Doctoral Dissertation

Exploring the Concept of Payment for Environmental Services to help Mitigate Human-Elephant Conflict in Thailand

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ABSTRACT

Humans depend on ecosystems and their services. Human well-being also relies on sound policy intervention in ecosystem management. However, we are faced with the degradation of ecosystems because of excessive demands from humans, demographic changes, and poor individual choices. Limitation of budgets is another important reason to explain why the government has not able to conserve ecosystem properly. To offset this last factor, the Payment for Environment Services (PES) mechanism for conservation through incentive-based means that has promise in helping to sustain our ecosystem and human wellbeing. PES is as a type of Pigouvian subsidy to internalize positive externalities through the creation of a parallel environmental-service market with non-market policies such as command-and-control measures. The idea of PES is based on the Beneficiary-Pay-Principle (BPP), the reverse of Polluter-Pay-Principle (PPP), where subsidies are financed directly and voluntarily by beneficiaries of environmental services. The logic of the PES approach is that those who provide environmental services should be compensated or rewarded for their services and that those who obtain the services should pay for their benefits.

This study set out to determine what policy options could be chosen for human-elephant conflict (HEC) reduction in the Khao Ang Rue Nai (KARN) wildlife sanctuary, with a focus on payments for environmental services (PES) as a policy instrument. The impacts of HEC are not only crop raiding by elephants, but also loss of lives for both human and elephants. This study conducted a cost-benefit analysis (CBA) of HEC mitigation options to select the highest net benefits option compared with the status quo over a 20-year period. The options were as follows: 1) habitat improvement and female elephant contraception; 2) habitat improvement, female elephant contraception and land-use change; and 3) habitat improvement, female elephant contraception, and electric fences. The results of the CBA were used as an input to select which policy option to implement in the pilot PES scheme. The results of the CBA show the highest net present values (NPVs) are in option 3 (habitat improvement, female elephant

contraception, and electric fences). Furthermore, the cost-effectiveness analysis (CEA) was also analysed to provide the unit costs of effectiveness on each policy intervention. The results of CEA accord with the CBA results.

This study also analyses the PES mechanism with respect to several of its facets, such as proposed environmental services, the potential service providers and buyers, the intermediaries, and monitoring and evaluation. Also, this study discusses the potential limitations of PES implementation, which are limited demand for environmental services, legal issues, transaction costs, economic leakage, and the likely permanence of the scheme. However, it should be noted that this study does not suggest that the PES scheme proposed should replace other conservation measures, but rather be considered as a parallel environmental market with other conservation policies. Furthermore, some of the lessons learned and policy recommendations made are seen to be very heavily influenced by how political change influenced the required legal amendments for environmental management and fundraising by initiating an incentive for service buyers based on their contribution to the scheme or by creating tangible incentives for the private sector to participate through institutions such as the Federation of Thai Industries and the Thai Chamber of Commerce rather than individual private companies. The information from the household survey can also be used to create incentive compatible and cost-saving strategies for villagers to work in the sanctuary. In summary, the PES system has the potential to turn human-elephant-conflict into human-elephant-harmony as it helps convert elephants from a pest to a valuable resource to be protected.

CHAPTER 1
INTRODUCTION

1.1 Background

Payment for environmental service (PES) is an innovation which uses financial markets to provide incentives for improving environmental management (Smith, 2008; Wunder et al., 2008). There is a growing interest in using the PES approach in conservation, especially in the classical case of watershed protection. It arose when it was becoming obvious that, as a result of budget constraints in many jurisdictions, the usual approaches (e.g. command-and-control measures) could not provide enough funds for conservation from government sources. PES can provide new source of funding especially if the private sector and service-provider communities can improve their livelihoods from investing their funds this way (Wunder, 2008).

The scheme of PES is as an incentive-based approach to conservation that has been applied increasingly in both developed and developing countries (Wunder et al., 2008; Corbera et al., 2009; Perrot-Maître, 2006). The goal of a PES scheme is to change behaviours that damage natural resources and environment (Smith et al., 2006), or to enhance the quality of the environment by providing an economic incentive to beneficiaries to adopt management practices favorable to environmental conservation. The logic of the PES approach is that those who provide environmental services (ES) should be compensated for this and that those who receive the services should pay for their benefits (Pagiola et al., 2005). In theory, the PES as a new type of subsidy financed directly and voluntarily by the beneficiaries of environmental services should be able to be better maintained over time compared to state budgets for environmental conservation or traditional subsidies which are financed by taxpayers (Perrot-Maître, 2006). The major types of environmental services that have been purchased up to now under PES schemes include: 1) carbon storage and sequestration; 2) wetlands conservation; 3) watershed protection (including soil

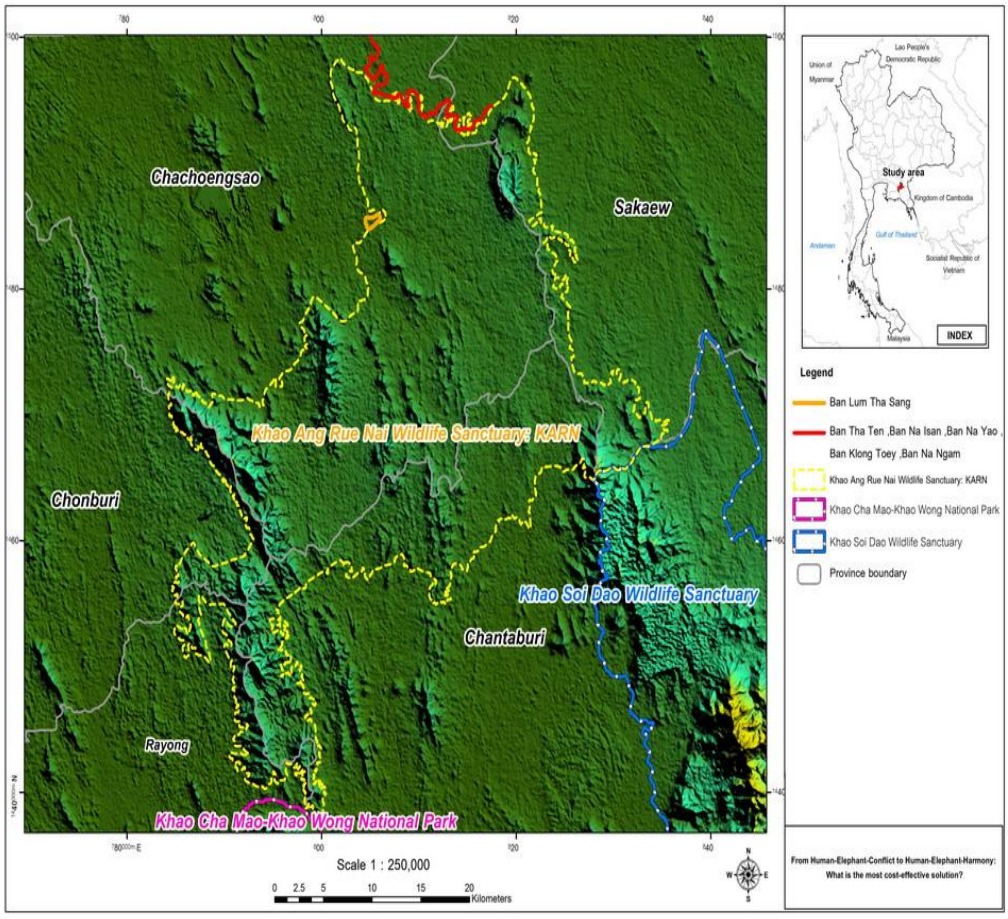
protection); and 4) species, habitat, and biodiversity protection (Forest Trends et al., 2008).

In Thailand, PES is a new concept and no formal PES scheme has been implemented (NESDB, 2011); however, there are some pilot projects using the concept of PES which have been applied, for example, the Inpang Carbon Bank project in the Inpang community network in three provinces, namely Kalasin province, Nakhon Phanom province and Sakhon Nakon province (Samek et al., 2011). The Inpang Carbon Bank project created markets in Thailand for local farmers who act as a service provider to adopt agroforestry for selling carbon to the Chicago Climate Exchange which acts as a beneficiary for carbon offset. The CATSPA (Catalysing Sustainability of Thailand Protected Area System) is another example of a pilot project using the PES concept in Thailand (DNP, IUCN and GEF 2011). The CATSPA was initially given financial support by the IUCN (United Nations Development Program) and the GEF (Global Environment Facility). There are five pilot areas that focus on different environmental services: 1) Doi Inthanon National Park for watershed protection; 2) Klong Lan for tourism services; 3) Hauy Kha Khaeng for biodiversity protection;4) Khao Cha Mao National Park for water supply service; and 5) Tarutao National Marine Park for coastal resource services. The CATSPA is an incentive-based mechanism through providing a monetary incentive to beneficiaries to adopt management practices favourable to environmental conservation.

This study explores the potential and feasibility of establishing a PES scheme in Khao Ang Rue Nai Wildlife Sanctuary (KARN) in the Eastern Region of Thailand, where villagers who are living in the areas surrounding KARN are affected by a human-elephant conflict problem. KARN is a lowland rainforest covering an area of 1,079 km^2 of lowland rainforest in five provinces in the east of Thailand (Chachoengsao, Chonburi, Rayong, Chanthaburi, and Sakaew provinces - Figure 1.1).KARN is also the watershed of the Bang Pakong River and the Prasae River, which are the main sources of surface water supply for residential areas, industries and agricultural production in these provinces.

However KARN is also one of the 7 protected areas in the Country harboring more than 100 elephants. With no natural predators such as fresh water crocodiles and tigers in the KARN the population of elephants has been increasing at a high rate compared to other areas. A study by Wanghongsa et al. (2008b) reported that the wild elephant population was estimated at 136 in 200 and accelerating at the rate of 9.83% per annum. Currently, only 36.61% of the sanctuary is appropriate as elephant habitat. Therefore, because of the shortage of food and water in the sanctuary, elephants often come out of the sanctuary resulting in KARN being one of the areas where the level of Human Elephant Conflict (HEC) is high in Thailand (Wanghongsa et al., 2008a).

Figure 1.1: The KARN Wildlife Sanctuary



Source: The author

The main impact from HEC in KARN is crop losses, but there have been human deaths, another impact that is considered unacceptable. The Human-elephant conflict in KARN is the most severe in the country due to the deaths of people and elephants. Between 1995 and 2009, 20 elephants were found dead. Five of them died of natural causes, 13 died of human-induced causes and 2 died of unknown causes (Table 1.1). Deaths from human-induced causes can be elaborated through three sub-categories of causes, which are 1) human-elephant conflict due to conflict on crop-raiding by elephants (9 elephants), 2) poaching for tusks (1 elephant), and 3) traffic accidents (3 elephants). Unfortunately, no systematic data of all human injury/death due to the HEC has been recorded. There are only data on the number of injuries and death of humans caused by traffic accidents (Table 1.2).

Nevertheless, the KARN Wildlife Sanctuary reported that two men have been found dead and one man injured due to the conflict between human and crop-raiding by elephants during period from October 2009 to August 2010. In addition, Srisuk et al. (2010) reported that crop damage in the Sub Wua Daeng (SWD) village, which is one of 90 villages surrounding the KARN sanctuary, was estimated at approximately 100,000 baht during the 11 months of their survey or approximately 109,000 baht (or USD3633) per year. Unfortunately, the SWD project did not collect household income data that could be used to identify the magnitude of such damage by comparing the crop damage to household income. However, the research in the SWD project has emphasized that even though the crop damage is not large in absolute terms, it is a large compared to average household income.As well, there is another concern to individual households where crop damage could be devastating if an entire crop is damaged by the elephant. Families also incur a loss of income and wellbeing due to the opportunity cost of devoting time to deterring elephants, rather than producing crops or earning income in other activities.

Table 1.1: The Death of Wild Elephants in the KARN Sanctuary during 1995 – 2009

Causes of death	No. of death
1. Conflict from crop-raiding	9
2. Natural death	5
3. Traffic accident	3
4. Poaching	1
5. Unknown reason	2
Total	20

Source: The Chachoengsao Wildlife Research Station

Table 1.2: No. of Injuries and Deaths of Humans and Elephants from Traffic Accidents during 2000-2008

	No. of injury/death	
	Human	**Elephant**
Injuries	11	4
Death	4	3

Source: The Chachoengsao Wildlife Research Station

While some measures have been implemented by government agencies to improve the degraded ecosystems and thus reduce the conflicts described above, these efforts fell short of the scope and scale of measures needed. Evidence from KARN and its surrounding villages suggests the current measures by the public sector cannot do much to make a difference. Hence, the idea of PES was considered as a possible solution. The proposed environmental service in the case

of KARN is forest habitat improvement and HEC mitigation measures corresponding to the category of species, habitat, and biodiversity classified by Forest Trends et al (2008).

As mentioned above, this study explores the feasibility and potential of investment by the private sector and general public for forest habitat improvement and HEC reduction through the mechanism of payments for environmental services. In addition to the potential use values that can be generated from private sector involvement and investment in eco-tourism activities, there are also the intangible benefits in the form of indirect use values from the rehabilitation of the ecosystem as well as the non-use value[1] of wild elephants, which has historical and cultural significance in Thai society. Furthermore, the benefits of habitat improvement will not only reduce the HEC problem, but also restore the ecosystem which is the source of surface water supply for downstream areas. The private sector can in this way act as both a service buyer and the beneficiary of environmental services. Some firms may like to contribute to the environmental program to generate goodwill or improved reputation by using their corporate social responsibility (CSR) budget to provide the reward for farmers to generate a positive externality for habitat improvement and HEC reduction. Furthermore, another potential source of demand can come from the general public who value wildlife conservation.

1. 2 Research Objectives

The overall research question for this study was to test the potential of the concept of Payments for Environmental Services (PES) as a policy instrument in reducing human-elephant conflict (HEC) where this occurs. The KARN wildlife sanctuary, Thailand was chosen as the test location and case study of HEC for PES development. The specific research questions were:

[1] Non-use values refer to the benefits that individuals receive from the knowledge that the natural resources exist (existence values) and their wish to ensure the natural resources is passed on to future generations (bequest values) (OECD, 2010 page 23)

1. To identify the options and analyse the highest net-benefit mitigation option for the alleviation of HEC in the KARN Sanctuary;
2. To estimate the unit cost of each HEC mitigation option;
3. To design a model PES mechanism to reduce HEC in protected areas based on this analysis;
4. To identify the financial needs and options for mobilizing the financial resources of such a PES scheme; and
5. To discuss what limitations there are to the implementation of PES in practice using data from the KARN sanctuary.

1.3 Description of the Study Area

Khao Ang Rue Nai Wildlife Sanctuary (KARN) is a part of Kwae-Rabom-Seeyat National Reserved Forest in Chachoensao province, next to the borders of Sakaew, Chantaburi, Rayong and Chonburi provinces, its territory was 67,562.50 rai (108 km^2), according to Royal Decree B.E.2520 promulgated to protect forests and wildlife from increasingly and completely destroyed by growing demands for additional land use, both for working and speculating (The Government Gazette Issue 94 Chapter 95, October 11th 1977).

Some 20 years later it was suggested to promulgate a Royal Decree to expand the area by an additional 500,000 rai (800 km^2) in order to preserve the fertile forests, wildlife and river sources in this 5 provinces joint area. As a result KARN then had a total of643,750 rai (1,030 km^2), within which are gathered the joint area of Sakaew, Chantaburi, Rayong and Chonburi preserved forests (Government Gazette Issue 109 Chapter 126, December 30th 1992). Thereafter, more than 300,000 rai (480 km^2) in the Khao Wong – Khao Wai area, which is a part of Kwae-Rabom – Seeyat Preserved Forest, was combined with KARN

Wildlife Sanctuary making its total area 674,352 rai (1077 km^2), according to Government Gazette Issue 118 Chapter 75 September 5th 2001).

At Present, KARN Wildlife Sanctuary is located in 5 provinces as follows;

1. 38,375 rai (61 km^2) in Chonburi province
2. 32,875 rai (53 km^2) in Rayong province
3. 179,375 rai (287 km^2) in Chantaburi province
4. 29,375 rai (47 km^2) in Sakaew province
5. 394,352 rai (582 km^2) in Chachoensao province

KARN's upper and middle area is mostly ridged plain, which is moderately steep, and is the source of many brooks and waterways that lead to main rivers, such as the Rabom-Seeyat steam that runs to Bang Pakong River at Bangklao district in Chachoensao province, the Lum Phra Peung Yai and Phra Sateung canals that run from Khao Sibhachan mountain to join Prajeenburi River, the Tanod canal that runs to Tamai district in Chantaburi province, and the Prasae canel that runs through Botong district in Chonburi provinceand into the sea at Rayong province.

The floristic nature of this area is mostly semi-evergreen forest, suited for wildlife habitats, such as, wild elephants, gaurs and bantengs, birds, insects and reptiles. The area consists of Khao Chamao National Park, Khao Kichakood National Park, Khao Soidao Wildlife Sanctuary and KARN Wildlife Sanctuary, and includes government sectors that are in charge of the area, both inner and outer, to preserve these fertile forests, to rehabilitate and reforest, to improve people's lives and build collective consciousness in natural resources preservation.

KARN Wildlife Sanctuary has high biodiversity; there are 132 kinds of mammals, such as, black giant squirrel, variable squirrel, crown gibbon, sambar, barking deer, wild elephant, gaur, and banteng etc. 107 kinds of reptiles are also found in the area and 22 kinds of amphibian, 105 kinds of insects and 23 kinds of

freshwater fish. KARN Wildlife Sanctuary is the nearest low and evergreen forest to Bangkok and also the transition zone between Central and Northeast region's ecological communities.As mentioned above, the Khao Ang Rue Nai Wildlife (KARN) Sanctuary is an area where human-elephant conflicts have become the worst in Thailand. The details of HEC impacts and mitigation measures can be described as follows:

1.3.1 Impacts of HEC in KARN

Human-elephant conflicts are presently found in 24 protected areas in Thailand, ranging in size between 84-2915 km^2 and 5-350 elephants (Wanghongsa et al. 2008b). Using a severity index of human-elephant conflicts, KARN is one of the two sanctuary that are ranked at level 15[2], which is the most severe level. Surrounded by farmlands and the geography of KARN that is a lowland rainforest are the factors that enable elephants to go out of the sanctuary easily to eat agricultural products, such as cassavas and paddy rice. Some farmers spend their money to turn on the electric light for their cassava farms for the whole night. They hope that it can help them to protect their farms from elephants. Also, some households use electric wire to electrocute elephants. The appropriate area that can be a habitat of wild elephant in KARN accounts for only 36.63% of the sanctuary. Therefore, the increasing number of elephants living at the corridor between KARN and farmlands will complicate the problem of HEC for both crop-raiding and elephant/human deaths in the near future.

[2] The severity index at the level no. 15 equals to losses of property and life of human and elephant.

1.3.2 Current HEC Mitigation Measures (Status quo)

Local people and related government agencies have applied some mitigation measures to alleviate the impacts of HEC, however, the level of these mitigation options are still not enough to reduce the HEC. The details are:

(a) Traditional measures by households

Local people who have been affected by crop-raiding by elephants have applied traditional crop protection measures. The aim of the traditional measures is to chase the elephants away. Examples of traditional measures are firecracker, plastic-bag flag, lighting fire, elevating hut to observe the farm, and electric fence (Figure 1.2).

