limited. Therefore CITES does in effect limit the potential benefits that communities (and others) could gain from the consumptive use of elephants in Namibia.

Elephants in north eastern Namibia are part of a much larger population of around 250,000 that covers Botswana, Namibia, Zimbabwe, south-western Zambia and south-eastern Angola. Both human and elephant populations in southern Africa have increased 20-fold over the last century resulting in compressed and fragmented elephant ranges, an escalating elephant overpopulation problem and increasing human-elephant conflict (Cumming and Jones, 2005). In this region, where the elephant population is entirely transboundary in nature, solutions have to be found that are equally transboundary. Opening up corridors for elephants to migrate into southwest Zambia or southeast Angola where elephant populations are low because of past heavy poaching is one possibility, although range expansion of this kind will include large areas of communal lands that are already settled by people. If these people are to tolerate elephants they need realistic incentives such as economic benefits from elephants. Conservancies in Caprivi could provide the key local management structures which, if coordinated with government strategies, could result in the conservation and safe movement of elephants between Botswana, Angola and Zambia (Diggle et al., 2006). Plans are underway to develop a transfrontier conservation area (TFCA) linking parts of south-east Angola, northern Botswana, southern Zambia, and western Zimbabwe with Caprivi in Namibia.

5. Practical Field Based HWC Solutions

Numerous methods both traditional and modern are being employed in Namibia at a field level to keep wildlife away from humans and human property, with varying levels of success. Conservancies often provide the appropriate local structures to plan and implement these measures, which include artificial barriers (electric fences, protection of water points, chilli pepper fences, chilli bombs), alternative water points for elephants, elephant trip alarms and improved livestock husbandry. A description of these methods and estimates of the costs of implementation are presented in Table 5. In the vast majority of cases, one technique alone will not be sufficient – a package of different techniques should be designed that is specifically tailored to meet the needs of the local situation. HWC varies enormously spatially, temporally and between species, and therefore responses and management approaches must be flexible.

In some cases, technical solutions may appear ideal, but might not be effective due to institutional failure. Particular attention must to be given to ensuring that appropriate governance structures are in place to implement the solution and maintain infrastructure as necessary.

Mitigation by CBNRM

As discussed above, in conservancies the benefits derived from wildlife through CBNRM are greater than the losses suffered by a conservancy from HWC, and therefore CBNRM in itself is an effective way to mitigate HWC. However, there is little or no preferential distribution of wildlife benefits to individual households that suffer more HWC than others. Resolution of this problem needs to occur at the conservancy level, and there are several mechanisms that could be used:

- Conservancies could, in their benefit distribution plans, specifically target households that suffer high HWC costs.
- In some cases, conservancies have the potential to considerably increase their incomes and to make larger amounts available for direct household benefits. The main constraint in this is a lack of capacity to manage more business partnerships and enterprises.
- There is a MET fund (Game Products Trust Fund-GPTF) derived from official and CITES-approved sales of ivory and other wildlife products. The GPTF is used to offset elephant damages, but the process to obtain the funds is time-consuming.
- There are ways to specifically increase the income raised by problem causing animals for communities, such as developing predator tracking safaris linked to tourism lodges in conservancies. Part of the income from these safaris could be put into a special conservancy fund that can be used to offset livestock losses.

- Some conservancies have begun to install Human Animal Conflict Self Insurance Schemes (HACSIS), designed to compensate for livestock losses to predators (Esterhuizen, 2004). There are some conditionalities for payments:
  - No payments will be made for livestock killed in a protected area or a conservancy designated wildlife zone;
  - No payments will be made for livestock that were not in a kraal;
  - Conservancy staff and traditional leaders advise whether strengthening is required on stock enclosures, and no payment is made if the improvements are not carried out;
  - Payments will not be made if members were warned that predators were in the area and took no action to bring the livestock to safety;
  - Livestock deaths must be reported within one day and verified by a community game guard.

These measures provide the appropriate incentives to ensure that behavioural practices that will prevent HWC are adopted by conservancy members. Newly organized conservancies need initial donor funding for these schemes, but it is hoped that they will become self-sufficient quickly. However if conservancies are not able to increase their incomes, total annual payments may need to be capped to prevent the scheme becoming a drain on conservancy finances. Some conservancies are considering establishing livestock herds to replace animals lost to predators rather than making payments. Other ongoing work deals with insurance schemes that would cover crop losses.

The following examples demonstrate how two conservancies have taken steps towards ensuring preferential benefits get to households that suffer from the most HWC. The first, the #Khoadi //hoas Conservancy in Kunene, is a community of indigenous people who were resettled during apartheid times and live a largely subsistence existence in a dry region of low agricultural productivity. They founded a conservancy and their main source of income is now trophy hunting. More than US $14,000 went to the community (about 3,500 people) in wages alone during 2006, and a variety of social projects were supported. Additionally, the conservancy got a grant from the Global Environment Facility (GEF) for the installation of protective walls around water points. Elephants have killed livestock at water points, caused damage to installations and damaged fences and gardens, as well as competing for scarce water. The conservancy concentrates much of its efforts and income on compensating the people who are most affected by elephant-inflicted damage – either through focussing water source protection schemes on the water points most affected by HWC, by paying compensation to those who have lost livestock to elephants, or by providing free diesel to people who's water has been consumed by elephants. Monitoring of elephant populations by locally employed 'environmental shepherds' allows the conservancy to identify the main problem areas to be prioritised for protection measures.

"I am grateful for the assistance I am getting from the conservancy. The wall around the water installations prevents the elephants from damaging the pump and the pipes, and the conservancy provided diesel, meat from hunting and stud rams to improve my livestock. If it hadn't been for the conservancy, the community would not have obtained funds for the wall to keep out elephants."

- Mr. Seth Awiseb, #Khoadi //hoas Conservancy, Kunene Region.

"Electric fences received under the GEF project are not working because of faulty equipment, and the company that had supplied the equipment has closed."

- Mr. Bob Guibeb, #Khoadi //hoas Conservancy, Kunene Region.

Table 5: Key features of field based HWC measures in Namibia.

Measure	Area used	Method	Effectiveness	Cost (where available)
Prevention				
Local HWC management plans	Ehirovipuka Conservancy, Kunene Region Draft plan developed	Develop integrated HWC management plan that addresses prevention, mitigation and roles of different stakeholders. In the case of Ehirovipuka, this includes co-management with staff of neighbouring Etosha National Park.	Yet to be finalized and tested.	Cost of developing the plan includes transport and other logistics for meetings
Improved livestock husbandry	Being promoted in #Khoadi //hoas Conservancy. Kunene Region	1. Herding of livestock (including use of dogs) 2. Kraaling livestock at night 3. Promoting synchronised birthing	All can be effective (Stander, 2005) but are rarely practiced. Problems include young boys going to school and no longer being available for herding.	
Mitigation				
Artificial barriers 1. Electric fences	Used in Etosha National Park, and conservancies in Kunene & Caprivi	Erection of electric fencing as a barrier particularly against elephants to prevent them from leaving a protected area, or to protect crops and/or settlements.	Mixed results. Can work if regularly maintained. Problems: Communities have not taken ownership and do not maintain fences; elephants find ways to break or go around fences; high maintenance costs (e.g. regular fence patrols in protected areas.)	Cost to cover area of 5km^2 = US$2 149 including wire and other equipment such as solar panels (Esterhuizen, *Pers. Comm.)*
Artificial barriers 2. Protection of water points	Kunene Region Conservancies, Nyae Nyae Conservancy	Construction of protective stone wall around water installations.	Effective if at least two large rocks thick, 1.8 m high, and if walls are a sufficient distance from the installation to prevent elephants reaching over. Access should be left to part of the reservoir for elephants to drink and there should be a separate, protected tank for domestic consumption.	Between US$716 and US$1,433 including materials, transport and labour (Esterhuizen, *Pers. Comm.)*
Artificial barriers 3. Chilli pepper fences	Caprivi	Fences lined with a mixture of grease and chilli peppers.	Initial indications are that this can be effective. Still being tested. Possible environmental implications of use of grease. Needs ready supply of ingredients and regular maintenance.	
Artificial barriers 4. Chilli bombs	Caprivi Region (also Mozambique and Zambia)	Ground chilli mixed with elephant dung and compacted in a brick mould and dried. Bricks are burnt along the edge of fields and smoke acts as a deterrent to elephants.	Seems to be effective, but time required for further testing and to see if elephants become used to the smoke.	
Alternative water points for elephants	Kunene Region	Provision of a water point away from the settlement and away from where livestock drink. Usually water is drawn off from the main installation at the settlement.	Not very successful as communities do not take ownership of the alternative water point and usually do not continue to maintain the water supply (sometimes because they cannot afford the additional diesel to pump water). The main water point needs to be completely inaccessible to elephants.	Around US$2,870 – 3,580 (Esterhuizen, *Pers. Comm.)*
Guarding fields	Caprivi Region	Villagers and conservancy game guards are deployed in fields during the growing season to scare away elephants.	Difficult to predict where elephants will appear. Can be dangerous. Difficult to cover a large area.	Loss of sleep and subsequent productivity

Elephant trip alarms	Caprivi Region	Trip alarms around fields consisting of car siren, battery, timer and polythene string mounted to existing fences or onto trees and poles.	Can work if the area is not too large and if elephants are entering fields from the same direction. Elephants can become habituated to the sound. Potential disturbance of people in settlements or tourism operations.	Around US$115 (O'Connell, 1995)
Reaction				
Relocation	Used for lions leaving Etosha National Park and in some communal areas	Relocation of a specific problem causing animal to another place or back to where it originated, particularly if from a protected area.	Difficult for elephants due to high costs, lack of areas where they can be moved to (there is already a problem of increasing numbers) and possibility they would return to original sites (Cumming and Jones, 2005). Can work for lions if they are "occasional raiders" rather than habitual problem animals (Stander, 2005.) Can be important alternative to lethal removal. Requires good understanding of lion behaviour and ecology.	
Lethal removal	Kunene/Caprivi	Shooting of identified and persistent problem animals that are a clear danger to property or life.	Effective in order to protect property or life if the correct animal can be identified.	
Reaction unit (to problem animals)	Proposed	Provision of designated personnel on the ground who can react to calls for assistance from villagers. Could be designated persons from conservancy game guards and MET staff.	Would be able to provide a quick response that could identify and deal with the problem causing animal.	
Self-insurance scheme	Kunene/Caprivi	Provision of funding to individuals to off-set (not necessarily fully compensate) for livestock and crop losses.	Initially supported by donor funds, gradually conservancies are taking over the funding using revenues from wildlife and tourism. Effective, but could become a drain on conservancy finances.	Potentially around US$2,000 a year per conservancy depending upon the number of incidents and whether a cap is placed on the total amount of payments made.

The second example is Kasika Conservancy in the Caprivi region, near the Chobe River on the border with Botswana's Chobe National Park. The park suffers from an overpopulation of elephants which are continually moving into Namibia. There is a HACSIS scheme in place that, in the course of one year, paid about $150 for each case of livestock loss, 16 in total. Payments for stock losses are linked to the use of crocodile fences at designated drinking places. The payments to off-set livestock losses have increased the tolerance of residents for wildlife (Diggle, *Pers. Comm*). The community has also established a chilli pepper plantation both as a cash crop and for the production of chilli bombs and chilli-greased fences (see Table 1), which so far have been successful in keeping elephants away from crops.

6. Monitoring and Evaluation

Accurate and consistent data is critical for good decision-making regarding HWC management. Information is required by managers at the macro, meso and micro levels to inform land-use and development planning, assist in developing appropriate HWC management strategies and in order to adapt strategies and actions over time as data indicates what works and why. Specific activities aimed at preventing or reducing conflict need more rigorous monitoring to determine their efficacy, and results need wider dissemination.

In Namibia, the event book system is considered to be the most robust and systematic system for monitoring HWC incidents (Stander, 2005), although the HACSIS scheme is also producing good data which includes a spatial perception of the impact of HWC, thus enabling managers to identify hot spots.

7. Conclusions

The economic analysis conducted in this study, combined with the assessment of the drivers of HWC, its dynamics and the solutions at micro, meso and macro levels, enable the following conclusions to be drawn:

- This study has provided analytical evidence that the Namibian government's policy of approaching HWC though CBNRM development is sound economically. The economic benefits associated with CBNRM initiatives in Caprivi are higher than the associated HWC costs at the community level. Therefore CBNRM, and the internalisation of HWC, provides a sustainable long-term solution to the problem and reduces the need for continual government interventions. One remaining problem is that the benefits communities receive from wildlife through CBNRM are not preferentially distributed to those households suffering from the highest levels of HWC, and therefore some households may suffer greater losses from HWC than economic benefits from living with wildlife. However there are several mechanisms such as insurance schemes that are proving effective at tackling this problem. Overall it seems clear that CBNRM is a model that could be successfully replicated elsewhere on the globe to mitigate the impacts of HWC.

- The study has shown how local, regional and national planning by ministries in non-conservation sectors can lead to increased HWC and increased costs to communities, the agriculture sector and the National Economy. It is therefore essential to implement cross-sectoral coordination that ensures all relevant ministries take existing and potential future HWC into account in land-use planning (agricultural developments, resettlement schemes etc.), water provision schemes and other rural development projects. This will prevent financial losses to farmers and other land-users, reduce losses to regional and national economies, strengthen the livelihoods of local communities and allow for more economic potential to be generated from wildlife.

- The study has shown that HWC is affected by international, national and regional (provincial) policies and structures – i.e. micro, meso, macro levels all play a significant role. It is clear that HWC management cannot be successful if these levels work in isolation and are not articulated through appropriate policy and implementation frameworks. Such coordination can reduce the costs of HWC to wildlife and all other stakeholders by increasing the efficiency of planning and implementation of development projects and by ensuring that HWC prevention and mitigation measures are integrated as part of a coordinated and systematic program. Attention needs to be given to the provision of supportive international and national policies, efficient national and regional decision-making frameworks and local institutions that have the capacity to address HWC. Overall, the opinions and considerations of local people should be better researched and taken more seriously.

