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RESEARCH REPORT

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The Effectiveness Of Electric Fencing In Mitigating Human-Elephant Conflict in Sri Lanka

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This study assesses the effectiveness of electric fences in reducing conflict between elephants and humans in Sri Lanka. The study looked at five electric fence projects that have been set up to prevent elephants from straying out of protected wildlife areas into farmers' fields. This conflict between people and elephants is a key social and environmental problem for the country.

A household survey gathered information about how effective the fences are and gauged local people's attitudes. The study also looked at why electric fences did not work. It found that, although electric fences do help mitigate conflicts between elephants and humans, they do not completely eliminate the problem and do not offer a 'stand alone' solution.

In each survey area, technical as well as socio-economic factors were found to determine levels of success. Community support for the fences was found to be vital. Poor, ad-hoc decisions were a key factor determining success or failure: Fences were often unsuccessful because elephant behaviour had not been properly taken into account.

The findings of the study indicate that a thorough appraisal is needed before an electric fence is set up and that adequate resources should be invested in their construction and maintenance. Local people should be involved in a fence's planning, construction and maintenance.

The report highlights the need for an integrated approach to the problem of human elephant conflict. Such an approach should involve comprehensive land use planning and habitat enrichment alongside well-planned electric fencing, where appropriate. Electric fences are only part of the solution.

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THE EFFECTIVENESS OF ELECTRIC FENCING IN MITIGATING HUMAN-ELEPHANT CONFLICT IN SRI LANKA

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EEPSEA was established in May 1993 to support research and training in environmental and resource economics. Its objective is to enhance local capacity to undertake the economic analysis of environmental problems and policies. It uses a networking approach, involving courses, meetings, technical support, access to literature and opportunities for comparative research. Member countries are Thailand, Malaysia, Indonesia, the Philippines, Vietnam, Cambodia, LAO PDR, China, Papua New Guinea and Sri Lanka.

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LIST OF ABBREVIATIONS

AMDP Accelerated Mahaweli Development Project

CBA Cost-Benefit Analysis

CEA Cost-Effectiveness Analysis

DSD Divisional Secretary Division

DWLC Department of Wildlife Conservation

HEC Human-Elephant Conflict

MDA Mahaweli Development Authority

VRR Victoria-Randenigala-Rantembe Sanctuary

THE EFFECTIVENESS OF ELECTRIC FENCING IN MITIGATING HUMAN-ELEPHANT CONFLICT IN SRI LANKA

L.H.P. Gunaratne and P.K. Premarathne

EXECUTIVE SUMMARY

Among the catalogue of environmental problems that face Sri Lanka, the conflict between humans and elephants is of growing concern. Human-Elephant Conflict (HEC) causes damage to human lives, property and cultivated crops and is currently the main threat to the survival of elephants in the country. This problem looks set to get worse, since 70% of the country's wild elephant population lives outside designated park areas and the increasing rural human population demands ever-more land resources. Therefore, the identification of appropriate policy options to deal with the HEC challenge is of paramount importance. A successful solution will go a long way to conserving the country's endangered elephants without causing further deterioration to the social welfare of Sri Lankan rural farmers.

Among the mitigation strategies that have been adopted, the establishment of a physical barrier in the form of electric fencing is considered to be the most effective measure. A substantial number of electric fences have been established in Sri Lanka and more are to be installed, an initiative that will involve substantial costs.

Against this background, a study was undertaken to evaluate the effectiveness of established electric fences in Sri Lanka. Five electric fences installed in conflict areas were evaluated by comparing the situation in areas 'protected' by fences to areas without this protection. The homogeneity of these treatment and control areas was first established. The effectiveness of the fences was estimated using a number of indicators. This field research was supplemented by the information received from key informants and secondary sources.

The study concluded that, although electric fencing does help mitigate HEC, it is not capable of completely eliminating the problem. Moreover, it was found that electric fencing cannot stand as a mitigation measure on its own. A number of technical as well as socio-economic factors were highlighted that determined the level of success of each fence. Among these, correct design, the consideration of geographical variation and elephant migratory patterns, the completeness of the fencing and community support for fence maintenance appeared to be crucial for success.

Ad hoc decision making, in relation to either the establishment of fences or settlements, contributed significantly to fence failure. This implies the need of an integrated approach to solve HEC problem with comprehensive land use planning and habitat enrichment where electric fencing is an important component.

1.0 INTRODUCTION

1.1 Background of the Study

The elephant is considered as one of the celebrities of the animal kingdom and is a prominent symbol of wildlife conservation in Sri Lanka. The elephant has played a central part in Sri Lankan history, culture, religion and mythology (and lately politics) for more than twenty-five centuries (Santiapillai, 1997 a). Tamed elephants have long been used for various sorts of work in the country including moving hardwoods, building and hauling loads.

However, the peaceful coexistence between humans and elephants has deteriorated significantly over the past few decades. This problem is not restricted to Sri Lanka. Elephants are subject to decline in many parts of the world. According to the International Union for Conservation of Nature (IUCN, 1996), there were about 100,000 elephants in Asia at the beginning of the 20th century. This number has now been reduced to 40,000 mainly due to habitat encroachment and poaching. In Sri Lanka, the elephant population was dramatically reduced to its present level of 3,500 due to the depletion of natural forests and the increase in the human population. Official records indicate that during past five decades, the forest cover has fallen from 50% to 22% and the human population has climbed from 8 million to 19.5 million. The increase of Sri Lanka's rural population has led to the destruction of forestland due to slash and burn agriculture, village expansion and irrigation development. The Accelerated Mahaweli Development Project (AMDP), which is Sri Lanka's major development scheme, has significantly increased the intensity of the conflict between humans and elephants. (Santiapillai and Jackson, 1990; De Silva, 1998). Today, the remaining elephants are confined to national parks and some forest pockets in the northwestern, eastern and southern parts of the island.

1.2 Human-elephant Conflict (HEC)

Elephants need large areas of land as they move to cope with seasonal food and water availability. The recent unprecedented levels of human encroachment into elephant habitats, together with the decreasing carrying capacity of Sri Lanka's forest reserves, have left many elephants with no choice but to depend on cultivated crops for food. Roaming elephants raid crops and damage houses and other properties and in some instances have killed people. Traditional strategies that have been used to chase off elephants, such as shouting, twirling, lighting firecrackers and making loud noises, are no longer effective in many areas where the HEC is intense. This means that many farmers are compelled to kill elephants. Over time, this conflict between humans and elephants has intensified since both peasant farmers and wild elephants have to compete for the same scarce and diminishing land and water resources. Table 1 shows the damage caused by human-elephant conflict during the past few years.

Table 1. Official Statistics of the Damage Caused due to Human-elephant Conflict

Year	*Human deaths by elephants*	*Number of elephants killed*
1991	32	32
1992	22	90

1993	60	103
1994	55	113
1995	57	94
1996	47	130
1997	54	164
1998	53	148
1999	81	107
2000	63	150
2001	34	151

(Source: Department of Wild Life Conservation, SL 2001)

The overall cost of the human elephant conflict is not limited to losses of human or elephant lives. It includes: the cost of crop and property damage; the cost of protecting crops and properties; and the impact it has on people's quality of life. This cost is set to rise. Given the fact that 70% of wild elephants live outside the country's designated park areas (DWLC, 2003), and that a steadily increasing rural population will place even more pressures on forest resources in years to come, it is clear that human-elephant conflict will be an ever increasing threat to the elephant population in Sri Lanka.

IUCN (1996) has declared that the Asian elephant is one of the most endangered species of large mammals in the world. Today, environmental groups, concerned citizens and government agencies have made elephant conservation a top priority. In Sri Lanka this can be justified in many ways. Sri Lankan elephants possess distinct genetic differences from the rest of the Asian elephants (Fernando et al, 2003; Gunasekera et al, 2003). Elephants are considered as 'flagship' species since their conservation helps the conservation of several other species (Desai, 1998). Also, elephants are considered as an 'umbrella' species, they need large areas of land for their range requirements, social organization and breeding. They are also a 'keystone' species as their presence alters the habitat in which they live, often opening up ecological niches that other species can exploit. The economic value of the conservation of elephants has already been established by several studies (Bandara and Tisdell, 2003).

1.3 Electric Fencing

Given the urgent need for effective elephant conservation, governmental as well as non-governmental agencies have intervened to try and deal with the problem. The strategies that have been employed include: the expansion of protected areas and the translocation of people; capturing and translocating aggressive male elephants; elephant drives; electric fences; compensation payments; and other measures such as elephant orphanages, elephant transit homes and foster elephant programs.

Electric fences are considered to be the most effective human-elephant conflict mitigation measure as long as they are strategically located and well implemented. Such fences also appear to be the people's favourite solution to the elephant problem since they physically separate human and elephant territories. The IUCN (2000) states that this method is a very economically efficient way to conserve these valued animals.

However, the Sri Lanka Wildlife Conservation Society (2004) states that electric fences do not stop villagers having a negative impact on elephant habitat. Some studies

have found that there are some elephants that are 'habitual fence breakers' (IUCN, 1996). Other studies have shown that fences need to be electrified in most savanna elephant ranges, since these are places where crop raiders are determined and persistent. However, the same studies find that electrification is not needed as much in forest elephant ranges where elephants appear not to be so persistent at crop raiding (IUCN, 2000).

It is clear that, if constructed appropriately, fences can provide protection to particular areas. However, at the same time a fence may produce negative externalities by increasing the conflict in other areas. Therefore, electric fencing cannot be considered as a blanket solution. It should also be kept in mind that electric fences have a fairly high establishment cost and that their success depends on parameters such as after care and maintenance and community activities.

In Sri Lanka a number of electric fences have been erected by the Department of Wildlife Conservation (DWLC) and other interested organizations to protect some areas where there has been a high incidence of HEC. To date, over 500 kilometers of electric fence has been constructed in several parts of the island both by the DWLC and by private companies and NGOs. Electric fences with a total length of 160 kilometers have been established with community participation. Meanwhile The DWLC plans to extend its construction program to several new areas in the northwest where the human-elephant conflict is most intense (DWLC, 2003).

Appendix 1 contains technical details and specifications of electric fences.

2.0 OBJECTIVES OF THE STUDY

Since policy makers strongly believe that electric fencing is the best solution to the HEC challenge, the in-depth evaluation of this approach is of particular relevance, particularly in terms of the efficient allocation of scarce conservation resources. Some misgivings remain about this technology and these need to be addressed. For example, it is clear that electric fences have relatively high initial establishment costs and that they also create a divide between rural communities and nearby forests.

This study was initiated to answer a number of these unresolved questions about the implementation of electric fences. In particular, it set out to see if electric fences can provide a stand-alone solution to the HEC problem. The general objective of the study was to investigate how effective electric fences are at mitigating the human-elephant conflict. This effectiveness was measured in terms of how the fences reduce elephant-related incidents that affect the lives and livelihoods of the rural farmers. In other words, its aim was to answer the question: “Are electric fences capable of assuring the survival of the elephants while improving the social welfare of the people who live in the vicinity of elephant ranges?”

The study’s specific objectives were:

(i). To evaluate the effectiveness of the electric fences which have been established in different parts of the country to mitigate human-elephant conflict in Sri Lanka.

(ii). To investigate the factors that determine the level of effectiveness of this approach.

REVIEW OF LITERATURE

During the past few decades there have been a substantial number of studies carried out on various aspects of elephant biology, conservation and ecology. However, only a limited number of studies have been done on the economic aspects of elephant conservation. The small body of literature on elephant economics is dominated by studies related to ivory trade issues or to ecotourism issues linked to the African elephant. For example, a group of environmental economists contributed to the drafting of the CITES (Convention for International Trade in Endangered Species) elephant ivory trade ban, while, the 'viewing value' of elephants was estimated using travel cost method by Brown and Henry (1989). Recently Bandara and Tisdell (2003) have estimated the total economic value of elephant conservation in Sri Lanka.

There has, however, been a small amount of research done on the Human Elephant Conflict HEC issue. Kemf and Jackson (1995) described HEC as a spatial problem since humans and elephants both compete for the same natural resources. The various dilemmas associated with HEC were discussed by Hart and O'Conell (1997). They summarized the status of the conflict in Asia and Africa by using examples taken from treatment studies in Nepal, India and Namibia. They argued that, because farmers loose potential earnings as a result of elephant destruction, they should be provided with some economic benefits from elephant conservation. Hoare (2000) debated the protectionist versus the utilization approach to elephant management. The protectionist approach gives less emphasis to HEC (Styles et al, 1997); while the utilization approach is based on the idea that the complete conservation of elephants is a luxury for developing countries. It argues that such countries should be able to make an economic return from their wildlife (Wickramasinghe and Santiapillai, 1999). Santiapillai (1997 b) emphasizes the need for a balance to be maintained between elephant conservation and human interests. They pointed out that most conservationists and writers in the popular media place too much emphasis on elephant conservation and place too much blame on the rural poor. He further states that farmers take the law into their own hands because they suffer from the constant depredations of elephants and that it is this that ultimately leads to the destruction of wild elephant populations. Desai (1998) identified the loss of habitats and land fragmentation as the main reasons for HEC in Sri Lanka. Recently Corea (2000) assessed the ecology of elephants with special emphasis on human-elephant conflicts in Sri Lanka. He was able to identify key areas of conservation and management that need to be addressed immediately.

With the escalation of the human-elephant conflict, a number of countries have initiated related studies and projects. In Thailand, the Wild Animal Rescue Foundation of Thailand (WAR) is setting up a project in Pala U District. They aim to design a process to reduce the impact of human-elephant confrontations. Bist (1997) has conducted a treatment study in North Bengal, India. This addressed the human-elephant conflict. The resulting paper is published in the text 'Practical Elephant Management – A Handbook for Mahouts'. This comprehensive study contains information on all aspects of HEC in the area. It includes details of: the types of elephant depredation found; the extent of the depredation; the impact of HEC on the elephants; and the causes of the conflict**.** In India, the Asian Elephant Research and Conservation Center

(AERCC) in Bangalore and the Nature Conservation Foundation have implemented projects to identify HEC mitigation measures. Other countries in the region including China, Sumatra and Laos have initiated several projects with the same aim. In Africa, studies by the African Elephant Specialist Group (AfESG) and the Kenya Wildlife Service's ESRI Conservation Program have used GIS technology to monitor elephant behaviour to help minimize HEC.

Since elephant conservation requires a high level of financial investment, most countries in the developing world cannot find the necessary financial resources to do it adequately. Tisdell (2003) discusses the general economic failure of international funding for biodiversity conservation. Bulte and van Kooten (2002) argue that in the case of elephant conservation, international monetary transfers might bring adverse implications for global welfare and in situ stocks.

4.0 METHODOLOGY

In this study, the treatment-control experiment procedure, which compares two groups, (i.e. with and without policy alternatives) was adopted to evaluate the effectiveness of electric fencing at the field level. A number of fences were chosen for study from a list of all the electric fence projects that had been established in Sri Lanka. For each of the areas selected for the study, information was collected from replicated field plots – some in areas protected by a fence (treatment) and some in areas not protected by a fence (control) – for a period of one year. The land areas sampled within each study area was kept the same, as is shown in the Tables 2 to 6. A number of socio-economic and production variables were used to establish the similarity of treatment and control areas (Table 7 to 10).