Figure 1.2: Traditional mitigation measures by households

Fire cracker | Plastic-bag flag | Handmade lamp | Elevating hut | Electric fence

Source: the author

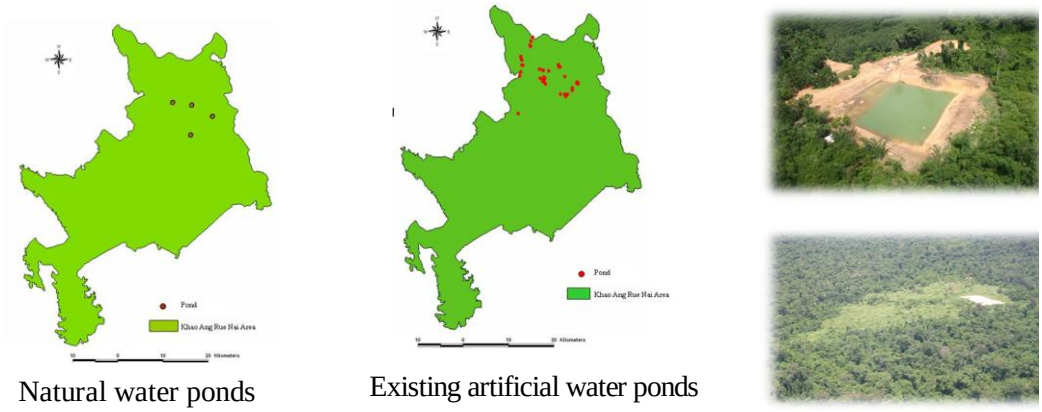
(b) Existing HEC mitigation measures by government agencies

The government agencies have some measures to alleviate the HEC problem, such as artificial water ponds (Figure 1.3), artificial salt lick (Figure 1.4), pilot ditch (Figure 1.5), road closure in front of KARN at night time during 9PM – 5AM (Figure 1.6), and compensation for crop damages (Table 1.3).With 9.83% of growth rate of wild elephants in KARN, the habitat improvement to create supplementary feeding for elephants should be the first priority measure; however, the current measures are still not adequate compared to growth rate of wild elephants. The salt/mineral lick is another source of nutrients for wild elephants and other wildlife. The salt lick is a salt deposit that animals regularly lick. In an ecosystem, salt/mineral licks often occur naturally, providing the

sodium, calcium, iron, phosphorus and zinc required in the early stage for bone, muscle and other growth[3].

The pilot ditch was built to act as an elephant barrier to prevent elephants coming into farm areas. The length of the pilot ditch is approximately 16 kilometres, which costs about 2 million baht or USD62500. The main problem of ditches is erosion of the side walls. The likelihood of erosion depends on soil conditions and rainfall (WWF, 2008). Therefore, effective of ditches after construction period depends on environmental factors (e.g. soil erosion) and good maintenance. However, it was now known that the pilot ditch cannot prevent elephants from crossing (Figure 1.5). Furthermore, since the road in front of the office of KARN has cut through the sanctuary as in Figure 1.6, it has caused the loss of human and wildlife. Wanghongsa et al. (2007a) reported that the road closure saved approximately 60% of wildlife compared to without the road closure. The government agency also provided the compensation for crop losses (Table 1.3) but the compensation rate is very low compared to the income loss of households due to crop-raiding by elephants.

Figure 1.3: the location of natural and existing artificial water ponds in KARN



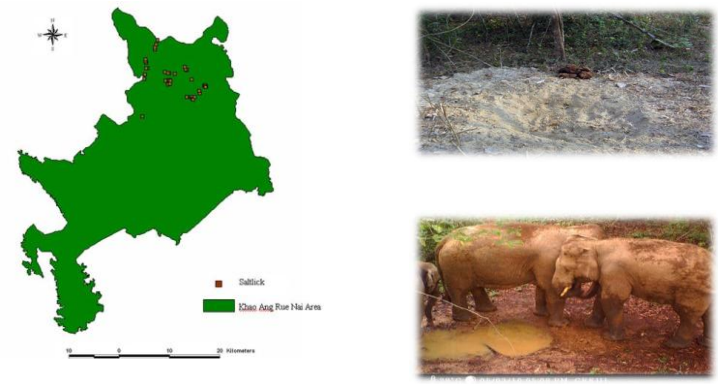
Natural water ponds

Existing artificial water ponds

Source: The Chachoensao Wildlife Research Station

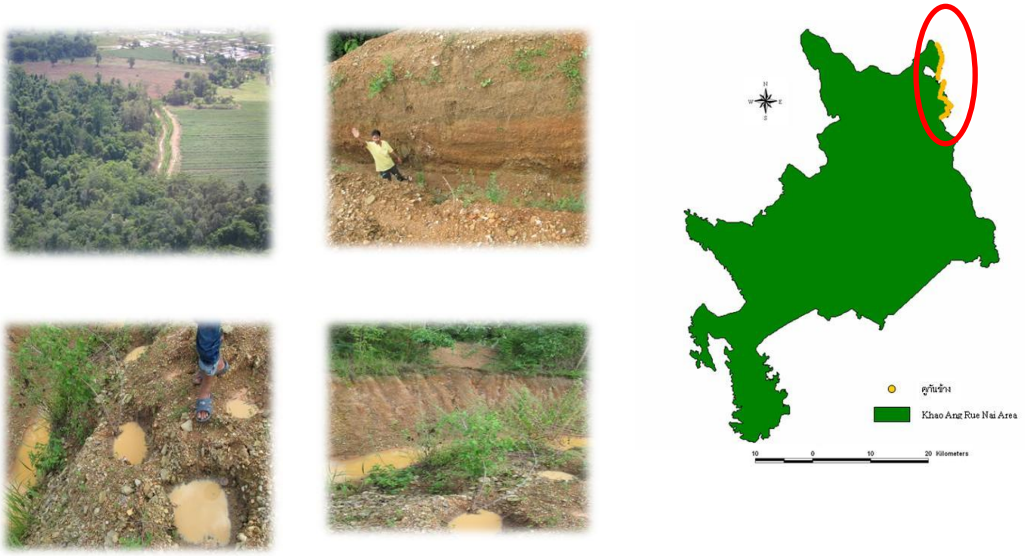
[3] http://en.wikipedia.org/wiki/Salt_lick (13 August 2010)

Figure 1.4: The location of existing artificial salt licks in KARN



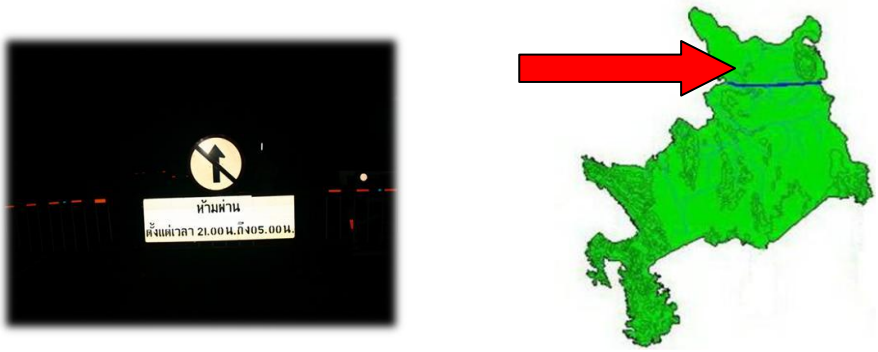
Source: The Chachoensao Wildlife Research Station

Figure 1.5: The location of pilot ditches



Source: The Chachoensao Wildlife Research Station

Figure 1.6: The location of road closure in front of the KARN office



Source: The Chachoensao Wildlife Research Station

Table 1.3: Compensation rates for crop damage

Crop type	Totally damaged (USD/hectare)
Rice	126
Dry crop (e.g. sugarcane)	174
Horticulture (e.g. papaya)	190

Source: The Chachoensao Wildlife Research Station

Note:

(1) 1 hectare = 6.25 rai and 1USD = 30 baht

(2) Compensation rate for partially damages of all crops is approximately USD60 per hectare

1.3.3 Other organizations

There are other organizations that are working on forest rehabilitation and HEC mitigation measures in the KARN sanctuary, namely the Five-Provinces

Forest Foundation and the Banpo Conservation Network. The details of each organization are described as follows:

The Five-Provinces Forest Foundation

The Five-Provinces Forest Foundation is one of the outstanding natural resources conservation and restoration foundations in Thailand. This transition zone forest, which is low-landed and evergreen, is 30-150 meters above the mean sea level, was abundant and had high biodiversity. But when the east region was developed, cities and industrial settlements were built along the coastline, the forest is not only altered to be water sources for expanding industrial section, but also its pollution purification sources.

At present, the forest cover of the Five-Provinces Forest is being decreased, from forest encroachment. As a result, the Ministry of Agriculture and Cooperatives has established the Five-Provinces Forest Protection Administration and appointed officers of Royal Forest Department and 13th united ranger to cooperatively patrol the area, in order to defend against encroachers. In 1993, Her Majesty the Queen appointed the project to be a Royal Project, and the Royal Thai Army has supported all operations. Her Majesty the Queen has suggested to the East Forest's administration that:

1. Everybody should cooperatively protect the forest and the army should be leading;
2. Acquire solutions to make man live with forest sustainably;
3. Use the least but worthiest of agricultural land;
4. Increase urban reforestation, start with wastelands;
5. Dredge the water sources, reservoirs, brooks, canals and swamp;
6. On account of forest's biodiversity, ecotourism should be promoted to educated people and children and to control numbers of tourists;
7. Provide more food and water sources for animals, in order to keep the wildlife in the territorial forest; and that the

8. The Royal Thai Army co-ordinate operations, including the public, in order to preserve the forest.

The Five-Provinces Forest Fund was established to sponsor all the above activities, and later became "The Five-Provinces Forest Foundation" on February 28th 2001, to support forest and wildlife preservation royal projects in the Five-Provinces Forest, in order to campaign for forest and wildlife preservation by arranging activities people can participate in, and to cooperate with other Charity Organizations in politics-free public interest. The Foundation has operated more than 100 projects, for instance, the ditch project which is also an impact assessment project, the group insurance project and scholarships for children of offices. In 2011, the Foundation's operation strategy has been assigned to be "provide and support career, improve all water sources, respond to the Queen's 8 suggestions; find the way man, forest and wildlife can live mutually and sustainably."

Roles of the Public Sector

The leaders who generate KARN's ecology restoration are Provost Vinaithorn Boonyachai Jittapalo and Mr. Sompob Wongpayak, live in Banpo district which is a plain surrounded by the Bang Pakong river. They are interested in the environmental, ecological and natural resources issues. Mr. Sompob used to farm shrimps but the shrimps were unfortunately dead, then he tried to find out the cause and discovered that it was mainly caused by a change in water quality. As a result, he gathered Banpo people and did the field visit at Khao Ang Rue Nai Wildlife Sanctuary. They found out that some part of forest has been encroached and turned into cassava fields, thereupon they unitedly reforested at the Tapkamnan forest by growing bananas; which is elephant's food, and held environmental activities continually.

The Banpo Conservation Network is to keep the Khao Ang Rue Nai Wildlife Sanctuary as the water source, natural education area, ecological and biodiversity area and subsistence area for 5 groups of people:

1) Youth Network which has 25 school students;
2) Local Entrepreneurs, such as, Toyota Motor Thailand Company Limited and Duck King Company;
3) Local people;
4) Government officers; and
5) Local Administration

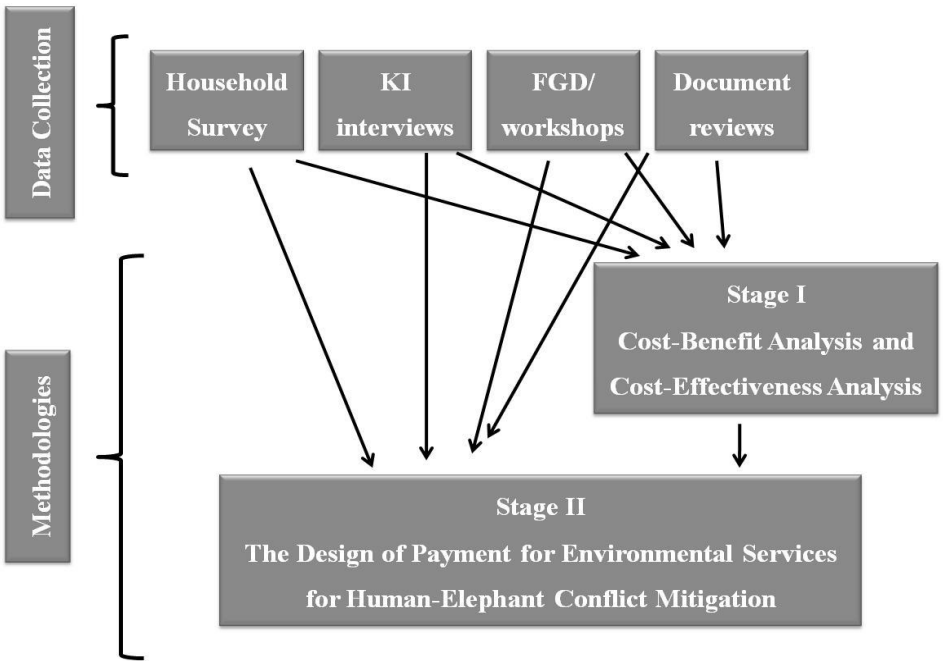
1.4 Methodology and Data Collection Methods

The study is in two stages: 1) identify the highest net benefit mitigation option for the HEC problem (Research Questions 1 & 2), and 2) design a PES mechanism for HEC reduction (Research Questions 3, 4 & 5; Figure 1.7). The objective of the first stage is the analysis of appropriate mitigation options to alleviate HEC. The methodologies used in this stage were cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA). The CBA was conducted to help decision-making relating to more efficient allocation of society's resources to select the appropriate option. The CEA was performed to provide further information on the average cost per unit of effectiveness of each policy option. The second stage was to design a PES scheme for HEC mitigation in KARN Sanctuary.

The data collection methods for the analysis leading to the construction of the model PES scheme were comprised of household surveys, key-informant interviews, expert interviews, focus-group discussions, workshops and related document reviews. The wildlife expert/key-informant interviews were arranged to get information on appropriate mitigation measures to deal with human-elephant conflict mitigation (HEC) measures and the costs of each mitigation option. Also, the PES and wildlife experts were interviewed for their suggestions to develop the

PES scheme. Focus-group discussion and workshops were arranged to get information on constraint and supporting factors to develop the PES scheme. The household survey was used to get information on attitude of households on HEC impacts, damage of crop raiding by elephant, and also mitigation measures by households. The household survey contacted 200 households in 6 affected villages. Information was also obtained from reviews of documents from both HEC and PES literature. These four sources of information were used in the cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and PES design. Also, the results of CBA on the highest net benefit of policy option were used as an input to design the PES mechanism. Also, the results of CEA provided the unit costs of HEC mitigation measures. Information on the highest benefit option from the first stage was used as the input for the second stage to design the PES schemes for HEC mitigation which is the main research of this thesis.

Figure 1.7: Methodologies and data collection methods in this study



Note: KI interviews = Key informant interviews

FGD = Focus group discussion

Source: the author

1.5 Structure of the Dissertation

The dissertation consists of eight chapters. The first chapter introduces the HEC problem, briefly describes the HEC situation and proposed HEC mitigation strategies. The methodologies and data collection methods are presented in brief. The second chapter discusses the theoretical underpinnings of PES including the theory of externality and Pigouvian welfare theorem and discusses how PES increases in economic welfare would move the economy toward Potential Pareto Improvement (PPI). The third chapter reviews the related literature on HEC mitigation strategies and experiences of PES schemes from developed and developing countries that can be used as lessons learned to develop a PES scheme. The fourth chapter presents the survey results of affected households from the HEC that reveals the impacts from HEC, household mitigation measures and households' attitudes toward the HEC problem. The fifth chapter analyzes the appropriate policy options to alleviate HEC using PES as the tool. The sixth chapter provides case studies by discussing the experiences in legal and institutional frameworks for PES from Vietnam and Costa Rica and also the challenges for Thailand. The seventh chapter assesses the potential PES scheme for HEC in KARN. The design of the PES program is discussed, assessing the means to deal with the issues of baseline, additionality, monitoring, evaluation, permanence, leakage and limitations of PES implementation. The last chapter provides discussion, conclusions and lessons learned from the study.

CHAPTER 2

THE THEORETICAL FRAMEWORK OF THE CONCEPT OF PAYMENT FOR ENVIRONMENTAL SERVICES

This chapter discusses with the theoretical framework for the concept of Payment for Environmental Services, which comprised of four components. The first section provides a background to the theoretical underpinnings of Payment for Environmental Services (PES), which come from the *Theory of Externality* and the *Pigouvian Welfare Theorem*, in which market failures are described as the main cause of environmental degradation. The second debates on *the Coase theorem* towards PES approach as discussed widely in the PES literature. The third section outlines the debates between environmental service and ecosystem service that are frequently found in the PES literature. The fourth section discusses the definition of PES and the fifth assesses the logic of PES and discusses how PES increases in economic welfare can move the economy toward Potential Pareto Improvement (PPI) for both environmental service buyers and providers. The sixth section presents the preconditions to implement a PES. The last section outlines how to analyze the efficiency of a PES schemes and discusses some features that have an effect on the efficiency of PES schemes in practice.

2.1 The Theoretical Underpinnings of PES

The theoretical underpinnings of PES can be explained by the *Theory of Externality* and by the *Pigouvian Welfare Theorem*. The root source of externalities in the environmental area is "*market failure*". Market failures are determined as a main cause of environmental degradation (Van Hecken and Bastiaensen, 2010), as can be explained as follows. Human well-being with regard to sustainable development depends on the sound policies or interventions in ecosystem management to response a dynamic interaction between human and other parts of ecosystem (Millennium Ecosystem Assessment, 2005). Furthermore, the Millennium Ecosystem Assessment reported that there was increasing degradation in capability of ecosystem to provide their service, which

caused by the excessive demand for ecosystem service, demographic changes and choices of individuals. The resulting market failure is one important reason that causes the excessive demand and inappropriate price signals (for externalities) for ecosystem services resulted in irrational resource uses and environmental degradation (Van Hecken and Bastiaensen, 2010). Market failure is the situation that the free market does not generate the optimal welfare compared to a perfect market economy (Sterner, 2003). Bator (1958) defines the market failure as "the failure of a more or less idealized system of price-market institutions to sustain desirable activities or to stop undesirable activities". The market failure occurs when the differences between private values and social values occur or called "*externality*" (Field and Olewiler, 2002). Baumol and Oates (1988) provide the definition of the externality that depends on two conditions as follows:

Condition 1: An externality is occurred when the values of individual's utility (say A's) including nonmonetary factors are chosen by others with no attention to the effects on A's welfare.

The example for the condition 1, regarding the negative externality, firms normally take into account only on what they will produce and what costs they have to pay (e.g. labor, raw materials etc.). Firms do not factor into their decisions (assuming no regulations to force them to) the negative impacts of their production – their external costs (e.g. air pollution, water pollution etc.), even though these costs represent the total costs of production to society. The external costs are borne by someone who does not make a decision about the production level resulted in oversupplied and under-price levels compared to the social optimal level (Field and Olewiler, 2002). The costs from the negative impacts from the production are called external costs or negative externality costs.

On the other hand, a positive externality or external benefit is a benefit that occurs to someone other than the decision maker from the actions of an unrelated party. It is important to note that not only is there less willingness to pay for a positive externality, the loss of social welfare is due to the under-supply of the

public good regarding positive externality activity compared to the optimum. For example, if farmers in the upstream watershed conserve the forest habitat they may receive some of their own agricultural benefits; however, their activities also create the external benefits for downstream water users in the form of flood protection, cleaner water, and other benefits. The market mechanism can relatively work well when the benefits of environmental services occur to those who make management decision as in the production of agricultural activities, however, when the benefits of environmental services flow to others (e.g. water purification), the interest of the resource manager may be not incorporate these impacts (Jack et al., 2008). The positive externality leads to a market willingness-to-pay for the good or resource that is less than the social willingness-to-pay (Field and Field, 2002). Therefore, in the presence of negative or positive externalities, the market mechanism does not produce the optimal social welfare.

Condition 2: The decision maker whose activity has an effect on others' utility levels does not receive (in case of positive externalities) or pay (in case of negative externalities) compensation as equal to benefits (or costs) to others.

The second condition is needed if the externality creates inefficiencies or resource misallocation because of condition 1. Therefore, when externalities exist, it typically calls for public intervention to make the markets work more efficiently (Field and Field, 2002). In many cases of natural resources and environmental context, when environmental services are non-excludable[4] such as biodiversity and watershed services, there is an incentive for the beneficiaries to be a "free-rider", however, many government interventions have been taken to control externalities by using command-and-control regulations and incentive-based instruments (e.g. taxes, user fees, subsidies, tradable permits) (Jack et al., 2008). In terms of *Pigouvian welfare theorem*, one can encourage the generation of positive externalities by subsidizing the marginal social benefits they provide (Baumol and Oates, 1988). Such subsidy can be called as Pigouvian subsidy. In

[4] It is impossible to prevent anyone to consume it (Thampapillai, 2002).

the absence of the subsidy, there would be too few of the actions that generate positive externalities compared to the social optimal level. The Pigouvian subsidy internalizes the positive externalities to the agents who produce them by providing incentives to produce more. The motivation for the subsidies is the attempt to reach efficient resource allocation.