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Human-Wildlife Conflict: Nepal

Human Wildlife Conflict: Nepal

Abstract

Conflicts between humans and wildlife in Nepal are a significant problem both for local people and wildlife conservation. This study covered three highly populated sites in the fertile south-western and south-eastern parts of the country (Terai). All three sites suffered from conflicts with elephants, and as the majority of people that suffer losses are already poor and vulnerable, the livelihood and food security implications are extremely significant. In two of the study sites, elephant damage caused economic losses amounting to the equivalent of around a quarter of annual incomes. However the third study site experienced losses of just 13% of annual incomes. The most likely reason for this difference is more effective land cover patterns in the third site, where there were more intact forest blocks in 'edge habitats' between forests and human used areas. In addition, across all three sites, there was a direct relationship between the percentage of human-used land (compared to forested land) and economic losses due to HWC. However fragmentation of forest habitats was actually a more significant factor in determining levels of economic loss from HWC than overall forest cover alone. This indicates that effective land-use planning that reduces fragmentation will be the most effective way to reduce HWC. Such planning would need to bring together all sectors with an influence on land (ministries of forests, environment, agriculture, development, infrastructure etc.) and include transboundary collaboration with India. Communities in all three sites agreed with this need.

Two of the sites have received significant attention from the government and NGOs in the implementation of sustainable conservation and development programmes. These sites had a tolerance of elephants and elephant damage, and a strong belief in community based natural resource management as a long-term viable solution. The other site had received little or no attention from government or NGOs, had a low tolerance of elephants and elephant damage (despite experiencing similar levels of conflict to one of the other sites) and engaged in retaliatory killing of elephants. This indicates the need for expansion of sustainable conservation and development programmes across Nepal.

A property damaged by elephants in Bardia, Nepal.

1. Introduction and background

Human Wildlife Conflict (HWC) is a critical issue in Nepal, and has become a fundamental aspect of wildlife management as it represents the most widespread and complex challenge currently being faced by the conservation community. HWC in Nepal results in loss or injury of human life, threats to economic security, reduced food security and reduced livelihood opportunities. In the long term, HWC (if not properly mitigated) leads to further impoverishment of the poor, reduced local support for conservation and increased retaliatory killings of wildlife causing vulnerability of wildlife populations. Understanding both the ecological and socio-economical context of HWC is prerequisite to bring about efficient and long-term management of the situation to the benefit of both wildlife and those communities who live alongside wildlife, something which is recognized by the Nepalese government. Nepal has poverty reduction as its primary goal for development, but it strongly recognizes the importance of environmental sustainability, for example by promoting wise biodiversity use and water management as important methods to reach this goal.

HWC in Nepal occurs primarily in the southern lowland area commonly known as the Terai region. The Terai covers about 23% of the total land area of Nepal (CBS, 2001) and is composed of alluvial and fertile land that extends from the western most part of the country to the eastern limit along a 900 km stretch. Representing little over 55% of the country's cultivated lands, the Terai is considered to be the bread basket of the country. It simultaneously contains five of the country's most important protected areas, and critical habitat for many endangered species including tigers, rhinoceroses and elephants.

2. Description of the problem

Over the last half century, the Terai region of Nepal experienced a massive population growth (3% during 1991-2001) induced by inter-regional migration and immigration. The population density now reaches 330 people / km^2 - more than double the national average. Consequently more and more wildlife habitats are being converted to settlements, agricultural lands and other forms of land-use in order to cater to the needs of the growing population. Over 65% of forest areas were converted for agricultural extension in the valley of Chitwan between 1961 and 1977 (Gurung, 1983). Other studies show that the forest area in the Terai decreased at an annual rate of 1.3% between 1978-1991.

This increase in human population and the resulting loss, degradation and fragmentation of habitats through human activities such as logging, animal husbandry, agricultural expansion and development projects has led to an increase in HWC (Fernando et al., 2005). Wildlife populations not only have less habitat in which to fulfill their nutritional, ecological and behavioural needs, but the remaining habitat is increasingly fragmented, leaving wildlife populations trapped in small insular refugees. As habitat becomes more fragmented, the boundary between wildlife habitat and human-use areas increases in length, providing greater opportunities for conflicts between animals and humans.

With a poverty rate of over 30% and an average wage of approximately US$1 per day, losses due to HWC can have serious consequences for local household economies in the Terai. Of all wild animals, the damage caused by elephants is the most pervasive due to their wide ranging behavior, fidelity to their home ranges, propensity and ability to destroy properties, and large appetite - an elephant eats around 200 kg of food per day, although an adult bull weighing 6,000 kg could consume up to 240 kg (Sukumar, 2003).

Asian elephants are particularly attracted to food crops because they are more palatable, more nutritious, and have lower secondary defenses than wild browse plants (Sukumar, 1990). A single elephant can destroy a hectare of crops in a very short time, a small herd can decimate a farmer's livelihood overnight. Often, the people who suffer these attacks are already economically and nutritionally vulnerable, and the loss of crops and livestock can have grave impacts on their income and food security. Paddy is responsible for more

than half of the average income in communities, and it is paddy which suffers the most from raiding by elephants.

Elephant attacks can also lead to human injury and/or death. Records show that in India alone, about 150-200 people on average were killed by elephants each year during 1980 – 2000 (Sukumar, 2003.) In addition, young men complain that they have problems attracting potential brides to areas where there are high levels of HEC (Human Elephant Conflict), due to the fear people have of living near wild elephants.

HWC in The Terai is transboundary in nature, as the animals either immigrate from the Indian side of the border or have immigrated in the past and stayed in Nepal.

"Because of these life threatening burglars, our boys here are facing problem in finding a mate, for no girls are willing to live in a village where they have to spend every night with fear."
- Mr Shankar Luintel, Bahundangi VDC.

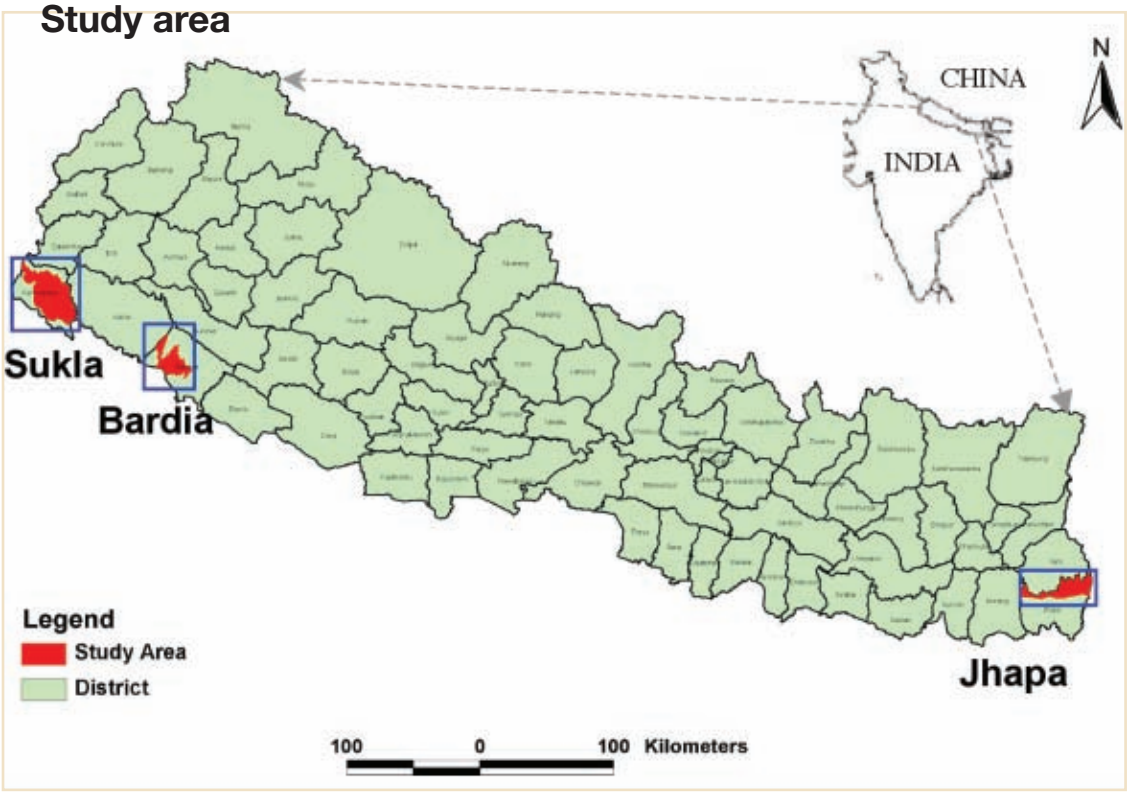


Figure 1:
Map of Nepal showing the locations of the three study sectors Shukla, Bardia and Jhapa.

3. Economic Analysis of HWC

The study focuses on three main areas within the Terai, which suffer some of the highest levels of HWC in the region: Bahundangi Village Development Committee (VDC) of Jhapa District, Mahendra Nagar Municipality of Shuklaphanta Wildlife Reserve, and six buffer zone VDCs of the Bardia National Park, hereafter referred to as Jhapa, Shukla and Bardia respectively. Two of these sites lie in the West of Nepal; Shukla and Bardia. Jhapa lies in the very eastern most point of Nepal.

All three sites have an extremely high population density (420-570 people/km^2) and produce mainly agricultural goods, especially paddy rice. The sites are situated within the fertile Ganges plains and extend into foothills up to around 1,500m. The climate is seasonal, and precipitation in the monsoon season is high.

Shukla contains a Wildlife Reserve that is rather small but connected via biodiversity corridors to other forested areas in Nepal and India. The National Park in Bardia - which is larger than the Reserve in Shukla - is extremely rich in biodiversity, and its buffer zone contains several community managed forests. Both sites receive substantial conservation and management support from the government and international organisations. In Jhapa, where there is no protected area, communities receive less attention and support. Here there is a stronger involvement with private businesses, and around 25% of household income is derived from the sale of cash crops. Cash crop sales are negligible in the other two sites. VDCs bear a great deal of responsibility for development in Jhapa.

At each site, ethnographic data, data on levels of HWC and its economic and livelihood implications were collected through a combination of social survey methods involving participatory techniques (focal group discussions and key informant interviews), structured questionnaire surveys and on-site observations. Land-use information (Landsat TM data) both at the time of the survey, and using historical records was also analyzed with the intention of assessing how different land cover patterns influenced economic losses suffered by communities as a result of HWC.

The socio-economic data revealed that Jhapa is relatively economically prosperous compared to Bardia and Shukla. Jhapa had significantly higher literacy rates than the other two sites, as well as lower family sizes. In addition, the majority of houses in Jhapa were well-built compared to the other two sites. The average landholdings in Jhapa were larger in size than those in Bardia and Shukla. Paddy was the most widely grown crop in all sectors and Jhapa had the highest production per household amongst the three sectors.

Over 90% of respondents in each sector reported that they faced problems with wildlife. Crop damage was the most common problem, followed by damage to property. Other problems such as loss of and injury to livestock were reported to occur in all sectors but were not as significant as that of crop loss.

Of all the animals, wild elephants were considered to be the greatest threat in terms of HWC in all three sectors. In Jhapa, elephants were considered to be the only animal that caused significant problems, whilst in Shukla and Bardia, respondents also raised concerned about conflicts involving wild boar, spotted deer, rhino, leopard, tiger, nilgai, swamp deer, porcupine and monkey.

The season and time of damage was similar in all three sectors. Two peak seasons for crop raiding were identified, one during maize or wheat maturing time (June – July) and another during paddy maturing time (September – November). Most of the crop raiding and property damage by elephants took place during the night. Elephants spend the day time inside parks or close to the forest areas.

The seasonality of HWC is partly caused by the drop in protein content of wild food plants towards the end of the wet season. When the protein content of food plants for elephants in the wild drops below the minimum level needed by an elephant for their nutritional needs, they generally turn to raiding maturing crops particularly paddy, maize and millet which have much higher protein levels (Sukumar, 2003).

Variability between HWC losses in the three sites

One of the most interesting findings arising from the analysis of the HWC data was a significant difference between Shukla and the other two sites in terms of the levels of HWC experienced, with Shukla suffering less conflict in all variables that were measured (see figure 2).

Shukla had fewer respondents reporting problems with elephants than the other two sites, whereas the proportion of villagers who had faced conflicts with elephants did not differ significantly between Bardia and Jhapa.

In all three areas, the greatest crop losses were in paddy, with Bardia and Jhapa both loosing more than three times as much paddy as Shukla. After paddy, the three sites differed in the crop most affected - in Jhapa, maize was lost in the greatest quantities, while in Shukla wheat was lost the most. Jhapa also lost a significant amount of cash crops such as beetle nuts and banana.

The overall economic value of crop loss in each site is provided in table 1. In Jhapa, the average household loss was Nepalese Rupees (NRs) 12,253 (US$ 193), and in Bardia NRs 10,108 (US$ 159) per year. The difference between these two areas was not statistically significant. However the total economic loss from HWC in Shukla was just NRs 3,392 (US$ 53), less than third of the losses suffered in Bardia, and almost a quarter of the losses suffered in Jhapa.

Looking at the economic loss in terms of the percentage it makes up of a household's total income from crop production, a similar pattern can be seen. HWC related economic losses make up 27% of household incomes in Bardia, and 25% in Jhapa. However in Shukla, HWC losses made up just 13% of overall income from crop production.

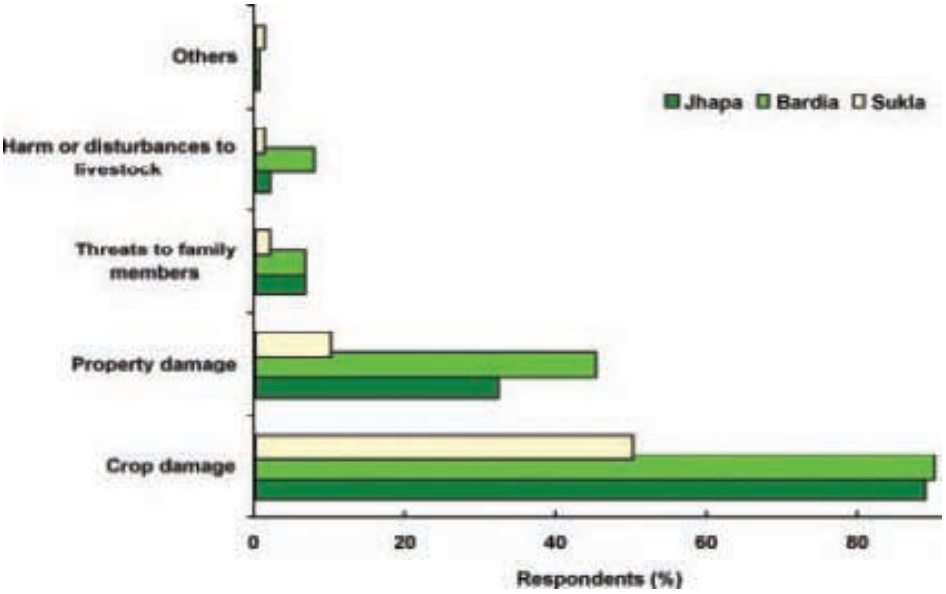
With regard to HWC damages other than crop loss, far fewer people in Sukla experienced damage to property or threats to family members than the other two sites (see figure 2).