The following section (4.1) describes the sample fenced areas selected for study; while section 4.2 contains the field data collection procedure; section 4.3 details the indicators that were used to evaluate the effectiveness of the electric fencing policy.

4.1 Sampling Procedure

4.1.1 Selection of the Electric Fences and Areas for the Study

In order to reduce the number and impact of human-elephant conflicts (HEC) in Sri Lanka, a number of electric fences have been implemented in different parts of the country. The selection of fences for this study was based on the severity of the HEC associated with each fence, the characteristics of their geographical areas and the institutions involved in their implementation. (Appendix 2 provides the sampling frame, i.e. the list of electric fences in Sri Lanka together with other details). The following electric fences were chosen:

- Kandeketiya electric fence near Victoria-Randenigala-Rantambe Sanctuary
- Herathgama electric fences near Kahalla-Pallekele Sanctuary
- Electric fence around Mahaweli System G

- Kalagama electric fence at Balaluwewa-Kalawewa sanctuary
- Lunugamwehera electric fence at Lunugamwehera National Park

Figure 1 shows the study areas together with some information on HEC.

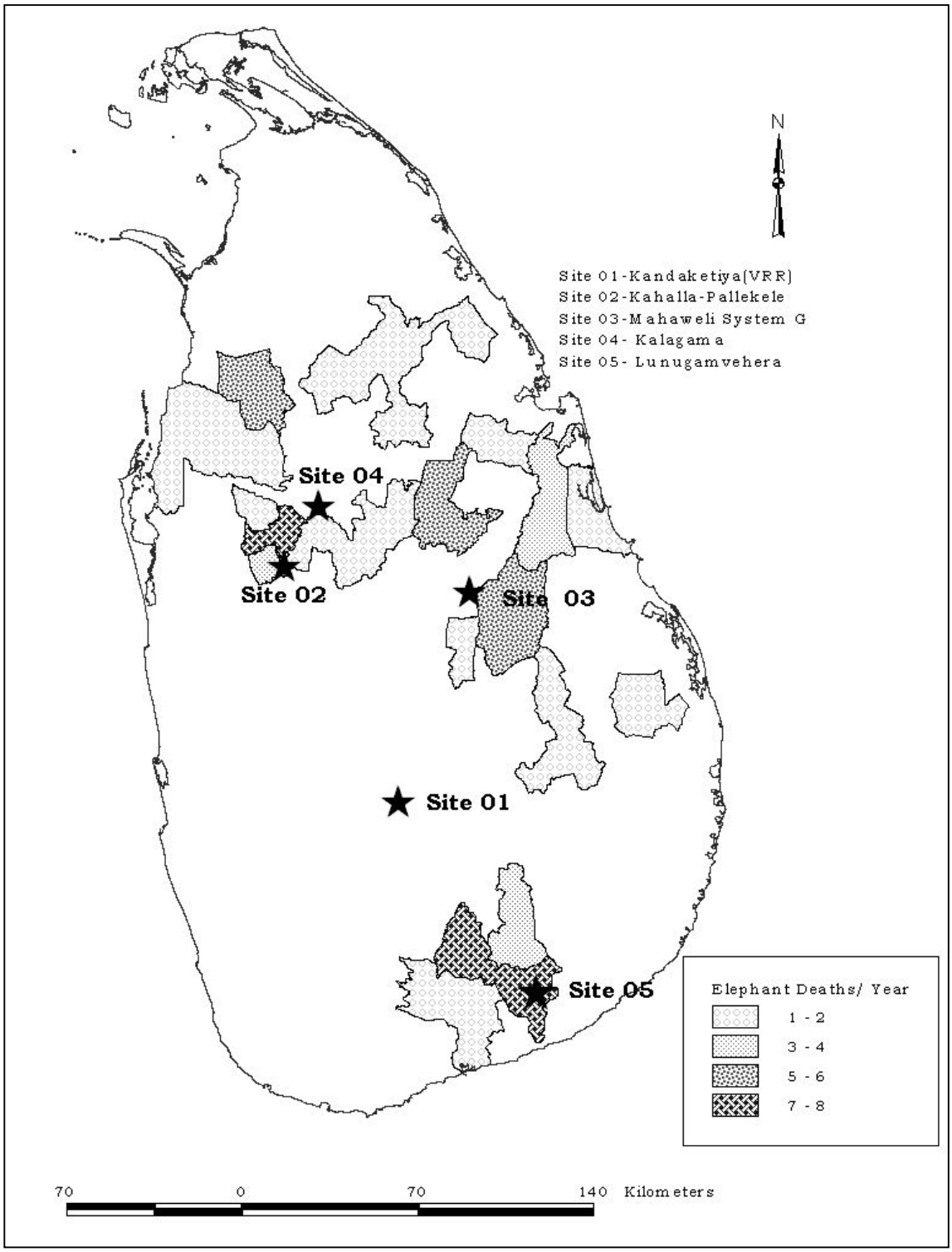

Figure 1. Study Areas and Distribution of HEC Based on Elephant Deaths in Sri Lanka (2004)

4. 2 Description of the Study Areas

4.2.1 Kandeketiya Electric Fence Near Victoria-Randenigala-Rantambe Sanctuary

The Victoria, Randenigala and Rantambe (VRR) sanctuary area is located in the Central Hills of the island. It is extensively covered with the forests of the upper Mahaweli catchments. The sanctuary is approximately 41,600 ha in area and there are 27 Grama Niladhari Divisions (village level administrative divisions) located in the sanctuary region (Figure 2). Due to intensifying levels of human–elephant conflict (HEC) around the sanctuary, an electric fence was established near the sanctuary to cover the Kandeketiya Divisional Secretariat Division. The fence was constructed between 1998 and 1999 and runs from Uma oya to Pathagala rock, a distance of approximately nine kilometers.

The survey covered 10 villages in the Victoria-Randenigala-Rantembe Sanctuary region (Table 2). In total 47 households were interviewed. The control group consisted of villages that did not receive any protection from the fence. The treatment group (i.e. villages protected by the fence) was divided into two depending on the intensity of the HEC they had previously experienced.

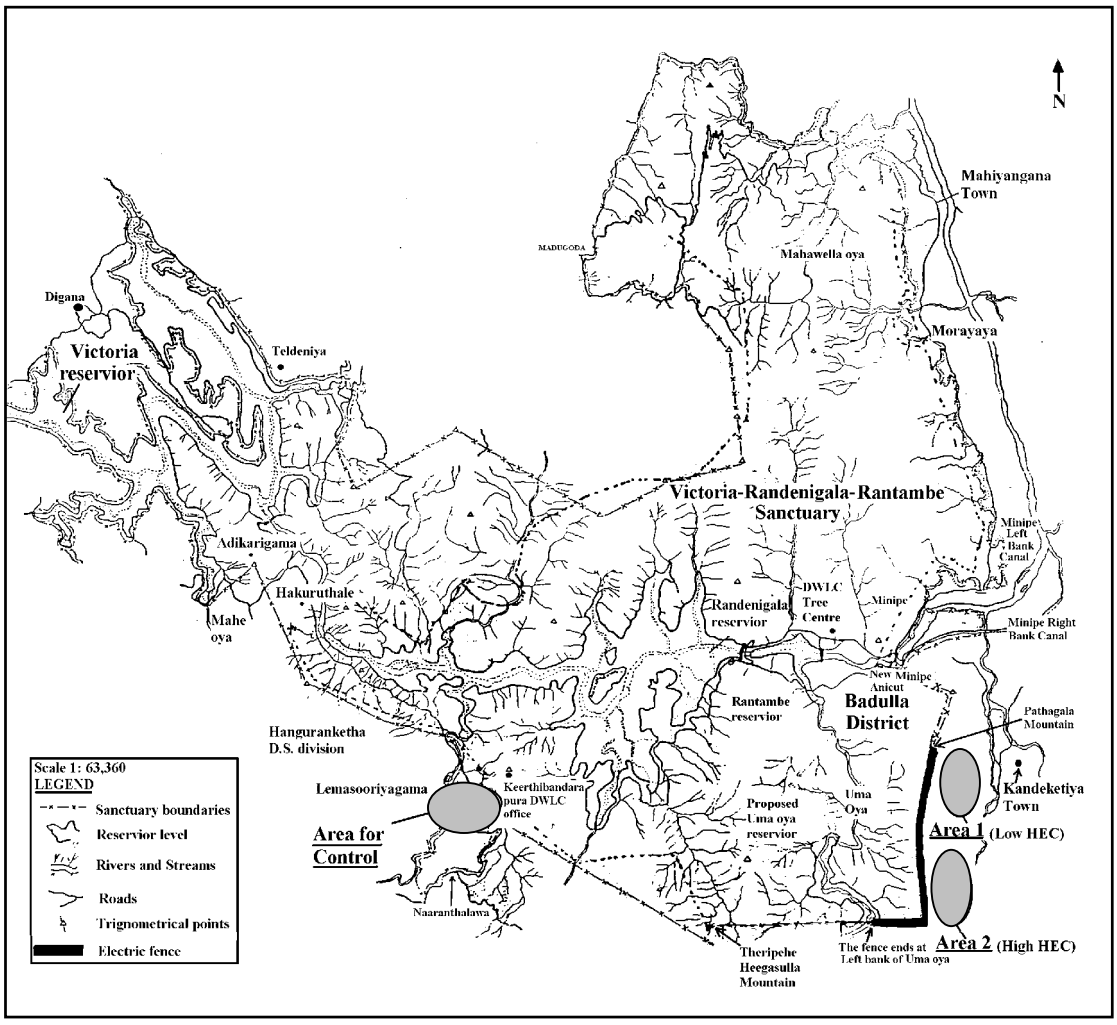

Figure 2. Map of Victoria-Randenigala-Rantambe Sanctuary
(Source: DWLC- Central region office, 2001)

Table 2. Villages and Area Information: Victoria-Randenigala-Rantambe Sanctuary-Kandeketiya Electric Fence

	Area 1	*Area 2*	*Control*
Name of the village	Unagolla Ekiriyawatte Maligathenne	Maliyadda Wewathenne	Lemasooriyagama Othalawa Serasumthenne Serupitiya Theripehe
Total land area of the sampled area	13 km^2	14.84 km^2	15 km^2
Length of the fence that covers the sampled area	3.75 km	1.5km	----

4.2.2 Herathgama Electric Fence Near Kahalla-Pallekele Sanctuary

Kahalla-Pallekele sanctuary is in the Northwestern region of the island. It spreads across three districts and is 21,690 hectares in size. It has sections in Palagala D.S. Division in Anuradhapura District, Polpithigama D.S. Division in Kurunegala District and Galewela D.S. Division in Matale District. The sanctuary's forest is one of the resting places for migrating elephant herds between Wilpattu and Sri Lanka's eastern forest. Hence, the villages around the reserve need continuous protection from seasonal elephant invasions and attacks.

The fence that was studied is located in Kurunegala District. It was constructed in the 2000-2001 period and is located along the Western boundary of the sanctuary. The fence extends about 33km from the Siyabalangamuwa reservoir to the Immihaminegama (Halmillewa) villages. It mainly protects the Polpithigama D.S. Division from attacks by a herd of approximately 30 to 40 elephants that live in the sanctuary. It specifically protects the Herathgama, Irrudeniyaya, Thibbatuwewa, Pothana, Koonwewa, Siyabalangamuwa, Pothuwila and Galahitiyawa areas (Figure 3).

The survey was conducted in villages close to the electric fence. Villages were selected based on information received from Department of Wildlife Conservation offices in the region. Villages outside the fence were selected for the control group. These villages were exposed to human elephant conflict at usual rates. Villages within 1,500 meters of the fence were considered to directly benefit from it. This 'treatment' group was further categorized as follows: (1) Villages closer to the northern end of the fence; (2) Villages in the middle area of the fence; (3) Villages at the southern end of the fence. The total number of households included in the sample for this fence was 58 (Table 3).

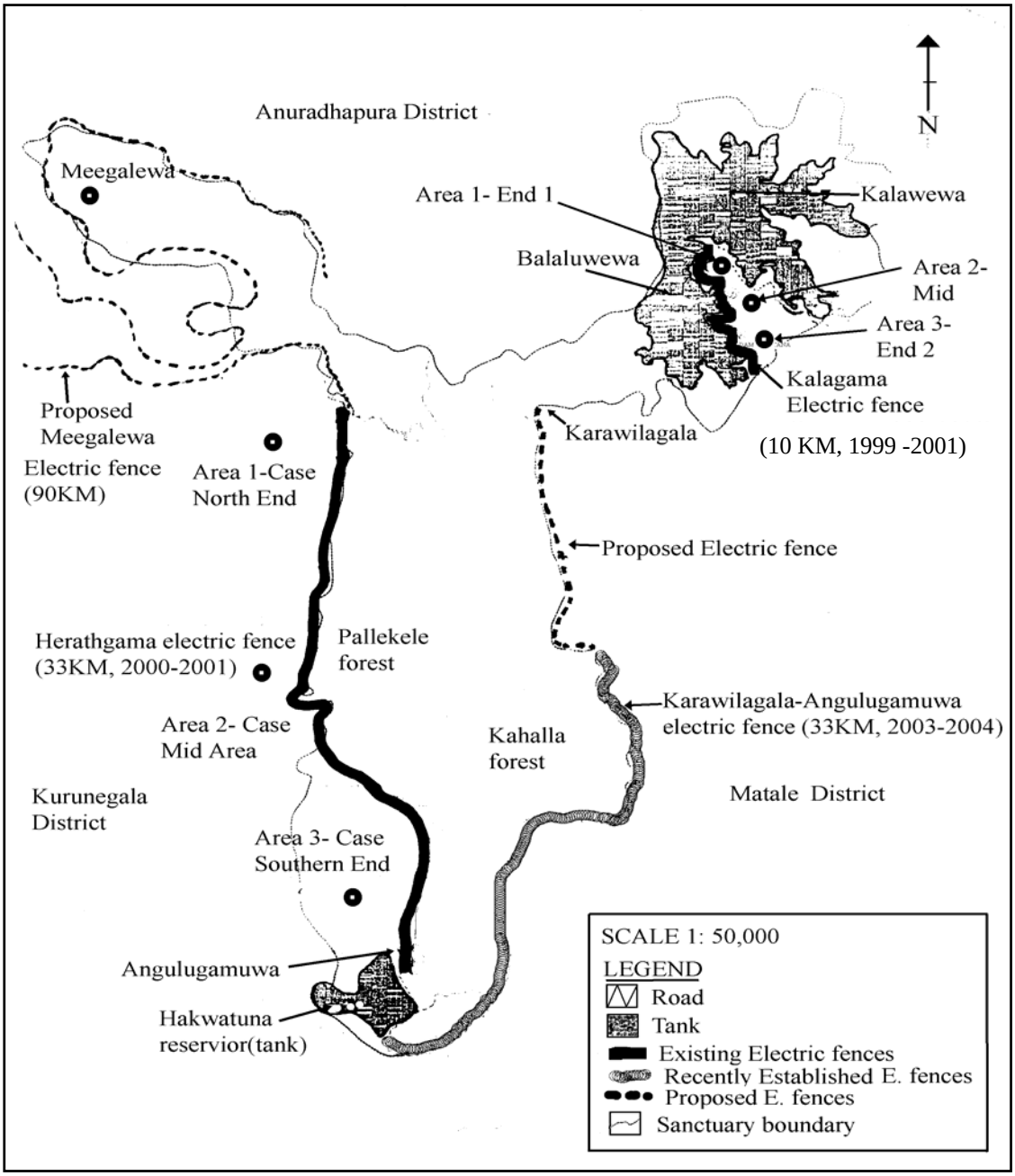

Figure 3. Map of Kakalla-Pallekele and Kalawewa-Balaluwewa Sanctuaries
(Source: DWLC Northwestern Regional office, Anuradhapura, 2003)

Table 3. Villages and Area Information: Kahalla-Pallekele Sanctuary - Herathgama Electric Fence

	Area 1	*Area 2*	*Area 3*	*Control*
Name of the village	Siyambalangamuwa Siyambelewa Hatangama (Galahitiyawa) (Thibbatuwewa)	Herathgama Pothuwila (Irudeniyaya) (Nikawewa)	Mahapitiya Bambaragalayaya Pansiyagama	Meegalewa Kalankuttiya Govigammanaya (Kankanigama) (Jayalanda)
Total land area of the sampled area	16.12 km^2	16.68 km^2	15.16 km^2	14.07 km^2
Length of the fence that covers the sampled area	7.5km	6km	6.75km	----

4.2.3 Electric Fence Around Mahaweli System G

Mahaweli System G is in the Elehera Divisional Secretariat Division, Polonnaruwa District in the North Central province of the island. The region is approximately 10,000ha in area. There are 28 Grama Niladari Divisions and nearly 10,000 families within System G.