PES is another form of incentive-based policy intervention that acts like a Pigouvian subsidy to internalize positive externalities, but works through the creation of a market rather than direct government payment. The beneficiaries of the positive externality pay the producers of that externality through some form of organized exchange process. The exchange process is typically set up by government, and may be run by it or through private intermediaries. In the case of human-elephant conflict mitigation, PES can be another policy option that can be compatible with existing measures (e.g. regulations on wildlife conservation). The PES scheme will be discussed in more detail later in Chapter 7 by using the theoretical framework of PES as mentioned above.

2.2 The Coase Theorem towards PES

The Coase theorem can provide a theoretical underpinning of PES mechanism where an optimum outcome can be achieved through negotiation among stakeholders with well-defined property rights to facilitate efficient market regulation of environmental problems (Engel et al., 2010; Gómez-Baggethun et al., 2010). The Coase theorem states that independent of who holds the property rights, an efficient allocation of resources can be achieved through voluntary exchange in cases of bilateral externalities if private property rights are clearly defined by enforceable contracts and there is no transaction cost (Coase, 1960). However, in practice, the Coase theorem is difficult to apply to the PES mechanism due to the high transaction costs that delay the agreement between the stakeholders to achieve the social optimum (Pirard et al., 2010). Furthermore, allocation of property rights is another concern, because property rights in many cases of PES are the de facto rights that it is not quite clear when establishing

negotiation process between those who own or manage the natural resources Muradian et al., 2010; Tocconi, 2012). However, the Coase theorem may be suitable for PES scheme when the market transactions are not too complex (Muradian et al., 2010) such as there are only few parties on negotiation but the Coase theorem might not be applicable when there are multiple stakeholders involved. This study also argued that a Pigouvian subsidy would be more appropriate for the theoretical framework underpinning of PES as explained in earlier section. It can be explained that PES is a form of incentive-based policy intervention to internalize positive externalities through creation of a parallel environmental-service market with conventional conservation approach such as command and control measures. Whether full efficiency is achieved depends on the design and operation of the PES system. This research shows that there are gains to be made in moving from the status quo to a PES-type system and hence this is the potential for a Pareto improvement that would be more efficient than the current situation where externalities persist due to HEC as shown below.

2.3 Environmental Services vs. Ecosystem Services

Environmental and ecosystem services are often used synonymously in environmental policy literature (Muradian et al., 2010; Greiner, 2010). The Millennium Ecosystem Assessment (MA) defines that "ecosystem services as the benefits people obtain from ecosystems" including provisioning, regulating, supporting, and cultural services (MA, 2005). Greiner (2010) categorized that the ecosystem service is outcome-based focusing on the wellbeing benefits of society from natural capital provision, whereas environmental service is input-based focusing on the efforts to provide natural capital improvement. In addition, Wunder (2005) explained that ecosystem service represents multiple services that are undivided into additive components; in contrast, environmental service refers to a separable nature of different services. This research focus on service provisions or input-based services where their nature of services is divisible, therefore, the term of "environmental service" would be properly used in this context.

2.4 Definition of Payments for Environmental Services (PES)

Environmental services are a growing concern for decision makers because of the market failures described above and the concern with environmental degradation. In the past, environmental degradation was addressed more through command and control policies – direct regulations, emission and technology standards, and so on. While the theoretical literature has long discussed the role of market creation to address environmental degradation, governments have only come to implement this type of policy in the last 10 to 20 years. The creation of a market is called a "Payment for Environmental (or Ecosystem) Service" and is based on the beneficiary-pay-principle (BPP), reversing the polluter-pay-principle (PPP) (Engel et al., 2008; Pirard et al., 2010, Gómez-Baggethun et al., 2010).The core principles of PES are straightforward: the ones who provide environmental services should be compensated and the ones who receive environmental services should pay for their provision (Pagiola and Platais, 2002). PES is another type of incentive-based or market-based mechanisms (Pagiola and Platais, 2002;Wunder, 2005; Jack et al., 2008; Engle et al., 2008; Adhikari, 2009; Forest Trend et al., 2008). The important advantage of incentive-base instruments compared to a command-and-control measure is their potential cost-effectiveness (Jack et al., 2008). This is because a PES is more flexible, for example, PES can be implemented in specific forest areas that higher values of ecosystem services but lower cost for conservation, whereas a command-and-control regulation would apply for the whole forest area and its transaction costs are too high (Engel et al., 2008).

A formal definition of PES is found in Wunder (2005) as "(1) a *voluntary transaction* where (2) a *well-defined environmental service* (ES) or a land use likely to secure that service (3) is being 'bought' by a minimum one *service buyer* (4) from a minimum one *service provider* (5) if and only if the service provider secures service provision (*conditionality*)". Firstly, PES is voluntary and negotiated basis which is different from command-and-control approach (e.g. regulation). Secondly, a well-defined ES that links ES and land use is needed to

make sure that buyers know what they are getting and would not question it. For instance, if it is not proven that forest cover can increase water availability, there will be no demand for forest protection to increase water supplies. Thirdly, every market transaction needs a buyer and a seller to make the exchange. Lastly, buyers only pay if the service is actually delivered, which is the most innovative characteristic of PES. Some PES programs were initiated before the name of "Payment for environment services" came to common usage, for example, the U.S. Conservation Reserve Program has compensated farmers for planting vegetation on environmentally sensitive cropland since the mid-1980s (Jack et al., 2008). In addition, Wunder (2008) described that PES is a promising thought because of the two innovative aspects, namely supply-side innovation, integrating supply and demand sides. Firstly, the idea of supply-side innovation on conservation providers assures to use the current conservation funds more efficiently with strong compliance with the agreement. Secondly, PES is a tool for buying conservation and creates sustainable financial supports for conservation by integrating supply and demand sides.

2.5 The Logic of the Classical PES Case on Watershed Services

The logic of the classical PES case on watershed services was developed as shown in Figure 2.1 (Pagiola and Platais, 2002; FAME, 2011). The figure illustrates the potential for a PES system. In Scenario I, the business as usual case, the land managers or upstream communities only view their benefits from conversion to farmland because there is no means to secure any of the benefits conservation might provide to the downstream users. The blue area under scenario 1 is the private benefit to the landowner and the red area represents to costs to the downstream parties. If a PES system could be introduced, the seller of the conservation benefits (the upstream landowner) would express its willingness to accept compensation for protecting nature (by, for example, converting less land to pasture) and the buyer (the downstream parties) will express their willingness to pay (WTP) for that amount of conservation. If the WTP is large enough to offset the losses to the upstream landowner (its foregone

income from land conversion), it will be no worse off and the downstream parties will be better off. The actual amount of money changing hands will depend upon a number of factors such as bargaining power, information, number of buyers and sellers and so on. The above relationship can be written as in following equation (FAME, 2011).

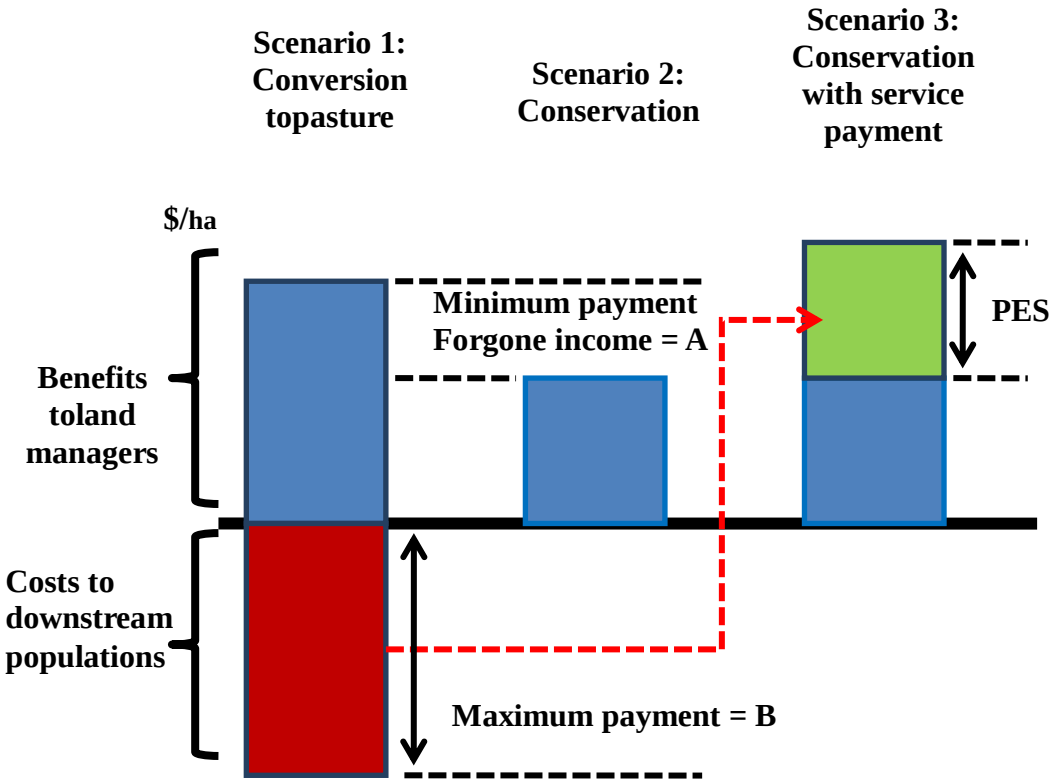
$$A = WTA \leq PES \leq B = WTP$$

when A = Forgone income or minimum willingness-to-accept (WTA) of land managers or upstream communities = net opportunity cost of conservation

B = External costs to downstream communities or maximum willingness-to-pay (WTP) of downstream communities or service buyers

PES = The payment level of the watershed conservation scheme

Figure 2.1: The Logic of PES for Watershed Services



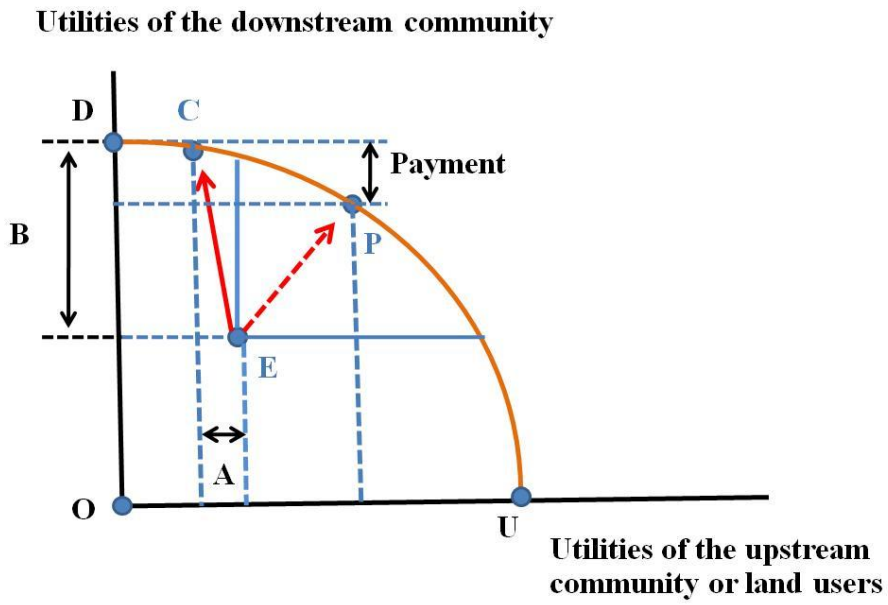
Source: Adapted from Pagiola and Platais (2002) and FAME (2011).

In welfare economics theory, the Pareto criterion refers to a technique for ranking alternatives of the economy (Just et al., 2004). According to this criterion, if it is possible to make at least one person better off from state A1 to state A2 without making anyone else worse off, therefore, state A2 is ranked higher than state A1. Hence, the movement from state A1 to state A2 is defined as a "*Pareto criterion*". However, in fact, it is almost impossible to implement any social policy without making at least one person worse off. Therefore, *Kaldor–Hicks principle* provides a more efficient outcome for those who are better off from the policy could compensate those who are made worse off, so that a Pareto improving outcome results or called *Potential Pareto Improvement (PPI)* (Varian, 1992). Figure 2.2 shows utility levels of the two members in the economy, upstream and downstream communities. The upstream community represents the land user or service provider, whereas the downstream community acts as the

service buyer of watershed services. The resources are limited; therefore, only inside of the DOU area is achievable. The DOU area is a bundle of environmental services for each of two members of society which is feasible to allocate for achieving a Pareto improvement. In principle, any allocation to the upper-right location that improves both upstream and downstream communities is a Pareto preferred.

At E, C and P represent the allocations of the scenario of business as usual (status quo situation), the scenario of watershed conservation without PES and the scenario of PES scheme respectively. Moving from point E (business as usual) to C (conservation), the downstream community saves their external costs of environmental degradation from watershed conservation (equal to B), whereas the upstream community losses their income due to conservation or less deforestation/conversion to pasture (equal to A). However, the upstream community may not want conservation (moving from point E to C) because their net benefit is negative (equal to "A" level). The PES scenario is the second-best option. With PES scenario, the downstream community (the beneficiary or service buyer) can compensate a part of welfare gains (less than "B" level but higher than "A" level) to upstream community (the service provider) who losses in welfare from conservation (equal to "A" level) through PES. Therefore, a movement from point E to P represents a Pareto improvement. For that reason, PES creates a Potential Pareto improvement or increase in economic welfare for both actors (FAME, 2011) and this notion can be applied to the Human-Elephant conflict situation.

Figure 2.2: Potential Pareto Improvement of a PES Scheme



Source: Adapted from FAME (2011).

2.6 Precondition for a PES scheme

Wunder (2008) described that there were five preconditions for PES implementation, namely economic, competitive, cultural, institutional and informational preconditions. The details of each component can be described as follows:

A. Economic precondition

Firstly, the "externality" should exist, for example, the benefits of environmental services from the landowner can provide the external beneficiaries. Secondly, the value of environmental services (service user's willingness to pay for PES) should be higher than the opportunity costs of service providers, for example, income foregone for giving up the first-best land-use plan (service provider's wiliness to pay plus transaction costs).

B. Competitive precondition

Ideally, a PES system should have enough buyers and sellers to be 'competitive' in that no one can dictate the price. Examples of competitive market systems for PES are difficult to find. Most PES schemes are monopsonies (transactions with one single buyer) or oligopsonies (transactions with only few large buyers who can influence on the negotiations). According to market precondition with supply and demand condition, most PES schemes never take place because of the high transaction costs. Nevertheless, market and competitive conditions are not necessary and sufficient preconditions for PES, therefore, the design of PES scheme should be focused on the contract theory rather than the market concept.

C. Cultural precondition

If service providers feel that the payment from PES is not an incentive for them or PES scheme is considered to be socially inappropriate, then PES cannot be used. When non-economic value systems are significant and functioning, there may be strong resistance for PES initiative and using non-monetary payments might be preferable. Hence, the design of PES would be adaptive to harmonize with pre-existing values and systems of natural resource management.

D. Institutional precondition

Most PES schemes have been developed at the local level, therefore, trust between service users (buyers) and providers is needed. However, there is a conflict of interests between service users and providers by nature. In addition, in many PES initiatives are the idea from external intermediaries. Hence, trust between users and providers are difficult to develop naturally. PES cannot be applied, especially if there is a great conflict and property rights for land are not clear. In contrast, PES is appropriate for the case of institutional ineffectiveness, such as when it is difficult to implement the command-and-control measures. Furthermore, the effectiveness of PES also depends on whether the legal system is able to enforce the PES contract effectively. Therefore, it would be preferable to

have contracts that are independent or not fully dependent on the legal system, and then the contract can be stopped or suspended in case of non-compliance**.**

E. Informational precondition

PES schemes are comparatively information-intensive, which has an effect on transaction costs. Moreover, transaction costs mostly are high at the beginning of the scheme (e.g. for negotiation, baseline assessment of environmental services, design of the system etc.) than at the operational stage (e.g. monitoring, administration etc.). Transaction costs can be a significant obstacle for PES scheme, particularly when several environmental-service buyers and sellers from different social norms involve or the targeted environmental service is complex.

2.7 The Efficiency of PES Schemes

One important question of PES schemes is whether the schemes are efficient or not. Efficiency is achieved when environmental services are conserved in the long term with the lowest usage of resources (Pirard et al., 2010). To analyze the efficiency of PES schemes, one needs a framework as well as an understanding on how the choice of baseline and duration of PES contracts can affect the efficiency of the scheme.

(A) Framework to analyze the efficiency of PES schemes

Engel et al. (2008) analyzed the framework to examine the efficiency of PES as showed in Figure 3.3. The horizon and vertical axis represent net private profits from the land users and the net value of environmental services they generate to others or positive externalities respectively. The top-right quadrant is "win-win" area where profits of land users and positive externalities take place, whereas the bottom-left quadrant is "lose-lose" area where profits of land users and positive externalities are in deficit. At bottom-right quadrant, the land users receive profits from their practices but create negative externalities. In contrast, land-use practices in the top-left quadrant are privately unprofitable but generate positive externalities. Furthermore, the 45^{o} diagonal divides between the area

whose total value to society is positive (above) and the area whose it is negative (below).

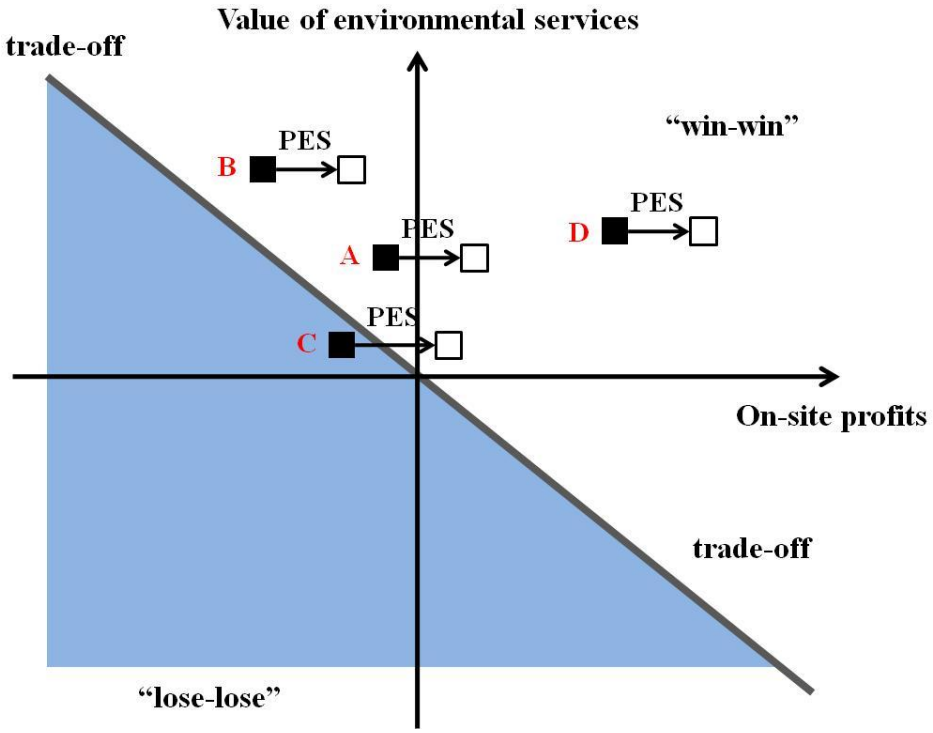
The case A in Figure 2.3 demonstrates the goal of PES where the PES scheme tries to make from individually unprofitable but positive externalities to privately profitable of land users, therefore, it can be an incentive for them to adopt the conservative practices. However, there are several cases of inefficient PES schemes. Firstly, the case B is the situation that payments are not adequate to encourage land-user to adopt socially-desirable practices, hence conventional land-use practices remain in use resulted in the failure to adopt preservative practice, although social benefits is higher than their costs. Secondly, the case C is where the costs of the payment to supply environmental services in socially-undesirable land uses are higher than the value of environmental services. This case is also socially inefficient because the benefits of land-use practices are lower than their costs. Lastly, the case D is the situation that there are no payments because land users would adopt the preservative practices anyway. However, the case D is not socially inefficient since the practices adopted provide socially efficiency but may represent financial inefficiency of the scheme where the scheme creates environmental services less than their unit cost. Moreover, it also can be socially inefficient when funds for the scheme are limited and reduce fund available that affects socially-efficient practices in other cases.