Table 1:
Economic value of crop loss (in NRs/Hh/year) incurred by each household (Hh) in Jhapa, Bardia and Shukla.

	Jhapa			Bardia			Shukla		
	NRs/Hh	SE*	%	NRs/Hh	SE*	%	NRs/Hh	SE*	%
Paddy	7942.65[a]	695.97	64.82	6987.75[a]	1143.99	69.13	2262.93	329.66	66.72
Maize	2473.95	282.62	20.19	1283.04	224.04	12.69	0.00	0.00	0.00
Wheat	0.00	0.00	0.00	516.00	146.62	5.10	1126.16	189.32	33.20
Millet	43.17	23.22	0.35	0.00	0.00	0.00	0.00	0.00	0.00
Mustard	146.84	63.77	1.20	377.50	79.64	3.73	0.00	0.00	0.00
Lentils	8.55[a]	8.55	0.07	943.78	304.57	9.34	2.67[a]	2.67	0.08
Cash crop	1637.86	386.37	13.37	0.70	0.70	0.01	0.00	0.00	0.00
Total loss	**12253.03[a]**	**1062.21**		**10108.77[a]**	**1314.36**		**3391.76**	**493.52**	

Means with the same letter in the same row are not statistically different (p>0.05) based on Tukey HSD test.
* Standard error of the mean

Figure 2.
Community experiences of negative interactions with problem elephants



Land use patterns – the explanation behind the differences?

So what has caused these large differences between Shukla and the two other sites Bardia and Jhapa? One factor that could be responsible is the difference in land cover patterns between the sites.

There was a significant difference in the make up of 'edge habitats' in the three sites. Edge habitats – those areas which form the frontier between elephant home ranges and human used areas - were classified into two broad land-use types: 'Forests' (forests and/or degraded forest), and 'Settlement' (agriculture, human settlements, water bodies etc). Shukla had significantly more forests in edge habitats than both Jhapa and Bardia. The latter two sites did not differ significantly. The lack of forest in edge habitats in Jhapa and Bardia as compared to Shukla is a strong possible reason for the increased HWC losses suffered in these two areas.

To further investigate the relationship between land-use cover and HWC, the overall amount of forest compared to settled land was calculated in each site. This was done at the scale of VDCs, which normally contain one or more villages. Settlement coverage was then compared to the economic value of crop loss in each VDC. There was a strong correlation between the percentage of settled land in each VDC and the extent of economic loss suffered due to crop damage (Figure 3). This is a strong indication that the transformation of elephant habitats to other uses such as agriculture and settlements, is highly likely to result in increased economic losses from crop damage. Statistical analysis of the data implies that about 36 % of the total variation in economic losses between the different VDCs can be attributed to land transformation.

A household survey in Bardia.

A focal group discussion, Jhapa.

Figure 3:
Impact of land transformation on the extent of crop damage by elephants.

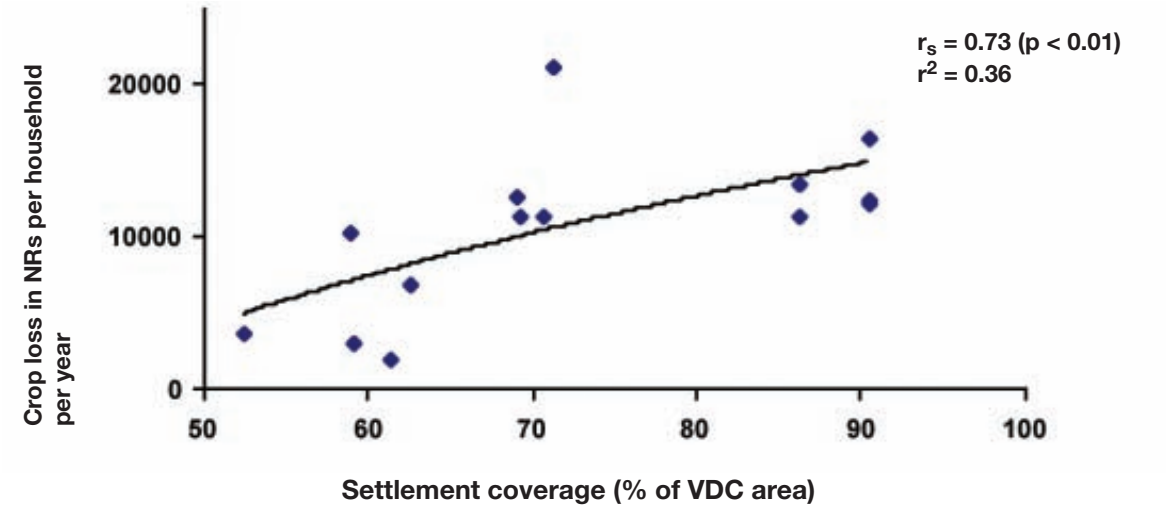
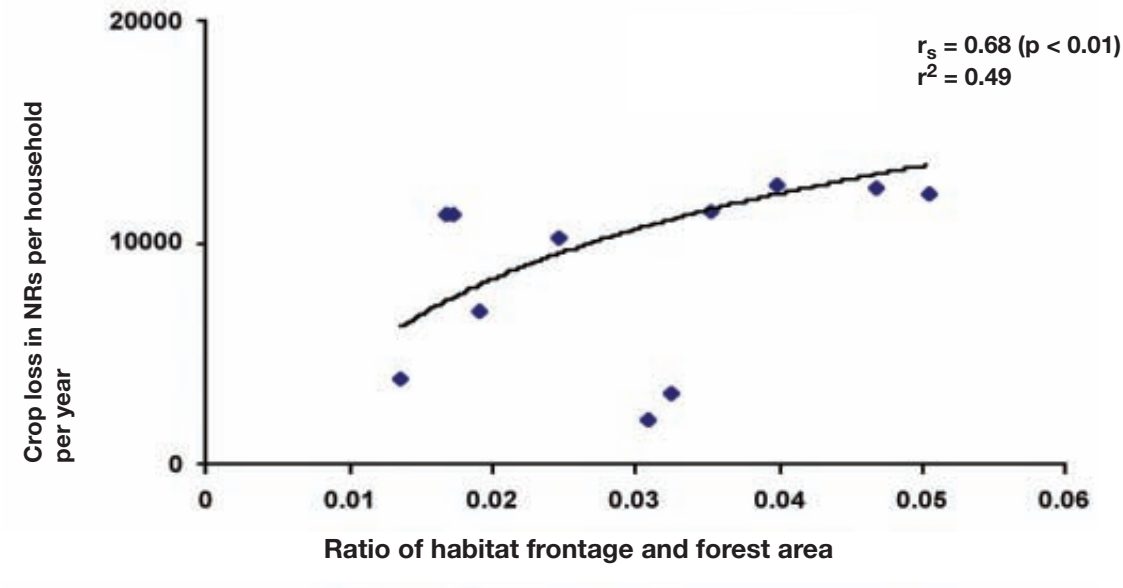


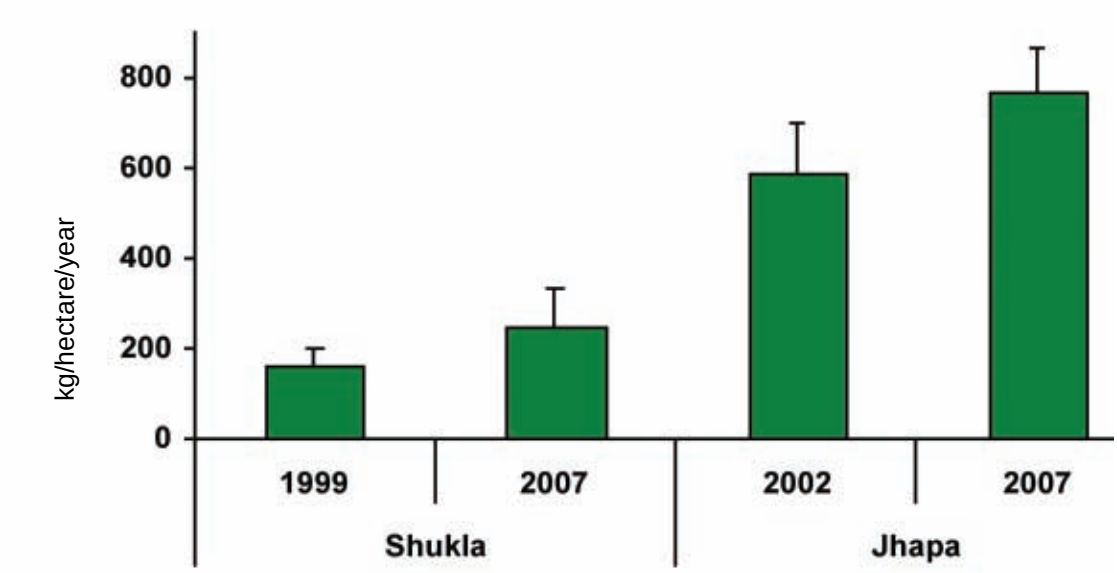
Figure 4:
Impact of habitat fragmentation on economic losses suffered as a result of elephant damage.



In addition to investigating overall forest cover vs. settled land, a measure of forest fragmentation in each VDC was also generated by calculating the ratio between habitat frontage (ie. the length of the boundary between forest and settlement lands) and the amount of forest cover. An area where forest was fragmented into many small pieces interspersed by settled land would have a high ratio as there would be a large amount of forest/settlement boundary. An area with the same amount of forest but contained in one solid block would have a low ratio as the boundary would be much smaller.

When levels of fragmentation were compared with economic losses, a strong positive relationship was seen between the amount of fragmentation and economic losses associated with HWC (see figure 4). This means that greater economic losses are suffered when the remaining forest habitats are fragmented into lots of small pieces, rather than existing as one large chunk. In fact, the level of fragmentation was actually more influential in determining the amount of crop loss than the amount of forest coverage itself – with 50% of the total variation in economic loss attributable to fragmentation (15 % more than settlement coverage alone). This strongly indicates that the shape and distribution of forest cover is a crucial factor in influencing levels of HWC, and further reiterates the importance of effective land-use planning that ensures that remaining forest areas are fragmented as little as possible.

Figure 5:
Temporal pattern of paddy loss to elephants in Shukla and Jhapa during the periods (1999 - 2007) and (2002 - 2007) respectively.



Changes in HWC and land use over time

Looking at how HWC levels have changed over time also paints an interesting picture (see figure 5). Shukla has suffered a 50% increase in paddy loss per household between 1999 and 2007. Jhapa experienced a 30% increase in paddy loss between 2002 and 2007. Lack of historical data meant that no analysis of this kind was possible for Bardia. However it is clear that HWC is increasing extremely rapidly, even just over the short timeframes used here.

Surprisingly, between 2000/01 and 2006/07, the forest cover in Bardia and Jhapa has remained relatively constant, and is only decreasing in Shukla. In fact, there are increasing amounts of forest cover in Bardia which are most likely due to recent expansion of community forests in and around the buffer zones. As the new vegetation is mainly occurring around the periphery of existing forests (figure 6, refer to WWF-Nepal for higher resolution map) this is also leading to reduced fragmentation and improvements in connectivity. If this trend continues, it can be expected to lead to a reduction in HEC – a positive sign for the future.

Conversely, the temporal pattern of land use change in Sukla showed a relative decline in forest cover over the years, and an increase in fragmentation in several VDCs. The small patches that remain may provide safe havens for indulgent crop raiders during the day time, allowing them to venture out into the surrounding human settlements at night (Sukumar 1990). The previously reported increase of 50% in paddy loss between 1999 and 2007 supports this conclusion. If land-use patterns are not urgently changed, economic losses from HWC are likely to continue to increase in Sukla.

The successful establishment of a wildlife corridor between the parks of Shukla and Bardia could take some pressure off the human-dominated landscape, and further reduce economic losses due to HWC.