The length of the fence around Mahaweli system G is 105km. It was constructed in 2000-2001 and farmer associations in the area are responsible for its maintenance. The fence is well maintained in tracks 24, 25 and 26 in the Bakamoona area. Maintenance work in tracks 27 and 28 is inadequate. Therefore, the effectiveness of the fence has been reduced in some places. The study was conducted in three areas, namely: Atthanakadawala-Seegala, Galmulla and Damanayaya. It covered 43 households (Figure 4).

Because the area is totally covered by the electric fence, the treatment and control situations were assessed based on before-fence and after-fence scenarios. The situation before the fence was constructed was considered as the control and the situation after the fence was constructed was the treatment. Given this approach, the same sample area was used for collecting data for both the before-fence and after-fence situations. For both the treatment and the control situations, villages were chosen that had experienced high, moderate and low levels of HEC before the fence was constructed (Table 4).

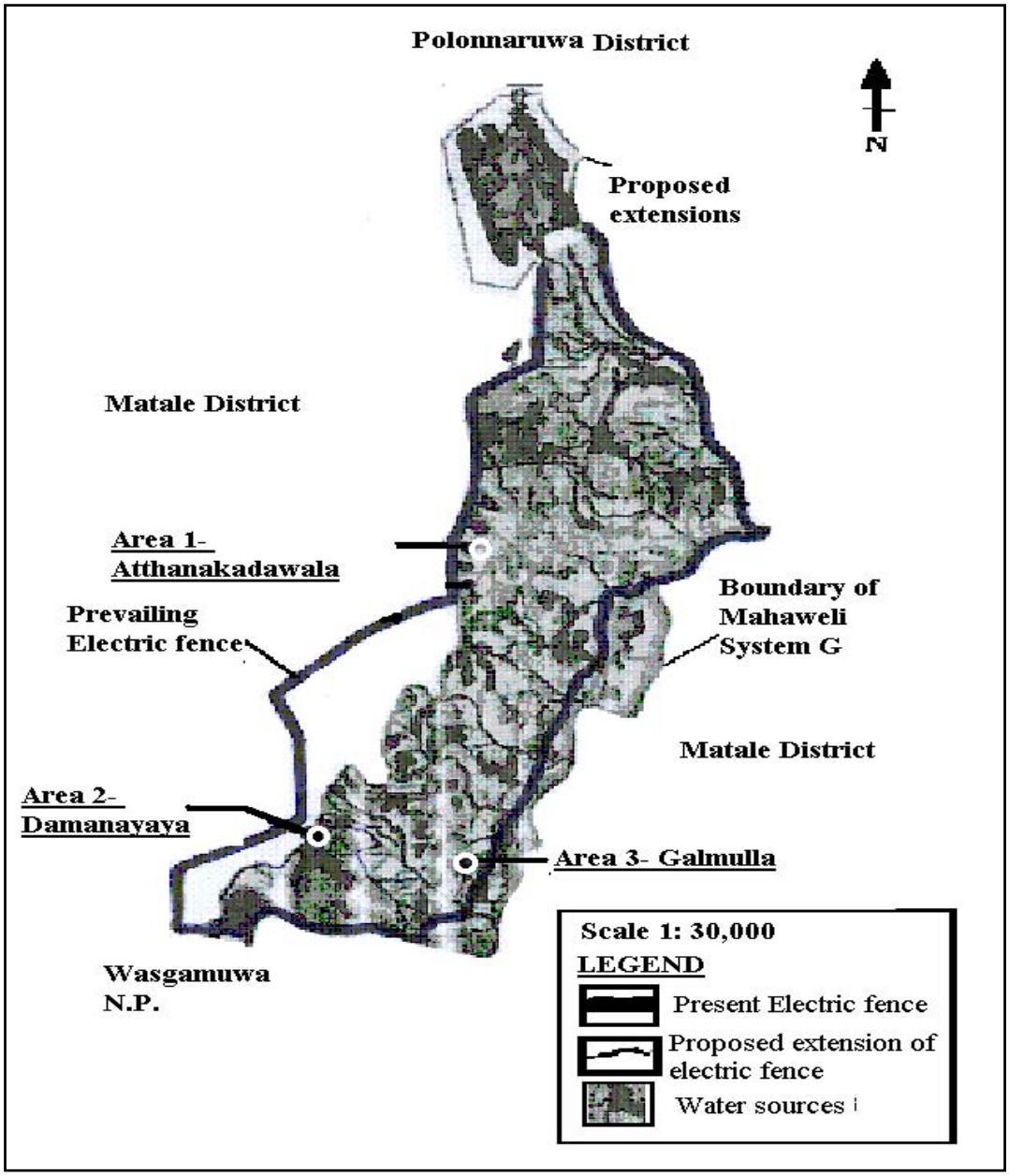

Figure 4. Map of Mahaweli System G
(Source: Regional Office, Mahaweli Development Authority, Bakamoona, 2002)

Table 4. Villages and Area Information: Mahaweli System G Electric Fence

	Area 1	*Area 2*	*Area 3*
Name of the village	Atthanakadawala Seegala	Galmulla	Damanayaya
Total land area of the sampled area	11.07 km^2	10.96 km^2	11.22 km^2
Length of the fence that covers the sampled area	3km	5km	3.5km

4.2.4 Kalagama Electric Fence at Balaluwewa-Kalawewa Sanctuary

This sanctuary makes up the catchment area of Kalawewa and Balaluwewa. The sanctuary and nearby settlements are located in the Anuradhapura District in the North Central Province. This area is considered as one of the most important places for elephants breeding in Sri Lanka. It is a transit area as well as a habitat for many (100-128) elephants.

The electric fence was established in 2001. It is located in the Palagala and Kekirawa D.S. Divisions of Anuradhapura District and is 22 kilometres in length. The fence runs from Konpolayagama to Undurawa along the boundary of Kalawewa-Balaluwewa sanctuary (Figure 5). The energizer is located at Dambewatana. The fence was established following requests from villagers in the region. More than 500 families benefit from the fence. However, the fence has been damaged in some areas as there was a dispute between villagers and the DWLC. This dispute occurred because the villagers' cultivation lands were acquired by the Department when it established the fence. At the time of the study the active fence only extended 10km and its coverage was therefore reduced.

The areas covered by the electric fence were divided into three groups based on their locations. These areas were classified as 'end 1', 'middle' and 'end 2'. The villages close to the fence area were frequently affected by HEC and therefore had low populations (Table 5).

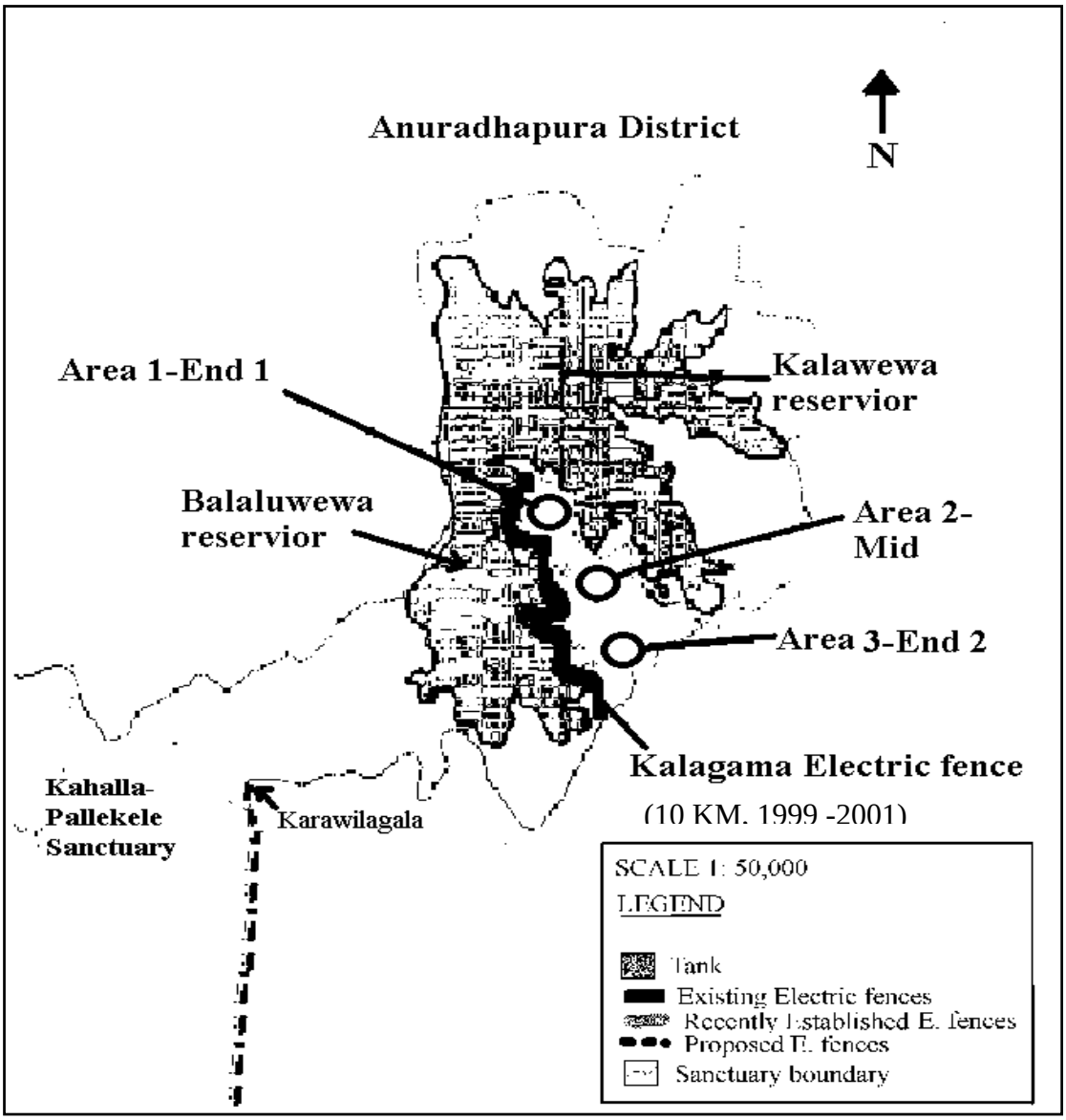

Figure 5. Map of Kalawewa-Balaluwewa Sanctuary
(Source: DWLC, Northwestern Regional office, Anuradhapura, 2003)

Table 5. Villages and Area Information: Kalagama Electric Fence

	Area 1	*Area 2*	*Area 3*	*Control*
Name of the village	Dambewatuna New Balaluwewa	Kalagama	Undurawa-North	Meegalewa Kalankuttiya Govigammanaya (Kankanigama) (Jayalanda)
Total land area of the sampled area	13.40km^2	12.66 km^2	12.91km^2	12.07 km^2
Length of the fence that covers the sampled area	2km	1.5km	1.75km	----

4.2.5 Electric Fence at Lunugamwehera National Park

Lunugamwehera National Park is located in the Hambantota district in the Southern region of the island. It is 23,499.77 hectares in area. There is thick forest cover, made up of hard-wood trees, in the boundary area where the park meets Block 5 of the adjacent Yala National Park. Lunugamvehera reservoir is located southwards of the Lunugamwehera Park and it takes up 3,282 hectares (Figure 6). Around 150 elephants have been recorded within the Lunugamwehera National park itself.

The electric fence is powered by three solar panels (one panel can provide energy for a 20-kilometers length). The DWLC examines the fence on a daily basis for failures, and maintenance work is carried out continuously. On certain occasions, elephants have damaged weak sections of the fence. Elephants have also knocked trees down on top of it. People have also damaged the fence when they take their cattle into the forest, or when they cut its wires to hunt wildlife.

The fence was established in a number of construction phases. Therefore, in some areas, it is not continuous. Starting from the Wilamba Wewa (a reservoir) bund close to the National Park, the fence extends 18km east. After a seven-kilometer gap, the fence continues in the direction of the Yala National Park. The fence also runs 12 kilometers west from the Wilamba Wewa reservoir to Devuram Wehera. The fence then runs north for about 14 kilometers.

As before, the study compared areas ‘with’ and ‘without’ electric fence protection. The villages for the treatment study were taken from the areas along the fence (Table 6 and Figure 6).