Another two concerns that have been discussed in many studies on efficiency of these schemes are leakage[5] and the permanence of PES schemes. If the scheme cannot prevent leakage, the environmental services from the scheme may be overestimated (Engel et al., 2008). Furthermore, the PES scheme should aim towards a long-term contract called permanence but also be able to adapt to changing conditions according to financial mechanisms and the circumstances of stakeholders (Smith et al., 2006; Engel et al., 2008). However, Engel et al. (2008) argued that in the case that the condition has changed so much, the agreement

[5] The conservation in one area may cause degradation in another area (Smith et al., 2006).

between the buyer and seller might not be achievable, resulting in continuing a scheme that would not be socially efficient. Therefore, the short-term contract might be sufficient in this case to cause a change from environmental degradation activities to environmental conservation practices.

Figure 2.3: A Framework to Analyze the Efficiency of PES



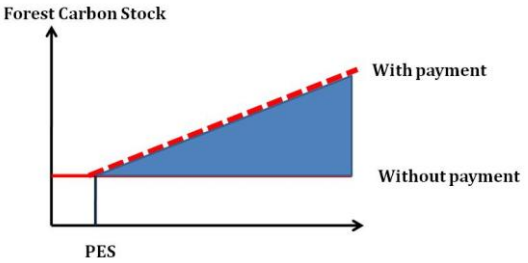
Source: Engel et al. (2008).

(B) Baselines of the PES scheme

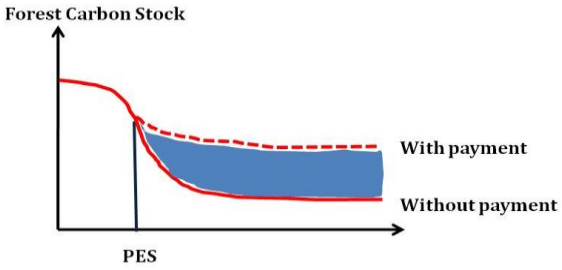
The key question that service buyers ask is whether the PES scheme has an adequately additionality (Wunder, 2007). To evaluate the efficiency of PES, the baseline needs to be set properly to measure how much more real improvement the scheme generates compared to a situation without the scheme. This is called additionality. The baseline scenarios (the difference in service provision between the with-PES scenario and the without-PES scenario) can be categorized to be three types (Figure 2.4), namely static, deteriorating, and improving baselines (Wunder, 2005). For example, in case of carbon credits, the

static baseline scenario would be the case when forest carbon stock is assumed to be constant in business as usual. The deteriorating baseline scenario presents the case that forest cover will be decreased even without PES, whereas the improving baseline scenario is the case that forest cover will be increase even without PES. Applying the wrong baseline can lower PES financial efficiency or even waste all money if no additionality environmental service will be provided (Wunder, 2007).

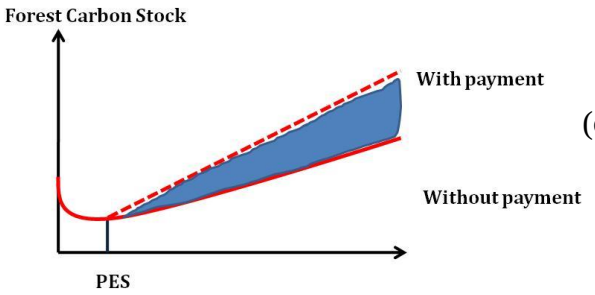
Figure 2.4: Three baseline scenarios



(a) Static baseline scenario



(b) Deteriorating baseline scenario



(c) Improving baseline scenario

Note: ■ additionality; Source: Wunder (2005)

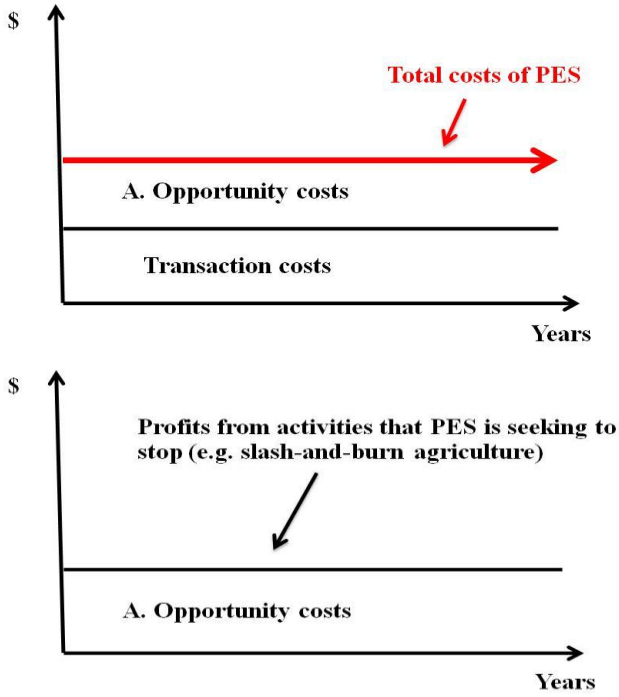
(C) Duration of the PES contract

The choice of PES contract is also important for the costs of PES implementation. The duration of the PES contract is another debate on PES design between permanent compensations versus temporary investments depending on the environmental service is delivered by the service provider (Pirard et al.,

2010b). Some more clarification on these two types of PES scheme, the permanent compensation is the providers who receive money need to stop some rights over the natural resources (e.g. the conservation agency buys logging right to public forest from the government or cessation of logging), whereas the temporary investment is the providers who receive payments conditional to investing in alternative conservation activities (e.g. planting trees in degraded lands with low productive alternatives). Wunder (2005) named the permanent compensation and temporary investment as "use-restricting" scheme and "asset-building" scheme respectively.

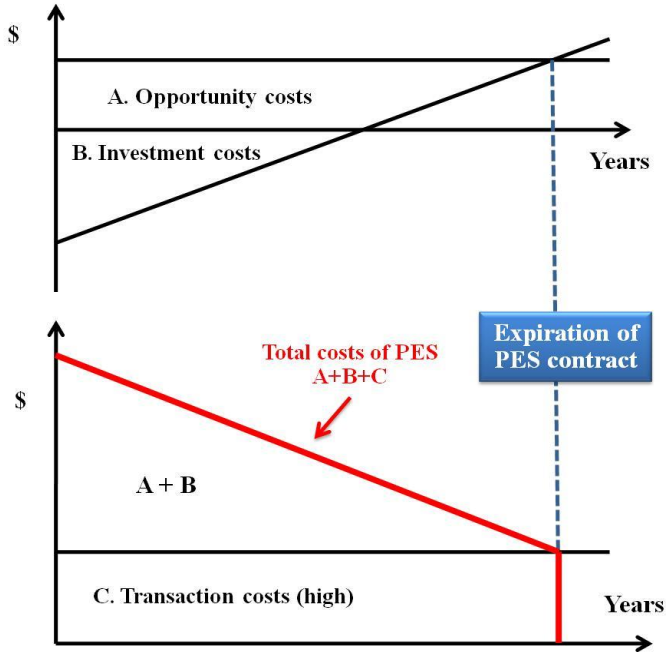
Pirard et al. (2010) suggested that costs of an asset-building PES scheme are generally cost-decreasing over time (Figure 2.5); in contrast, costs of the use-restricting PES scheme are growing over time (Figure 2.6). The advantages of the use-restricting PES scheme is its simplicity and lower costs in the short-term compared to the asset-building PES scheme (see red curve in Figure 2.5 and 2.6). It is easier to offer farmers money and monitor the cessation of farming close to the KARN border for example than to provide training to set up sustainable management programs for the Human-Elephant interface, however, the use-restricting PES scheme might be costly (continued payments) and ineffective (demand for agricultural land still exists). Therefore, while the use-restricting PES scheme may be effective at project level, which is likely to provide quick ecosystem benefits, it may create a "leakage" effect somewhere else. Furthermore, the freezing of rights over natural resources resulting in potentially relative scarcity of basic commodities is expected to increase the price of these commodities and therefore the cost of the PES scheme (through the increasing of opportunity costs). Therefore, while the costs of the asset-building PES scheme are more expensive in the short term because it includes investment and transaction costs that are expected to be high (fencing, food supplies in the sanctuary, etc), its benefits are clearer in the long-run than the use-restricting PES scheme.

Figure 2.5: Costs of the Use-restricting PES scheme



Source: Pirard et al. (2010).

Figure 2.6: Costs of the Asset-building PES scheme



Source: Pirard et al. (2010).

2.8 Conclusion

This chapter has described the theoretical framework for PES. The theoretical underpinnings of PES can be explained by the theory of externality and the Pigouvian welfare theorem. Under the theory of externality, the main sources can be explained by the concept of market failure. However, the externalities can be either negative or positive. In the case of positive externalities, beneficiaries can encourage the generators of positive externalities by subsidizing them for marginal social benefits they provide (Baumol and Oates, 1988). Such subsidies can be called Pigouvian. Therefore, PES is an incentive-based policy intervention as a Pigouvian subsidy in order to internalize positive externalities through creation of an environmental-service market. Furthermore, PES also can create a Potential Pareto Improvement (PPI), or increase in economic welfare for both service providers and beneficiaries (service sellers). However, the preconditions (namely economic, competitive, cultural, institutional and informational) before PES implementation need to be considered. To measure the efficiency of a PES scheme, several aspects should be considered, such as how to set the baseline properly to measure additionalities or the choices of a PES contract that has an effect on costs of the scheme.

CHAPTER 3

REVIEW OF LITERATURE

The review of literature can be separated into two parts. First, the reviews of PES and PES-like[6] programs that relate the problem of paying for environmental services to this study (wildlife conservation and watershed protection) are presented. Second, the chapter reviews the experience of human-elephant conflict (HEC) mitigation strategies from South Asia and Africa and experiences from two selected HEC cases in Thailand. Also, the conclusion of this chapter is presented.

3.1 Payment for Environmental Services (PES)

There is a growing interest in using PES approach in conservation because the current approaches (e.g. command-and-control measures to isolate elephants from human interaction) that require significant funds and budgets for conservation are typically too small to implement all the measures. The payment scheme is an innovation using markets to provide incentives for improving environmental management (Smith, 2008; Wunder et al., 2008). The logic of the PES approach is that those who provide environmental services (ES) should be compensated for their services and that those who receive the services should pay for their benefits (Pagiola et al., 2005).

Furthermore, Wunder (2005) has argued that PES can be distinguished from other conservation approaches in terms of the degree of reliance on economic incentives and the context that targets directly to conservation rather than integrate into development approach. For example, the purpose of command-and-control regulations is to conserve the natural resources and environment without any incentive and voluntary features as PES.

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[6] A PES-like program refers to the programs that match most criteria of PES definition but not all (Wunder, 2007).

There are two reasons to make PES a promising idea (Wunder et al., 2008). First, PES is an important supply-side innovation of the direct buyers of conservation. The conservation activities frequently are seen as unattractive to the service providers such as farmers and fishers. PES approach can be the way to deal directly with social and private benefits where service providers are paid directly regarding measured ES units are delivered. Second, PES can be viewed as a demand-side innovation. In many cases, conservation is viewed as the responsibility of the government and most conservation funding relies only on the government budget, but PES puts buyers and sellers of conservation together, so those who benefit from environmental services have a more direct means of paying for these benefits. Furthermore, conservation funding must battle with other requirements of scare budgetary resources (e.g. poverty alleviation and economic development). PES can provide new funding for conservation by matching the users (or service buyers) directly with service providers.

The reviews of PES and PES-like programs in this section were selected based on environmental services related to this study, which are wildlife conservation and ecosystem restoration. In term of demand-side management, PES/PES-like programs can be categorized to be two types, namely government-finance and user-financed PES programs. The service buyers of government-financed programs are a third party (especially the government) and voluntary only on provider sides, whereas the service buyers and service providers of user-financed programs are voluntary (Wunder et al., 2008). There is a growing number of PES/PES-like programs of government-financed PES programs including the Costa Rican payments for environmental services (PSA) (Pagiola, 2008), Working for Water (WfW) in South Africa (Turpie et al., 2008) and Sloping Land Conversion Program (SLCP) in China(Bennett, 2008). In addition, the user-financed program of several PES/PES-like schemes have been established, such as watershed services between downstream users and upstream landowners in Bolivia (Asquith et al. 2008), hunting and eco-tourism in Zimbabwe (Frost and Bond, 2008) and eco-tourism in India (Wangchuk et al., 2010), wildlife-friendly rice in Cambodia (Clements et al., 2010), habitat credits

for federal governments or private companies in United States who want to offset impacts on habitat and gopher tortoise populations (Gartner, 2010), and the New South Wales Biodiversity Banking and Offsets Scheme (BioBanking Scheme) for developers who want to offset the negative impact of their development (DECC, 2007). However, the habitat-credit-trading system in United States would be classified to be a user-financed program, even service buyers can be the government sectors because the service buyers in this case is not the third party as in other schemes.

3.1.1 Environmental service (ES) provision

This section aims to review the major key components of PES design as mentioned in the literature, namely environmental services, baselines, additionality, leakage and permanence. Table 3.1 gives the definitions and how significant each effectiveness indicator is likely to be. These are aspects of all PES schemes that must be addressed in their design and operation.

Table 3.1: Definitions and their significances of each effectiveness indicators for a PES scheme

Indicators	Definition	The significance of each effective indicator
Baselines	Baselines are the current status of environmental services in any area.	We need to consider what would hypothetically happen without the PES scheme, therefore, to construct a counterfactual ES baselines are required to track the delivery of these services to benefit users. These baselines must be chosen carefully and should account for changes over time that are expected to occur without a PES scheme being in place.
Additionalities	Additionalities are additional environmental services in the PES scheme compared to a baseline, and can be called the "marginal benefit services" provided by service providers.	Additionalities are the goal of the scheme. Additionalities are the effects that would not have occurred without the scheme. If there is no additionality, it means we pay for the activities that happen anyway.
Leakage	The results when activity in one location causes degradation to shift to another area.	The PES scheme should prevent "leakage" or make sure that environmentally-damaging impacts are not displaced elsewhere.
Permanence	The PES scheme should try to establish a long-term basis or "permanence".	The PES scheme should be designed on a long-term basis because the service provision will be ended when the payments are terminated. Consequently, the PES scheme cannot be sustained.

Note: ES = Environmental services

Sources: Smith et al. (2006), Forest Trends et al. (2008); Wunder (2005).

Table 3.2 summarizes the main characteristics of PES programs in selected cases. Among these cases, most schemes, except Sloping Land Conversion Program (SLCP), include multiple ES. According to government-financed programs, the Working for Water (WfW) program responded to the effect of the threat that invasive alien plants posted to water supplies (Turpie et al., 2008). The SLCP was initiated by the central government in China that tried to reduce soil erosion and desertification and increase forest cover by retiring steeply sloping and marginal lands from agricultural production (Bennett, 2008). The Payment for Environmental Service (PSA) in Costa Rica was introduced to provide ES for watershed protection, forest conservation and timber plantation managed by FONAFIFO, a semi-autonomous agency with independent legal status (Pagiola, 2008).

Regarding user-financed programs, The Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) is a program initiative to alleviate the conflict between farmers and wildlife that were treated as pests (Frost and Bond, 2008).The Rural District Councils (RDCs) were chosen to serve as the intermediaries to manage wildlife revenues on behalf of communities. Safari operators are the ones who buy the rights through the contracts with the RDCs for bringing sport hunters and eco-tourists to their concession areas to hunt (a set quota of animals), track, observe and take pictures of wildlife under some conditions for communities; not to disturb or hunt wildlife in concession areas, to limit expansion of crops and livestock and to restrict human settlement to agreed zones. Similarly in the case of CAMPFIRE, the Snow Leopard Conservancy (SLC) in India, as one of intermediaries, proposed a program to mitigate the snow leopard-human conflict and snow leopard conservation by providing non-monetary incentives that enhanced income from ecotourism for rural households (Wangchuk et al., 2010). The non-monetary incentives can be in the form of assistance in setting up ecotourism/homestays/protecting livestock corrals under a conservation condition according to the contract with SLC-India and the local Village Management Committee. In Bolivia, the PES scheme was introduced to supply the conservation of bird and watershed protection via annual contracts for

tree-cutting and hunting bans on enrolled areas (Asquith et al., 2008). The agri-environment payment program in Cambodia is the payment scheme in the premium prices to wildlife friendly products for farmers those who are carrying out with compliance with land-use plan and no-hunting rule (Clements et al., 2010). Furthermore, the voluntary Sandhill (gopher tortoise) habitat credit trading system is quite different from the previous cases. In this system, the eligible forest owners within specific areas will be issued credits for verifiable gopher tortoise habitat and/or agreed upon management activities (Gartner, 2010). Each credit is a unit of trade on habitat conservation/restoration and can be voluntarily purchased by the government or private sectors to offset impacts on Sandhill habitat and gopher tortoise populations. Similarly, the product of the New South Wales (Australia) BioBanking Scheme being bought and sold is called biodiversity credits, which are assessed from biodiversity condition or population of threaten species (DECC, 2007). The BioBanking Scheme launched in July 2008. In principle, Biobanking is a voluntary market-based instrument (MBI). Three main groups of stakeholders are involved; namely the landowners, developers and conservationists. The suppliers of credits are landowners who agree to reserve all or part of their land as a BioBank site and manage this site for conservation. Biodiversity credits can be bought by developers, by conservationists and even by individuals (e.g. for their charity reasons).

3.1.2 Baselines and Additionality

Table 3.3 presents the effectiveness indicators of the PES/PES-like schemes as described above. The PES scheme will be accomplished when it can provide additionality to current status, therefore, the goals of the payment scheme need to be identified as baselines (Smith et al., 2006; Forest Trends et al., 2008). This baseline must be chosen carefully because if ES would increase without the payment scheme, it means we pay for action that would have happened anyhow, which may lead to a loss of credibility (Smith et al., 2006; Wunder, 2005). However, additionality is difficult to measure in practice because it requires comparing "with-PES-intervention" scenario with "business-as-usual"

counterfactual scenario (Wunder et al., 2008). Moreover, every case attempted to measure additionality according to ES provision.

In these sample cases, an indicator used for measuring additionality for watershed protection is a change of stream flows and land uses, whereas indicators for wildlife conservation are additional wildlife population and reduction of economic and mortality losses due to human-wildlife-conflict. For watershed service provision, an increase of clearing invasive alien species and stream flow were used as proxies for additionality in the case of Working for Water (WfW) (Turpie et al., 2008). They claimed that the program has cleared more than one million of invasive alien species during 1997 - 2006 that can increase stream flow by nearly 46 million cubic meters annually. Total land areas for retirement were used as a measure of the Sloping Land Conversion Program (SLCP), however, no explicit baseline that can be evaluated what would happen without SLCP scheme (Bennett, 2008). Nevertheless, it was claimed that SLCP provide additionality because farmers would not retire their lands without the scheme. For PSA case, the forest-cover was used as the baseline of the scheme, however, the indicators for additionality were not clear since the lack of data on each activity was (Pagiola, 2008).

According to the indicators of environmental services on wildlife conservation, three indicators to measure additionality of the CAMPFIRE program are 1) the populations of elephants, buffalo and other large species in CAMPFIRE areas, compared to change in other areas in Zimbabwe; 2) a change in wildlife habitat in CAMPFIRE areas using remote sensing; and 3) total wildlife revenue in CAMPFIRE areas as a proxy of wildlife production (Frost and Bond, 2008).Similarly, a reduction in livestock depredation and additional tourism revenues of the snow-leopard conservation scheme were applied as indicators for additionality of the scheme (Wangchuk et al., 2010; Jackson and Wangchuk, 2004). A change of land use compared to the baseline was applied to be an indicator to measure additionality of bird habitat and watershed protection in Bolivia (Asquith et al., 2008). Nevertheless, additionality might be low since the

land under the conservation contract is not the most threatened by agricultural clearing. This is because the lands that have clear ownership are at low risk of deforestation. Regarding market-based habitat credit trading system, habitat condition and gopher tortoise population were employed as indicators to measure additionality of habitat improvement and gopher tortoise conservation (Gartner, 2010). According to a BioBank scheme in New South Wales, the assessment of biodiversity values and threaten species is required to determine the number of biodiversity credits that can be created at a BioBank site or required at a development site (DECC, 2008); therefore, the additional biodiversity credits can be a proxy of additionality.