Figure 6.
Change in forest cover in Bardia during the period between 2000/01 to 2006/07

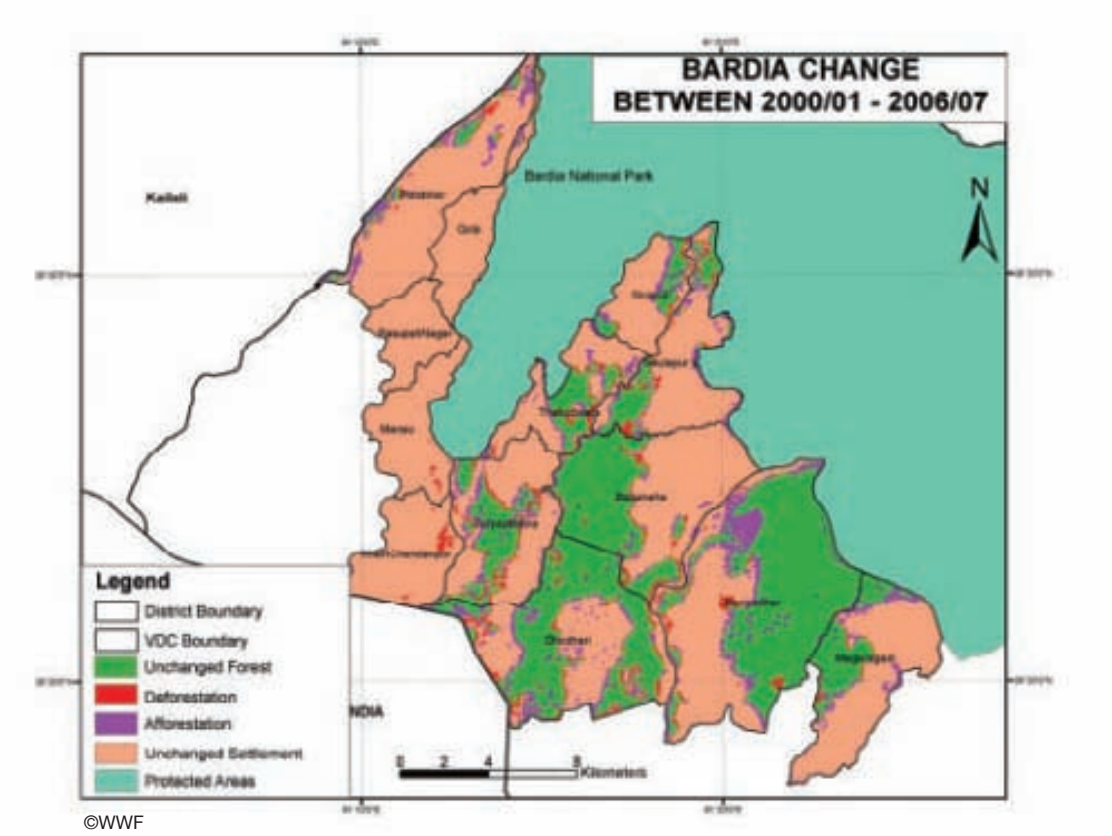


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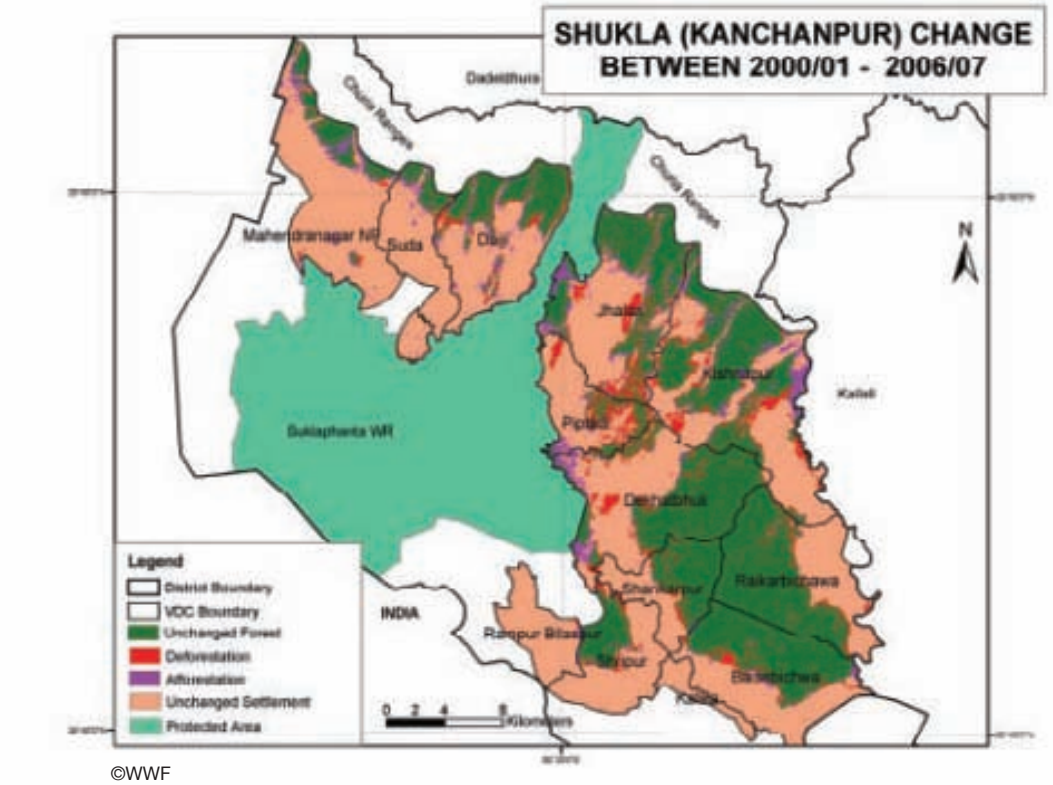
Figure 7.
Change in forest cover in Shukla during the period between 2000/01 to 2006/07



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Economic benefits of living with wildlife

The economic benefits of living with wildlife for communities in Nepal come from many different areas. Firstly benefits are derived through the conservation of the forests which are the natural habitats of these species. These forests are of critical importance to local people providing products such as fuel, fodder, housing, agricultural tools, household implements and medicine. Forest foods are also an important supplement in times of hardship. Local communities in and around forests are supported to form legally mandated User Groups who are assigned rights and responsibilities for the management of the forests, and for the sustainable use of the resources they contain.

Furthermore, local communities also receive direct livelihood benefits from wildlife conservation through tourism. Several areas in Nepal have nature-based tourism run though innovative community management models which have helped develop tourism revenue-sharing in protected areas with bordering buffer zone communities. These initiatives have provided local communities with substantial financial and employment benefits. These communities currently receive 50% of the total revenue generated in the protected area, of which 30% goes into conservation activities, 30% into community development activities, 20% into income generating activities, and10% into conservation education. The remaining 10% are administrative costs.

However the economic benefits from living with wildlife occur mostly in Bardia and Shukla where there are national parks and where the NGO and government conservation presence has been strongest. More work needs to be done in Jhapa and indeed the whole Eastern Terai area to bring these benefits to communities and provide a financial incentive for living with wildlife.

4. Dynamics and drivers of HWC

One of the key drivers of HWC in the Terai region is land-use change, in particular fragmentation of forest habitats as indicated by the importance land cover patters play in economic losses due to HWC. Thus in order to effectively manage HWC adequate land-use planning mechanisms are required to ensure that key habitat is retained and fragmentation is reduced to a minimum.

The study also canvassed the opinions of the communities in the three sites on what they felt were the key causative factors for HEC. Nearly all respondents believed that increasing elephant populations were the problem. Most people in Jhapa supported the opinion that shrinking habitat for elephants was also to blame. However in Bardia, only half agreed with this statement – half did not. In Shukla, almost all people strongly disagreed with this statement. The reason for this is likely that Shukla still has large intact patches of existing forest, particularly when compared to Jhapa. Moreover, the respondents from Shukla strongly agreed that elephants were attracted to crops because of their natural preference. However respondents from all three sites strongly agreed with the notion that people should reduce their impact on wildlife habitats. This is a good indication that there is an understanding and acceptance that the human impact on the landscape should be managed to allow for the survival of important biodiversity.

The transboundary nature of the elephant populations also brings in a more complex dynamic to the situation. The fact that elephants migrate between India and Nepal in all three sites and thus are not in one site for the whole year, likely means conflicts are lower than they otherwise would be. However each site will have its own transboundary dynamic - in Jhapa for example, elephants migrate into Nepal from Assam, India, where new tea estates have been established which are pushing elephants out of their natural habitats. It is therefore important to have a full transboundary picture of the elephant populations and land-use patterns in order to effectively plan and manage HWC in this region. Respondents in all three sites agreed that elephant management needed to be conducted collaboratively with India.

This study has also indicated the importance and effectiveness of conservation interventions. In Western Terai, various initiatives such as the Terai Arc Landscape (TAL) and Western Terai Landscape Complex Project (WTLCP) have been launched to conserve biodiversity at the landscape level and improve the living standard of local communities living with wildlife. As it would be expected, respondents from the two Western sites had a strong belief in sustainable community-based natural resource management as long-term strategic solution, including political decentralization, community forestry, tourism development and better integration of women. They also firmly rejected the notion of reducing elephant populations. This strongly implies that continued support from park authorities and conservation organizations such as WWF, NTNC and UNDP in participatory conservation and development activities has led to enhanced tolerance for elephants and understanding of long term sustainable solutions in Western Terai.

However no such conservation initiatives have been undertaken in Eastern Terai, and in Jhapa, the Eastern site, respondents agreed overall with the notion of reducing elephant populations to reduce HEC, demonstrating a strong lack of commitment to elephant conservation. It is therefore not surprising that 80% of the respondents in Jhapa thought that there had been an increase in retaliatory killing of elephants, while most respondents (>90%) denied this in Shukla and Bardia. Indeed, it has been reported that 13 elephants have been killed in Jhapa between 1980 and 2001 (Yadav, 2003). Jhapa communities were frustrated with the lack of government services and want a stronger involvement of local communities in decision making. This strongly implies that participatory conservation and development initiatives like those in Western Terai should be established in the East of the country.

A final point to note is that the human population density that currently exists in Nepal may already have reached a ceiling – it is possible that rural areas cannot support any more human inhabitants without seriously jeopardizing the environment and the environmental services it provides (clean water, air, soil stability etc). One potential solution to this scenario might be a well planned and implemented process of urbanization that will help to keep people and wildlife apart. This would include the establishment of small and middle-sized rural centers with economies built on products from the surrounding rural areas. In urban centers where people are further away from animals, it might be easier to create the tolerance needed to keep the remaining biodiversity in harmony with the human endeavors for improving livelihoods.

5. Practical field-based solutions

Communities in the 3 areas perceived differently the success and failure of their field-based measures to keep elephants at bay. Guarding the fields and chasing elephants by making noise and using fire is widely conducted across all sites and is seen as mostly successful in Shukla, but not in Bardia or Jhapa. This agrees well with Sukumar (2003) who observes that these techniques are merely effective to drive away inexperienced crop raiders, whereas veteran raiders (usually adult bulls or even some family groups) are not often fooled by these ‘scare tactics’.

People in Shukla and Bardia are unsure about the efficiency of trenches and hedgerows at keeping elephants out of fields. Electric fencing is seen as successful by the people of Jhapa, but not by people of Bardia and Shukla. However in Jhapa the fences are connected to the national grid, and are not safe, sometimes killing people, livestock and elephants. Four elephants have been killed in this manner in recent years.

Influencing land-uses has proved successful in reducing HWC. For example, around Bardia National Park, farmers were encouraged to switch from farming maize (which was a significant target for elephants) to menthe, which doesn’t attract elephants. Four distillation plants for menthe oil were established, and market linkages developed. As menthe oil is highly marketable and provides good incomes, farmers are able to recover from crop depredation shocks. In 2004, 75 farmers earned US$5,600 from the sale of 750kg of metha oil (WWF Field Visit Report, 2005).

Also in Bardia, an endowment fund exists which compensates local communities for wildlife-induced damage. Money is paid directly to the victims of HWC. The vast majority of respondents in all three sites thought that the government should compensate for HWC damages incurred.

Overall there appears to be no 'catch all' solution to keep elephants out of fields. The vast majority of respondents believed that one of the biggest problems with HEC was the inefficiency of current protection measures. Behavioral flexibility of elephants thereby enabling them to quickly modify their foraging strategies in response to the protective measures is also believed to be one of the major problems. More research and practical application of different techniques is required to resolve this issue.

Various techniques are used to keep elephants out of fields: Electric fences, this one in Jhapa connected to the main electricity line, fog lights to scare elephants away, and farming menthe – a crop that elephants do not like.

6. Conclusions and strategic recommendations

In all sites, HWC causes a considerable economic loss to farmers who are already poor and vulnerable. Jhapa and Bardia were most severely and about equally affected by human-elephant conflict in terms of crop damage, with households in both sites losing nearly one quarter of their total annual income from crop production to HWC. Communities in Shukla on the other hand lost just 13% of average annual incomes – significantly less than both Bardia and Jhapa.

Further analysis indicated that a significant factor in this disparity of HWC losses between Shukla and the other two areas is land-use. Shukla has a higher proportion of forest areas in 'edge habitats' than the other two sites, and a close correlation was found between the proportion of 'settled' habitat and levels of economic damage due to HWC. This closely agrees with the propositions of Barnes, Asika and Asamoah (1995) in Africa and Sukumar (1991) and Fernando et al. (2005) in Asia.

Furthermore however, the analysis indicated that the level of habitat fragmentation was actually a more important factor in determining levels of economic damage from HWC than the amount of forest cover itself. Similar findings by Sukumar (2003) in the Kodagu District of India further attests to this notion. Thus strong attention should be given to the planning and arrangement of land-uses throughout a landscape, as good land-use planning that reduces fragmentation will have the greatest impact on reducing economic losses from HWC. Such planning systems will necessarily have to include all sectors with any involvement or impact on land – i.e. forestry, environment, agriculture, development, infrastructure etc., as well as transboundary cooperation with India. The local people from the all three sites surveyed share this view. In addition, land-use planners will need to become aware of, respect, and work around the ecological boundaries and corridors that elephants follow, rather than administrative boundaries that elephants don't. More data on the population and behavioral ecology of elephants together with both temporal and spatial pattern of land-use dynamics in both Nepal and India would provide the necessary starting points for effective management and land-use planning.

Another important finding of this study is the different level of HEC tolerance and attitudes to conservation across the study sites. Comparison of conservation attitudes among people of Bardia and Jhapa clearly showed that people from the former sector were more tolerant to HEC than the latter, despite the similar level of HWC damage occurring in both places. This indicates the important role being played by governmental organisations and NGOs in Bardia and reiterates the need for a similar course of action in Eastern Terai.

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Human-Wildlife Conflict: Indonesia

Human-Wildlife Conflict in Indonesia

Abstract:
The study deals with the highly complex situation of human-elephant conflict in Riau Province of Sumatra, Indonesia. The area has experienced extreme deforestation during the last few decades, driven by the palm oil, pulp & paper industries, individual farmers from Sumatra and immigrants from other Indonesian islands. The rapid loss and fragmentation of wildlife habitat has led to conflict between humans and wildlife, causing a threat to human lives, local livelihoods and oil palm plantations. Habitat loss, the thus induced wildlife conflict and resulting retaliatory actions against elephants, have led to a decline of 80% in Riau's elephant population over the last quarter of a century.

Currently the most conceivable way to maintain habitat and reduce HWC in the future while securing a future for Riau that incorporates both development needs and survival of its unique and globally important biodiversity, is to embrace novel sustainable financing mechanisms and strategic land-use plans that take aspects of ecosystem functioning and sustainability seriously into account. There are new opportunities to do this through Payment for Environmental Services mechanisms, in particular for carbon. Riau's peat swamp forests are estimated to hold Southeast Asia's largest store of carbon, and global carbon credits could bring financial benefits to the region that potentially outweigh the current financial gains available from palm oil and pulp.