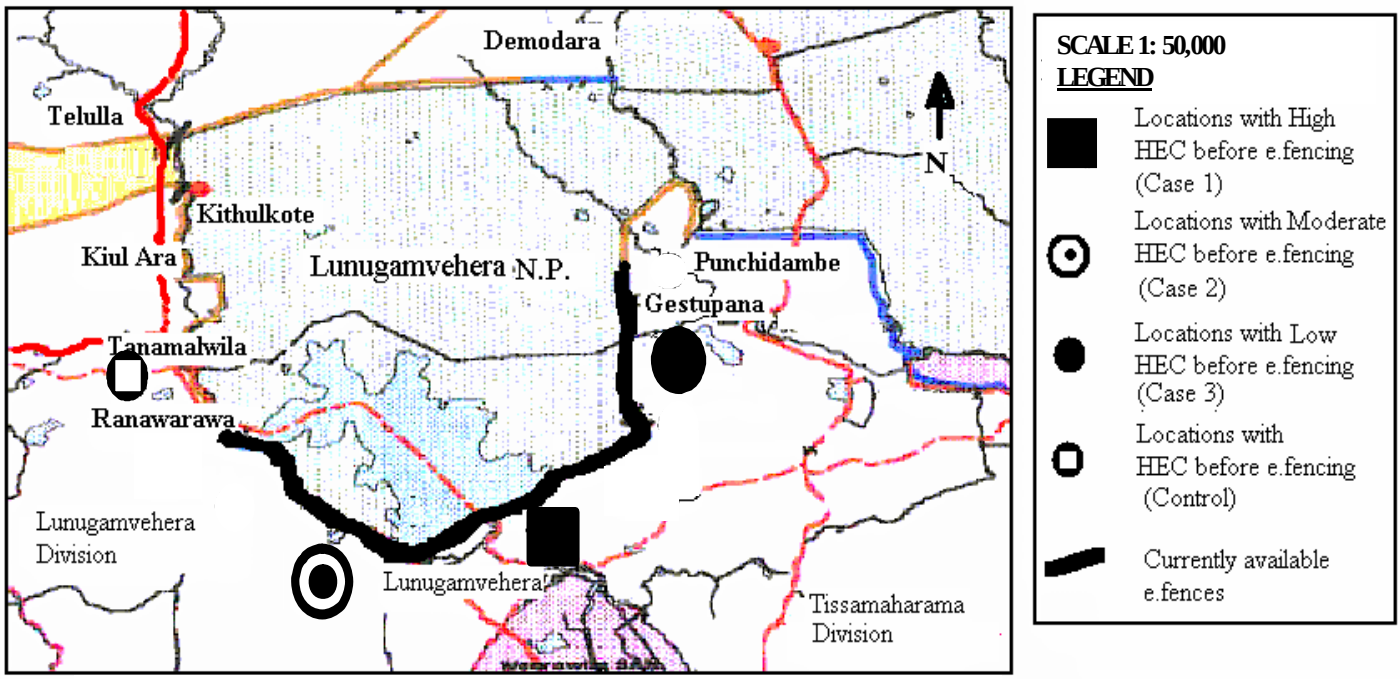

Figure 6. Map of Lunugamvehera National Park
(Source: GIS Unit, DWLC, 2003)

Table 6. Villages and Area Information: Lunugamvehera Electric Fence

	Area 1	*Area 2*	*Area 3*	*Control*
Name of the Village	Hunathuwewa Karawile Thammennawa	Punchiappujandura Boogahawewa Lunugamvehera	Gestupana Colony 1 Colony 2 Padikepuhela	Ranawarawa Kiulara Thanamalwila
Total land area of the sampled area	12.5 km^2	12 km^2	11.4 km^2	12 km^2
Length of the fence that covers the sampled area	3.75km	4km	1.5km	----

4.3 Questionnaire Construction and Interview Schedule

4.3.1 Primary Data Collection

A structured questionnaire was used for the household survey which was administered during the period November 2003 – March 2004. The questionnaire included the following sections:

- General household information.
- Land ownership.
- Behavioral pattern of the wild elephants before and after the electric fences were constructed.
- Number of incidents of crop and property damage, and the associated costs, before and after the electric fences were constructed.
- Number of injuries, and the associated costs, before and after the electric fences were constructed.
- Number of human deaths before and after the electric fences were constructed.
- Severity of the damages.
- Attitude of the villagers towards the electric fencing in the sample areas.

The questions were asked as an interview and the questionnaire was filled out by the researchers. The questionnaire was pre-tested several times before it was used. A copy of the questionnaire is given in Appendix 3.

Some of the information given by respondents was triangulated using information provided by key informants. Data collection from key informants in villages was done through informal discussions. Village level officers (*Grama Niladhari*), heads of farmers' associations, priests and village school principals were also interviewed.

Additional information was collected from several institutions in each of the study areas. This included data on the length of each electric fence, the date they were established, their expected life spans and the total number of wild-elephant-related incidents in each region during the previous few years. In sampling, the treatment and control areas were treated similarly, based on the information received from the respective Divisional Secretary offices.

During field visits, researchers were able to observe the existing electric fences, construction work on new fences and elephant-related damage to crops.

Collected information was entered into a computer database using MS Excel work sheets. Before data entry was begun, the data was processed and converted to a standard format.

4.3.2 Secondary Information

Relevant secondary information was collected from several government institutions and officials. The principal government agency responsible for elephant conservation, the DWLC, keeps records of HEC based on the number of human and elephant deaths and on the number of complaints received about crop or property damage. Information and secondary data on different elephant conservation options were obtained from DWLC offices at Minipe, Hasalaka, Keerthibandarapura, and Randenigala, Migalawa, Herathgama, Galgamuwa, Galkiriyagama, Anuradhapura, Mahaweli system G-RPM office, and from Divisional Secretariat offices at Bakamoona and the Mahaweli Information Centre, Kandy. Information collected from these sources also included: The total number of elephant-related incidences recorded during the past few years; information relating to existing HEC mitigating measures; and the total human population of areas and villages.

4.4 Indicators of Effectiveness

In this study, the following indicators were used to measure the effectiveness of electric fencing.

- The number of human lives saved per year.
- The number of human injuries reduced per year.
- Annual reduction in the incidence of property damage.
- Annual reduction in the incidence of coconut plant damage.
- Annual reduction in the incidence of damage to other perennial plants.
- Annual reduction in the incidence of damage to paddy lands.
- Annual reduction in the incidence of damage to other crops.
- Annual reduction in the incidence of damage to stored paddy.

5.0 RESULTS AND DISCUSSION

5.1 Socio-economic and Production Related Information in Treatment and Control Areas

As described in the Methodology section, treatment (with fence) and control (without fence) plots were selected in such a way that households in each area were homogeneous in terms of their socio-economic and land-related characteristics. Information on demographic and farm-specific variables was used to statistically establish this similarity. Tables 7 through 10 provide means and standard deviations together with t statistics for some of the variables considered. The information related to Mahaweli system G is not presented since the effectiveness calculation for this area was based on a 'before' and 'after' assessment.

Table 7. Comparison of Socio-economic and Production-related Variables: Kandeketiya Electric Fence Area in Victoria-Randenigala-Rantambe Sanctuary

Variable	*Mean*		*t-value*
	Control	*Treatment*	
Samurdhi beneficiaries % of recipients amount (SLR)	40% 450	41% 370	-0.37
Monthly income (SLR) farming non-farming	2100 900	2450 1100	1.15 0.56
% houses with galvanized, tiled or asbestos roofs	45	40	
% houses with cemented floors	40	38	
% houses with bricked or cemented walls	40	40	
% houses having electricity	27	23	
Household size	5.2	5.5	
Land Extent of upland farming (Ac.) Yala	1.35	1.27	-0.42
Land Extent of upland farming (Ac.) Maha	0.66	0.61	-0.23
Fully-owned upland holdings (Ac.)	0.31	0.63	2.29*
Fully-owned lowland holdings (Ac.)	0.21	0.36	1.4
State-owned upland holdings (Ac.)	1.10	0.53	-2.22*
State-owned lowland holdings (Ac.)	0.10	0.06	-0.55
Land extent of lowland cultivation (Ac.)-Yala	1.50	1.05	-1.71
Land extent of lowland cultivation-(Ac.)- Maha	0.70	0.59	-0.49

* Statistically significant at P = 0.05.

Table 8. Comparison of Socio-economic and Production-related Variables: Herathgama Fence Area in Kahalla-Pallekele

Variable	*Mean*		*t-value*
	Control	*Treatment*	
Samurdhi beneficiaries			
% of recipients	38%	40%	
amount (SLR)	360	370	0.23
Monthly income (SLR)			
farming	3,200	2,830	-0.36
non-farming	6,750	4,200	-1.04
% houses with galvanized, tiled or asbestos roofs	35	35	
% houses with cemented floors	37	37	
% houses with bricked or cemented walls	42	40	
% houses having electricity	35	33	
Household size	6.3	5.7	
Land extent of upland farming (Ac.) Yala	2.13	1.07	-1.44
Land extent of upland farming (Ac.) Maha	1.12	1.20	0.31
Fully-owned upland holdings (Ac.)	1.57	0.80	-2.92*
Fully-owned lowland holdings (Ac.)	1.45	1.02	-0.58
State-owned upland holdings (Ac.)	0.23	0.54	1.46
State-owned lowland holdings (Ac.)	9.52	0.22	-1.16
Extent of lowland cultivation (Ac.) Yala	1.91	0.95	-1.30
Extent of lowland cultivation (Ac.) Maha	1.91	0.95	-1.30

* Statistically significant at P = 0.05.

Table 9. Comparison of Socio-economic and Production-related Variables: Kalagama Electric Fence at Balaluwewa-Kalawewa Sanctuary

Variable	*Mean*		*t-value*
	Control	*Treatment*	
Samurdhi beneficiaries			
% of recipients	32	38	
amount (SLR)	365	370	0.46
Monthly income (SLR)			
farming	2215	2025	-1.30
non-farming	740	825	1.37
% houses with galvanized, tiled or asbestos roofs	32	35	
% houses with cemented floors	43	40	
% houses with bricked or cemented walls	32	28	
% houses having electricity	42	35	
Household size	6.7	6.1	
Land extent of upland farming (Ac.) Yala	1.15	0.94	-0.46
Land extent of upland farming (Ac.) Maha	1.12	1.56	1.11
Fully-owned upland holdings (Ac.)	1.57	0.67	-2.27*
Fully-owned lowland holdings (Ac.)	0.74	1.17	3.21*
State-owned upland holdings (Ac.)	0.43	0.47	0.86
State-owned lowland holdings (Ac.)	0.22	0.34	0.53
Extent of lowland cultivation (Ac.)Yala	0.62	0.50	-0.69
Extent of lowland cultivation (Ac.) Maha	1.25	1.23	-0.83

* Statistically significant at P = 0.05.

Table 10. Comparison of Socio-economic and Production-related Variables: Lunugamvehera Electric Fence

Variable	*Mean*		*t-value*
	Control	*Treatment*	
Samurdhi beneficiaries			
% of recipients	10%	11%	
amount (SLR)	300	310	0.23
Monthly income (SLR)			
farming	4105	3825	-1.37
non-farming	3210	2854	-1.14
% houses with galvanized, tiled or asbestos roofs	61	63	
% houses with cemented floors	56	57	
% houses with bricked or cemented walls	60	62	
% houses having electricity	37	34	
Household size	5.8	6.1	
Land extent of upland farming (Ac.) Yala	1.50	1.86	2.56*
Land extent of upland farming (Ac.) Maha	2.83	2.17	-1.04
Fully-owned upland holdings (Ac.)	0.80	0.74	-0.16
Fully-owned lowland holdings (Ac.)	0.63	0.24	-1.10
State-owned upland holdings (Ac.)	0.73	0.80	2.43*
State-owned lowland holdings (Ac.)	0.38	0.32	-0.23
Extent of lowland cultivation (Ac.)Yala	0.92	0.65	-0.79
Extent of lowland cultivation (Ac.) Maha	1.06	0.87	-0.70

* Statistically significant at P = 0.05.

The purpose of the comparison of the socioeconomic and production-related variables (Tables 7-10) was to establish the similarity of the treatment and control sites within each of the study areas. As shown in Table 7, in the Victoria-Randenigala-Rantambe study area, all study sites were statistically similar at P = 0.05, except in respect to the variable 'fully-owned upland holdings'. The same variable was statistically different (at P = 0.05) in the Balaluwewa-Kalawewa-Balaluwewa study area (Table 9). In the Kahalle-Pallekele study site, the variable 'fully-owned upland holdings' appeared to be different between the treatment and the control sites (Table 8). As shown in Table 11, no variables except for 'overall land extent in upland farming' and 'state-owned upland holdings' were statistically different in the Lunugamvehera study area. The analysis indicates that, overall, there was homogeneity – in terms of the considered socio-economic and production-related variables – between the treatment and control areas in each of the study sites. A cross comparison of the socioeconomic characteristics of the five study areas are presented in Tables 21 and 22.

5.2 Effectiveness of Electric Fencing

The five study areas were chosen as a representative cross-section of the ways in which electric fences have been implemented in Sri Lanka. The implementation strategies adopted within the sites ranged from fencing that partially protected wildlife sanctuaries to fencing that fully protected farmlands (Appendix 2). Within each of the sampled areas, the variability of the effectiveness of the fencing was estimated by collecting data from along different sections of the fence.

The number of elephant-related incidents in each of the sampled areas are given below in Tables 11–15. These show the details of conflicts reported from both non-fenced (control) areas and fenced areas (treatment). The information clearly indicates that electric fencing was not capable of completely mitigating HEC in all the study areas. However, when compared with the no-fence situation, fenced areas recorded fewer elephant-related incidences. This implies that electric fencing did make a contribution to mitigating HEC.

Table 11. Number of Elephant-related Incidents Occurring During a One-year Period (2003-2004) in the Sampled Area – Kandeketiya Electric Fence in Victoria-Randenigala-Rantambe Sanctuary

Treatment	*Number of Incidents*							
	Human Deaths	*Human Injuries*	*Property Damages*	*Plants destruction-Coconut*	*Plants destruction-Others*	*Crop Damages-Paddy*	*Crop Damages-Others*	*Damage to Stored Paddy*
Control (without fence)	01	02	10	25	18	08	02	06
Area 1 (with fence)	01	00	08	19	05	04	02	05
Area 2 (with fence)	00	01	03	03	02	02	02	04

Table 12. Number of Elephant-related Incidents Occurring During a One-year Period (2003-2004) – Herathgama Eectric Fences in Kahalla-Pallekele Sanctuary

Treatment	*Number of Incidents*							
	Human Deaths	*Human Injuries*	*Property Damages*	*Plants destruction-Coconut*	*Plants destruction-Others*	*Crop Damages-Paddy*	*Crop Damages-Others*	*Damage to Stored Paddy*
Control (without fence)	00	01	05	65	15	09	00	05
Area 1 Northern end (with fence)	00	00	04	23	02	03	01	00
Area 2 - Middle area (with fence)	00	00	03	16	01	02	02	02
Area 3 - Southern end (with fence)	00	00	02	33	12	07	06	00

Table 13. Number of Elephant-related Incidents Occurring During a One-year Period (2003-2004) - Electric Fence Around Mahaweli System G

Treatment	*Number of Incidents*							
	Human Deaths	*Human Injuries*	*Property Damages*	*Plants destruction-Coconut*	*Plants destruction-Others*	*Crop Damages-Paddy*	*Crop Damages-Others*	*Damage to Stored Paddy*
Area 1 Control (without fence)	00	00	03	135	30	04	01	00
Area 1 (with fence)	00	00	00	01	10	03	01	00
Area 2 Control (without fence	00	00	03	100	101	100	01	01
Area 2 (with fence)	00	00	00	32	35	05	00	00
Area 3 Control (without fence	02	00	03	21	04	25	24	04
Area 3 (with fence)	00	00	01	29	01	08	04	01

Table 14. Number of Elephant-related Incidents Occurring During a One-year Period (2003-2004) - Kalagama Electric Fence at Balaluwewa-Kalawewa Sanctuary

Treatment	*Number of Incidents*							
	Human Deaths	*Human Injuries*	*Property Damages*	*Plants destruction-Coconut*	*Plants destruction-Others*	*Crop Damages-Paddy*	*Crop Damages-Others*	*Damage to Stored Paddy*
Control (without fence)	01	00	03	20	24	50	32	02
Area 1- End I (with fence)	00	00	00	10	00	00	00	00
Area 2- Middle area(with fence)	00	00	00	02	00	02	00	01
Area 3- End II (with fence)	00	00	00	15	00	02	00	00

Table 15. Number of Elephant-related Incidents Occurring During a One-year Period (2003-2004) - Electric Fence at Lunugamwehera National Park

Treatment	*Number of Incidents*							
	Human Deaths	*Human Injuries*	*Property Damages*	*Plants destruction-Coconut*	*Plants destruction-Others*	*Crop Damages-Paddy*	*Crop Damages-Others*	*Damage to Stored Paddy*
Control (without fence)	00	01	02	43	52	58	47	00
Area 1 - earlier high HEC (with fence)	00	00	01	10	05	16	19	00
Area 2 – earlier moderate HEC (with fence)	00	00	02	13	17	10	11	00
Area 3 – earlier low HEC (with fence)	00	00	02	14	20	03	28	00

Note: area 1, area 2 and area 3 were high, moderate and low conflict areas, respectively, before the establishment of the fence.