3.1.3 Leakage and Permanence

Another element to convince service buyers that PES scheme will be effective is to prevent "leakage" or conservation actions in one area will not shift degradation to another area (Smith et al., 2006; Forest Trend et al., 2008; Wunder et al., 2008). Leakage is occurred when the scope or level of interventions (e.g. whether the scheme includes the entire watershed or only part of watershed) is lower than the required services (Wunder et al., 2008). In case of the scheme including only a part of watershed, if the soil erosion displaces elsewhere, the leakage would occur. All these sample schemes tried to design carefully to prevent the leakage. For example, the WfW scheme in South Africa may argue that there was no leakage since clearing alien species in specific areas by employing unemployed workers might not lead to degrade other forest areas. In case of CAMPFIRE, most communal areas where contain the wildlife population are part of the program, therefore, the leakage problem would be less significant (Frost and Bond, 2008). The case of snow leopard conservation would be similar because prime wildlife areas are targeted. Unfortunately, initial credit transactions were expected to occur in 2010; therefore, there is no information on monitoring and leakage in the scheme of habitat credit trading system. Also, there is no information provided on leakage in the BioBanking scheme in New South Wales. Pagiola (2008) claimed that leakage in Payments for Environmental Service

(PSA) in Costa Rica was limit because there was no report on impact to other areas.

The question on whether the scheme would be on a long-term basis or called “permanence” is another concern about the design of PES/PES-like schemes (Smith et al, 2006; Wunder et al., 2008). In all sample cases, the length of the scheme depends on the contract period; therefore, it can say that the permanence of each scheme may not be secured. In user-financed programs, the schemes depend on the satisfaction of the users whether they receive the service they desire, whereas the government-financed programs depend on continued budget allocations (Wunder et al., 2008). Furthermore, the permanence of the scheme also depends on other economic factors, for example, the permanence of CAMPFIRE program also depends on the relative market prices of wildlife and agricultural commodities, which could impact the land-use practices (Frost and Bond, 2008). Moreover, there was an effort to design the scheme to encourage permanence in the supply side of ES in the SLCP program by introducing tax exemption given to farmers on income earned from trees and grasslands planted under the program (Bennett, 2008). Although the BioBanking scheme period depends on the contract period, it can likely be a long-term scheme as long as the development generates the negative impacts to the environment and the laws allow developers to offset them. The demand for biodiversity credits is still remain. Hence, the scheme should be adaptively designed to ensure that ES is responsive to the changing needs of service buyers (Smith et al., 2006) and market conditions (OECD, 2010).

Table 3.2: Design of selected PES and PES-like case studies

Country	Environmental services	Service buyers	Service providers	Intermediaries
Government-financed programs				
1) Working for Water (WfW), South Africa (Turpie et al., 2008)	Watershed protection and biodiversity by clearing alien species	Central government (85%) and water users (15%)	Working for Water (WfW) by employing workers	WfW
2) Sloping Land Conversion Program (SLCP), China (Bennett, 2008)	Watershed protection	Central government	Rural households	Village, township and county governments
3) Payments for Environmental Services (PSA), Costa Rica (Pagiola, 2008)	Water and forest conservation and timber plantations	FONAFIFO (autonomous state agency)	Private landholders, indigenous communities	FONAFIFO (autonomous state agency)
User-financed programs				
4) CAMPFIRE, Zimbabwe (Frost and Bond, 2008)	Human-wildlife conflict mitigation and landscape beauty	Private safari operators and international donors	Communities through Rural District Councils (RDCs)	RDCs (in part representing communities)
5) Bolivia (Asquith et al., 2008)	Bird habitat and watershed protection	Pampagrande Municipality, US Fish and Wildlife Service	Santa Rosa farmers (46 landowners)	Fundación Natura (NGO)

Table 3.2: Cont.

Country	Environmental services	Service buyers	Service providers	Intermediaries
6) Agri-environment payment, Cambodia (Clements et al., 2010)	Wildlife conservation by hunting ban of key species	Tourists who buy wildlife-friendly rice	Rural households	(1) village committees: management of tourism services, (2) PA authorities: legally approve tourism agreements and enforcement, (3) External agency: certification & marketing, (4) Private sectors: sales of rice
7) Snow leopard conservation, India (Wangchuk et al., 2010; Jackson and Wangchuk, 2004)	Snow leopard conservation and Leopard-human conflict mitigation	Tourists	Rural households	the Snow Leopard Conservancy (SLC-India) and the local Village Management Committee
8) Market-based habitat credit trading system, USA (Gartner, 2010)	Habitat improvement and gopher tortoise conservation	Government /private sectors who want to offset impacts on gopher tortoise habitat	Landowners	the American Forest Foundation and Longleaf Alliance
9) BioBanking NSW (DECC, 2007)	Biodiversity offsets to improve biodiversity condition	Private companies who want to offset impacts on their development	Landowners	New South Wales Department of Environment and Climate Change (DECC)

Source: 1. (1) – (5) were adapted from Wunder et al. (2008), 2. Sources of (6) – (8) were indicated in the table

Table 3.3: Factors affecting effectiveness and efficiency of selected PES and PES-like case studies

Countries	Baselines	Additionality	Leakage	Permanence
Government-financed programs				
1) South Africa (Turpie et al., 2008)	Baseline of stream flows	Increased water runoff	None	Not secured beyond contract period
2) Sloping Land Conversion Program (SLCP), China(Bennett, 2008)	No explicit baseline	Total land areas for retirement	Only one survey suggests leakage does occur	Not secured beyond contract period
3) Payments for Environmental Services (PSA), Costa Rica (Pagiola, 2008)	Static forest-cover baseline	Unclear	Low	Not secured beyond contract period
User-financed programs				
4) CAMPFIRE, Zimbabwe (Frost and Bond, 2008)	Baselines of key species' population, wildlife habitat, and wildlife revenue	Additional number of wildlife population and hunting revenues	Limited, since prime Wildlife areas are targeted	Not secured, but changed local attitudes to wildlife
5) Bolivia (Asquith et al. 2008)	Baselines of vegetation cover and land uses	Probably low, as low-threat areas are enrolled	Low; some at on-farm level	Not secured beyond contract period

Table 3.3: Cont.

Countries	Baselines	Additionality	Leakage	Permanence
6) Agri-environment payment, Cambodia (Clements et al., 2010)	Unclear on key species population	Unclear on key species protection but farmers got benefits from higher prices of rice	No information	Not secured beyond contract period
7) Snow leopard conservation, India (Wangchuk et al., 2010; Jackson and Wangchuk, 2004)	Baseline of livestock loss	Reduction in livestock depredation and additional tourism revenue	Limited, since prime Wildlife areas are targeted	Not secured beyond contract period
8) Market-based habitat credit trading system, USA (Gartner, 2010)	Baseline of habitat conditions and gopher tortoise population	Additional number of gopher tortoise population	No information	Not secured beyond contract period
9) BioBanking NSW (DECC, 2007)	Baselines of biodiversity values and threaten species	An increase in the habitat or population of a threatened species	No information	Not secured beyond contract period

Source: 1. (1) – (5) were adapted from Wunder et al. (2008), 2. Sources of (6) – (8) were indicated in the table

3.2 Human-Elephant Conflict (HEC) Mitigation Strategies

3.2.1 Experiences from South Asia and Africa

Human-Elephant Conflict (HEC) measures are often called as "mitigation" because most HEC could never be completely eliminated; therefore, conflict reduction should aim to reach the local "tolerance level" toward elephants rather than expect to eliminate the problem (Dublin and Hoare, 2004).The main factors causing the increasing confrontation between human and elephants are expansion of agricultural and human settlement into the forest, loss of elephant habitats and blocking of elephant migration routes, and human activities that attract elephant (e.g. crop planting and building water reservoirs for irrigation or power generation near elephant habitats, Perera, 2009). The reviews in this section focus on the current HEC mitigation and also innovative measures to alleviate the conflicts. Many studies (e.g. O'Connell-Rodwell et al., 2000; Osborn & Parker, 2003; Fernando et al., 2008; Gunaratne & Premarathne, 2006) try to look at the effectiveness of current mitigation measures, whereas some studies (e.g. Zhang & Wang, 2003) attempt to test the new methods to alleviate the impacts of the conflict. However, no one method can be standalone solution (Fernando et al., 2008; Gunaratne & Premarathne, 2006).A review of mitigation measures is discussed in the literature that follows.

In many cases of HEC in Asia and Africa, main damage is caused by elephant males who turn into habitual crop-raiders (Hoare, 1995). There are a few studies on economic losses from crop-raiding. Zhang and Wang (2003) reported that the main impact of HEC in Simao, China was crop loses and property damages in which total economic losses between1996-1999 were approximately 2,600,000 yuan RMB or USD314600. Amwata et al. (2006) reported that economic losses of crop production due to elephant raiding in the areas adjacent to Mochongoi Forest, Baringo, Kenya ranged from between USD 75 to 2,000 or a mean of USD 450 per farmer annually. Ngene and Omondi (2009) estimated the economic losses of crop raiding by elephants in the areas adjacent to Marsabi

National Park and Reserve in Kenya between August 2004 and July 2005 (excluding December 2004 and April 2005 due to rains). The crop losses of 414 farms were approximately USD208814 during that period. Furthermore, factors that influenced the risk of crop raiding are also important. Barnes et al. (2005) found that a major influence to a farm's risk of crop raiding depending on distance to boundary, size of cultivated areas, number of crops planted on the farm, and degree of farm's isolation. Farm adjacent to park boundary were most at risk and larger farms tended to more attractive to elephants. More food crops would also likely increase the probabilities of crop raiding. Finally, the isolated farms were more vulnerable than those in the clusters because farms in the clusters might help each other to guard the crop, while isolated farms are more likely to leave their crops unprotected for a long period.

The HEC mitigation measures analyzed can be broadly categorized into 10 types, the details in each measure can be described as follows:

(A) Traditional Methods

The traditional methods are usually made from low-tech materials that are found in rural areas (Parker, 2007; Nelson et al., 2003). These measures range from making fire or a noise with firecrackers and yelling to the erection of human effigies (scarecrows), in which the main propose of these measures is to chase elephant away (Nelson et al., 2003; Fernando et al., 2008; Parker, 2007).The reason that traditional methods are still widely used is they are easy to use and have low costs (Nelson, 2003; Fernando et al., 2008). The problem with all traditional measures is that they tend to become ineffective overtime because elephants become habituated[7] once they learn there is no real harm (Parker, 2007; Nelson, 2003; Hoare 2001; Zhang & Wang, 2003) and elephant behavior is adaptable (Osborn & Parker, 2003) and trainable. Other disadvantages of traditional measures are the need to be used in combination and the danger of using methods near elephants that lead to psychological stresses on households

[7] Habituated means elephants can learn that method is serious no harm to them, then after period of exposure, they just ignore it (Hoare, 2001).

and communities (Nelson, 2003).In addition, these confrontational methods raise the risk of injury and death to local people from elephants as the aggression levels increase on both sides (Fernando et al., 2008).

Moreover, there are other supplementary methods to traditional measures such as olfactory and auditory methods. The example of olfactory is chilli ropes where chilli paste is mixed with grease and applied on ropes strung along the boundary to drive elephants away (Fernando et al., 2008). Regarding auditory methods e.g. alarm and elephant distress calls[8], these are in the experimental stage. An alarm by itself can be ineffective as elephants habituate to the lack of serious threat, however, when elephants are near the boundary, alarms can help farmers detect elephants before they enter fields (Fernando et al., 2008). In O'Connell-Rodwell et al. (2000)' experiments in Namibia, they found that the alarms were good for short trip-alarms (maximum 1 km) because the sound of the siren seemed to be effective within approximately 500 meter. The major problem of alarms is that many farm areas are too large to protect solely by the alarms. Another problem is the negative externality to neighbouring unprotected farms. They also tried to test elephant distress calls by using natural air-borne elephant distress calls to chase elephants away from farms, however, the study found that it was ineffective because elephants may be capable to recognize individual identities from calls. Nevertheless, the main obstacle to elephant distress calls is the equipment to record and play back is complicated and expensive (Nelson et al., 2003; Osborn and Parker, 2003). In addition, the GPS satellite radio is another supplementary option to traditional methods by monitoring the movement of individual problem elephant, and then it can warn villagers of their presence in a particular location, however, the barrier to apply this method is because this technology is very expensive (around USD5000-8000 per collar) but has a life-time only 1-2 years (Fernando et al., 2008).

[8] It is a range of elephant calls that humans can be either audible or not (infrasound). The aim of this experiment is to search for a call that they might be an elephant deterrent, then such calls will be recorded and played back to elephants (Fernando et al., 2008).

(B) Elephant Barriers

An elephant barrier or physical barrier is an obstruction constructed to prevent elephants from coming into crop fields or villages or to contain elephants in a particular area (e.g. protected area) (Fernando et al., 2008).Elephant barriers are often seen as the enduring solution in HEC, and is likely built where the conflict is severe (Nelson et al., 2003). There are several elephant barriers, for example, ditches, un-electrified fences, stone wall, buffer crops, and electric fences. The details in each measure are as follow:

Fernando et al. (2008) explain that in theory, the structure of elephant proof ditches should be too wide for an elephant to step across and too narrow for an elephant to get into, or 3m wide at the top, 1m wide at the bottom, and 2-m deep. They also argued that ditched with concrete site walls were dangerous because elephants were unable to climb up if they fell in. The effectiveness of ditches was increased by erosion-resistant soil, vegetative ground-cover and regular maintenance (Nelson et al. 2003). However, another problem of ditches is that elephants may fill them by kicking in the sides, and then they can walk through (Perera, 2009).The investment cost of digging a ditch is estimated to be around USD2,160 per km in India and around USD4000 per km in Sri Lanka (Fernando et al., 2008).

Un-electrified or standard fences regular fencing material (wire and concrete or wooden posts) will be sufficient if elephants are not persistent raiders (Nelson et al., 2003). Hoare (1995) suggested that the use of small individually-owned fence projects surrounding the farm areas by one or two households might be efficient because of some reasons; locally-made components are not expensive; the component robbery could be eliminated; the deficiencies of maintenance costs would be decreased. For elephant proof wire fences, built with steel cables and iron girder, are expensive option that made this option was not applicable (Fernando et al., 2008). Stone wall is another option that is relatively expensive construction costs, for example, the cost of stone wall construction in Kenya is

approximately USD3500 per km (Nelson et al., 2003). Then, stone walls are not widely used and have a few practical applications (Fernando et al., 2008).

Buffer crops or unpalatable crops (e.g. tea, coffee, tobacco, chilli, and citrus) are another elephant barrier that is in experimental stage. Fernando et al. (2008) described that an idea of buffer crops is to decrease the attractiveness of areas to elephants by substituting crops consumed by elephants with those they do not. However, the obstacles to apply this method are that this measure needs many hundreds of km^2 switch to unpalatable crops and also requires adopting agricultural practices different to traditional practices. Additionally, the returns on unpalatable crops may be not good as the cultivated crops; therefore, farmers may hesitate to do plant them.

Electric fences are perceived to be the most successful barrier against elephant raiding if they are maintain properly accompanied with punishing elephant measures such as shooting repeated problem elephants (Fernando et al., 2008; Nelson et al., 2003; O'Connell-Rodwell et al., 2000). The location of the electric fences should be cautiously chosen and the design should be in accord with the characteristic of the problem (de Silva, 1998). Nelson et al. (2003) classified a fence design to be three types; 1) surrounding agricultural land and/or houses and people, 2) surrounding the elephants and their range, 3) a straight line barrier along a park boundary between elephants and farmland. They argued that the first design would be most effective because elephants are likely walking along the length of the fence to search a way to enter the farm; therefore the latter two designs would be less effective compared to the first one. Also, they summarized that the fence maintenance problem were associated with power supply and vegetation growth that causes power leakages.

In addition, the effectiveness of electric fences did not only depend on how to maintain the fences, but also number of problem elephants (O'Connell-Rodwell et al., 2000; Osborn and Parker, 2003). Nelson et al. (2003) suggested that the unpalatable buffer crops might be enhance the success of electric fences. Gunaratne and Premarathne (2006) assess the effective of five electric fences

projects in Sri Lanka. The effectiveness of electric fences was evaluated in terms of how the fences reduce incidents of HEC thorough household attitudes. The study found that electric fences could alleviate the conflicts but did not completely eliminate the problem. Therefore, the electric fences do not offer a "stand alone" solution but are only part of the solution. The main factors for success of electric fences are appropriate design of fences, geographical variation, elephant migration patterns and community support for fence maintenance. Fernando et al. (2008) cited that individual owned fences were effective in reducing crop damages from 80% to 20% in India.

Regarding the construction costs of electric fence, Nelson et al. (2003) quoted the construction costs of electric fences in five areas; 1) Kenya, the construction cost was about USD2000 per km, and maintenance costs roughly USD150 per km in 1995, 2) Tsavo, the construction cost was about USD10800 per km in 1996, 3) Zimbabwe, the construction and maintenance costs for community enclosure type were about USD1350 per km and USD88 per km respectively and for low specification household enclosure type were approximately USD 170 per km and USD11 respectively, 4) Mozambique, the construction costs were about USD1081 per km, 5) Ghana, the construction cost was approximately USD2500 per km. O'Connell-Rodwell et al. (2000) reported that the construction costs at Lianshulu in Namibia was roughly USD621 per km. Fernando et al. (2008) quoted that construction costs of electric fences in Indira Gandhi Wildlife Sanctuary, India in 2007 cost around USD2829 per km, whereas the construction cost in Sri Lanka is around USD3500-5000 per km. Even though fence construction is not economically viable compared to crop losses, fences also have extra benefits (e.g. controlling cultivating and exploiting natural resources) that are not included in the calculation (de Boer & Ntumi, 2001).

(C) Supplementary Feeding

The idea of this measure is to deposit elephant foods, such as sugarcane, in the areas where crop-raiding is the trouble; therefore, it can attract elephants and keep them in designated areas, however, the problem will be occurred if the

method is discontinued or the supplementary feeding is not sufficient for them (Fernando et al., 2008).

(D) Killing elephants

In India and Sri Lanka, hundreds of raiding elephants, which are mostly adult males, were killed annually by farmers is a normal occurrence, even though killing elephants is a highly controversial, emotive issue, and unacceptable in cultural context of Asian countries (Fernando et al., 2008; Perera, 2009). The killing of problem elephants is also used in Africa (Hoare, 1995). Moreover, the advantage of this method is that it is relative cheap as a quick-fix solution with extra supply of free meat for local people (Nelson et al., 2003; Hoare, 2001). Nevertheless, the problem elephant behavior still exists, even when culprit individuals are eliminated from these populations for decades, because others replace them (Hoare, 2001; de Boer & Ntumi, 2001; Perera, 2009). This method assumes that individual elephant causes the problem; however, this argument may be biased because of (Hoare, 1999): 1) the difficulty in recognizing individual elephants at night in forests; 2) the likely rapid killing of repeat elephants by authorities; 4) most research projects are focused on high conflict areas; and 5) local people support this method to force wildlife authorities to eliminate a problem animal. Nelson et al. (2003) suggests that killing elephants to decrease population density hoping to alleviate the level of crop-raiding is doubtful. The reasons of this argument are 1) there is replacement hypothesis; and 2) there is evidence to support the idea that problem elephant activity depends on elephant behavior rather than elephant density. Hoare (2001) proposed the "problem component" theory to explain whether the same individual elephants are the cause of the conflict incidents. The problem component idea believes that even individual problem elephants are removed; others will naturally imitate them without having to be taught, therefore, the problem will remain.