Farmers hut after elephant damage. Santiapilai Sumatra, Indonesia.

Poisoned elephant family, Sumatra, Indonesia.

1. Introduction and background

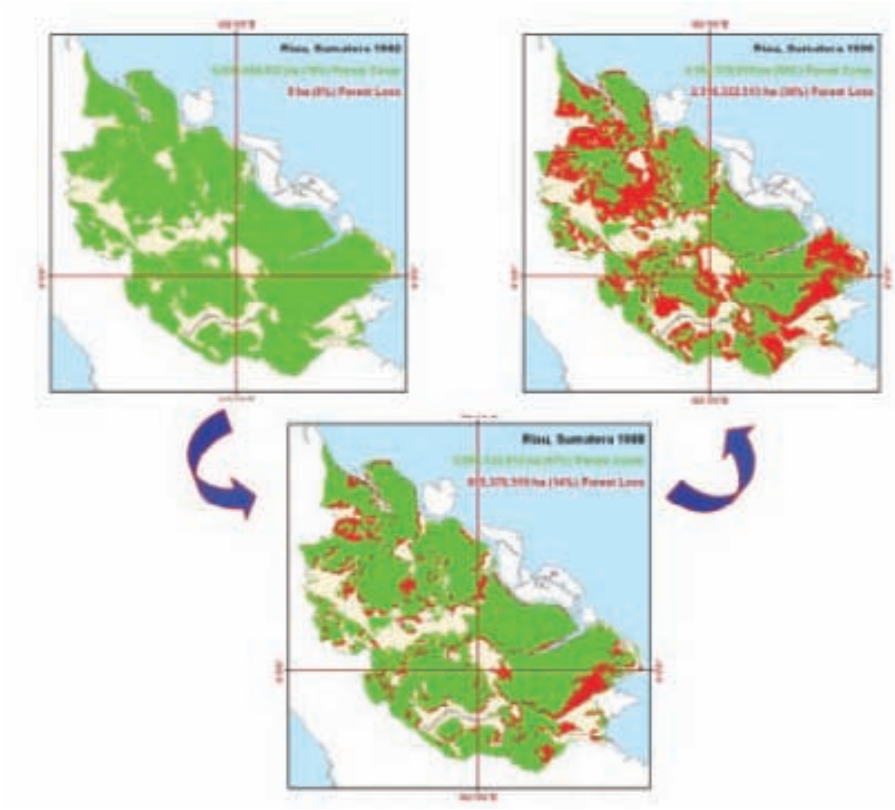
Sumatra, Indonesia's largest island, is one of the most biologically significant places on earth. It is home to 201 mammal species and 580 bird species, 9 of which are endemic to the mainland. It is the only place in the world which contains all four of Asia's most charismatic flagship species - tigers, rhinos, elephants and orang-utans - as well as other unique species such as *Rafflesia arnoldii* (the world's largest individual flower).

Sumatra is also home to a growing and largely poor human population. Indonesia's population of 200 million people is distributed unevenly over thousands of islands, and for several decades the government conducted a transmigration movement from overpopulated islands like Java and Bali to the then relatively empty spaces of Borneo, West Papua and Sumatra. The guided immigration to Sumatra stopped in 2000, but it made Sumatra one of the most populous islands in the world.

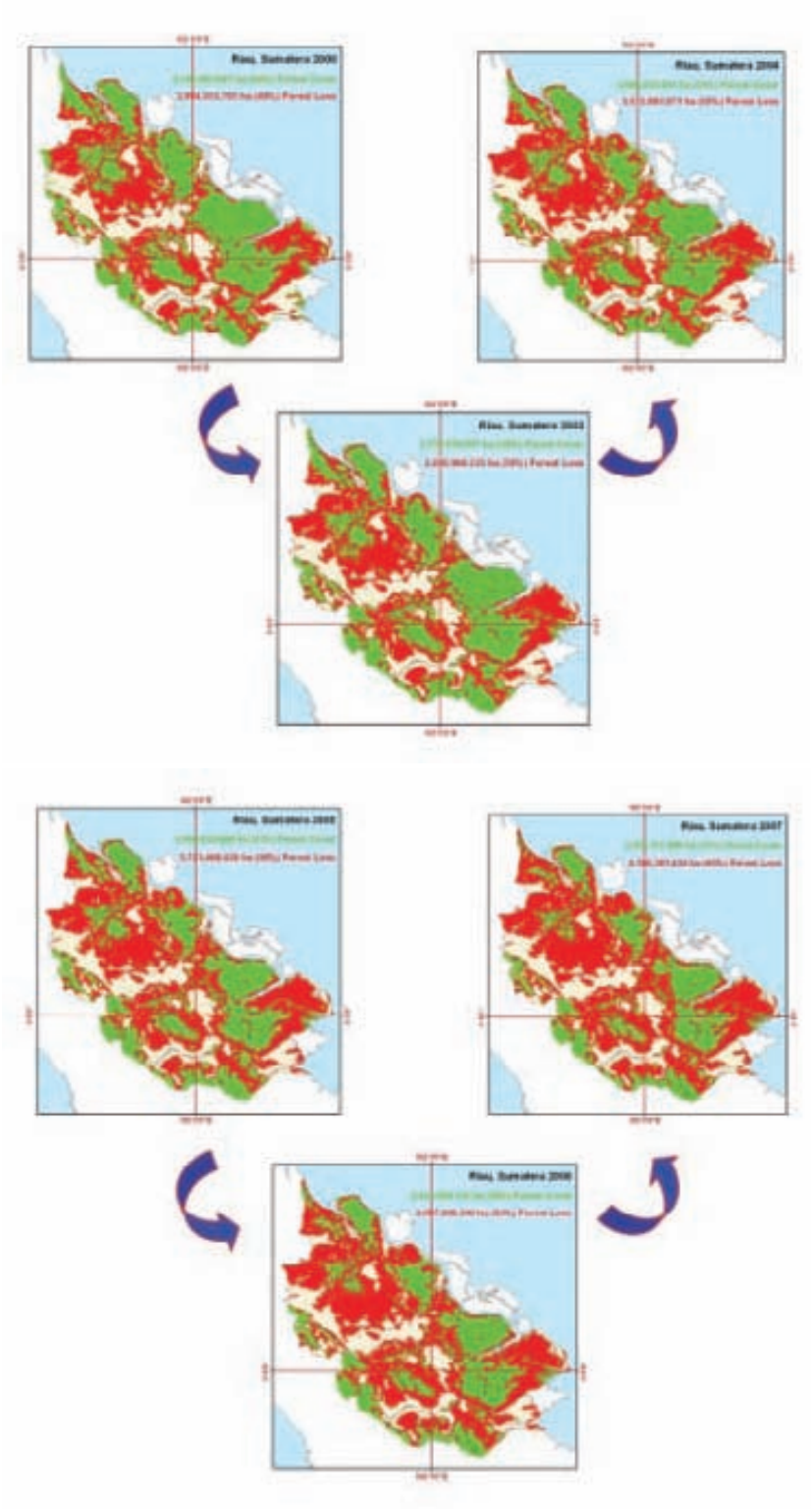
Riau Province, in central Sumatra, Indonesia, contains some of the last significant blocks of dry lowland forest habitat left on the island, and is also home to vast peatlands estimated to hold Southeast Asia's largest store of carbon. Only 25 years ago, Riau was almost completely covered with tropical rain forests, however extensive deforestation and conversion have made present day Riau a very different place. Between 1982 and today, Riau has lost 65% of its then forest coverage (4 million hectares) which shrunk from 78% to 27% of the province[1] (Uryu, 2008) (see figure 1). 29% of this lost forest was cleared for industrial oil palm plantations, 24% for industrial pulpwood plantations, and 17% became 'waste' land (land that is deforested but not replaced with any crop cover). Wastelands are mostly the end product of a chain of illegal logging that starts with timber being extracted for saw mills (which started and grew rapidly during the eighties) and ends with the last trees being sold to the province's two gigantic pulp mills.

Timber exploitation and forest conversion have been and continue to be illegal in many cases, enabled by government authorities' weak or even completely lacking enforcement of its laws relating to the use of Indonesia's natural resources.

Figure 1: Forest Cover Changes 1982-2007 in Riau Province, Sumatra, Indonesia.



[1] For detailed information on Riau's land use history and predictions of its future, see Yumiko Uryu et al. (2008) Deforestation, Forest Degradation, Biodiversity Loss, and CO2 Emissions in Riau, Sumatra, Indonesia. WWF Technical Report. http://assets.panda.org/downloads/riau_co2_report__wwf_id_27feb08_en_lr_.pdf



2. Description of the problem

Elephants need access to food, water, minerals and shelter and elephant habitat needs to contain a combination of all of the above. The loss and fragmentation of Sumatra's forests has meant that many of them no longer fulfill the resource requirements of elephant populations and elephants instead turn to feed on human-owned crops, causing economic losses to local livelihoods and industry, as well as damage to human properties and occasionally human injury or death. These incidences are termed Human Wildlife Conflict (HWC).

Elephants in Riau consume a variety of crops, including those grown by local communities for sustenance. Whilst at a district or provincial level, this damage might not be of great significance, as HWC incidents are often localized they can be problematic for a single farmer or small group of farmers whose crops are targeted.

Elephant damage to oil palm plantations is mainly caused by elephants eating the vegetation points of young trees This kills the tree, meaning that new trees must be bought and planted. Elephants are not interested in the actual oil palm fruits which grow once the trees are 3 to 4 years old, but may eat the trunk hearts and unfolded fronds of trees that are between 6-8 years old. After oil palms are older than 8 years, they are relatively safe from elephant damage as the elephants can no longer reach the points of the young leaves, although some damage to oil palm trees up to 10 years of age has occurred. A normal plantation tree would then have another 20 years of productive life left. Elephants are not particularly attracted to rubber, although they have been known to eat saplings, leaves and strip their bark. Elephants sometimes use acacia plantations as temporary habitats, and have been known to eat the bark of acacia trees, but have never been known to eat acacia leaves.

In addition to the replacement of natural elephant habitat with crops which are attractive to elephants, human activities such as logging generate secondary vegetation which is also very attractive to elephants and may draw them closer to human settlements. Whilst many elephants mostly raid crops when they are unable to find sufficient natural resources to sustain them, others become habitual raiders (Desai, 2002). In addition, it has been hypothesized that bulls may engage in high-risk activities like crop-raiding as a means of increasing their reproductive potential through improved nutrition (Sukumar, 1991).

Table 1: Number and causes of conflict related elephant deaths in Riau.

Death Causes	Year								Total 2000 - 2007
	2000	2001	2002	2003	2004	2005	2006	2007	
Relocation-related*	2 (16)	0 (11)	21 (49)	2 (38)	1 (23)	17 (49)	11 (28)	5 (11)	59 (225)
Conflict**	2	0	19	2	15	4	22	10	74
Total	**4**	**0**	**40**	**4**	**16**	**21**	**33**	**15**	**133**

Source: WWF Indonesia Riau Program
* Parentheses indicate the total number of elephants captured and relocated
** Elephants killed either by gun-shooting, poisoning or trapping

In response to losses caused by elephants, elephants are killed by local people or captured by Government for relocation or for permanent removal from the wild. Elephants are a protected species, therefore killing or otherwise harming elephants is illegal. Despite this, elephant killings have occurred on numerous occasions - four mass poisonings of elephants have been recorded in Riau since 2002 alone. In 2002, 17 elephants were found poisoned near Mahato in Tapanuli Selatan, North Sumatra. In 2004, six elephants were poisoned in Rokan Hulu. In 2004, six elephants were poisoned in Kepenuhan near Mahato, and in 2006, another six elephants were poisoned in Mahato. Other such poisonings may have gone unnoticed. However, hundreds more elephants have been captured for relocation, and many of these elephants die or "disappear" during the process. Such operations have often been facilitated by oil palm plantation owners providing incentives to remove the offending elephants rather than investing in HWC mitigation activities like fencing or patrolling. In addition, claims of HWC are not always fully verified before relocation attempts in a particular area are made. See table 1 for elephant deaths by cause during the last seven years.

These extensive killings and removals, combined with the possibility that remaining elephant populations are stressed and thus may have reduced fertility (Williams, pers. comm.), has meant that in Riau the decline of elephant numbers is advancing at a faster percentile rate than deforestation. Riau's elephant population has fallen from well over 1,000 in 1984 to little over 200 in 2007, a decline of more than 80% percent in less than 25 years (see table 2, and figures 2 and 3).

Table 2: Estimated elephant population size in Riau, Sumatra.

Year	Estimated Population Size (Min - Max)	Forest Cover (Ha)	Estimated Number of Elephant 'Pouches'	Data Source
1985	1067 - 1647	6,025,299	11	Blouch and Simbolon (1985)
1999	700 - 800	3,614,878	16	BKSDA Riau (1999)
2003	356 - 453	3,082,409	15	BKSDA Riau and WWF (2003)
2007	184 - 266	2,292,283	9	WWF (2007)

BKSDA = the Agency for the Conservation of Natural Resources

Figure 2: Changes in forest cover and elephant pouches over time in Riau.