In all cases, (Tables 11-15), the areas without an electric fence had experienced a higher level of elephant damage than the fenced areas. This indicates that fencing can help to mitigate HEC. However, fencing was not capable of completely eliminating the incidents of HEC as shown by Tables 11-15. In the Victoria-Randenigala-Rantambe site, the number of human deaths in sub-area 1 was similar to that of the control area. The number of incidents of property and crop damage was not substantially reduced in area 1, indicating that area 1 was vulnerable to elephant attack even with an electric fence.

A more successful situation was found in the other study areas. In the Kahalle-Pallekele study area, a low number of elephant-related incidents was reported for the fenced area, although there was some property damage and some destruction of coconut plants. The respondents indicated that, although the frequency (i.e. probability) of elephants visiting their area was extremely low, it was possible for a small herd of elephants to destroy coconut trees and small houses even in a single visit. The number of elephant-related incidents was quite low in Mahaweli system G compared with the situation before the area was fenced. However, plant destruction was recorded, especially the destruction of coconut trees. This was mainly due to occasional elephant herd visits during the dry season. The elephants entered the area through weak points in the fence. Similarly, coconut plant destruction was also found to be relatively high in the fenced study areas in Kahalle- Pallekele and Kalagama-Balaluwewa. This was due to similar reasons. In the Lunugamvehera study area, a high number of crop-related damages were recorded.

The effectiveness of electric fencing was measured using the indicators described in the methodology section. The effectiveness of electric fencing per unit area

of covered land and per kilometer-length of fence is presented in Tables 16-20. In the Victoria-Randenigala-Rantambe area the electric fence was more effective in preventing HEC in area 2 than in area 1 (Table 16). Key informants also said that area 2 had had a high level of HEC before the fence was constructed – again highlighting the fence's effectiveness.

The effectiveness of the electric fencing in Kahalle-Pallekele showed a high variability for all the indicators. However, though damage to coconut trees were high in fenced areas (Table 12), the effectiveness of the fence in relation to this variable (i.e. avoiding damages to the coconut plants) was high in all three sub sample areas. For the same reason, the effectiveness of electric fencing was relatively high in sub area 3 of the Mahaweli system G. There was no substantial variability in effectiveness across the sample areas protected by the Kalagama electric fence. In all these areas, the effectiveness of the fence in preventing damage to paddy areas was high compared to its effectiveness in preventing other types of damage. In Lunugamvehera, the effectiveness of electric fencing was high in sub area 3 for all the considered variables.

As shown by Tables 16-20, there was a wide variability in the effectiveness of fences across the study sites. The lowest levels of effectiveness was found in the Kahalle-Pallekele area. The electric fences in Victoria-Rantambe-Randenigala (area 2), Kalagama (area 2) and Lunugamvehera (area 3) were most effective at preventing human deaths or injuries.

Table 16. The Efectiveness of the Electric Fence in Reducing the Number of Elephant-related Incidents During a One-year Period (2003-2004) in the Sampled Area: Kandeketiya Electric Fence in Victoria-Randenigala-Rantambe Sanctuary

Indicator	*Area 1*		*Area 2*	
	Per unit area	*Per unit length of the fence*	*Per unit area*	*Per unit length of the fence*
Number of human lives saved	0	-	1	0.67
Number of human injuries reduced	2	0.53	1	0.67
Number of incidences of property damages reduced	2	0.53	7	4.60
Number of coconut plants saved	6	1.6	22	14.74
Number of other perennials plants saved	13	3.45	16	10.72
Number of incidences of damages to paddy lands reduced	4	1.07	6	6.42
Number of incidences of other crop damages reduced	0	-	0	-
Number of incidences to damages to stored paddy reduced	1	0.28	2	1.34

Table 17. The Effectiveness of the Electric Fence in Reducing the Number of Elephant-related Incidents During a One-year Period (2003-2004) in the Sampled Area: Herathgama Electric Fence in Kahalle-Pallekele Sanctuary

Indicator	*Area 1*		*Area 2*		*Area 3*	
	Per unit area	*Per unit length*	*Per unit area*	*Per unit length*	*Per unit area*	*Per unit length*
Number of human lives saved	-		-		-	
Number of human injuries reduced	1	0.13	1	0.16	1	0.15
Number of incidences of property damages reduced	1	0.13	2	0.32	3	0.45
Number of coconut plants saved	42	6	49	7.84	32	4.74
Number of other perennials plants saved	13	1.69	14	2.24	3	0.45
Number of incidences of damages to paddy lands reduced	6	0.78	7	1.12	2	0.30
Number of incidences of other crop damages reduced	-1	-0.13	-2	-0.32	-6	-0.90
Number of incidences to damages to stored paddy reduced	5	0.65	3	0.48	5	0.75

Table 18. The Effectiveness of the Electric Fence in Reducing the Number of Elephant-related Incidents During a One-year Period (2003-2004) in the Sampled Area: Mahaweli System G.

Indicator	*Area 1*		*Area 2*		*Area 3*	
	Per unit area	*Per unit length*	*Per unit area*	*Per unit length*	*Per unit area*	*Per unit length*
Number of human lives saved	0	-	0	-	2	0.57
Number of human injuries reduced	0	-	0	-	0	-
Number of incidences of property damages reduced	0	-	0	-	2	0.57
Number of coconut plants saved	134	44.6	68	13.6	-8	-2.28
Number of other perennials plants saved	20	6.67	66	13.2	3	1.71
Number of incidences of damages to paddy lands reduced	1	0.33	95	19	17	9.69
Number of incidences of other crop damages reduced	0	-	1	0.2	20	11.4
Number of incidences to damages to stored paddy reduced	0	-	1	0.2	3	1.71

Table 19. The Effectiveness of the Electric Fence in Reducing the Number of Elephant-related Incidents During a One-year Period (2003-2004) in the Sampled Area: Kalagama Electric Fence at Balaluwewa-Kalawewa Sanctuary.

Indicator	*Area 1*		*Area 2*		*Area 3*	
	Per unit area	*Per unit length*	*Per unit area*	*Per unit length*	*Per unit area*	*Per unit length*
Number of human lives saved	1	0.5	1	0.67	1	0.57
Number of human injuries reduced	0	-	0	-	0	
Number of incidences of property damages reduced	3	1.5	3	2.0	3	1.71
Number of coconut plants saved	10	5	2	1.34	5	2.85
Number of other perennials plants saved	24	12	24	16	24	13.68
Number of incidences of damages to paddy lands reduced	50	25	48	32	48	27.36
Number of incidences of other crop damages reduced	32	16	32	21.3	32	18.33
Number of incidences to damages to stored paddy reduced	2	1	1	0.67	2	1.14

Table 20. The Effectiveness of the Electric Fence in Reducing the Number of Elephant-related Incidents During a One-year Period (2003-2004) in the Sampled Area: Lunugamvehera Electric Fence

Indicator	*Area 1*		*Area 2*		*Area 3*	
	Per unit area	*Per unit length*	*Per unit area*	*Per unit length*	*Per unit area*	*Per unit length*
Number of human lives saved	0	-	0	-	0	-
Number of human injuries reduced	1	0.27	1	0.25	1	0.67
Number of incidences of property damages reduced	1	0.27	0	-	0	-
Number of coconut plants saved	33	8.8	30	7.5	29	19.43
Number of other perennials plants saved	47	12.69	35	8.75	32	21.44
Number of incidences of damages to paddy lands reduced	42	11.34	48	12	55	36.85
Number of incidences of other crop damages reduced	26	7.02	36	9	19	12.73
Number of incidences to damages to stored paddy reduced	0	-	0	-	0	-

The variability of the effectiveness of fencing among the study areas is partly attributed to contextual differences such as land use patterns, farming practices and geographical variations. This variation can be further attributed to the information provided in the Tables 21 and 22 that which describes the differences among the study areas. There were substantial differences in the five sample areas in terms of socioeconomic and other variables which may be reflected in the different levels of effectiveness.

As described in the section 4.1, the Victoria-Randenigala-Rantembe area consists of traditional villages, whereas Mahaweli system G and Lunugamvehera are newly-settled irrigation project areas. The other two areas, namely Kahalle-Pallekele (KP) and Kalawewa – Balaluwewa (KB), had a mixture of traditional villages and settled areas. As shown in the Tables 21 and 22, traditional villagers are normally purely subsistent farmers and most of them live below the poverty line. Commercial farming can be mostly found in new settlements. Farming experience also varied in the five areas. Residents in traditional villages had been farmers for generations. However, the proportion of full-time farmers was fairly high in all the sampled villages located close to the elephant ranges.

Household size and the education level of the respondents did not vary significantly. Farm size varied between the different areas. The abundance of tree crops also varied. This was mainly due to climatic variations and other geographical factors. Similarly, the crops grown in the two major cultivation seasons (i.e., Yala and Maha) were different due to water availability.

In respect to the effectiveness of the various electric fences, some of the salient features are worth a special mention. Of these, saving human lives receives the highest priority. Here effectiveness ranged from 0 to 0.7 implying that, in the effective areas, one kilometer of fence was able to save approximately one human life. The fences' effectiveness at reducing injuries ranged from 0.13 to 0.67. These human-related incidents could be attributed to peoples' activities such as the number of visits to nearby forests (Tables 21 and 22) or to prevailing levels of HEC in each area (Table 23). Similarly property damages ranged from 0 (Lunugamvehera) to 4.6 (VRR) which may be related to the availability of electricity and to the topography of the lands. The type of crops cultivated, cultivation seasons and herd characteristics (i.e. presence of aggressive male elephants) are some of the reasons that could explain the differences in effectiveness.

The information contained in Tables 11-20 indicates that one of the main intended purposes of the electric fences – the complete elimination of elephant attacks on people was not fully achieved. It was not possible to judge how effective the fences were in achieving their other main purpose – the reduction of the number of elephants killed by humans. This was impossible to judge since it was not possible to record elephant deaths and injuries due to human actions. However, DWLC records indicate that there has been no substantial reduction in the number of elephant deaths in the five study areas. This implies that electric fences make little or no impact on elephant conservation. Therefore, it can be concluded that electric fencing is not capable of eliminating HEC.

Of the socio-economic variables considered in Tables 21 and 22, some may have a direct influence on the effectiveness of electric fencing. People who rear cattle send their animals to the nearby forests. This deprives the elephants that are feeding within the forests. Therefore, elephants are compelled to visit farm fields. This, in turn, reduces the effectiveness of the fencing (as is the case in the Victoria-Randeigala-Rantembe area). Similarly, when local people are highly dependent on their local forest resource (for harvesting of non-timber forest products or visits for other purposes) then that has a similar negative effect on the effectiveness of an electric fence. Educated people in villages are less dependent on forests and also co-operate with wildlife officers to maintain fences. Education levels therefore positively influence the effectiveness of electric fences (as is the case in Mahaweli H region).

Table 21. Mean Values of the Household and Production Characteristics of Five Study Areas

Variable	*VRR*	*Kahalle-Pallekele*	*Mahaweli System G*	*Kalagama Balauluwewa*	*Lunugamvehera*
Age of the respondent (years)	48	40	42	40	39
Education level of the respondent (years in school)	04	07	10	08	09
Farming experience of the respondent (years)	33	28	18	31	17
Household size	5.5	5.7	5.5	6.1	6.1
% full time farmers	92%	95%	100%	100%	100%
Farm income (SLR)	2,450	2,830	8,200	2,025	3,825
Off-farm income (SLR)	1,100	4,200	4,123	825	2,854
Land extent of upland farming (Yala)	1.27	1.06	0.5	0.94	1.50
Land extent of upland farming (Maha)	0.60	1.20	0.5	1.56	2.83
Land extent of lowland farming (Yala)	1.05	0.95	1.8	0.70	1.86
Land extent of lowland farming (Maha)	0.58	0.95	2.5	0.70	2.17
Major field crops grown (Yala)	Rice Tobacco	Rice Chillies Onions Maize	Rice Chillies Onions	Chillies Maize	Vegetables Onions Maize
Major field crops grown (Maha)	Rice Millet	Rice	Rice	Rice	Rice

Table 22. (Table 21 cont). Mean Values of the Household and Production Characteristics of Five Study Areas

	VRR	*Kahalle-Pallekele*	*Mahaweli System G*	*Kalagama Balauluwewa*	*Lunugamvehera*
Major tree crops grown in uplands	Coffee Jack Coconut	Coconut Jack Mango	Neem Coconut	Neem Coconut Mango	Coconut Jack
% people who rear cattle	70%	33%	10%	28%	42%
% people who depend on nearby forest for firewood	90%	92%	42%	67%	48%
No. of visits to nearby forest per week	7	6	0.3	4	1

Note: In preparing this summary table, only the data related to the treatment area were used.

Table 23. Reported HEC Incidences in Different Wildlife Regions in Sri Lanka (2004)

Variable	*North-Western*	*Southern*	*Mahaweli*
Number of Elephant Deaths	37	28	32
Number of Human Deaths	25	5	12
Number of Human Injuries	5	1	7
Crop damages- Number of Incidences*	606	69	Not available
Property damages- Number of Incidences*	91	78	Not available

*Note: Approximate values
(Source: DWLC, No Proper records available for the Central region)

In general the study reveals that the success of electric fences in combating HEC is determined by two broad categories of factors, namely technical factors (related to fence design and administration) and socio-economic factors (related to the stakeholders in the conflict).

5.3 Technical Factors that Affect the Effectiveness of Electric Fencing

The study revealed that there are a number of factors that are either related to fence design or overall governance which influence the success of a fence.

5.3.1 Inability of Government Bodies to Maintain the Rules and Regulations

The purpose of electric fencing is to physically separate the two parties in the HEC situation; this sometimes requires the translocation of one party in a particular area from designated human or elephant habitats. It was found that, in some villages, people initially agreed to move from a sanctuary area but later resisted leaving. The information relating to the Victoria-Randenigala-Rantambe (VRR) sanctuary indicates that it was the inability of government bodies to maintain the rules relating to the

translocation of people that contributed to the increasing number of HEC incidents in this area.