(E) Translocation

There are two criteria used to select elephants for translocation: 1) habitual fence breakers and 2) discrete family groups in small units that could be relocated

all at once (Omondi et al., 2002). Theoretically, translocation seems provide the straightforward solution, however, in fact the implementation demands high degree of expertise and logistics (Perera, 2009) such as preliminary studies of the social structure of the elephants whether the whole herds should be moved or only problem males moved (Nelson et al., 2003). Furthermore, capture and transport require several activities that include identification of a particular individual, capture, restraint, transport and release (Fernando et al., 2008). Nelson et al. (2003) summarized a number of disadvantages for this measure, which were: 1) there is possible replacement of these problem elephants with another one within the population, 2) it is no guarantee that these elephants will not continue their problems in the new place, or just move back, 3) the welfare of elephants during capture and translocation needs to be concerned, for example, the elephant translocation in Kenya, elephants have had to endure stressful period of imprisonment in vehicles because of logistical problems during transportation (Hoare, 2001). In several cases, elephants died from injuries during capture, for example, translocation from Sweetwaters Rhino Sanctuary to Meru National Park in Kenya (Omondi et al., 2002), 56 elephants (9 individual bulls and 9 family groups) were translocated in 12 capture operations within 22 days. Five elephants died during the capture process, whereas four died during transportation. Nevertheless, the typical case of translocation is to restock of elephants to tourism purposes such as transit to tourism areas or for hunting concession.

Nelson et al. (2003) quoted that the translocation costs in Uganda were about USD100000 and operation cost for vehicle alone in Kenya was about USD140000. Fernando et al. (2008) reported that the operation cost for translocation in Sri Lanka was roughly USD2000.

(F) Compensation

In theory, compensation should be possible to completely eliminate the economic loss through proper level, however, in practice farmers tend to over-claim compensation (Fernando et al., 2008) and decrease in efforts to prevent damages (called “perverse incentive”). In practice, compensation is viewed as

inadequate by farmers (de Silva, 1998; Zhang and Wang, 2003; Perera, 2009).de Silva reported that villagers who affected from HEC in Sri Lanka complained that their payments were deferred for the two or three years with unrevealed reasons but they needed it to pay back the loans they took for production cost. However, an advantage of compensation scheme is that incidents of crop-raiding were reported, allowing the serious HEC areas to be identified (Nelson et al., 2003) and this may increase tolerance levels of farmers towards elephants (Fernando et al., 2008).Conversely, de Boer and Ntumi (2001) claimed that compensation did not reduce the HEC conflict. In addition, Hoare (2003) did not recommend employing compensation for elephant damages due to a number of reasons: compensation is unable to decrease the level of the problem; compensation reduces the incentive for self-defence of farmers; compensation cannot address the unquantifiable social opportunity costs borne by affected people from HEC; schemes are burdensome and expensive for administration; compensation opens to broadly cheating happens on over-claims; funding is never sufficient; fair evaluation is impossible.

Nelson et al. (2003) argued that most compensation schemes have been unsuccessful because they tried to address the effect, rather than the causes of the conflict. They raised some disadvantages of compensation schemes, which were 1) compensation cannot lead to reduce the conflict and there is no end point for compensation; 2) an increase in claims may lead to either corruption or a decrease in crop-guarding, 3) complaints of low payments compared to the actual losses; 4) unequal disbursement may cause social conflict; 5) compensation is complicate, expensive and slow to administers because it needs to train assessors, and cover large areas; 6) compensation have no effect on the relationship between local people and wildlife authorities.

(G) Wildlife Utilization Schemes

The wildlife utilization scheme aims to the use of wildlife for revenue generation through community based natural resource management known by acronym CBNRM (Nelson et al., 2003). Benefits from tourism or hunting problem elephants were returned to the local community fund; therefore, both

income generation and HEC alleviation can change local communities' perceptions of elephant from burdens to revenue generation assets, at the same time reduction level for HEC (Hoare, 2001). However, Hoare (2001) showed that there are many barriers to implement this scheme to overcome: requiring complex and long-term partnerships among wildlife authorities, local authorities, private sectors and local communities; requiring a pre-requisite of policy on legal and illegal use of wildlife that has to be formulated at national level.

(H) Land Use Planning

The land use planning to deal with HEC is the long-term process that needs government support, especially legislative and/or policy changes would be expensive option but its long-term benefit is not only HEC alleviation, but also habitat improvement for other species and improving a positive relationship between elephant and local people (Nelson et al., 2003). Hoare (2001) suggested the general guiding principle of land use planning by doing the following:

1) Reducing the conflict interface between human and elephants, for example, reducing human settlement encroachment into elephant ranges and relocating agricultural activity out of elephant ranges;

2) Facilitating defence against problem elephant, for example, reducing the size of crop farms, changing the cropping systems (e.g. changing from traditional crops into unpalatable crops or changing timing of harvest, diversifying into more crop types to reduce the exposure);

3) Increasing agricultural production more efficient, for example, reducing the dependency of local economy on agriculture; and

4) Modifying some movement of problem elephants, for example, creating or securing elephant movement routes or corridors, securing elephant and human access to water sources (e.g. manipulating the water resources or mineral licks to change elephant distribution), reposition protected area boundary, and expanding protected area.

(I) Proposed new methods

The HEC mitigation measures have to be based on adaptive management by combining traditional and new measures with support from proper research studies (Hoare, 1995). Also, the HEC problem should be included as a part of broader issues of elephant conservation, not viewed as an isolated problem (Hoare, 2001). There are several measures proposed to deal with HEC problem, which most of them are in experimental stages.

Osborn and Parker (2003) suggested that the appropriate strategy is to bring farmers into the mitigation process. The authors argue that when more responsibility of farmers for crop protection is held, the more successful mitigation will be. By developing the low-technique methods, such as modification of the crops, farm location in relation to movement pattern of the crop raiding, system of rotating guard duty etc, will be most sustainable solution. Innovative methods also were proposed, for instance, elephants may be emitting low frequency distress calls when they are culled. These elephant vocalizations can be a repellent but the equipment to record and playback is expensive. Furthermore, the role of external agencies can provide technical assistances to develop techniques for crop protection. In addition, the GPS satellite radio is another option by monitoring the movement of individual problem elephant, and then it can warn villagers of their presence in a particular location. However, the barrier in applying this method is that it is again costly (around USD5000-8000 per collar) but has a life-time only 1-2 years.

Nevertheless, continuous monitoring and adaptive management is a key success of HEC mitigation. Four suggestions on HEC mitigation were recommended. Firstly, one reason to escalate HEC is infrastructure development; therefore, incorporating HEC in infrastructure project at the planning stage is needed. Secondly, HEC mitigation should be considered at the elephant population level rather than at the site level. Thirdly, quantitative data on the monitoring scheme of mitigation program across several countries is an urgent need. Lastly, the “cookbook” of HEC mitigation techniques is also needed to help

individual project do not spend a lot of time to learn from failures at their project site but can learn from other experience in other areas (Fernando et al., 2008).

The pilot project named "living with the elephant" was initiated that comprised of three parts: a community development fund, environmental education program, and elephant habitat preservation. By providing USD100 for each family who involved the project, farmers need to follow the management regulations of the fund such as no threat to elephants and no deforestation. The study argued that the attitude of farmers to elephant changed from hatred to attempting to coexist with elephants (Zhang and Wang, 2003).

Biological technologies are another alternative to mitigation HEC, there are some trails of these kinds of measure in the experiment stage (Perera, 2009): (a) trials of temporary infertility in female elephants was applied in Africa using glycoproteins of the Zona Pellucide (ZP) of pig oocytes as a vaccine injected into horses and elephants, it found that three doses injected during three weeks using drop-out darts prevented pregnancies for more than one year; (b) vaccinating male elephants to manipulate aggression showed that vaccination of bull elephant reduced the aggression for periods of 6-9 months.

Habitat enrichment of protected areas has also been proposed as a mitigation measure for HEC (de Silva, 1998). There are several measures for habitat enrichment: 1) restoration of ancient reservoirs or construction of new reservoirs in protected areas because water is very scarce during the dry season in most forest areas; 2) growing of vegetation (e.g. grass) that can be food for elephants; replacement of existing teak and eucalypt plantations with natural forests in protected areas; periodic manipulation of the vegetation to increase elephant foods in the forest e.g. pruning the trees so that it will have more new growth that can be made available for elephants.

Finally, an environmental education program, namely the Elephant Outreach Program, was proposed as part of the HEC mitigation measure in Botswana in 2001 (Marchais et al., 2009). This program is designed to raise awareness about wildlife protection for pupils in town and villagers who are living

near wildlife habitats. The expected benefits of this program are that it can generate the positive attitude of people to elephants.

3.2.2 Selected HEC cases in Thailand

In this part, the two areas, Kui Buri National Park and Salakpra Wildlife Sanctuary of HEC mitigation in Thailand were reviewed. The details of each area can be described as follows:

(A) Kui Buri National Park

The Kui Buri Nation Park is located in Prachuap Khiri Khan province. The human-elephant conflict in Kui Buri national park began in 1994 (Chumnankid, 2007). In 2006, World Wildlife Fund (WWF) staff conducted a household survey of the 25 local communities living within three kilometers of the boundary of Kui Buri national park. The total sample was 758 interviewed households (Parr et al., 2008). Under this project, it was calculated that there were 268 km^2 (167,551 rai) of pineapple plantations located within three kilometers of the Kui Buri National Park boundary based on satellite imagery. For the pineapple fields located in immediate proximity to the National Park, villagers had land ownership documents for 205 fields covering 661.12 ha (4,132 rai); 179 fields encompassing 442.24 ha (2,764 rai) had no land title, while 78 fields were rented. The total sample was 543 agricultural fields, and 217 fields (40%) had been recently raided by elephants. For the farmers who were affected by crop damage, 66 farmers reported that elephants came out of the forest more than 50 nights a year, while 22 farmers stated that elephants were in their fields between 200–365 nights per year. The peak months for intrusions were April, followed by February and then May. Most farmers observed elephants between 16.00–18.00 hr (34.3%). The thirty four farmers were interviewed on the level of damage occurred, 27 farmers estimated the impacted crop at less than 1.6 ha (10 rai). 15 farmers estimated the damage at less than USD250 (10,000 baht); 25 farmers estimated the damage between USD250–1250 (10,000–50,000 baht), 11 estimated damage at USD1250–2500 (50,000–100,000 baht), while seven farmers estimated damage at over USD2500 (100,000 baht). Sixty-eight farmers reported that fireworks were the most

effective to deter the wild elephants, while others used spot lights and gas lamps. Also, electric fencing was erected and some villagers burned tires to chase elephant away.

For mitigation at government level, under the royal project of forest restoration and conservation in Kui Buri reserve forest, the 20,000-rai pineapple crops that was surrounding the protected area was expropriated to improve habitat for wildlife. The examples of habitat improvement are water resource improvement, forest restoration, and provision of supplementary feeding for elephants (WWF, 2009). The supplementary feeding for elephants was provided by villagers who received the payments from the project fund. This activity would attract the raiding elephants, thereby preventing raiding and reducing HEC.

(B) Salakpra Wildlife Sanctuary

The Salakpra wildlife sanctuary is located in Kanchanaburi province. The crop raiding incident was first recorded in 1982 (Sitati, 2007). The measures such as bamboo fences or home-made alarm systems were applied by households. However, when crop raiding became more frequent and more intense, households tried to apply more effective measures such as simple electric fences, non-electric fences, watchtowers in tall trees, planting unpalatable crops, torches and reflecting CDs, catapults and firecrackers and guarding crops at night (Sitati, 2007).

In 2007, the Elephant Conservation Network (ECN) started a crop protection trial, including a ditch and electric fences (Ritthirat, forthcoming). In this project, the total length of the ditch is 3,867 meters and the construction budget was about 300,000 baht (USD 100000), excluding the rent of the heavy machine lend by the Kanchanaburi-based army. ECN staff collected crop damages of crop raiding by elephants in two periods, one year before and after the ditch construction (October 2006- September 2007 vs. October 2007-September 2008). The result showed that the crop loss caused by raiding before the ditch construction was 111,099 baht (USD3703), as compared to 13,190 baht (USD440) during the post-ditch period, or it has decreased by 88%. Regarding to electric fences, experimental sites selected for the trial comprise both private

farms/houses and elephant enter/exit routes of the park. An electric fence was erected around a 20-rai sugarcane field. The trial was monitored for 12 months (from March 2007-February 2008). The result of monitoring showed that a reduction of crop damage, from 29,742 baht (USD991) to 5,316 baht (USD177) after the trial, or about 82%.

3.3 Conclusion

This chapter has outlined the reviews of PES and PES-like programs that are related to the environmental services analyzed in this study (wildlife conservation and ecosystem restoration). Secondly, it reviewed human-elephant conflict (HEC) mitigation strategies covering HEC experiences from South Asia and Africa and experiences from two selected HEC cases in Thailand. These reviews form the basis for the research questions outlined in the next chapters, and the research field work undertaken.

CHAPTER 4

HOUSEHOLD SURVEY[9]

This chapter is comprised of three sections. The first section describes the study areas. The second section demonstrates the results of the household survey and the last section is the conclusion of this chapter. The household survey of affected households from HEC was conducted to gain information for a cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and to aid the design of payment for environmental service (PES) criteria for ecosystem restoration and HEC reduction. However, before the survey, information from focus group discussions and key informant interviews, such as from wildlife experts and the headmen in study areas, was used to design the draft household questionnaire. A pretest was conducted to check whether the questionnaire was workable; 30 samples were pretested in total. After the pretest, the questionnaire was revised.

The household questionnaire consists of three sections. The first section covered socioeconomic characteristics. The second dealt with the situation and impacts from HEC, including frequency of crop-damage incidents and damage costs. The last section investigated what households individually and collectively have done to deal with HEC, including assistance from external sources. This section also explored whether the affected people had planned to deal with HEC. The total sample size of 200 was randomly obtained in the six selected villages which are the most affected villages from HEC. The survey was conducted by the face-to-face interview during March 2011.

4.1 The Study Areas

The villagers in the six study areas migrated from other provinces in the northeast region of Thailand to these areas around 30 years ago. This reason can explain why most of them have dealt with the HEC problem individually. The

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9 The household survey was financially supported by the Economy and Environment Program for Southeast Asia (EEPSEA) under the project on "Analysis of Policy Options to make From Human-Elephant-Conflict to Human-Elephant-Harmony" and reported in the EEPSEA report.

socio-characteristics of households and crop types in each area are as in Table 4.1. The six villages adjacent to KARN, namely Na Yao village, Na Isan village, Lum Tha Sang village, Tha Ten village, Na Ngam village, and Klong Toey village, were selected to be the study areas. The reason for choosing these six villages was that they have the most severe problems of HEC. However, only in Lum Tha Sang village have all households been affected from crop raiding, whereas only some households in the other study areas have been affected. Most crop types in the study areas, e.g. cassava, rice and corn, are cash crops that can be food for elephants. The detail of each study area follows.

Table 4.1: Socio-characteristics of households and damage information in each area

Characteristics	The Study Areas					
	Na Yao	**Na Isan**	**Lum Tha Sang**	**Tha Ten**	**Na Ngam**	**Klong Toey**
No. of total households	1,001	252	24	220	545	205
No. of affected HH from HEC	450	30	24	32	30	150
Crop type	cassavas, rice, and rubber tree	cassavas rice, and sugarcane	cassavas and corn	cassavas, rice, rubber tree, and eucalyptus	cassavas and rubber tree	cassavas, rubber tree and rice
No. of sample sizes	50	47	13	32	20	38

Source: interviews with the headmen in each study area

4.1.1 The Na Yao Village

Na Yao village is located at Village no. 15, Tha Kra Darn sub-district, Sanamchai district, Chachoengsao province. The total households in Na Yao

village are approximately 1,001 (2010). According to official records, there were 50 households who registered for compensation from crop-raiding problem in 2010. The crop types in this area are cassava, rice and rubber tree. According to in-depth interviews with the villagers, crop fields adjacent to the park were more impacted than the ones located further away from the park. They also mentioned that elephants were quite clever. Before elephants enter the field, they will make a noise first to make sure there is no response from human, and then they will enter the field. Sometimes, elephants did not eat crops but just play (also resulting in crop damage). In some households, dogs tried to protect crops by barking at elephants, however, this made things worse because it frightened the elephants. Consequently, elephants caused more damage by tramping crops as in Figure 4.1. Another impact of HEC in this area that can outweigh the economic costs of crop damage is human death. During the survey, there was one case of human death due to HEC in this village. Mrs. Malee Panongped (Figure 4.2) lost her 30-years-old son in 2010 when he was guarding crops at night. Another example of the impact due to HEC is the case of Mr. Sopa Klongsin. He and his two brothers have to move to live in the crop, even though they have their own houses in the village. He said that guarding the crop at night leads to loss of sleep.

In the past, only traditional techniques such as shouting, drum-beating, noise-making, firecracker and light were applied to chase elephants away, however, an elephant is a highly adaptable animal. They are habituated to such measures, once they learn there is no real harm. At present, electrified fences are employed in some areas but also cannot completely eliminate the crop loss. The main damage due to HEC is crop losses, especially rice and cassava. Moreover, there is also property damage such as damages of guarding huts (Figure 4.3). This impact puts households under stress because some households have to get loan money to build a new hut.

Figure 4.1: Crop raiding by elephants in Na Yao village

Source: Mr. Rueangyot Thongsopin

Figure 4.2: Mrs. Malee (left) and Mr. Sopa (right)

Source: Ms. Wisanee Oumjank

Figure 4.3: The hut in the field was damaged by elephants

Source: Mr. Rueangyot Thongsopin

4.1.2 The Na Isan Village

Na Isan village is located at village no. 16, Tha Kra Darn sub-district, Sanamchai district, Chachoengsao province. The total households in Na Yao village are approximately 252 households in 2010. According to official record, there were 30 households who registered for compensation from crop-raiding problem in 2010. The crop types in this area are cassava, rice and sugarcane.

Besides applying mitigation measures individually, households also have employed collective action to guard crops at night together (Figure 4.4). Using radio communication to contact each other when they observe elephants entering the fields, they will act as a team to chase away elephants by using firelock and shooting it into the air to scare elephants.

Figure 4.4: Collective action to guard crops at night

Source: Mr. Rueangyot Thongsopin

4.1.3 The Lum Tha Sang Village

Lum Tha Sang village is located at village no. 25, Klong Thra Kao sub-district, Tha Ta Kiap district, Chachoengsao province. The total households in Lum Tha Sang village were approximately 24 households in 2010. According to official record, there were 24 households who registered for compensation from crop-raiding problem in 2010 or total households in this village were affected from crop raiding. The crop types in this area are cassava and corn. During focus group discussion, villagers in Lum Tha Sang village mentioned that human

behavior can also be a pull factor of crop raiding by elephants. For example papaya vendors would like to make merit by providing ripe papayas that could not be sold out at roadside for elephants. Even though, in the past, elephants did not eat papayas, when they tasted it and knew that they could eat it, they started to raid papaya crops thereafter.

According to an in-depth interview of an ex-headman of Lum Tha Sang village, his 20-rai corn crop was totally destroyed by elephants in 1980. After that event, he changed to grow unpalatable crops that elephants do not eat it instead (e.g. chilli, eggplant, and sesame). Even though elephants do not eat that kind of plant, the crop also was damaged because elephants walk through this route to search for water and food. Mr. Ma Seedam is another villager who was stabbed by an elephant's tusk during guarding his crop in 1995. He showed his scars at his stomach, finger, and ear (Figure 4.5). Furthermore, the villagers reported that there were two culprit elephants that were always persistent crop raiders and sometimes they blocked the truck which was carrying sugarcane in order to eat it. The villagers called these kinds of elephants "*a sugarcane robber*". During the household survey, the research team also found that one of that two culprit elephants. He was searching for the food on the road (Figure 4.6).

Figure 4.5: Mr. Ma who showed his scars injured by an elephant's tusk in 1995

Source: Mr. Rueangyot Thongsopin

Figure 4.6: The one of the two culprit elephants in Lum Tha Sang village

Source: Mr. Rueangyot Thongsopin

4.1.4 Tha Ten Village

Tha Ten village is located at village no. 9, Pra Phloeng sub-district, Kao Chakan district, Sakaew province. The total households in Tha Ten village were approximately 220 households in 2010. According to official record, there were 30 households who registered for compensation from crop-raiding problem in 2010. The crop types in this area are cassava, rice, eucalyptus and rubber tree. Even though the government agency already built the pilot ditches in this area, the damage of crop-raiding have not been lessened because the ditch could not prevent elephants to cross it (Figure 4.7). Some wildlife expert claimed that the ditch was not constructed to an appropriate specification.