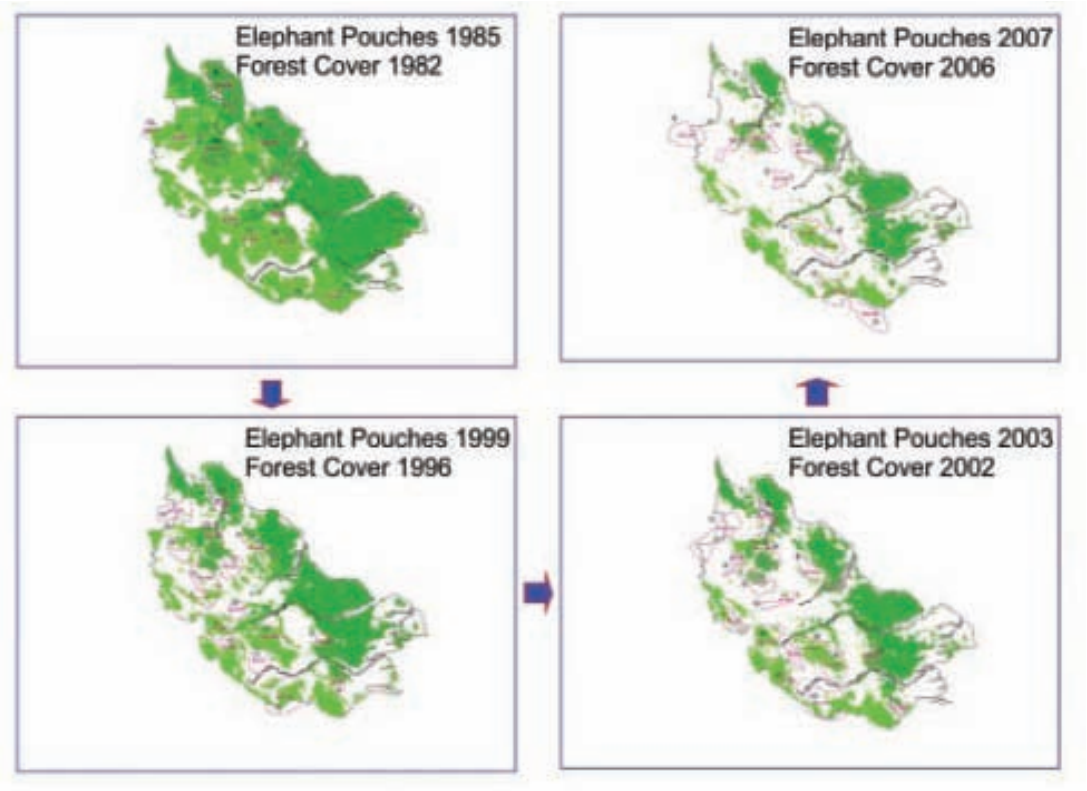
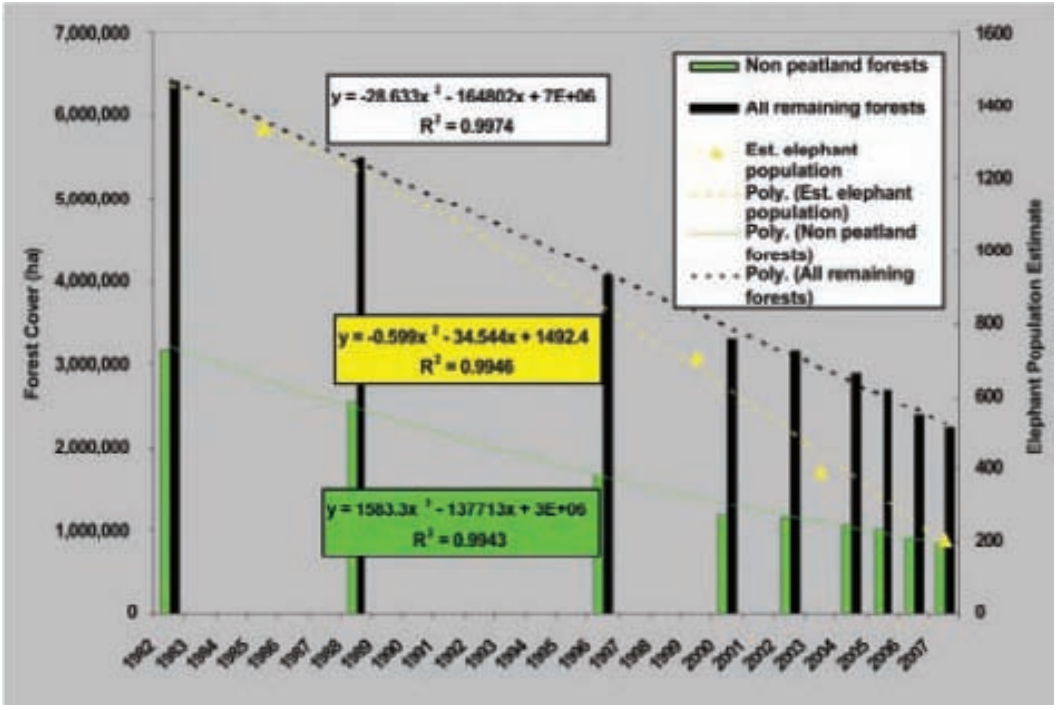


Figure 3: Decline in forest cover and estimated elephant population in Riau over time.



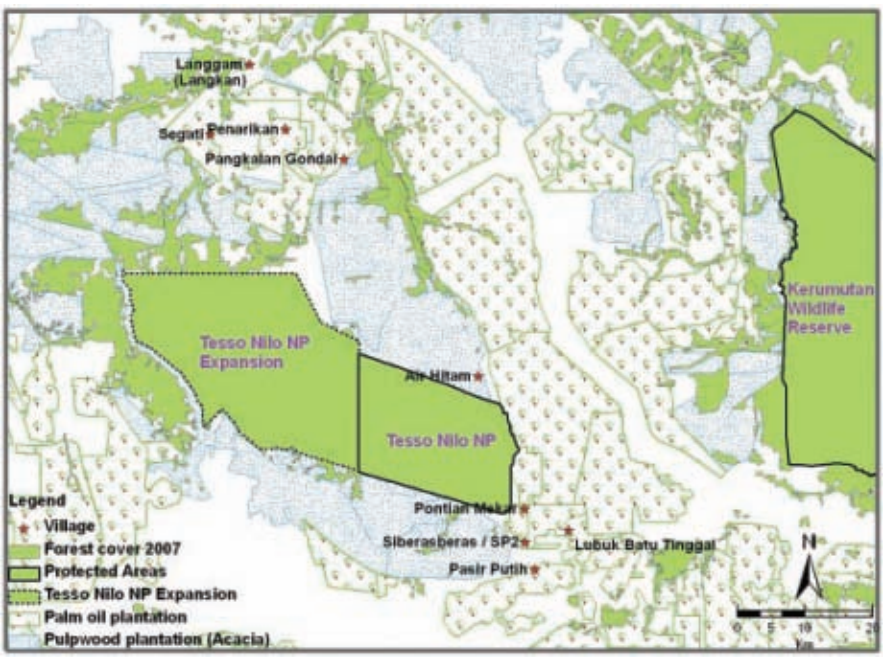
3.1 Economic analysis of HWC

This study undertook a micro level analysis of the economic impacts of HWC on small farmers and industry (both oil palm and pulp & paper companies) using questionnaire based interviews to collect general socio-economic data as well as information on the extent and voracity of HWC. 447 households were interviewed, and evidence of HWC provided by villagers was verified by site visits to damaged plots, allowing 'calibration' of data to ensure loss claimed by farmers reflected the real level of damage. As it was only possible to do this for recently raided farms, where the evidence would still be apparent, only 13 palm oil farms were able to be verified by site visits. The remaining data relied primarily on the memory of respondents of the damages they incurred. Thus the data may reflect in some cases more the perception of damages rather than the actual damage itself. However this in itself is an important perspective.

Tesso Nilo was chosen as the study area as more than 30 villages have experienced conflict with elephants either now or in the past. 38,000 ha of Tesso Nilo was established as a national park in 2005, and another 60,000 ha has been proposed as an extension. Tesso Nilo is a flat lowland rain forest landscape, and is considered to be one of the most appropriate areas in Riau for the conservation of wild elephants.

Human population density in the study area near Tesso Nilo National Park (and the proposed extension) is about 30 people / km^2. People are either indigenous to the area, local migrants from neighboring provinces, or were resettled there from more populous Indonesian islands by the Government.

Figure 4: The distribution of the villages surveyed for this study



Village name	Sub District
Segati	Langgam
Langkan	
Penarikan	
Pangkalan Gondai	
Air Hitam	Ukui
Pontian Mekar	Lubuk Batu Jaya
Lubuk Batu Tinggal	
Sei Beras-Beras	
Pasir Putih	Kelayang

Small farmers

The villages in which the current study has been conducted have on average a population of 2042 individuals, comprising 492.6 households, and a density of 28.4 individuals/km^2.

More than 80% of the 447 households surveyed generated their main source of income from agriculture, and for 69% of all households, this includes oil palm. Nowadays, 'agriculture' in these villages is almost synonymous with farming of oil palms, as almost all farmers are using their land for this crop. The mean size of a household's oil palm plot was 1.7 ha. There were a number of individuals in the study area who own up to100 ha of oil palm, but they were not available to be interviewed for this study.

In five of the villages (Lubuk Batu Tinggal, Sei Beras-Beras, Pontian Mekar, Pasir Putih, Air Hitam, and Langkan) oil palm stands owned by farmers in are in productive ages (6 – 9 years old) and their fresh fruit branch (FFB) production varies between 7 and 9 ton/ha/yr. If the price of 1kg FFB is 1,200 Indonesian Rupiahs (US$ 0.13 at US$1= 9,100 Rupiahs), a 2 hectare of oil palm stand at this age can generate an annual income of 16,800,000 – 21,600,000 Rupiahs (US$ 1,846 – 2,374), or a monthly income of 1,400,000 – 1,800,000 Rupiahs (US$ 154 – 198). This is gross monthly income, not taking into account production and other costs. Plantations in three other villages (Segati, Penarikan and Pangkalan Gondai) are mostly below 3 years of age so are not yet producing. It is important to note here that smallholder's farms actually vary greatly in the treatment quality and thus in the productivity of their plantations. As such the above figures (and those provided below for rubber) indicate more or less the average productivity values based on respondents' feedback in interviews.

Slightly more than 15% of respondents owned rubber plantations. Rubber has been an integral part of the trans-settlement process as families which were brought from Java and resettled here were each granted 2 ha of rubber plot as the basis of their livelihood. Today the mean size of rubber plantations was 1-2 ha. Possession of 2ha rubber stands potentially brings Rupiahs 1,850,000 /month (US$ 203), which is comparable to that generated by 2 ha of 9 year-old oil palm stand. However owners of old rubber stands seem to be more interested in converting their rubber gardens into oil palm farms. At Pangkalan Gondai, for example, respondents indicated that the number of households planting oil palms on land formerly maintained as rubber gardens is increasing.

There is a wide gap in land and income distribution, with the incomes of some people up to 25 times higher than those of others. The local minimum wage in Riau (the minimum amount of wage/pay in the province, as determined by the government) has changed from around 600,000 to around 800,000 Rupiahs per month from 2000 to 2007 (US$66 – 88). Using these standards as a benchmark, about 10% of the study group was poor or very poor. Using the World Bank's definition of poverty being an income less than one US dollar per day per person, about 30% would be defined as poor.

Levels of HWC vary greatly between what is remembered by villagers, news archives, and what is recorded in official statistics. There are also large differences between years and between households. Just 89 households (19.9%) out of 447 households interviewed claimed to have been victims of HEC in the study area within the period of 2000 – 2007. Not all claims concerned damage to palm oil farms, but all referred to property damage or losses.

Of those 89 households that experienced HEC events, on average 70.8% of respondents had only experienced it once, and just 4.5% had experienced it more than twice during the 2000 – 2007 period. On average, each respondent experienced HEC 1.3 times during this period (see Table 3).

Table 3: Number of HEC events experienced by victims

Sub-district	n	Number of HEC*		
		1	2	<2
Kelayang	17	17	-	-
Lubuk Batu Jaya	22	15	7	-
Ukui	19	13	6	-
Langgam	31	18	9	4
Total	**89**	**63**	**22**	**4**
%	**100**	**70.8**	**24.7**	**4.5**

*During 2001 - 2007

The timing and location of the HEC events in each village was also interesting. Although the age of oil palm plantations was not homogenous in the villages surveyed, many of the farms in villages in the northern section of Tesso Nilo (e.g. Segati, Penarikan, and Pangkalan Gondai) were young (3 years old or younger) whereas most of the farms in the southern section of Tesso Nilo (Lubuk Batu Tingaal, Sei Beras-Beras, Pontian Mekar, Pasir Putih and Air Hitam) were mostly productive, around 6-9 years old. In Langkan farms were already older than 8 years old. Table 4 shows how in the northern villages where oil palm stands are older HEC events stopped very early during the reporting period (after 2002.) However the three villages whose oil palm plantations were under 3 years of age in 2007 had very high levels of conflict in the last three years. Langkan, whose plantations were mostly older than 8 years, experienced no damage at all. This high level of conflict in the first three years of growth, and apparent decline in HEC events as oil palm stands get older, is likely due to the fact that after the stands are around 8 years old they are out of the reach of elephants. This indicates that much more stringent and effective mitigation measures must be undertaken to prevent HEC during the first period of plantation growth, when conflicts will be much more severe.

Table 4: Records of HEC events in each sampled village during 2000 – 2007

Predominant ages of village oil palm plantations in 2007	Village	Year							Total
		2001	2002	2003	2004	2005	2006	2007	Total
Productive (6-9 years)	Lubuk Batu Tinggal	1	1	-	-	-	-	-	**2**
	Sei Beras-Beras	1	-	-	-	-	-	-	**1**
	Pontian Mekar	2	2	-	-	-	-	-	**4**
	Pasir Putih	-	1	-	-	-	-	-	**1**
	Air Hitam	2	1	-	-	-	-	-	**3**
	Langkan	-	-	-	-	-	-	-	**0**
Young (up to three years)	Segati	-	-	-	-	-	4	5	**9**
	Penarikan	-	-	-	-	1	3	4	**8**
	Pangkalan Gondai	-	-	-	-	-	4	6	**10**
	Total	**6**	**5**	**-**	**-**	**1**	**11**	**15**	**38**

Estimates of the economic value of 'instant loss' that villagers suffered due to HEC in their sub-districts were calculated. 'Instant loss' comprises of damage to oil palm and/or rubber stands (including the cost of replanting) but only includes the amount of actual economic value that has been lost or paid. The 'instant loss' value does not consider the amount of potential economic value that is lost (i.e. the income that one ha of oil palm stand could potentially bring if it was to reach productive age and remain productive for, say, 20 years). It also excludes losses arising from other kinds of damages such as damage to property and other types of agricultural fields (for example rice, corn and other annual crops including peanut, cassava and banana). However feedback from respondents indicated that these kinds of damages are relatively insignificant.

The estimates produced by this study do not try to quantify in economic terms losses from human injuries or deaths (which are of course highly significant in their own terms). It was noted for example that one person was killed in a Langgam village by a raging elephant bull in February 2007.