As shown in Table 2, the effectiveness of the Kandeketiya electric fence near to the Victoria-Randenigala-Rantambe Sanctuary appeared to be low, especially in areas that had had previously high levels of HEC. The observations, informal interviews and data obtained from the Victoria-Randenigala-Rantambe area indicated that almost 100% of the major elephant damage was suffered by people who had agreed to move from their lands when Victoria-Randenigala-Rantambe was declared a sanctuary in 1989. It is clear that people who are now in the HEC area at Victoria-Randenigala-Rantambe were reluctant to move and therefore stayed. They were reluctant for a number of reasons such as: fear of taking on new challenges in settlement areas; fear of the collapse of their sustainable traditional life style; reluctance to leave relatives; and misgivings about dry weather in the settlement areas. When the fence was established, the organisation responsible for resettlement was the Mahaweli Development Authority (MDA). These responsibilities were then handed over to the DWLC. The MDA no longer operates in the area and the DWLC have not carried out any follow-up activities to enforce translocation. Unfortunately, the electric fencing that covers a part of this particular sanctuary will only be successful if the translocation of people from the designated elephant habitats is completed. This situation illustrates the lack of co-ordination between government bodies and their inability to maintain follow-up activities. There is also the problem that protective legal measures have been weakened. This could escalate the human-elephant conflict.

5.3.2 Incomplete Coverage by the Fence

The electric fences in this study demonstrated two different approaches in relation to their coverage. The first approach is the one that is used on the fences that were established earliest. This strategy involves fully or partially enclosing elephant habitats so that the elephants cannot intrude into the surrounding farmland. This also makes it difficult for villagers to enter into the elephants' forests. This approach can be found in Victoria-Randenigala-Rantambe and Kahalla-Pallekele. These national parks or sanctuaries are awkwardly shaped with difficult terrains. This means that, in practice, complete coverage was not often achieved, mainly due to budgetary limitations. For example, in the Victoria-Randenigala-Rantambe area, the fence only covers the areas where HEC was most intense. Where there is a gap in fence coverage, elephants can move in search of food and water during dry periods. In these locations people can also move into the forest, however, the DWLC can partially protect elephant territories from human encroachment by policing park boundaries.

The second approach, which has been promoted recently by policy makers, is to fence around human settlements. The fence at Mahaweli system G surrounds a settlement area and protects its inhabitants from invading elephants from the nearby forests (Figure 6). This settlement area is completely covered by the fence and any HEC incidents occur mainly due to fence breakages. The number of such incidents in the sampled areas is fairly low. No records on human deaths or injuries were found except in area 3. This area is much closer to the Wasgomuwa forest reserve and there may have been frequent attacks before the fence was established. The destruction of plants by elephants was found to be fairly common, even after the fence was put up (Table 13). This may be due to weak points along the fence.

Which ever approach was taken, it is clear that building a fence that provides complete coverage is very difficult. This is mainly due to the complexity of the HEC challenge (i.e. merging of forests and villages) and financial limitations. This means that in most of the study areas, the fences are incomplete and only cover the really intense conflict areas.

5.3.3 Ignorance of Geographical and Other Variations in Establishing

It was found that the electric fences typically needed some modifications in the way in which they were implemented. Those modifications included the addition of new sections, the continuation of fences so that they properly covered conflict area, and the use of sufficient and appropriate installation equipment. These kinds of improvements are needed along the Kandeketiya electric fence at Victoria-Randenigala-Rantembe. People in this area perceived that the fence was less effective than it should be. This was because the fence ends at the Umaoya (a stream) and does not have sufficient length to prevent elephant invasions. To stop these invasions, the river (along which elephants walk and enter into the protected area) need to be fenced with modern techniques like floating fences. People in the Victoria-Randenigala-Rantembe area pointed out that the fence had been erected along improper lines and that this was another cause of weakness. The area has a predominantly hilly topographies and the fence is located along the side of the mountains. This type of location leads to frequent elephant damage.

A similar situation was found in the Kalawewa-Balaluwewa area. Some parts of the Kalagama fence have been extended leaving paddy lands inside the forest. This means that local people have a negative perception about the fence. People located near the middle part of the fence said that they did not participate in maintenance work because they suffer huge losses on account of the electric fence. This lack of maintenance results in the failure of the fence in this area. Sixty percent of people in the area accepted that electric fencing represented a solution to HEC, but that the present fence was too compromised a design and therefore should be improved.

5.3.4 Ignorance of Water and Feed Availability to the Elephants

A lack of food and water is one of the key factors that induces elephant depredation. Wet-zone forests (e.g. Victoria-Randenigala-Rantambe) have lush green vegetation and water throughout the year but the situation is opposite in dry areas such as Kahalle- Pallekele, Mahaweli System G and Balaluwewa-Kalawewa-Balaluwewa. In the Kahalle-Pallekele area water is scarce during the Yala season (April to September). This means that most of the rain-fed farmers cultivate crops other than paddy. Elephant raiding is usually high in the latter part of this season and this can, in turn, lead to high levels of crop damage (Table 12). This indicates that without proper habitat-enrichment programmes, the existing fences will continue to be damaged by free-ranging elephants.

Water bodies need to be shared between people and wildlife (including elephants). However, it was found that some communities felt that they should be entitled to a greater share of the available water resources. For example, in Lunugamvehera and in some places in the Herathgama fenced areas, farmers have fought successfully for more water bodies to be fenced into their areas. This has meant that elephants face a shortage of water and that, in dry seasons, break the fences to get a drink.

Another fact that influences the overall success of electric fencing is the elephant's migratory behaviour. For example, the Kahalla-Pallekele area is important as a migration route for elephants between the Wilpattu National Park on the northwestern side of the country to forests in the eastern and north central parts of the country. Electric fencing is successful only if such traditional elephant migration corridors are maintained. This can be done by analyzing the geography of an area before establishing a fence.

5.3.5 Flaws in Strength and Other Designing Aspects

The strength of the electric fences was another factor that affected the level of satisfaction that people felt for electric fencing. This was because enraged elephants usually try to break fence or poles if they are weak. It was found that, in some places, the effectiveness of electric fences had been reduced due to weak concrete posts. These were not of sufficient strength because they had not been made according to set standards. This situation was experienced by the people in Lunugamwehera. Concrete posts also need to have a sufficient depth under ground so that they are firm enough – this was not the case in some areas.

A lack of attention to the design of the fences in some areas was also considered as a key reason for their ineffectiveness. According to many respondents, this was due to poor planning. There are also other design aspects to be considered. For example, in some electric fences, such as Kalagama, Lunugamvehera, strengthening iron bars have not been fitted. In some cases, such as Mahaweli System G, the number of power supplying units is not sufficient. Therefore the proper design of electric fences has to be considered to be of prime importance.

5.4 Socio-economic Factors that Influence the Effectiveness of Electric Fencing

Though there are a number of traditional or cultural HEC mitigation options available, electric fencing has taken precedence during the past few years – as shown by the increasing number of established fences. Given the fact that fencing is not 100% effective (see previous section), in some situations people still prefer alternative solutions in high conflict areas. In other words, although electric fences are prominent in HEC areas, their social acceptance appears to be highly contextual. This is because an electric fence physically separates forests and villages. In rural villages, people have maintained links with nearby forest areas for generations. They are used to sending their livestock into the forests. They are also used to visiting forests to collect firewood and other non-timber products and are often involved in other forest-based activities such as sand collecting, illegal cultivation practices, illegal logging and illegal brewing etc. Given these traditional links, a fence may psychologically, as well as socially, affect the villagers it separates from their surrounding forests. Therefore, in evaluating the overall success of electric fencing, it is important to consider people's perceptions about their effectiveness. Tables 24 and 25 show that respondents' willingness to be separated from surrounding forests by a physical barrier and their perceptions of the success of the 'electric fence' approach. People in the HEC conflict areas do not perceive electric fencing as highly effective and a substantial fraction (16% - 33%) gave fencing a low satisfaction rating.

Table 24. People's Perception on Separation of Villages and the Forest by an Electric Fence

Response	*VRR*	*Kahalla-Pallekele*	*System G*	*Kalagama*	*Lunugam--vehera*
Willingness to be separated by an electric fence	44.20%	38.89%	81.60%	60.00%	62.43%

Table 25. People's Perception on Success Rate

Study area	*High*	*Moderate*	*Low*
Victoria-Randenigala-Rantembe VRR	21.74	47.82	30.43
Kahalla Pallekele	48.65	35.13	16.21
Mahaweli System G	39.53	37.21	23.26
Kalagama	33.33	33.33	33.33
Lunugamvehera	38.88	44.44	16.66

According to local people, electric fences have a number of weaknesses with respect to effective functioning. The factors that lead to this low satisfaction rating are discussed below.

5.4.1 Inadequate Community Support to Maintain the Fence

Another factor that is crucial to the effectiveness of an electric fence is its after care and maintenance. This fact was quite evident in one of the study area, Mahaweli H. As this area is completely fenced, one should not expect any elephant-related incidents to be reported here – however, this was not the case. The effective length of the fence in the study site was 1.5 km and observations revealed that there were points along this section of the fence that were partly damaged (in area 3). This led to elephant breakthroughs.

Community support for a fence is key if it is to be well maintained. Given the information received from key informants and the DWLC officials, it was clear that the level of community support for the fences under study was determined by a number of factors:

- Activities of community-based organizations and farmer organizations.
- The distance from farm fields or homes to the fence.
- The level of risk perceived by the villagers. (It is obvious that the level of risk is low in the electric fencing).
- The community's nvolvement in farming (i.e. full time or part time).

Community participation in the construction and maintenance of the fences under study is given in Table 26. This shows that communities participate less in fence

maintenance than in fence construction. The study covered fences with different ages. These ranged from one to 15 years. In practice, fences were established mainly due to escalating levels of HEC. It is clear that when the fences were new, peoples' interest was highest. It is also obvious that their enthusiasm and interest declines over time and that their involvement in fence maintenance therefore declines as well. This is shown in changes in the effectiveness of the Kalagama electric fence at the Balaluwewa-Kalawewa sanctuary. The fence's effectiveness was high in its first year and relatively low during the study period. It is clear that this is due to poor maintenance, since evidence of coconut plant destruction indicates that elephants enter into villages through weak points in the fence (Table 14).

Table 26. Community Support for Construction and Maintenance in Fenced Areas

Study area	*Labour*		*Material*		*No participation*	
	Const.	*Maint.*	*Const.*	*Maint.*	*Const.*	*Maint.*
VRR	47.82	60.87	39.13	17.39	13.04	21.74
Kahalla Pallekele	86.48	45.94	10.81	29.73	2.71	24.32
System G	95.35	44.18	4.65	34.88	0.00	20.93
Kalagama	77.78	11.11	22.22	44.44	0.00	44.44
Lunugamvehera	55.56	27.78	19.44	16.66	25.00	55.56

The researchers inspected the condition of each of the sampled fences. The condition of fence wire and posts was assessed, as were the continuity of fence power supplies and the effectiveness of weed clearance. The condition of each of the fences was then grouped as either 'moderately satisfactory' or 'not satisfactory'.

The researchers also gauged the overall functioning of community-based organizations or farmers' groups. Their performance was judged as either satisfactory or not. This assessment was based on the activities the groups had carried out and the number of meetings they had held during last six months.The information for the 14 sampled fence areas was arranged in a 2x2 table (Table 27) and analysed. A contingency table analysis (based on χ^2 analysis), computed a value of 8.54 at degrees of freedom 1 and P = 0.05. This shows that, in the study areas, there is an association between how well community-based organizations are functioning and the condition of the electric fences. This implies that the proper functioning of a local community-based organization is one of the key factors that determines the success of an electric fence.

Table 27. Relationship between Fence Conditions and Community-based Organizations

Condition of the fence	*Functioning of community based organization*	
	Satisfactory	*Not satisfactory*
Satisfactory	9	1
Not satisfactory	1	3

5.4.2 Financial Limitations to Meet the Maintenance Costs

Another reason for the poor perception local people have of electric fencing is that less and less government fund has been allocated for fence maintenance. There is no specifically established fund to meet the after care/maintenance expenses of electric fences. Given the prevailing high poverty in the study areas, people were not willing to contribute to maintenance work or for purchasing supplies such as a new solar battery for an electric fence power unit. This situation was found in Mahaweli System G, where people complained about the inefficiency of government (i.e. DWLC) officers. According to their point of view, government officers were not efficient in the way they replaced damaged parts of the electric fence. However, people's perception of the protection provided by the electric fence in this area is high (81.60%). They realized that HEC would be much worse if the fence is not available. This is because their area was a elephant habitat before it was converted to the Mahaweli settlement in 1984. As shown in Table 27, most of the sample respondents lived in close proximity to the fence, so that its proper maintenance is key for the protection of their crops and properties.

5.4.3 Inaccessibility to Forests

Another factor that influences the social acceptance of electric fencing is the fact that the fences can make nearby forests inaccessible to villagers. When establishing fences, the DWLC always attempts to protect wildlife reserves by establishing fences around their boundaries. In general, farming community in such areas were used to invading nearby forest reserves to carry out shifting cultivation. In some cases, farmers complained that land in their villages was acquired to build electric fences. Some of this was paddy land or well-established upland cultivation areas; although these areas may actually belong to the government they had been 'colonised' by people long ago. This kind of acquisition happened in the Undurawa area close to the Kalawewa Balaluwea sanctuary. However, according to the perception of farmers in this area, electric fencing can be an effective and valuable HEC mitigation measure. They felt that the effectiveness of the fence in their area was compromised due to poor routing, the fact that insufficient consideration had been taken of people's behavior and the way in which they interacted with the forest. In particular, traditional communities have been neglected or ill treated by the authorities when land acquisition is done for fencing. Table 28 shows the details of respondents' proximity to the forest.

Table 28. Proximity to the Fence (in percentages)

Study area	*Close location*	*500-1000m*	*More than 1000m*
Victoria-Randenigala-Rantembe	44	52	4
Kahalla Pallekele	54	35	11
Mahaweli System G	81	16	2
Kalagama	44	56	0
Lunugamvehera	50	47	3

A reasonable fraction of the sampled population expressed their willingness to coexist with certain mitigating measures. The response was quite high with electric fencing compared to other options (Table 29).

Table 29. Acceptance of Coexistence by the People in Fenced Areas

Study area	*Acceptance of options(Percentage)*				
	Electric fence	*Transloca--tion*	*Elephant drives*	*Relocation*	*Other*
Victoria-Randenigala-Rantembe	42.52	18.39	9.19	16.09	13.80
Kahalla Pallekele	50.00	26.19	2.38	7.14	14.28
Mahaweli System G	80.00	13.33	0.00	0.00	6.67
Kalagama	50.00	14.28	14.28	0.00	21.42
Lunugamvehera	43.86	21.05	21.05	3.51	10.53

5.4.4 Lack of Technical Know-how on Fencing Equipment

Peoples's perceptions of electric fencing are low in some areas, because those involved in fence maintenance have not had sufficient training. This situation can be improved by providing training and awareness for responsible community groups. Those who have been trained also need to be given authority to take decisions on electric-fence-related issues.

According to communities involved in fence maintenance work, one of the key issues relating to the work is a lack of long-term monitoring and coordination. Community participation is much higher at the initial stages of fence implementation. This is because the community has prioritized HEC in their area as a key issue that must be solved quickly. However, over time participation levels reduce and consequently the maintenance works fails (Table 26).

5.4.5 Disputes between Settlers and Non-settlers

The perception of the success of electric fencing was quite different between early settlers (or traditional villagers) and new settlers. As discussed in the previous section, early settlers believe that fencing initiatives are biased towards the new settlers. Also, they say that there used to be coexistence between humans and elephants and that this deteriorated mainly due to new settlements. For example, in the Kalawewa-Balaluwewa sanctuary area, the early settlers perceived that the electric fence has not given them any significant benefits. Instead, they felt that it had led to the loss of their paddy lands. The fence also stopped them from accessing the forest to meet their requirements for cattle feeding, firewood collection and other income-related uses. This situation was exacerbated by a dispute between the community and the DWLC related to land acquisition. This has meant that there has been limited support for the fence at Kalagama by early settlers (or traditional villagers).