Figure 4.7: Elephants could cross the ditch into the crop fields

Source: the author

4.1.5 The Klong Toey Village

The Klong Toey village is located at village no. 21, Tha Kra Darn sub-district, Sanamchai district, Chachoengsao province. The total households in Klong Toey village were approximately 205 households in 2010. According to official record, there were 150 households who registered for compensation from crop-raiding problem in 2010. The crop types in this area are cassava, rice and rubber tree. Villagers in this area claimed that there were approximately 30 – 40 elephants entering the crop field simultaneously in 2011. Furthermore, there was collective action initiated by the headman and supported by provincial administration organization and sub-district administrative organization to grow elephant's food (e.g. banana and sugarcane) in the 50-rai area of the park (Figure 4.8). The villagers and students in the village collectively contributed their labor force, and some villagers not only contributed their labor forces, but also provided their banana or sugarcane sprouts to plant in the park. This activity has been employing once a year since 2009, however, villagers think the level of this activity is still not enough.

Figure 4.8: Collective action of Klong Toey villagers to plant elephant' foods

Source: A headman of Klong Toey village

4.1.6 The Na Ngam Village

Na Ngam village is located at village no. 19, Tha Kra Darn sub-district, Sanamchai district, Chachoengsao province. The total households in Na Ngam village were approximately 545 households in 2010. According to official record, there were 30 households who registered for compensation from crop-raiding problem in 2010. The crop types in this area are cassava and rubber tree. The

villager explained that there were a lot of elephants that entered the crop field simultaneously which are the same herd (approximately 30-40 elephants) that entered to crop field in Klong Toey village. This is because Klong Toey village is its neighboring village.

4.2 Results of the household survey

4.2.1 Socioeconomic of the households

Table 4.2 summarized the general characteristics of households in study areas. The average family members are approximately 4 persons per family. The average agricultural area is roughly 33.6 rai or 5.4 hectare per household, which the total agricultural area in Lum Tha Sang village is quite small (7.6 rai or 0.012 km^2 per household) compared to other areas. Households in all study areas are not local people but they migrated from the northern region to this area, which average year households have lived in the study area approximately 21.6 years. The average of annual agricultural income is roughly 151,067 baht per household or USD5036 per household. The average of total household income is approximately 183,950 baht per household or USD6132. However, the household incomes of Lum Tha Sang village (80,398 baht per household or USD2680 per household) and Tha Ten village (81,943 baht per household or USD2731per household) are relatively low compared to other areas.

Table 4.2: General characteristics of households in study areas

Socioeconomics characteristics	Study Areas						
	Na Isan	**Lum Tha Sang**	**Na Yao**	**Tha Ten**	**Klong Toey**	**Na Ngam**	**Total**
No. of household members (persons)	4.2	3.2	4.5	3.9	3.9	4.8	4.2
Agricultural area (rai)	28.2 (.045 km^2)	7.6 (.012 km^2)	44.3 (.071 km^2)	28.7 (.046 km^2)	41.1 (.066 km^2)	28.9 (.046 km^2)	33.6 (.054km^2)
No. of years households has lived in study area (years)	20.5	26.5	23.5	23.1	18.2	19.9	21.6
Annual agricultural income (baht/HH)	157,143 (USD20692)	44,797 (USD1493)	199,926 (USD6664)	58,415 (USD1947)	203,954 (USD6798)	123,872 (USD4129)	151,067 (USD5036)
Annual non-agricultural income (baht/HH)	20,692 (USD690)	35,601 (USD1187)	46,097 (USD1537)	23,529 (USD784)	28,579 (USD953)	50,288 (USD1676)	32,882 (USD1096)
Annual household income (baht/HH)	177,835 (USD5928)	80,398 (USD2680)	246,023 (USD8201)	81,943 (USD2731)	232,533 (USD7751)	174,161 (USD5805)	183,950 (USD6132)

Source: Household Survey, 2011

Note:

(1) USD1 =THB30

(2) 1 square kilometer = 6.25 rai

(3) All values are in 2010 prices

4.2.2 Situation and impacts from HEC

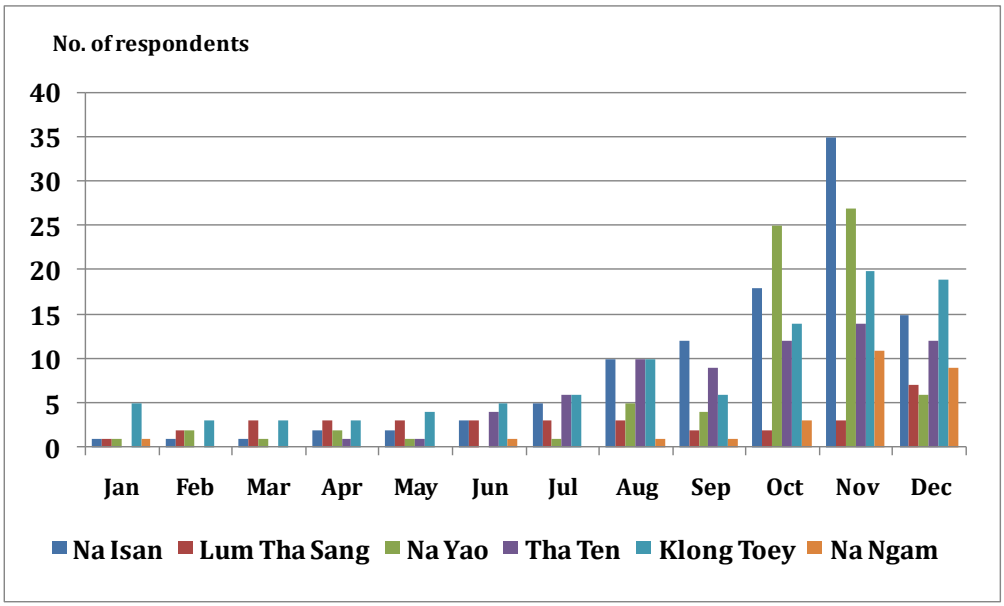
Households were asked when they were first affected by crop raiding. The information in Table 4.3 indicated elephant crop raids have been more frequent over time. Furthermore, when asked which month the crop-raiding incident is high, most households revealed the incident of crop raiding was high frequency during August through December (Figure 4.9), which is the harvesting period. The harvesting period for rice production is between October and December, whereas the harvesting period for cassava crop is between September and December. The crop-raiding incident is gradually increasing in August and reaches the peak in November, afterwards the incident of crop-raiding declines in December. The incidents of crop raiding have happened as a seasonal pattern in every year. Because all study areas are not irrigated lands, therefore, the agricultural practices depend only on the rainfall. This reason explains why farmers did not change their crop calendar, even they know the crop-raiding period each year. The average number of crop-raiding incidents for all six study areas is approximately 25 incidents per month during high frequency period of crop raiding (Table 4.4). Moreover, there is no difference among average incidents of crop raiding in each study area. On the other hand, the average incident during low frequency period of crop raiding is approximately 6 incidents per month. Therefore, the overall average incident of crop raiding is roughly 15 incidents per month. In addition, average nights to guard crop for all study areas is approximately 212 nights per year (Table 4.5). While farmers have to guard rubber trees, some farmers mentioned that while elephants did not eat rubber trees but they play and damage them when they walk through the fields. Furthermore, some households reported that they dare not to guard their crops at night because they are afraid that elephants might hurt them.

Table 4.3: The first incident of crop raiding by elephants

Time period	No. of affected households from crop raiding	%
Before 1988	6	3.0
1988 – 1992	13	6.5
1993 – 1997	12	6.0
1998 – 2002	36	18.0
2003 - 2007	83	41.5
After 2007	50	25.0
Total	200	100.0

Source: Household Survey, 2011

Figure 4.9: Number of crop-raiding incidents per month



Source: Household Survey, 2011.

Table 4.4: High frequency period of crop-raiding incidents by elephants

Villages	No. of crop-incidents of high frequency period per month		
	Min	**Max**	**Mean**
1. Na Isan	1	30	23.4
2. Lum Tha Sang	20	30	29.2
3. Na Yao	1	30	23.5
4. Tha Ten	1	30	22.7
5. Klong Toey	3	30	26.2
6. Na Ngam	3	30	27.4
Total	1	30	24.6

Source: Household Survey, 2011.

Table 4.5: No. of nights for crop-guarding per year

Study Area	No. of night for crop-guarding per year
Na Isan	224
Lum Tha Sang	214
Na Yao	270
Tha Ten	234
Klong Toey	167
Na Ngam	165
Total	**212**

Source: Household Survey, 2011.

An average crop-damaged area due to HEC in 2010 is approximately 6 rai/household/year or 0.0096 km^2/household/year (Table 4.6), which accounted for nearly 18% of the total crop area. An average total damage cost due to HEC in 2010 is approximately 34,825 baht/household/year or USD1161/household/year, which accounted for roughly 19% of the average household income. The average crop-damaged cost is accounted for 99% of the total damage cost. In absolute term of damage cost in 2010, the total damage cost in Klong Toey village was the highest one. However, the damage cost in Lum Tha Sang village is the highest rank in term of the share of household income, which accounted for roughly 34% of the average household income. Furthermore, as mentioned in previous section, the HEC caused not only the direct costs such as crop and property damages, but also a loss of life (that reported by one respondent in Na Yao village) and 2 injuries. Additionally, when asked whether households are worried about HEC, 89% of respondents reported that they were anxious that elephants might raid their crops/property or harm them.

Table 4.6: Damage costs due to HEC in 2010 classified by study areas

Categories	Damage costs due to HEC in 2010 (baht/HH)						
	Na Isan	**Lum Tha Sang**	**Na Yao**	**Tha Ten**	**Klong Toey**	**Na Ngam**	**Total**
Crop-damaged area (rai)	4 (.0064 km^2)	3 (.0048 km^2)	6 (.0096 km^2)	3 (.0048 km^2)	10 (.016 km^2)	9 (.0144 km^2)	6 (.0096km^2)
Crop-damage cost	24,357 (USD812)	27,677 (USD922)	34,293 (USD1143)	17,709 (USD590)	57,805 (USD1927)	48,074 (USD1620)	34,582 (USD1153)
Property damage cost	221 (USD7)	46 (USD2)	679 (USD23)	-	59 (USD2)	-	243 (USD8)
Treatment cost due to injuries	10	-	38	-	-	-	12
Total damage cost due to HEC in 2010	24,578 (USD819)	27,723 (USD924)	34,971 (USD1166)	17,709 (USD590)	57,864 (USD1929)	48,074 (USD1602)	34,825 (USD1161)
Total annual HH income	177,835 (USD5928)	80,398 (USD2680)	246,023 (USD8201)	81,943 (USD2731)	232,533 (USD7751)	174,161 (USD5805)	183,950 (USD6132)
Damage costs as a share of income (%)	14	34	14	22	25	28	19

Source: Household Survey, 2011.

Note:

(1) USD1 =THB30

(2) 1 km^2= 625 rai

(3) All values are in 2010 prices

4.2.3 Mitigation strategies to deal with HEC

Table 4.7 presents the existing mitigation options to deal with HEC. The existing mitigation measures are complementary options; therefore, this can explain why every household applied more than one option. All study areas are quite new communities; households have been living in these areas around 30 years ago. This is a reason why most households have individually dealt with crop-raiding problem. A catapults and fire crackers (Figure 4.10) are the most popular measure (55.2%). Almost one-third of respondents (29%) also built the hut to guard their crops at night; however, this option consists of co-benefits such as households can take a rest in a hut after doing farm work. Unlike a normal hut (Figure 4.11), the main reason for building elevated huts is to guard crops from crop raiding by elephants but only five households (1.8%) built such a hut for crop guarding. The reason for the ones who did not apply this option is because they think that it is dangerous to climb up and down the tree. Some households (6.5%) applied un-electrified or electrified fences surrounding their crops (Figure 4.12). Some households use the light to protect their crops by supplying the electricity to the field (1.8%) or using a hand-made lamp (Figure 4.13) to produce light in the crops (4.3%). When asked the effectiveness of mitigation measures, all respondents think that the measures cannot eliminate the impact but can lessen some impacts.

Table 4.7: HEC mitigation measures by households

Mitigation measures	No. of respondents*	%
1. Fire cracker	154	55.2
2. Un-electrified or electrified fences	18	6.5
3. Building a hut to guard crops	81	29.0
4. Light: Supplying the electricity to the crops	9	3.2
5. Building an elevating hut on the tree to guard crops	5	1.8
6. Light: lamps in the crop	12	4.3

Source: Household Survey, 2011.

Note: * respondents indicated more than one choice

Figure 4.10: Catapults and fire crackers

Source: Mr. Rueangyot Thongsopin

Figure 4.11: A hut and an elevated hut in the field

Source: Mr. Rueangyot Thongsopin

Figure 4.12: The electrified (left) and un-electrified (right) fences by households

Source: the author

Figure 4.13: Hand-made lamps in the field

Source: Mr. Rueangyot Thongsopin

Table 4.8 illustrates the mitigation costs of crop raiding borne by households. The most expensive method is the electrified or un-electrified fence, which average cost is about 7,285 baht or USD243 per household. The second most-expensive option is lamp (5,353 baht or USD178 per household) because this method requires kerosene or gasoline as a source of energy. The price of fire cracker itself is not expensive, about 5 baht or USD0.17/firecracker but households needed to use it every night. According to household survey, households use roughly 13 firecrackers per night during high frequency period of crop raiding and 3 firecrackers per night during low frequency period. This reason explained why the firecracker option is the third most-expensive method; with average cost is about 5,227 baht or USD174 per household. Lighting by supplying electric to the crop is another method to keep elephants away from crop fields, which average cost is about 3,989 baht or USD133 per household. The costs for a hut and elevating hut options are cheaper than other options, which are about 1,941 baht or USD65 per households, and 1,434 baht or USD48 per household respectively. Furthermore, the average mitigation cost by households is approximately 5,917 baht or USD197 per household per year.

According to the number of nights households guard their crops, the average night to guard crops is approximately 212 nights per year. Average household income and family member are 183,950 baht and 4.2 persons per household respectively. Therefore, average per-capita income is roughly 43,798 baht per year or 120 baht per day. If we assume that number of working hours is the same as number of crop-guarding hours, then the opportunity cost of time for crop guarding would be 120 baht or USD4 per night. In addition, someone may claim that it is overestimated if we use the 100 % of income as opportunity cost because households just guard their crops, not working as a daytime. Therefore, only 30% of household income was used as a proxy of opportunity cost of time for crop guarding at night. Consequently, the opportunity cost of time for crop guarding cost an estimated 7,632 baht or USD254 per household per year.

The total HEC cost borne by households included 1) damage costs (34,825 baht or USD1161 per household per year), 2) mitigation costs (5,917 baht or USD197 per household per year), and 3) opportunity costs to guard crops at night (7,632 baht or USD254 per household per year). Therefore, ***the total household cost due to HEC is approximately 48,374 baht or USD1612, which accounts for 26% of annual household income.***

Table 4.8: HEC Mitigation costs of affected households in 2010

Mitigation measures	**No. of respondents**	**Mitigation costs (baht/HH/year)**		
		Min	**Max**	**Mean**
1. Catapult and fire cracker	152	500 (USD17)	18,000 (USD600)	5,227 (USD174)
2. Un-electrified or electrified fences	18	222 (USD7)	32,000 (USD1,667)	7,285 (USD243)
3. Building hut to guard crops	81	86 (USD3)	21,716 (USD724)	1,941 (USD65)
4. Light: Supplying the electricity to the crops	9	700 (USD23)	12,500 (USD417)	3,989 (USD133)
5. Building elevating hut on tree to guard crops	5	100 (USD3)	4,200 (USD140)	1,434 (USD48)
6. Light: lamps in the crop	12	60 (USD2)	21,600 (USD720)	5,353 (USD178)
Average mitigation costs for all measures	***200***	***0***	***36,914 (USD1,230)***	***5,917 (USD197)***

Source: Household Survey, 2011.

Note:(1) USD1 =THB30

(2) All values are in 2010 prices

When asked whether they have planned to deal with HEC in the future (Table 4.9), majority of respondents (90%) have no plan about coping with the future impacts of HEC. However, some households (7%) have planned to build the fence surrounding their crops. Other mitigation preparations that households planned are to change to grow unpalatable crops (2%), change to another occupation (0.5%), and making battery lamp in the field (0.5%).

When asked whether they have collectively coped with HEC (Table 4.10), about 28 % of respondents said that there were collective actions to deal with HEC, which are working as a team to grow elephant foods, patrol crops at night, build a fence or ditch, act as a group to ask for helps from government agencies, and have a meeting on how to deal with HEC problem. On the other hand, 72% of respondents said that there was no collective action. The reason that they cannot work collectively because they think it is better to work individually and it is difficult to work together.

Table 4.9: Mitigation plan to deal with HEC by households in the future

Mitigation plan	No. of respondents	%
No plan	180	90.0
Plan to change to grow unpalatable crops	4	2.0
Plan to build un-electrified or electrified fences	14	7.0
Plan to change an occupation	1	0.5
Plan to make a battery lamp in the crop	1	0.5
Total	200	100.0

Source: Household Survey, 2011

Table 4.10: Collective action to deal with HEC

Collective action to deal with HEC	No. of respondents
Collective action	***55(27.5%)***
• Work as a team to chase elephants away (e.g. by using firecracker)	34
• Work as a team to build the fence	2
• Work as a team to build a ditch	1
• Act as a group to ask for helps from related government agencies	2
• Work as a team to patrol crops	3
• Work as a team to grow elephant foods	11
• Have a meeting on HEC mitigation	2
No collective action	***145(72.5%)***
Reasons to have no collective action • Working individually is better	143
• Difficult to work together	2

Source: Household Survey, 2011

Most households (66%) did not get any assistance from external sources (Table 4.11). Only approximately 34% of respondents received assistance from both central and local government agencies in term of financial assistance and compensation from crop loss. Furthermore, one respondent from Na Yao village who lost her son during crop guarding at night reported that she got financial assistance from her neighbors to help her for her son's funeral ceremony.

Table 4.12 presents the proposed mitigation measures by households to deal with crop raiding problem, most respondents suggested the elephant barrier

such as electrified or un-electrified fences (32%) and ditch (15%). Some respondents recommended habitat improvement such as planting more foods and increasing water resources for elephants (15%). Other measures were also proposed; for example, supplying electricity in the crop at night (15%), work as a team to patrol the crop at night (5%) and translocation (4%). Nevertheless, some respondents (4%) believe that there is no effective method to prevent crop raiding, whereas some households (9%) have no idea how to deal with this problem.

Table 4.11: Assistance from external sources

Assistance from external sources	No. of respondents
Did not get any assistance	131(65.5%)
Got assistance	69(34.5%)
1. Central government agencies	*16*
• Governor's office (e.g. necessity bags and financial assistance)	3
• Khao Ang Rue Nai wildlife sanctuary (e.g. compensation)	4
• District office (e.g. compensation)	5
• Five provinces bordering Forest Preservation Foundation (e.g. financial assistance)	3
2. Local government agency	*52*
• Sub-district Administrative Organization (e.g. compensation)	52
3. Neighbors (e.g. financial assistance for funeral ceremony for the one who died from human-elephant conflict)	*1*

Source: Household Survey, 2011

Table 4.12: Proposed mitigation measures to deal with HEC by households

Mitigation measures	No. of respondents	%
No effective method to deal protect their crops	7	3.5
Do not know	17	8.5
Electrified/un-electrified fences	64	32.0
Ditch	30	15.0
Translocation	8	4.0
Planting more foods for elephants/increasing water resources for elephants	30	15.0
Supplying electricity in the crop at night	29	14.5
Work as a team to patrol the crop at night	10	5.0
Other methods (e.g. changing to plant unpalatable crops, contraception, and elimination)	5	2.5

Source: Household Survey, 2011

The majority (89%) of respondent consider the future impacts of HEC to be more severe than the current impact (Table 4.13), which most of them think that it is because the increasing population growth of elephants. Some of them who think the future impact of HEC would be more severe believe that elephants were released into the park by the Queen of Thailand. It is also widely rumoured in Salakpra wildlife sanctuary. The Elephant Conservation Network (ECN) staff explained that it was a strategy of the park rangers because villagers would not dare to harm elephants if elephants were released by the Queen. Consequently, some villagers believe that they cannot do anything and the only one solution is to

translocate elephants to other areas. This belief can prevent households to employ the mitigation options by themselves. However, some households (8%) believe that the impact of HEC would be the same as current situation, whereas few households (1%) think the impact of HEC would be less severe in the future because they believe the fence built by government agencies is effective.