The instant economic loss claimed by 89 respondents from four sub-districts during 2001-2007 ranges between 0.5 and more than 10 million rupiahs (US$ 55 - 1,099). Whilst 20.2% of the respondents experienced only relatively minor damage (between 0.5 and 1 million Rupiahs, or US$ 55 - 109), 24.7% said that HEC cost them between 1 and 2 million Rupiahs (US$ 109 - 220), and 36% stated they had suffered losses of between 2 and 5 million Rupiahs (US$ 220 - 549). 5.6% of the respondents claimed to have lost more than 10 million Rupiahs (US$ 1,099).

Overall, the average economic losses due to HEC was around 2.5 million rupiahs (US$ 275) during the study period, or 354,000 rupiahs annually (US$ 39). Out of the four sub-districts studied, the respondents in Langgam sub-district claimed higher losses than any other district - around 660,000 Rupiahs annually (US$ 73). This is not surprising as Langgam contains all three villages with young oil palm plantations (up to three years old in 2007).

Comparing these losses with the US$ 1,846 – 2,374 per year that a farmer with a 2 hectare sized oil palm plantation would earn, or the US$2,436 that a farmer with a same sized rubber plantation would earn, these figures do not appear to be extremely significant to the village as a whole, particularly as this damage is only caused to a fraction of households surveyed (89 out of 447).

A survey for the previous period (1997 – 2000) (WWF Indonesia – Riau Elephant Conservation Program, 2001) drew a much larger loss estimate suffered by smallholder farmers in Riau – around 1,860,000 Rupiahs (US$ 204) per household per year. This is around five times higher than the annual loss per household in this period (2000-2007). The main reasons for this significant difference are likely to be two fold. Firstly, it is likely that during the second period of analysis (2001-2007) the trees in some of the surveyed villages had grown out of reach of the animals, therefore greatly reducing the vulnerability of the crop to elephant damage. Secondly, the abundance of elephant herds roaming in the area might have dropped considerably since 2000 (see table 5), directly as a result of habitat loss and the previous high levels of conflict.

Table 5: Population of elephants in Tesso Nilo National Park

Year	Estimated Elephant Number in Tesso Nilo	Distribution Pouches
1985	150	One large pouch
1999	158	Fragmented into 2 smaller pouches (northern and southern)
2003	70 - 80	Decline in abundance noted in each of the 2 smaller pouches
2007	70 - 90	A slight increase in abundance as a result of relocation

Data source: WWF-Indonesia Riau Programme

One notable point of concern to conservationists which became clear during the field surveys was that the area proposed as an extension to Tesso Nilo National park is being invaded by illegal loggers turned land encroachers coming from neighboring provinces and other parts of Riau. Every encroacher converting forest inside the proposed Tesso Nilo area means more elephants in search of food in long-established villages on the periphery of the Tesso Nilo forest.

Companies

There are at least 14 registered companies operating in the vicinities of the surveyed villages. Oil palm and pulpwood plantations in the area have concession sizes of on average around 14,000 ha. The two logging companies each have huge concession areas of over 40,000 ha but have reportedly stopped their operations since most of their concessions are part of the proposed Tesso Nilo National Park extension area.

Seven companies were sampled in the study area, comprising one pulpwood company and six oil palm companies. The average number of HEC events experienced by each company (including the pulpwood company) between 2001 and 2007 was 3.6 - almost three times that of the individual farmer.

Conflicts were fairly minimal in pulpwood estates, with RAPP, one of the two major pulpwood estate companies in Riau, stating HEC was of no concern at all. Wild elephants do sometimes live in acacia estates (the only crop of the company) but they do not cause significant damage. Indeed WWF radio-collared an elephant from March – September 2007 which spent around 50% of its time in an acacia plantation situated just outside of the Tesso Nilo park boundary (WWF Indonesia, 2007). During this time, no significant damage was caused.

However RAPP decided to collaborate with WWF and pay for the operation of a Flying Squad (trained elephants used for pushing intruding elephants back to nearby forest patches). This was primarily to help protect the villages around its pulp wood concessions and ultimately to protect the wild elephant population in Tesso Nilo from conflict killings. This adds to RAPP's annual budget of at least 20 million Rupiahs (US$ 2,198) for preventing HWC.

Oil palm trees growing in a cleared forest, Tesso Nilo.

Table 6: Estimates of instant economic loss due to HEC during 2001 – 2007 as suffered by seven sampled companies (in Indonesian Ruphias).

	Oil Palm Companies						Pulp & Paper Company
Company name	ASP	MUP	PSJ	LIH	IIS	PV	RAPP
Total annual cost or loss	17,857,142	211,428,571	123,571,429	13,571,429	45,714,286	10,714,286	20,000,000

Note: 1 US$ = Rp 9100. Companies: ASP (Agrita Sari Prima), MUP (Mitra Unggul Pusaka), PSJ (Pputra Supra Jaya), LIH (Langgam Inti Hibrido), IIS (Inti Indo Sawit), PV (Perkebunana V).

The damage caused by elephants to oil palm estates is much more severe. The total annual loss suffered by each palm oil company varied from around 7 million Rupiahs (US$ 785) to 40 million Rupiahs (US$ 4,396). Combined, the costs of preventative measures and direct losses of crops and property resulted in a total annual economic loss for each company from 10.7 million Rupiahs (US$ 1,177) to over 211 million Rupiahs (US$ 23,234) – an average of 70 million Rupiahs (about US$7,700) per plantation company per year.

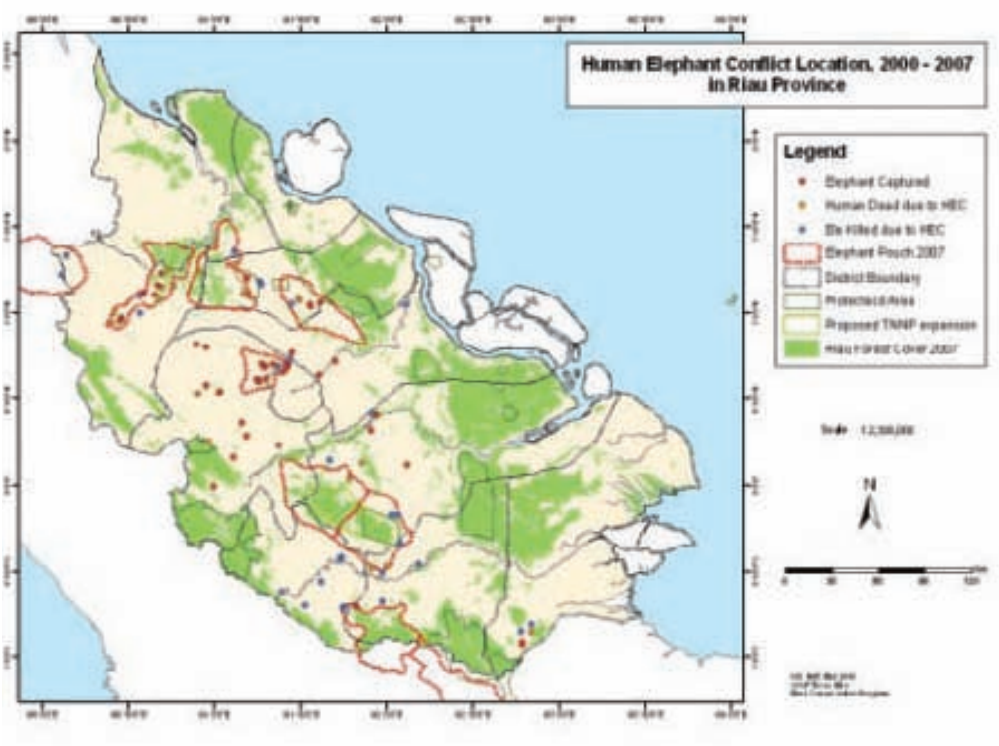
This is much lower than estimates produced by the WWF Riau Elephant Conservation Program in 2001 using similar methods. According to these previous estimates, HEC cost each large estate around Tesso Nilo between 1997 and 2000 as much as 300 million Rupiahs monthly (US$ 32,967), or 3,600 million Rupiahs (US$ 395,604) per year. As was the case with the small farms, the most likely explanation for this dramatic difference is the presumed overall decline in elephant numbers, and the fact that the plantations in the former period were younger and more vulnerable to damage by elephants.

Villagers have varying perceptions about the advantages and disadvantages of the presence of large plantation companies. Most of them (86.2%) agree that the most important benefit they have derived from large companies has been reduced isolation through the construction of roads. Conservation groups, however, argue that the roads facilitate increased and often illegal exploitation of otherwise unreachable natural resources. Interestingly, less than 15% of the respondents stated that the importance of these companies has been to provide jobs for villagers.

Young Sumatran elephant in fields, Way Kambas, Sumatra, Indonesia

3.2 Geographic locations of human and elephant deaths

Figure 5: Geographic locations of human and elephant deaths due to HWC in Riau from 2000 - 2007



Note: For a more detailed map of conflict locations including layers for oil palm and acacia plantations, please go to www.panda.org/species/hwc

Whilst this study focused on looking at the economic costs of HWC in terms of crop loss, it is also important to address costs of HWC in terms of losses of human lives, and elephant deaths. Map 3 depicts the geographic locations of human deaths, and elephant deaths and captures between 2000 and 2007, as well as showing geographic locations of elephant pouches and remaining forest in 2007. Whilst no statistical analysis has been conducted on this data, it seems apparent from a visual analysis that the majority of human and elephant deaths have occurred in or around those elephant patches which have lost significant amounts of forest. The prevention of loss of human life must be of paramount importance, as well as prevention of more deaths and captures of Riau's elephants which are already on the brink of extinction. Therefore the absolute priority must be to prevent any additional degradation or conversion of remaining forest particularly within elephant pouches.

4. Dynamics and drivers

The following section presents the dynamics and drivers of conflict at the micro, meso and macro levels.

Micro level

One of the obvious problems at the micro level in Riau is the poverty of local communities who are looking for ways to improve their livelihood situation, and the influx of people into Riau from other areas of Sumatra and Indonesian islands.

The process of deforestation often starts with illegal logging conducted at a local level. Many villagers in the study area admit either to having logged illegally in the past, or to still be doing so at present. Illegal logging offers double benefits - logs and land, with the logs providing cash for starting small-scale farming of palm oil or rubber on the land. Alternatively, both can be sold, with land fetching 2 to 3 million Rupiahs/ha after land clearing (information from respondents), and much more after it is planted with 3 year old oil palms. Illegal logging is rarely an independent activity, local or newly incoming people are operating with financial

support from outsiders. Businessmen, so-called *tokèh*s, pre-finance local illegal logging operations and then sell the often pre-ordered timber to saw mills, or gangs who clear forest to sell to the province's two pulp mills. The two huge pulp and paper companies in Riau, for example, had repeatedly been identified by local NGOs as users of illegal logs.

The growth of oil palm estates run by companies is also a major driver on the micro-level, particularly when their operations are unsustainable. In addition to the direct impact of these companies on Riau's forests, many companies run co-management systems which offer a chance for local smallholders to develop farms. The company builds farms for the villagers, for which they pay in credit and sell their product solely to the nursing company. One company with its own nucleus concession area of say 3,000 ha may be able to legally extend its estate to more than 6,000 ha by recruiting local smallholders' land. In effect, the actual area used for farming could multiply two or three fold. The respondents in the sampled sub-districts generally stated that the oil palm companies significantly improved their livelihoods through this mechanism. However there have also been a number of cases where companies end up in conflict with local people, often when the government gives concession permits ('*Hak Guna Usaha'* – HGU) to companies for land which local people believe belongs to their clans ('*tanah ulayat*').

The fact that both large companies and local people drive the rapid land-use change in Riau means that both must be fundamentally involved in any sustainable solution.

Another driver of the problem is the extreme lack of enforcement of government regulations relating to land-use. An example of the extent of this can be seen through the establishment of pulpwood plantations in one particular area of Riau (which covers about 55% of the province). 96% of all pulpwood plantations created here replaced natural forest still in good condition, despite the existence of Government regulations which only allow the establishment of pulpwood plantations on "waste" lands. Without proper enforcement, exploitation and conversion of Riau's forests becomes a 'free for all' environment that attracts unscrupulous interests from outside of the province, further exacerbating the problem.

Building plantations on real waste or degraded lands is not an attractive option for plantation owners, whereas lands with degraded forest, where there is still leftover timber to extract, are attractive. The Government has granted Permits for Timber Extraction (IPK – '*Ijin Pemanfaatan Kayu*') as an incentive to plantation investors to convert degraded forest, in the hope that plantation development will reduce poverty of the communities in the area. In practice however there have been a number of cases where plantation investors left directly after cleaning up the timber.

Finding solutions is made harder by the current low tolerance of local communities, and as a result, local government, to elephants and conservation. This is most evidenced in the very high levels of retaliatory killings, despite a relatively low economic cost of HWC to local communities (the clear exception here is the extreme cases of human injury and death). The respondents of this study stated that one of their primary concerns was the expansion of the Tesso Nilo elephant population, as they believed that HEC in the surrounding areas would increase if no effective barriers were put in place. Thus the establishment of Tesso Nilo landscape as the center of elephant conservation in Riau is seen as a threat rather than an opportunity by the local communities there. They also have a negative attitude towards WWF whom they misperceive as the organization responsible for relocating troublesome elephants to their area. All relocations are conducted by the Government Agency for the Conservation of Natural Resources (BKSDA).

Meso

The impact of drivers and dynamics described in the micro section means that at the meso scale across Riau the loss of forest has been, and is predicted to continue to be, dramatic. Looking into the future, a "business as usual" scenario suggests that Riau's natural forest cover would decline to 6% (a loss of 2 million hectares) by 2015, from 27% today (Uryu et al., 2008). Another scenario based on full implementation of Riau's draft provincial land-use plan and conversion of all natural forest in industrial concessions, suggests that mainland natural forest cover would decline to 15% by 2015 (a loss of 1 million hectares). 74% of this deforestation would be as a result of conversion for pulp wood plantations, 23% as a result of conversion to oil palm plantations.

The loss of this forest would have severe implications for biodiversity, including elephants which, as stated above, have diverse and complex ecological requirements. Thus neither scenario projected above is compatible with long term elephant conservation.