Table 30. Details on Settlers and Non-settlers in Study Areas

Study area	*Lived in area for generations*		*Recent settlers*	
	Control	*Treatment*	*Control*	*Treatment*
Victoria-Randenigala-Rantembe	100	100	0	0
Kahalla Pallekele	62	75	38	25
Mahaweli System G	14	14	86	86
Kalagama	38	33	62	67
Lunugamvehera	8	5	92	95

In newly-settled areas, the community's perception of elephant conservation and human elephant coexistence was totally different from that of traditional villagers (Table 30). In most parts of these settlements, fences were satisfactorily maintained and in some areas there were gates to access forestlands. These new communities did not have any experience with elephants before they settled about two decades ago. They mainly view elephants as pests and detrimental to their commercial agricultural activities. Instead of using traditional methods to chase elephants away they depend on government support (i.e. establishing and maintaining electric fences). They appreciated the fencing as a protective measure and blamed the early settlers for not maintaining their portions of the fences (which caused elephant invasions into their areas). In some cases, people involved in commercial cultivation were not reluctant to kill elephants by poisoning or shooting. In Mahaweli system G area where 100% of the people were settlers, it was felt that a fence was the best solution to the HEC problem. This was suggested by the majority of respondents (81.60%).

Table 31 summarizes the factors that affect the level of success of electric fencing.

Table 31. Factors Iinfluencing Success and Failures of Electric Fencing

Factor	*Impact*
Coverage of the fence	
Partially cover the forest (e.g. Mahaweli G)	Negative
Partially cover the farmland (e.g.Victoria-Randenigala-Rantembe)	Negative
Technical and designing aspects	
Ignorance of elephant migratory routes	Negative
Technical aspects to suit special conditions (e.g. Rivers)	Negative
Strength of the post	Positive
Coverage of the post by wires	Positive
Role of Government organizations	
Inability to maintain the regulations	Negative
Inefficiency in making compensation payments	Negative
Inability to consider the farmers' problems (e.g. Poverty)	Negative
Contacts with community base organizations	Positive
Need assessment and proper planning	Positive
Community support	
Proper functioning of community based organizations	Positive
Good relationship among organizations	Positive
Maintenance of the fence	Positive
Financial limitations to buy batteries	Negative
Perception and attitudinal factors of the stakeholders	
Level risk	Positive
Disputes between settlers and non-settlers	Negative
Forest links	
Dependence for nontimber products	Negative
Illegal activities	Negative
Encroachments	Negative
Habitat enrichment	Positive
Use of other mitigation measures	
Biofencing	Positive
Use of bombs/firecrackers	Positive
Translocation of aggressive elephants	Positive

6.0 CONCLUSIONS AND RECOMMENDATIONS

The conflict between farmers and wild elephants, which has escalated during the past five decades, is now becoming a major social as well as a political issue in Sri Lanka. The conflict is mainly due to the fragmentation and degradation of elephant habitats as a result of large development projects which ill-treated wildlife and biodiversity conservation. There was a 50 percent loss of the forest cover during the last 50 years and, with the increasing rural population and scarcity of arable lands, the problem will become more intense in the future. Given the fact that most of the wild elephants live outside park areas, mitigating the conflict is viewed as the best way of conserving endangered elephants in Sri Lanka (Fernando, et al, 2003).

With the increasing intensity of the conflict, the traditional methods of controlling elephant attacks may no longer be effective in most situations. Establishing a physical barrier - electric fencing - is considered as the most effective solution and during the last decade a substantial amount of money has been invested in this approach. This study assessed the effectiveness of electric fencing to answer the question of whether electric fencing is capable of protecting elephants as well as meeting the needs of local residents involved in the conflict.

Based on a survey that covered all types of electric fences in Sri Lanka, the study found that, although electric fencing makes a positive contribution to mitigating the conflict, the intended benefits were not being fully achieved.

The major policy implication of the study is related to the questions of why electric fencing fails and what the factors are that influence its success. Ad hoc decisions and improper planning which ignore the needs of stakeholders in the conflict have contributed significantly to the failure of this approach. For example, in establishing some of the fences in the study, the elephants' breeding behavior and migratory pattern were not considered. De Silva (1998) also agrees with this argument and states that most of the actions taken to mitigate HEC are ad hoc and transient in nature.

The underlying assumption of fencing around parks is that wild elephants should live in designated areas (i.e. park areas). However, given their huge food and water requirements (approx. 150 kg per day. There are about 100 spp that are edible to elephants. Elephants eat 17 hours per day), migratory behavior, long life spans and the limited carrying capacity of their forest homes, it is inevitable that free-ranging elephants raid crop fields.

This indicates that the establishment of electric fencing should be linked with a comprehensive land use planning exercise where elephant habitats (i.e. park areas) should be grouped and interconnected via elephant corridors. The habitat should then be enriched and fenced. Therefore, electric fencing should not be seen as a medium-term solution but as an integral part of a long-term solution package.

As presented in the results section, getting the design of fencing right is also important if it is to be successful. Such design should take into account the geographical

location, and water and land resource availability. The results showed that poor electric fence design, coverage and layout led to the HEC conflict escalating in other areas.

The study clearly indicates that the roles and responsibilities of the respective government bodies influence the success of electric fencing. These functions include the translocation of elephants or people from designated habitats, the implementation of regulations and the monitoring of established fences. As shown in the Victoria-Randenigala-Rantembe case, a lethargic and inefficient government system has contributed to fence failures.

Most of the technical failures are found with early-established fences and are due to incorrect spacing and placement of wires, frequent drops in power and some problems with support posts. In some cases, it was observed that the points and locations through which elephant often moved were not properly covered. The other technical factors that determine the success of electric fencing are: ignorance of the geographical variation and water and food availability in reserves; the provision of coverage only in reported high-conflict areas; and the inability to obtain community support for fence maintenance. Among the layout problems, the one that most influenced success was whether the fence provided full coverage or partial coverage. Elephants find alternative routes around incomplete fences, especially when there are no natural barriers. In some cases, it was found that electric fencing had split elephant populations and that the remaining elephants raided more often than before the split. Another important observations is that some people thought that electric fencing is a 'last solution'. This meant that they were not interested in using any other barriers, such as bio-fences, to support the electric fence.

The level of success of electric fencing is influenced by a number of social factors. An investigation of people's acceptance and perceptions of electric fencing is also important as fencing segregates people from forests, and this is often not taken into account by policy makers. Indeed, they often jump to the conclusion that electric fences are the best solution without considering other factors. Some of the factors that influence social acceptance (i.e. negligence of the geographical aspects and limited fund availability) are related to the technical factors identified earlier.

The findings of the study imply that a thorough pre-assessment is needed before a fence is established. Attention should be paid to present land use patterns, degrees of habitat fragmentation, elephant behaviour (population size, migratory patterns etc.) in nearby reserves or sanctuaries, and peoples' perception of electric fencing. Cost effectiveness should be the prime criteria in deciding an alternative. For example, the translocation of aggressive elephants may be less costly compared to fencing in some situations.

According to the people surveyed, electric fencing will be much more effective if it is integrated with other mitigation measures. For example, in the Kandeketiya Divisional Secretariat Division in VRR, 25 percent of respondents suggested the translocation of aggressive elephants from Victoria-Randenigala-Rantembe. In the Kahalle Pallekele area where the highest elephant related deaths are recorded, about 20 percent of people (20.37%) suggested the translocation of aggressive elephants to other protected areas. Another interesting suggestion made by some respondents (12.96%) is to establish corridors between forest areas. This would be a practical solution to minimize the invasion of human settlements by migrating elephants. Another important

suggestion made by some respondents (12.96%) is habitat enrichment. This could be done by planting fodder trees in the elephants' forest areas. In Lunugamvehera, as in other regions, people suggested the translocation of aggressive elephants to larger national parks and sanctuaries. This response was provided by 20.91% of respondents in the sample. This indicates that the weakness of the fences can be overcome by incorporating other appropriate mitigation measures.

The study indicates that community support is key to the success of a fence. Fences are often cut by illegal timber fellers and illicit liquor producers. Such events can be policed by well-organized community-based organizations. Community support is also critical in several other ways. Community labour is required to establish a fence and, most importantly, for fence maintenance. Community organizations have a role to play in protecting a fence and keeping its route clear. Overall, community support for electric fencing should have the practical backing of the authorities who should provide funds and materials (e.g. posts for replacement). Without this support the intended benefits of fencing cannot be achieved. Policies that promote the coexistence of humans and elephants are also worthwhile promoting at this level. They will make electric fencing a more positive contributor to the mitigation of HEC.

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APPENDIX 1

Technical Specifications for Electric Fencing Equipments

The different components of an electric fence, and their uses, are listed below:

1. Energizer:
The energizer is used for providing energy to the fence wires. The standard energizer can be powered by 230 Volts AC as well as 12 Volts DC batteries. The peak energizer stored energy shall be a minimum 25 Joules. The energizer should incorporate internal adaptive control to maintain effective high energy different pulses at accepted levels.
The current consumption of the energizer shall not exceed 1 Ampere under normal working conditions and 2 Amperes under any circumstances. Output energy of the energizer is minimum 6.5 Joules at 500 Ohms load resistance. The energizer unit must incorporate advanced lightening protection.

2. Solar Power System:
A solar array of 12 Volts with 7.5 Amperes peak current is required. Power generation is done by solar panels. The Solar Controller in the Solar Power System shall be capable of handling 10 Amperes at 12 Volts and shall be able to protect the load against short current conditions. Cut- out switches should be designed to isolate fence voltages from 0 to 15 kilovolts to eliminate shocks.

3. Galvanized wire:
Galvanized fence wires should be made out of hot dipped galvanized high tensile steel. Minimum Zinc coating shall be 260g/m^2. Minimum tensile strength shall be 1200 MPA and minimum breaking strength 600kg. DC electrical resistance shall not exceed 35 ohms/1000 meters.

4. Concrete posts:
The concrete posts used for fencing need to be reinforced and made through a process of mechanical vibration so that they are strong enough not to fall over if pushed by a wild elephant. The distance between two adjacent posts is 20 meters.

5. Wire joining clamps, permanent tension springs, wire tighteners, load out cable, lightning diverters (adjustable), live insulators with anchor clips and porcelain strain insulators:
Wire joining clamps are used for linking wire parts in length. They shall be of good conductivity at the wire joints and be able to clamp all wires up to 4mm. Permanent tension springs shall be designed to achieve and easily maintain the designed fence tension. Wire tighteners are designed to adjust tightening and loosening needs. Load-out cable should be 2.5mm in dimension and specially designed for underground application. Lightning diverters divert lightning from the fence to the earth to protect the energizer. Live insulators with anchor clips and porcelain strain insulators are made of high quality porcelain and must be complete with a galvanized anchor. It shall be designed to have minimum tracking distance of 25 millimeters and should be fire resistant.

6. Spring gates, flood gate controller:
Spring gates shall be able to accommodate different sizes of gate spans without over stretching. Flood gate controllers shall reduce /prevent energy discharges to the ground (through water) during floods by shutting off the floodgates automatically.

7. Fabricated wires, extended iron-bar arms:
Fabricated wires and extended iron-bar arms provide a better protection to the posts as the whole fence is ‘live’ when in operation.

The electric fencing equipment has been manufactured according to IEC 60335-2-76 (1999-06) International Electromechanical Commission Standard for Current Limited Electric fence Energizers. Electric fences use the electric system of 3 wire 'live earth live design’. Standard electric fences used in Sri Lanka are of the 3 wires and 1 guard wire type since these are cheaper.

APPENDIX 2

List of Electric Fences Established in Sri Lanka and their Details

Admin. region of Asst. Director	Name of the fence	Route /location	Length	Spring gates	Energizers	Constructed by	Started	Finished	Access route	Maintenance	Current situation	Other
CENTRAL	Fence at Uma oya -left bank	Uma oya-left bank	I— 8 km II—8 km	10 9	1 1	GEF-DWLC GEF-DWLC	1992 1998	1993 1999	I—Haliela via Kandaketiya Galauda road II—Bathmedilla on Badulla main road	DWLC DWLC	I—Completed 8 km, Solar power supply II—8 km, established only posts, works stopped temporarily	I—No permanent workers for maintenance II—same to above
CENTRAL	Fence at Bopattalawa Livestock farm	-	Covers 140 acreage	-	2	NLDB	Feb. 1995	March. 1995	Main road to Bopatthalawa farm	NLDB	Only a part of the fence is functioning	The location of the fence is changed acc. to the need of the farm
CENTRAL	Fence around Ambewela farm	-	8 km around the farm	-	-	NLDB	-	-	Route around the farm	NLDB	Active	-
CENTRAL	Fence around Newzeland farm	-	5km around farm	1	2	NLDB	1992	1998	Route within the farm	NLDB	Active	-
MAHAWELI	Fence around Girithale Elahera road	From Girithale Elahera road to Parakrama Samudraya	15km	1	1	DWLC	06.02 .1996	14.11. 1997	Have a maintenance route	DWLC	Active	-
MAHAWELI	Fence around Sigiriya Aluthwewa	Route from Aluthwewa to Weewala	10km	1	1	DWLC	1993	-	Have a maintenance route	DWLC	A part of the fence is functioning	Required new posts to replace for broken ones
MAHAWELI	Fence at Wasgamuwa-Himbiliyakada	From Himbiliyakada to Mahaweli river	18km	1	1	DWLC	1994	-	Have a maintenance route	DWLC	Active	-
MAHAWELI	Fence in Maduruoya -Ulhitiya	From 7 D ela to Orchad at Ulhitiya	45km	2	3	Mahaweli Authority	-	-	Route abandoned, not accessible	Mahaweli Authority system C	Inactive	Maintenance has been given up
MAHAWELI	Ulhitiya- Mahaweli	From Pahala Yakkure	40km	-	2	Mahaweli	-	-	do	do	do	do

	Southern bank	to Ulhitiya Oya				Authority						
MAHAWELI	Fence from Pahala Yakkure to Manampitiya	from Pahala Yakkure to Manampitiya	32km	1	2	do	1995	1996	do	do	do	do
MAHAWELI	Fence in Maduru oya-Damminna	From Damminna to Saibon	9km	1	1	do	1996	-	do	do	do	Do
MAHAWELI	Fence in Pussallayaya	From Hunuwila oya in Hettipola-Handungamuwa road to Bridege of Gamburu oya	2km	8	1	-	-	-	Hettipola Handungamuwa road	Villagers in Pussellayaya, Handungamuwa	active	Maintainance has been given up
MAHAWELI	Kekulawala Dehiatthakandiya road	-	-	-	-	-	-	-	-	-	-	-
EASTERN	-	From 17 junction at Ekgaloya to Dembataella	16km	6	1	GEF-DWLC	-	-	Ampara via 17 junction – Hingurana, Ampara via 17 junction - Inginiyagala	DWLC	completely established and well functioning	-
NORTHWESTERN	Neelabemma	From boundary of park along Kalaoya	16.5km	-	1	DWLC	Oct.1998	-	Neelabemma road	DWLC	15.5km is well functioning	Posts have been provided for the rest
NORTHWESTERN	Fence at Rajarata farm , Galkiriyagama,Dambewatana	Around farm	-	1	1	farm	-	-	Galkiriyagama, Dambewatana	farm	active	-
NORTHWESTERN	Fence at Pulliyankulama	From Kadawala road to Gammiris weta	18km	4	2	Irrigation Department	-	-	Puliyankula--ma road	Irrigation Department	active	-
NORTHWESTERN	Fence around Paragaswewa farm	-	-	1	farm	-	-	Paragaswewa road	-	farm	active	-
NORTHWESTERN	Fence at Neelabemma south	Vilacchiya road	-	1	1	farm	-	-	-	-	active	-
NORTHWESTERN	Oyamaduwa (Vilacchiya farm) fence around the farm	-	-	-	-	-	-	-	-	-	-	-