Macro

The overall drivers of the extensive deforestation in Sumatra come from outside Riau, with much of the pulp/paper and palm oil products sold throughout Indonesia, as well as exported to Europe, the US and elsewhere in Asia. While dependence on a small number of monoculture products (as is the case in Riau) often renders producers vulnerable to the risks of changing markets (as well as the risks associated with such dramatic ecological changes) this is much less the case with tree cultures in Riau. The trees are well adapted to the conditions of soil and climate which exist on Sumatra, and the demand of national and international markets, especially for oil palm, is nearly endless. Indonesia uses just 30% of the palm oil produced in the country for local consumption, exporting the rest (Tambunan, 2006).

This demand has recently been exacerbated by highly ambitious plans to increase palm oil production for use as a biofuel for sale on the national and international market. There is always some uncertainty about future developments, however it is safe to say that the future demand of the world market for bioenergy, be it near-by economic giants such as China and India, or the European Community and the USA, will be close to limitless. More than 50 countries worldwide now have targets for bioenergy – for example the European Union has committed to a 5.75% market share of biofuels in the overall transport fuel supply by 2010 (European Union, 2003). Taking into account the growing demand for palm oil for bioenergy as well as traditional uses, the FAO estimates that palm oil production will double between 1999/2001 and 2030 (FAO, 2006).

In addition to concerns about the ecological sustainability of many biofuels, there is growing skepticism about their carbon-neutrality. In Sumatra for example, palm oil plantations established by clearing natural tropical forest, especially on peat soil, will not be climate neutral. There is also concern that an increase in oil palm production for energy use may have wider sustainability impacts, such as food shortages, food price increases, or displacement (bioenergy production displacing agricultural production and pushing it into other areas, causing a net expansion of the area under cultivation and associated forest loss).

There are now several initiatives aimed at establishing standards for biofuels, including oil palm (the Round Table on Sustainable Palm Oil - RSPO)[2]. As part of its work, the RSPO is promoting Best Management Practices and protocols for HWC within the companies with whom it is involved. However introduction and adoption of oil palm sustainability criteria is very slow and the biofuel hype is very big. Many forests may have disappeared before a critical mass of sustainable palm oil buyers has been reached.

[2]For more information on RSPO see http://www.rspo.org/

5. Solutions

In both the currently foreseeable future scenarios for Riau, natural forest cover will be reduced to the extent that huge amounts of biodiversity will be lost (including probable extinction of Sumatran elephants and tigers), water/soil quality and stability would probably be negatively affected, indigenous people would lose access to non-timber forest products, and Indonesia would contribute greatly to global warming through the carbon that will be released both from deforestation and the release of carbon from peat soils.

To reverse current trends and make sure Riau is able to fully capitalise on its natural assets before they are lost, new solutions are urgently needed.

Land-use planning

The most important solution to prevent losses of human lives and livelihoods, whilst allowing Riau to maintain its globally important biodiversity as well as ensuring sustainable development and livelihood opportunities for Riau's human population is to develop land-use planning processes that take aspects of poverty reduction, ecosystem functioning and sustainability seriously into account. Land-use plans must be developed in a way that incorporates avoidance of HWC at the core of planning. The following should be the fundamental concepts:

- No more conversion or degradation of remaining forest in Riau should be allowed. There are 900,000 hectares of waste land in Riau. The Government should limit any new plantation development to waste lands (bearing in mind that some of these lands will need to be regenerated for corridors – see below). While large companies will have the funding for the initial additional costs that will be necessary for establishing plantations on waste land (such as activities to improve soil quality), smallholders might need micro-credits and extension services initially.
- Large conservation zones should be established as National Protected areas. Riau's nationally controlled protected areas were less deforested (only 7-8% since 1994) than provincial or other types of protected area (19% since 1994). These areas should be clearly marked as villagers and incoming forest encroachers often use the absence of a real boundary mark of the park area as excuse for illegal encroachment of the area.
- Appropriate corridors should be established between these areas to allow for migration and genetic exchange. Degraded or waste lands will need to be regenerated for this purpose.
- Ecological considerations, in particular current and potential HWC, must be taken into account in all land-use decisions, including roads or other developments that may block elephant migration.
- Stringent field based conflict mitigation measures must be undertaken in oil palm plantations to avoid conflict, particularly for the first 8 years of plantation development. These measures should follow the "Guidelines on the Better Management Practices for the Mitigation and Management of Human-Elephant Conflict in and around Oil-Palm Plantations in Indonesia and Malaysia" (Chong and Dayang Norwana, 2005) (see section 5 below).
- Costs of HWC and HWC mitigation measures must be included in prospecting budgets for oil palm plantations when considering their economic merit against other forms of land-use (such as forest conservation for carbon sequestration).

Problematic, however, is the continuing lack of will or capacity to fully implement land-use plans and enforce environmental laws. This is a fundamental problem that needs to be urgently addressed by the government authorities.

Financing

Innovative finance mechanisms for forest conservation are now essential to provide an economically viable alternative to oil palm and pulpwood growing as a form of development for Sumatra. Mechanisms that ensure proper and equitable distribution of funds to local communities would enhance enforcement of conservation-based land use plans as forest conservation would be in the economic interest of the people involved. The negative impression many local people have towards wildlife might be changed into a positive one, and local people might be better empowered to become the guardians of forests and the wildlife they contain.

(i) PES - elephants

Payments for Environmental Services (PES) schemes reward those whose lands provide services with subsidies or market payments from those who benefit. Services are the multiple benefits that people receive from nature, such as water purification and flood control by wetlands.

For Sumatra, a simplified framework for calculating payments for biodiversity conservation, in this case paying people to live with elephants, could take the following format:

1. Estimate the direct costs of managing the elephants (e.g. costs of rangers, enforcement) for several alternatives
2. Estimate the indirect costs of damage caused by elephants (e.g. loss of products, infrastructure, limbs and life)
3. Estimate the lost opportunity costs to farmers deciding to live with elephants, under different elephant management regimes (e.g. land they may not crop)
4. Estimate what funds can be made from elephants (e.g. tourism, trophy hunting, sale of tusks, hides and meat – where relevant and legal)
5. Estimate the ecological and economic benefits that will be derived from the maintenance of forest as elephant habitat (e.g. use of non-timber forest products, sustainable use of species other than elephants, provision of clean water and soil stability)

(1+2+3 – 4+5) = (global biodiversity costs for maintaining elephants)

The difficulty lies in the implementation of a PES scheme. Decisions need to be made about who pays in, who receives the money, and who takes responsibility for a just distribution. One possibility is that PES could occur through a biodiversity fund into which the international community would pay, with international conservation organizations in collaboration with local governments taking responsibility for implementation. Another possibility would be to charge a stipend or voluntary 'tax' on the agricultural industries most responsible for HWC (such as the oil palm industry) and use those funds to input into the scheme. Their products could then potentially be sold for a higher price on the international market as 'elephant friendly' (see section iii below).

(ii) PES - carbon

With global climate change a mounting and serious problem, discussions are now taking place about payments for ecosystem services at a global scale – for the sequestration of carbon. Both natural forests and peat soils are important long-term stores of carbon on earth, with peat soils able to store 30 times more carbon than the tropical forests above them. Riau's peat soils, sometimes over 10 meters deep, are estimated to store the largest amount of carbon in Indonesia – 14.6 gigatons. Deforestation and land draining starts an oxidation process of the peat soils which can release 5,000 to 10,000 years worth of stored carbon. Between 1990 and 2007, estimated total emissions from deforestation, forest degradation and decomposition and burning of peat in Riau was 3.66 gigatons of CO_2, contributing to Indonesia's ranking as one of the world's biggest emitters of carbon (Uryu et al., 2008). Carbon sequestration by vegetation re-growth of the acacia and oil palm plantations that replaced these natural forests was just 0.39 gigatons of CO_2. Drained peat is also at very high risk of forest fire, which adds the dramatic economic and health costs of trans-boundary haze to the already very negative impacts of peat deforestation.

It is clear that maintaining the natural peat swamp forests of Riau has huge potential to act as a major part of global atmospheric security by sequestering carbon. In fact, on current estimates, the potential value of trading protected carbon stocks of these forests may be comparable or even more valuable than conventional uses of natural forests such as agricultural plantations.

Carbon sequestration should occur in a way that also conserves biodiversity and the potential benefits associated with it. This would be done by creating a framework of well connected landscapes consisting of community-managed agroforestry systems with carbon as one product. The landscapes would occur in the most important areas for biodiversity and include wildlife corridors to ensure survival of elephants, tigers and other species. Some of the unsolved problems with this system include 'leakage' (why pay to stop deforestation in one site when the same operator starts deforesting another site), how to pay the up-front costs, how to make the system permanent and how to distribute the economic benefits. The danger persists that governments will take the money and local communities will remain marginalised. This would, again, lead to a situation where conservation of the forests is not guaranteed as there would be no buy-in for local communities to forest conservation and small scale encroachments would continue.

The main carbon trading systems for avoided deforestation will occur through Kyoto II implementation after 2012. As stated above, however, by 2015 Riau will only be left with 6% of its natural forest, and cannot therefore wait until 2013 for Kyoto II's official channels to become available. A possible solution exists in the various Voluntary Markets that are springing up around the world. Generally, the buyers on these markets are conservation and/or sustainable development oriented, and are willing to offset their emissions by paying for avoided deforestation or avoided forest degradation. WWF is currently developing a standard for the design of such projects.

(iii) 'Wildlife Friendly' Products

Another possibility is the development of a certification scheme for 'wildlife-friendly products', benefiting farmers who produce crops or other products in an elephant-friendly manner, by ensuring a higher price for their products in American, European and big city niche-markets. This approach is already operating with success for many products/labels, and there are discussions underway to create one unifying 'wildlife friendly' brand to strengthen consumer base and marketability.

A complimentary package of all the above schemes will probably prove to be the most effective way to provide the economic foundation for forest conservation in Riau.

Macro level drivers

It is also imperative that the macro level drivers are addressed, and that national and international companies buying illegal or unsustainably grown oil palm or pulp products immediately change their buying practices. Paper and pulp should be sourced from Forest Stewardship Council approved sustainable forestry operations. Palm oil products should be purchased from those plantations that form part of the Round Table on Sustainable Palm Oil. Buyers should improve chain of custody awareness to ensure they don't buy products from companies known to illegally or unsustainably convert natural forests.

6. Practical field-based solutions

Even under the best land-use planning scenarios, there will likely always be some conflicts between humans and wildlife. As such, the implementation of field-based professional HWC mitigation solutions may always be necessary.

WWF has summarized the field based mitigation methods for avoiding human elephant conflict in oil palm plantations in the report "Guidelines on the Better Management Practices for the Mitigation and Management of Human-Elephant Conflict in and around Oil-Palm Plantations in Indonesia and Malaysia." These include barriers such as fences (electric and non-electric) and trenches; repellents such as noise, lights, fire, burning of elephant dung mixed with chilli seeds and chilli oil; guarding of fields, and compensation. The report also covers land-use changes such as protected areas, corridors, habitat enrichment and buffer zones.

Some of the companies assessed during this study had used trenches to protect their farms from intruding elephants. These ditches have a standard size of 1.8m deep, 2.4m wide/ above, 1.2m wide/bottom. However, to be effective ditches must be dug encircling the whole concession area (one company had completed a ditch which reached a total length of more than 30 km) and the construction of this barrier can be very costly, up to 50 million Rupiahs (US$ 5,495) per km. These costs can be reduced by building the barrier collectively involving a variety of stakeholders. According to the representatives of two companies, electric fences do not deter elephants effectively while ditches with dimensions as stated above do. Elephants frequently break even the strongest of fences and electric fences are not always immune as elephant tusks do not conduct electricity (Nelson *et al.,* 2003).

However the potential ecological impacts of barriers such as trenches must also be taken into account. They may for example hinder the movement of many other relatively harmless terrestrial animals, potentially leading to genetic fragmentation and isolation.

Another technique that has so far proved quite effective is using squads of trained elephants to push back their intruding wild cousins ("flying squads"). However it is hard for the squads to be mobile enough to always arrive timely at locations where HEC occurs, especially when these locations are far from the squad camps. For an area as large as Tesso Nilo, at least six squad camps would be needed to ensure effective patrolling by elephants along its HWC prone boundary sections. In addition, operating elephant squads can be very costly (often more than 20 million Rupiahs per month (US$ 2,200) for a squad unit of 4 elephants). The sustainability of this method is therefore doubtful unless stakeholders such as the plantation owners can be involved in maintaining the squads financially. Indeed, one pulp and two oil palm firms have already signed deals on cooperating with WWF in using this method.

Human-Elephant conflict (Tesso Nilo). Flying squad team (riding Sumatran elephant) in action. Riau, Sumatra, Indonesia.

7. Conclusions and recommendations

The situation in Riau is illustrative in many ways of a worst case scenario in the management of the complex requirements of both people and wildlife. The elephant population is plummeting and with few remaining forest patches large enough to support populations, the future of the Sumatran elephant is extremely precarious. Riau's Sumatran tiger population has also declined by 70% since 1982, and in 2007 was estimated at just 192 individuals (Uryu et al., 2008). The remaining animals are fragmented into small forest patches and unless these areas are connected with forest habitat Riau's tiger population will no longer be viable. An important reason for the rapid decline in both species is HWC, which also places a burden on the livelihoods of local farmers and commercial plantation owners.

If current trends continue, Riau is projected to lose all but 6% of its natural forest cover by 2015. Riau is therefore in jeopardy of losing the wealth of its world class biodiversity and the carbon of its forests and peat soils, thus relinquishing an enormous opportunity to stabilize the global environment and generate economic benefits and development opportunities for its rural communities through carbon credits.

However, the new opportunities that may become available for carbon credits can only be capitalized on effectively if a new strategic and coordinated effort is made to manage Riau's forests, wildlife and human development needs in a multi-use mosaic that delivers both biodiversity conservation and improved human livelihoods. Essential to this will be:

(i) a strong political commitment for enforcement and implementation,

(ii) dedicated and coordinated management and planning from all sectors (environment, development, forestry, agriculture, etc),

(iii) a coordinated engagement structure which connects all levels from the micro, meso to macro including responsible engagement of the international business and consumer community.

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Sumatran elephant and calf, members of WWF's Elephant Flying Squad used to reduce conflict between people and wild elephants.



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