SOUTHERN	Yala block 1-southern boundary	From Banduwewa to Kocchipathana	13km	-	1	DWLC	01.10 .1999	30.10. 1999	-	DWLC	Active	-
SOUTHERN	Western boundary of Katagamuwa and Katharagama Sanctuaries	From Kocchipathana to Gothamigama	7km	4	1	DWLC	01.10 .1999	30.10. 1999	Sithulpawwa road	DWLC	active	-
SOUTHERN	South boundaries of Yala iii and iv	From Gothamigama to Kohombagatha (Menik ganga)	10km	1	1	DWLC	1993	1994	Katharagama Buthhala road	DWLC	active	-
SOUTHERN	From dam of Lunugamwehera reservoir to Walaba wewa	From western and southern boundary of the park	17km	1	2	DWLC	06.11 .1997	30.10. 1999	Road towards reservoir dam	DWLC	constructed portion is active	Further extension will be towards Kohombedigatha
SOUTHERN	From Lunugamwehera reservior dam to Deuramvehera	Western boundary of the park	10km	1	2	DWLC	01.03 .1992	01.10. 1992	Thanamalwila-Thissamaharama road	DWLC	active	-
SOUTHERN	From Kithulkote to Demodara	Northeastern boundary of the Lunugamvehera park	18.5km	1	-	Pelawattha Sugar Company	1996	1997	no	Pelawattha Sugar Company	inactive	-
SOUTHERN	From Demodara to Ayakapolla	Towards northern boundary of Yala v and western boundary of Yala vi	17.8 km	1	-	Pelawattha Sugar Company	1995	1996	Goonaganara,Katharagama Butthala road	Pelawattha Sugar Company	inactive	-

APPENDIX 3

QUESTIONNAIRE FOR HOUSEHOLD SURVEY - HUMAN-ELEPHANT CONFLICT IN SRI LANKA

(A). DISTRICT:

(B). A.G.A. DIVISION:

(C). VILLAGE AND G.S. DIVISION:

PART A- SOCIO ECONOMIC BACKGROUND INFORMATION

(1). Name of the respondent:.....
(2). Name of head of the household (if different from above):.....……
(3). Occupation of the head of the household:.....
(4). Land ownership of the family:

Type of the ownership	Extent	
	UL	LL
Fully-owned		
State owned (licensed)		
Tenant		
Chena		

** indicates the lands in WL reserves*

(5). Family details:

Family Member No.	Age (yrs)	Sex *1. Male 2. Female*		Relation to household head *1. Head 2. Wife 3. Son/ daughter 4. Parents 5. Grand parents 6. Grand children 7. Other*	Education *1. No schooling 2. No. of years of schooling*	Civil Status *1. Married 2.Unmarried 3.Widow 4.Widower 5.Separated 6.Divorced*	Occupation				Monthly Income (Rs.)	
							farming	Work outside / Off farming		Do not work *1. Yes 2. No*	Farming	Off farming
								Local	Outside (abroad)			
Head				1								
Wife				2								
1		M	F	3								
2		M	F	3								
3		M	F	3								
4		M	F	3								
5		M	F	3								
6		M	F	3								
7		M	F	3								

** Indicate the respondent*

(6). Do you receive Samurdhi or any other government support? Yes No

Amount Rs.

(7). Details of housing facilities

Roof	Floor	Walls	Drinking water	Toilets	House Lighting
1.cadjan/Hay	*1.No. floor*	*1.Tats*	*1.well (own)*	*1.No toilet*	*1.Kerosene*
2.Tar sheets	*2.Clay/Cowdung*	*2.Wood*	*2.Well (public)*	*2.Pit latrine*	*2.Biogas*
3.Galvanized	*3.Bricks*	*3.Clay*	*3.Piped from own well*	*3.Bucket latrines*	*3.Solar power*
4.Plastic sheets	*4.Cement*	*4.Bricks*	*4.Piped from other well*	*4.Water sealed*	*4.Electricity (CEB)*
5.Asbestos	*5.Other (specify)*	*5.Stones*	*5.Unprotected*	*latrine*	*5.Other*
6.Tiles		*6.Cement/*	*(waterfall, stream etc.)*	*5.Other*	
7.Other		*plastered*			
		7.Other (specify)			

(7.1). No.of rooms: [ ]

(8). Land (home garden)

Accessibility		Valuable Trees	No	Type of the land		Types of buildings in the land	
Close to the road							
Distance-Motorable		*Jak*		*Gravel / stony land*		*Boutique*	
Distance-Not Motorable		*Breadfruit*		*Flat land*		*Workshop*	
		Teak				*Others*	
		Mahogany					
		Others					

**Boutiques /Workshops 1-Well functioning 2- Moderate 3- Weak*

(9). If you have electricity, indicate the availability of electric appliances in home.

Item	Available or not
Cassette player	
VCR/VCD	
Refrigerator	
Iron	
Electric kettle	
Kitchen appliances	

(10). Vehicles

Type of the vehicle	Have /not	No. of vehicles
M.bike		
Three wheeler		
Cart		
Car		
Van		
Lorry		
two wheel tractors		
four wheel tractors		
Others		

(11). How long have you been in this village?

For generation	
Recent settlers	

(12). Did you receive lands from Mahaweli Project? | *Yes* | *No* |

(12.1). If yes to 12, what are the reasons for not leaving the existing place?

1. ----------
2. ----------
3. ----------

(12.2). Did you receive any compensation from Mahaweli Project? | *Yes* | *No* |

(12.3). If yes to 12.2, Details of those compensations:

Amount	
Date	

PART B- CROP AND LIVESTOCK PRODUCTION

(13). Crops cultivated during last year:

Land block	Extent	Tenure type **1.fully owned** **2.tenent** **3.chena** *4.other*	Irrigation *1.major* *2.minor* *3.rainfed* *4.other*	Crops grown	
				Yala	Maha
1					
2					
3					
4					
5					

(14). Inputs used:

Season	Crop	Type of inputs	Amount/ Quantity	Total Cost (Rupees)	Yield
Maha	*1.Rice*	*1. Seeds*			
		2. Fertilizers			
		3. Chemicals			
		4. Labour			
		5. Other			
	2	*1. Seeds*			
		2. Fertilizers			
		3. Chemicals			
		4. Labour			
		5. Other			
	3	*1. Seeds*			
		2. Fertilizers			
		3. Chemicals			
		4. Labour			
		5. Other			
Yala	*1.Rice*	*1. Seeds*			
		2. Fertilizers			
		3. Chemicals			
		4. Labour			
		5. Other			
	2	*1. Seeds*			
		2. Fertilizers			

		3. Chemicals			
		4. Labour			
		5. Other			
	3	*1. Seeds*			
		2. Fertilizers			
		3. Chemicals			
		4. Labour			
		5. Other			

(15). Rearing of farm animals

Types of animal	No. of animals	Production	Value
Buffalo			
Poultry			
Swine			
Goat			

PART C- OFF FARM ACTIVITIES / NON FARM ACTIVITIES

(16). If you are not a farmer,

(16.1). Current occupation:.....

(16.2). Job Status: employed

Permanent	Temporary	Contract basis	Self

(16.3). Monthly income: Rs.....

PART D- ACTIVITIES AND SOCIAL STRUCTURE

(17). Outside travels by family (per week)

Member	Frequency of travels out side per week	Purpose	Times

(18). From where do you fulfil following requirements:

Timber	forest	Own lands	buying	other
Firewood	forest	Own lands	buying	other
Medicinal herbs, Yams and other food items	forest	Own lands	buying	other

(19). How far is a forest away from your place? ☐ meters / kilometers

(19.1). Frequency of your visit to the forest:

Daily	Weekly	Monthly	Not special	Rarely	Not at all

---

(20). If you rare animals like cattle, buffalo or goat (according to 15),

(20.1.). Do you send your animals in to the forest? | Yes | No |

(20.2). Food availability for animals in the forest? | High | Moderate | Low |

(21). Are there any incidences of firing the forest/ bushes/ bush fires? | Yes | No |

(21.1). Who are responsible for these according to your experience?

(21.2). What they expect from those firings?

(22). Ways of your involvement in CBO activities:

CBO involved	Family member Involved in CBO	Activities done by the CBO	Position held	Major activities

(23). Government officials involved in HEC and perception on their works:

Officer/Organization	Role	Perception		
		Good	Moderate	bad
1.				
2.				
3.				
4.				
5.				

(24). Are there any NGO involved in mitigating HEC in your area? Yes | No

If yes, give details.

Name of NGO	Activities	Attitudes towards their works		
		Satisfactory	Moderate	Not satisfactory
1.				
2.				
3.				
4.				
5.				

PART E – ELEPHANT RELATED INCIDENCES

(25). Elephants seen by family members (frequency):

1. Daily	2. Weekly	3. Monthly	4. Seasonally	5. Rarely

(25.1). Times you **mostly** seen elephants?

Morning *4 –9am*	*Day time* *9am-3pm*	*Evening* *3-7pm*	*Night* *7pm-4am*

(25.2). Times of recorded elephant' attacks in the village

Morning *4 –10am*	*Day time* *10am-3pm*	*Evening* *3-7pm*	*Night* *7pm-4am*

(26). Reasons for the recent attacks in the village (year 2003)

Case	What people say about the incidence	According to your perception, what is the reason for this incidence?
1.		
2.		
3.		

(27). During year 2003,

(27.1). Number of human deaths:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Village Total
No. of deaths														
No. of injuries														

(27.3). Number of property damages by value

Property	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	V. Total
Houses	No. of damages														
	Cost of damages														
Harvest	No. of damages														
	Cost of damages														
Vehicles	No. of damages														
	Cost of damages														
Plants/ Trees	No. of damages														
	Cost of damages														
Raring animals	No. of damages														
	Cost of damages														
Other	No. of damages														
	Cost of damages														

(27.4). Number of crop damages by amount and crop

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	V. Total
No. of crop damages														
Extent of damage														
Cost of damage														

(27.5). Number of productive days lost

Member	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Head												
Wife												
Children												
Others												

(28). Did you receive any compensation for elephant attacks? Yes | No

(28.1). Compensations received by you/ your family:

Incidence	No. of incidences	Organization/s contributed	Date/s received	Total Amount/s	Your satisfaction on compensations		
					Efficiency	*Scheme*	*Amount*
Deaths							
Injuries							
Property damages							

Highly satisfied – 1 Satisfied –2 Not satisfied-3

(28.2). Compensations received by the village:

Incidence	No. of incidences	Organization/s contributed	Date/s received	Total Amount/s	Your idea of the receiver's satisfaction on compensations		
					Efficiency	*Scheme*	*Amount*
Deaths							
Injuries							
Property damages							

Highly satisfied – 1 Satisfied –2 Not satisfied-3

(29). Attitude on aggressiveness of elephants (with time):

1.Increasing	2. Not change	3. Decreasing	4. Cant say any

(29.1). Attitude on human activities on elephants or related situations:

1. Increasing	2. Not change	3. Decreasing	4. Cant say any

(30). Your knowledge / awareness on

	Yes/ No
1. individual elephants who raid the crop and damage properties	
2. route of entry to the village	
3. frequency and pattern of visit	
4. food habit	

PART F – CURRENTLY PRACTICING METHODS FOR CONTROLLING HEC

(31). **Fence**

(31.1). Do you remember the initiating date of the fence? Yes | No

(31.2). If yes, to 38, did you participate in construction of the fence? Yes | No

(31.3). If yes, to 39, In which way?……..

…….

(31.4). If no, why? What are the reasons?……

……

(32). Did the villagers contribute in fence construction? Yes | No

(33). Do you participate in maintenance works of the fence? Yes | No

(34). Do you like to participate in any kind of works related to the fence? Yes | No

(34.1). Which type of contribution?……

……

(35). Do you like to contribute in activities related to the extension of the fence? Yes | No

(35.1). In which way you contribute?

(35.1.1).
Funding:(amounts)……

……
(35.1.2).
Labour:…….

…….
(35.1.3).
Maintenance:…….

…….

(36). Do you think the fence was effective in controlling elephant attacks to the village? Yes | No

(36.1). How you say so, give details(before and after the fence construction):
……
……
……
……
……

(37). If the fence is not effective, what are the weak points you have experienced on the fence?
……
……
……
……

(38). What are the suggestions to improve the fence?
……
……
……
……

(39). Protective methods used to manage the conflict by you /villagers:

Method	Whether apply /not	Attitude		
		Effective	Less effective	Not effective
1.Thunder crackers/ bombs				
2. Signal				
3. Fire crackers				
4. Fire				
5. Shouting				
6. Changes of Cropping patterns				
7. Cultivation repellent plants				

8. Use of Repellent chemicals				
9. Use of Chillie powder				
10. Fencing				
11. Other methods				

(40). **Bombs and fire crackers (Mostly used methods)**

	Amount used per Year	From where you received	Unit price	Total cost Per year
Bombs				
Firecrackers				

(40.1). Weaknesses of using bombs:
……
……
…….

(40.2). Weaknesses of using fire crackers:
……
……
(41). How can they be improved?
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PART F – SUGGESTIONS TO SOLVE THE CONFLICT

(42). How do you rate the HEC.

1. High	2. No change	3. Low	4. Can not say any

(42.1). If changed, what are the most possible reasons according to your perception?

1.----------

2.----------

3.----------

(43). Acceptance of coexistence.

What is your choice?

1. Completely removal of elephants from this area	**Agree**	**Disagree**	**No idea**
Reasons:			
2. Translocation of aggressive elephants	**Agree**	**Disagree**	**No idea**
Reasons:			

3. Establishment of elephant corridors	**Agree**	**Disagree**	**No idea**
Reasons:			
4. Separate an area for elephants by a fence	**Agree**	**Disagree**	**No idea**
Reasons:			
5. Establishment of elephant conservation and management unit	**Agree**	**Disagree**	**No idea**
Reasons:			
6. Plantation of fodder trees	**Agree**	**Disagree**	**No idea**
Reasons:			
7. Provision of support by DWLC such as fire crackers, hurricane torch etc.	**Agree**	**Disagree**	**No idea**
Reasons:			
8. Relocation of village from the vulnerable area	**Agree**	**Disagree**	**No idea**
Reasons:			
9. Others (specify)	**Agree**	**Disagree**	**No idea**
Reasons:			

(44). Remarks:

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