When asked respondents whether they are willing to volunteer to work for habitat improvement in KARN (Table 4.14), 93% of respondents are willing to work in KARN. Some respondents gave a reason whether they will or will not volunteer to work in KARN, they still have to pay for their own mitigation costs, and therefore, they are willing to work in KARN. Some respondents stated that they might be willing to volunteer (1%) or they were not sure about it (5%). The reasons for the ones who are not sure to volunteer to work are that they do not think this measure would be effective or they are not available/live too far or they are too old to work. Nonetheless, only 2 percent of respondents said that they were not willing to work in KARN. Their reasons are because they are not available or live too far or he is too old to work. Only one respondent stated that it should have a payment for working in KARN.

Table 4.15 shows that households' attitude toward elephants in KARN, more than a half of respondents (60%) stated that they did not hate elephants but also did not want them to raid the crops, whereas 27 percent of respondents said that they are afraid of elephants to harm them or fear to lose their crops. However, 14 percent of respondents stated that they dislike or hate or get angry with elephants because elephants damage their crops. This information indicates that most households still did not hate elephants; even they have been impacted from crop losses for many years. This could be a good sign for possible mitigation measures through PES involving the local households in the future.

Table 4.13: Household' attitudes toward HEC in the future

Reasons	Attitude toward HEC in the future				Total
	The same	More severe	Less severe	Do not know	
Increasing rate of elephant growth	1	155	0	0	156
Decreasing of food for elephant in KARN	1	5	0	0	6
Cannot do anything	6	2	0	0	8
Believe that someone released elephants into the park	1	7	0	0	8
The government agencies already erected the fence	0	0	2	0	2
Others (e.g. elephants are more clever or elephant do not be afraid of human anymore)	1	5	0	0	6
Do not know	5	4	0	5	14

Source: Household Survey, 2011

Table 4.14: Household's volunteers to work in KARN for habitat improvement

Reasons	Whether you are willing to volunteer to work in KARN				Total
	Not willing to volunteer	Willing to volunteer	Might be willing to volunteer	Not sure	
If these measures are effective, I am willing to volunteer to work	-	168	-	-	168
Even we will not volunteer to work in KARN, we have mitigation costs	-	15	-	-	15
Willing to volunteer to work but do not think these measures are workable		3	-	1	4
Busy/live too far	1	-	2	5	8
Need to consult with neighbors what they think	-	-	-	2	2
Too old	1	-	-	1	2
Should have payments	1	-	-	-	1
Total	3 (1.5%)	186 (93.0%)	2 (1.0%)	9 (4.5%)	200 (100.0%)

Source: household survey, 2011

Table 4.15: Household's attitude to elephants

Attitude to elephants	No. of respondents	%
Do not hate elephants but do not want them to raid crops	119	59.5
Fear to be hurt by elephants or fear to lose their crops	53	26.5
Dislike/hate/angry with elephants because they damage crops	27	13.5
No comment	1	0.5
Total	200	100.0

Source: Household Survey, 2011

4.3 Conclusion

This chapter describes the survey of the six villages adjacent to KARN sanctuary which are the most affected HEC areas, namely Na Yao village, Na Isan village, Lum Tha Sang village, Tha Ten village, Na Ngam village and Klong Toey village. The total sample size of household survey was 200. The survey was conducted by a face-to-face interview. The household survey shows that the average crop-damaged area is approximately 6 rai/household/year or 0.0096 km^2/household/year, which is almost 18% of total crop area. Average annual damage cost is 34,825 baht/household or USD 1,161/household.

Mitigation measures undertaken by households are complementary options. This explains why all households have applied more than one option. Average annual mitigation costs are 5,917 baht/household or USD 197/household. Another cost borne by households is opportunity cost of time to guard their crops at night. This study assumes that opportunity cost of time is accounted for only 30 percent

of household income. Therefore, average opportunity cost of time to guard crops at night is 7,632 baht/household/year or USD 254/household/year. Consequently, the average HEC cost borne by households is 48,374 baht/household/year or USD 1,612/household/year, which accounts for 26 percent of their annual household income.

Additionally, the result from the household survey on the question "whether households are willing to work on mitigation measures, to install water holes, remove invasive species and build salt licks, for free" is interesting. It found that 93 percent of respondents are willing to work for free. This shows that households are rational because if the policy options are workable, the household do not have to spend time protecting their crops. So the opportunity cost of their time is effectively the time they would have spent guarding their crops. The opportunity cost of time of households would therefore serve as a lower bound estimate of the costs on service providers of a PES scheme. This is an important message for future PES schemes.

CHAPTER 5
THE COST-BENEFIT ANALYSIS AND COST-EFFECTIVENESS ANALYSIS OF HEC MITIGATION STRATEGIES[10]

This chapter is comprised of three sections; 1) cost-benefit analysis (CBA) of HEC mitigation strategies, 2) cost-effectiveness analysis (CEA) of HEC mitigation strategies and 3) conclusion. The CBA and CEA were used as tools to compare three policy options over a 20-year period to deal with human-elephant conflict in the study area.

5.1 Cost-Benefit Analysis of HEC Mitigation Strategies

5.1.1 Steps of Cost-Benefit Analysis (CBA)

The cost-benefit analysis (CBA) was used as a tool to compare three policy options over a 20-year period to deal with human-elephant conflict in the study area. The objective of CBA is to help social decision making to select the more efficient allocation of society's reources (Broadman et al., 2006). The three policy options were examined are 1) habitat improvement activities and contraception of female elephants, 2) habitat improvement activities, contraception and land-use change, and 3) habitat improvement activities, contraception, and electric fences. The seven steps of CBA adapted from Boardman et al. (2001) were conducted:

Step 1: Defining the referent groups

The referent group refers to the group of individuals whose welfare will be accounted for when assessing the costs and benefits of the project. The reference group of this project is affected households from HEC who their crops locate near the KARN.

[10] The cost-benefit analysis and cost-effectiveness analysis was financially supported by the Economy and Environment Program for Southeast Asia (EEPSEA) under the project on "Analysis of Policy Options to make From Human-Elephant-Conflict to Human-Elephant-Harmony" and reported in the EEPSEA report.

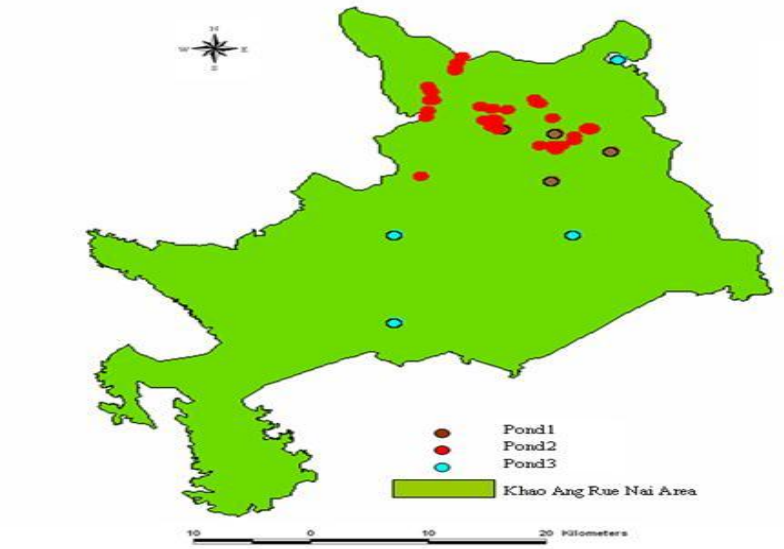
Step 2: Identify the alternative methods of achieving the objectives

Even though the local people and related government agencies currently have applied some mitigation measures, the level of these existing measures still are not enough to eliminate the HEC problem. According to expert opinion, the alternative to alleviate the HEC problem is to improve the level of the current mitigation activities (habitat improvement) and combine this with other options (contraception of female elephants, land-use change and electric fences). The details of each policy options are as follows:

1. Habitat improvement and contraception

The wildlife expert, who is a former head of the Chachoensao Wildlife Research Station, suggested that the best mitigation strategy is to keep elephants in the sanctuary by improving habitat for elephants to enable them to sustain life without raiding the farm. The proposed measures are to improve the level of the mitigation activities for habitat improvement, comprised of 1) increasing water ponds, 2) increasing salt/mineral licks, and 3) increasing grassland area. The new water resources should be established in a deep jungle to prevent elephants away from the sanctuary. The blue plots in Figure 5.1 show the location of additional water ponds. Figure 5.2 shows the location of additional salt licks (the yellow plots). The widespread of alien species is the important reason that affected the size of grassland. In the deep forest, however, when sunlight cannot reach the ground, the grass cannot grow as well. To increasing grassland by replacing alien species (e.g. the bitter bush) with species of grass (e.g. wild sugarcane) will be another option to increase source of food for wildlife. Figure 5.3 shows the location of the new proposed grassland. The contraception or birth control of female elephants will be introduced when the populations of elephants exceed the maximum capacity level (500 elephants).

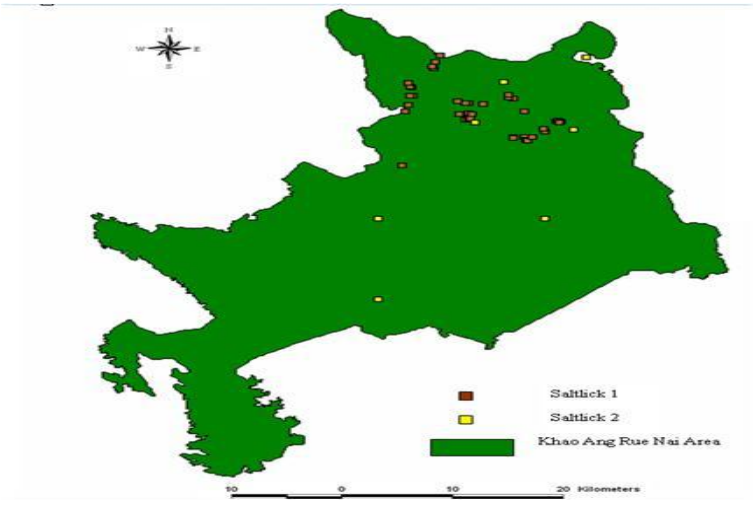
Figure 5.1: Location for proposed artificial water-ponds



The blue plots show the location of additional water ponds

Source: The Chachoensao Wildlife Research Station

Figure 5.2: Location for proposed artificial salt-lick

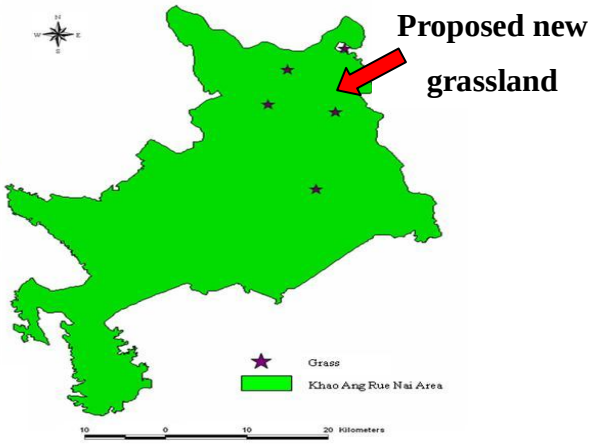


The yellow plots show the location of proposed artificial salt lick

Source: The Chachoensao Wildlife Research Station

Figure 5.3: Location of the proposed new grassland

Grass cannot grow because the sunlight cannot reach it



Source: The Chachoensao Wildlife Research Station

2. Habitat improvement, contraception and land-use change

Habitat improvement activities and contraception of female elephants will be introduced at the same level of scenario 1. Furthermore, the area within 0.5 km of the boundary of the KARN sanctuary that is considered a high risk zone for crop raiding will be changed from existing food crops to unpalatable crops that elephants do not consume.

3. Habitat improvement, contraception and electric fences

Under this scenario, habitat improvement activities and contraception of female elephants will be introduced as the same level of scenario 1. In addition, electric fences will be erected in the risky area (220 km of the total 460-km boundary of KARN).

Step 3: Listing of outputs and impacts and potential impacts

The costs and benefits in each scenario can be listed as in Table 5.1. The avoided costs (damage costs, protection cost, and opportunity cost of time) can be viewed as the benefits of the project because the existing costs borne by households will be alleviated when the mitigation measures are implemented.

Step 4: Quantifying and monetization the outputs and impacts

The Information on costs of mitigation measures will be also obtained from reviews of documents, literature, and the expert interviews. The benefits of the project are based on field survey findings discussed in Chapter 4. The technique for cost and benefit estimation and source of information can be shown in Table 5.1.

Table 5.1: Categories of benefit and cost estimation

Categories	Technique to estimate	Source of information
Benefits (Avoided costs)		
1.1 Avoided damage costs of affected households from crop raiding	Market value	Field survey
1.2 Avoided protection costs of affected households from crop raiding	Market value	Field survey
1.3 Avoided opportunity cost of time that spends to guard crops at night	Market value (forgone income)	Field survey
Cost: Habitat improvement and contraception		
2.1 Investment and maintenance costs of mitigation activities (water pond, salt lick, grassland etc.) to improve habitat in KARN	Market value	Expert interview
2.2 Contraception	Market value	Expert interview

Table 5.1: Cont.

Categories	Technique to estimate	Source of information
Cost: Habitat improvement, contraception and land use change		
3.1 Investment and maintenance costs of mitigation activities (water pond, salt lick, grassland etc.) to improve habitat in KARN	Market value	Expert interview
3.2 Contraception	Market value	Expert interview
3.3 The costs of forgone opportunities (the net present value of the next-best economic use of the resources and land) In this case, it is forgone income of existing food crops to unpalatable crops that elephants do not consume.	Market value	Field survey
Cost: Habitat improvement, contraception and electric fences		
4.1 Investment and maintenance costs of mitigation activities (water pond, salt lick, grassland etc.) to improve habitat in KARN	Market value	Expert interview
4.2 Investment and maintenance costs of electric fences	Market value	Field survey

Source: the author

Step 5: Calculate Net Present Value (NPV)

The values of the costs and benefits during the 20 years of the project period are discounted to get the present values by using 3%, 5% and 8% discount rates, each rate indicating differences in time preferences for consumption now as opposed to the choice of delaying consumption to future periods. The NPV of the different scenarios are compared. In principle, all projects with NPVs > 0 are considered to have passed the NPV test since it is considered as an improvement in the social welfare.

The NPV of a project is equivalent to the present value of the total benefits minus the total costs. Therefore, it assumes that at least one NPV is positive. If no NPV is positive, however, none of the proposed options are superior to the status quo. Then the status quo should be in place. With the project time frame of this study being 20 years, the NPV is calculated from the following:

$$NPV = \sum_{t=0}^{19} \frac{B_t - C_t}{(1+r)^t}$$

Step 6: Performing sensitivity analysis

Sensitivity analyses are an essential stage of CBA to determine the sensitivity of the NPV given changes in a key parameter. The sensitivity parameters were discount rate, namely 3%, 5% and 8%, and growth rate of crop-raiding damage, namely 5%, 10% and 15%.

Step 7: Compare the NPVs and make recommendation based on NPVs

The recommended option is the scenario with the largest NPV. The policy options should be ranked ordered from the largest NPV to the smallest NPV.

5.1.2 Description of Alternative Scenarios for CBA

According to key informant interviews, some HEC mitigation strategies (e.g. killing elephants and translocation are still unacceptable for Thai society. As mention earlier, an elephant in Thailand is not just an animal, but it also a cultural heritage species for Thai society and a white elephant was even included in the

flag of Thailand, therefore, both translocation and elimination are not currently the choice of HEC mitigation measures for Thailand. Furthermore, when the problem elephant is translocated, another elephant will replace in the few months (de Silva, 1998). Even compensation is a current mitigation measure but compensation rates are quite low as indicated in Table 1.3 in Chapter 1. During the household survey, the villagers even said that the transportation cost to go to the local government office was higher than the compensation they received; hence they did not go to claim it. Also, compensation is not suggested as the mitigation measure by the experts. This is because farmers tend to over-claim compensation (Fernando et al., 2008) and decrease in efforts to prevent damages or called "perverse incentive". While wildlife utilization scheme such as elephant hunting is also unacceptable strategies for Thai society.

From above reasons, Mr. Sawai Wanghongsa, who has been working on wildlife conservation in the Khao Ang Rue Nai (KARN) Wildlife Sanctuary for almost 30 years and the wildlife expert and former of the head of the Chachoengsao wildlife research station, suggested that the first priority measure to alleviate HEC problem is habitat improvement activities (e.g. water ponds, mineral licks, grassland conversion, supplementary feeding plantation for elephants). He also recommended the mitigation strategies that are applicable for Thai society which are habitat improvement, contraception, land-use change, and electric fence. Furthermore, these strategies can be complementary measures. Therefore, the three recommended policy options to alleviate the HEC problem are: 1) habitat improvement and contraception, 2) habitat improvement activities, contraception and land use change, 3) habitat improvement activities, contraception and electric fences by comparing whether each new policy option is preferable to the status quo. These three alternatives were examined by using the CBA as a tool to opt for the more efficient allocation of society's reources. The benefits and costs categories of each scenario can be described in Table 5.2. The benefits for all policies are avoided costs from crop-raiding problem borne by households, which are damage costs, protection costs, and opportunity costs of time for crop guarding at night. The investment cost category depends on

mitigation activities of each scenario, which are habitat improvement activities, contraception and electric fences. Another cost category is a payment by using weighted average crop return for rice and cassava in the study area as a proxy for farmers to convert traditional crops to unpalatable crops in the risky zone in policy 2. In addition, the residual costs borne by households are incurred in options 1 and 2 but not in option 3 where traditional crops in risky zones will be convert to unpalatable crops.

It should be noted that the CBA conducted here underestimates the benefits of reducing HEC because the benefit is not valuing the life saved of the humans or elephants. The approach to value of life, namely the value of statistical life (VSL), by using a wage hedonic approach to estimate the tradeoffs of workers between wages and the risk of death on the job is still controversial if the value is too high or too low. Taylor (2003) mentioned two controversies on VSL estimation. First, when there is a large variation in the VSL estimation it is difficult to select which value is best for any specific policy option. Second, a concern is whether a VSL estimation derived from studies of fatal workplace risks is appropriate for reducing risks of death from illnesses because illnesses may be a delayed reduction in the quality of life and/or pain involved. Besides the controversy of VSL estimation, another reason to not place the value of life in the analysis is that inclusion of these values might have produced higher benefits but not change the ranking of the policy options.

In addition, sensitivity tests were conducted. For each sub-scenario, three discount rates were used in the calculation of NPV, namely 3%, 5% and 8%. The parameters for conducting sensitivity analysis for this study will also include the growth rate of crop-raiding damage, namely 5%, 10% and 15% annually, because the crop-raiding damage may increase higher or lower than the growth rate of elephants, which is approximately 10% annually.

Table 5.2: Benefits and costs categories in each scenario

Scenarios	Benefits	Costs
Status quo	-	Total costs from crop-raiding problem borne by households (damage costs, protection costs, and opportunity costs of time)
Habitat improvement and contraception	Avoided costs from crop-raiding problem borne by households	1) Costs of habitat improvement activities and contraception 2) Residual costs from crop raiding problem borne by households
Habitat improvement, contraception and land use change	Avoided costs from crop-raiding problem borne by households	1) Costs of habitat improvement activities and contraception 2) Payment for farmers to convert traditional crops to unpalatable crops in the risky zone
Habitat improvement, contraception and electric fences	Avoided costs from crop-raiding problem borne by households	1) Costs of habitat improvement activities and contraception 2) Costs of electric fences 3) Residual costs from crop raiding problem borne by households

Source: the author

5.2.1.1 The Status Quo Scenario

The Status Quo scenario assumes that nothing will be done in addition to the efforts already invested as mentioned in previous section. Costs occurred in this scenario are the costs from crop-raiding problem borne by households with no more interference from the public sector, which are damage costs, protection costs and opportunity costs of time for crop guarding at night. The details of cost estimation in each category can be described as follows:

1) The crop-raiding damage costs borne by households: assumptions based on scientific studies in the KARN and expert interviews to calculate damage costs are:

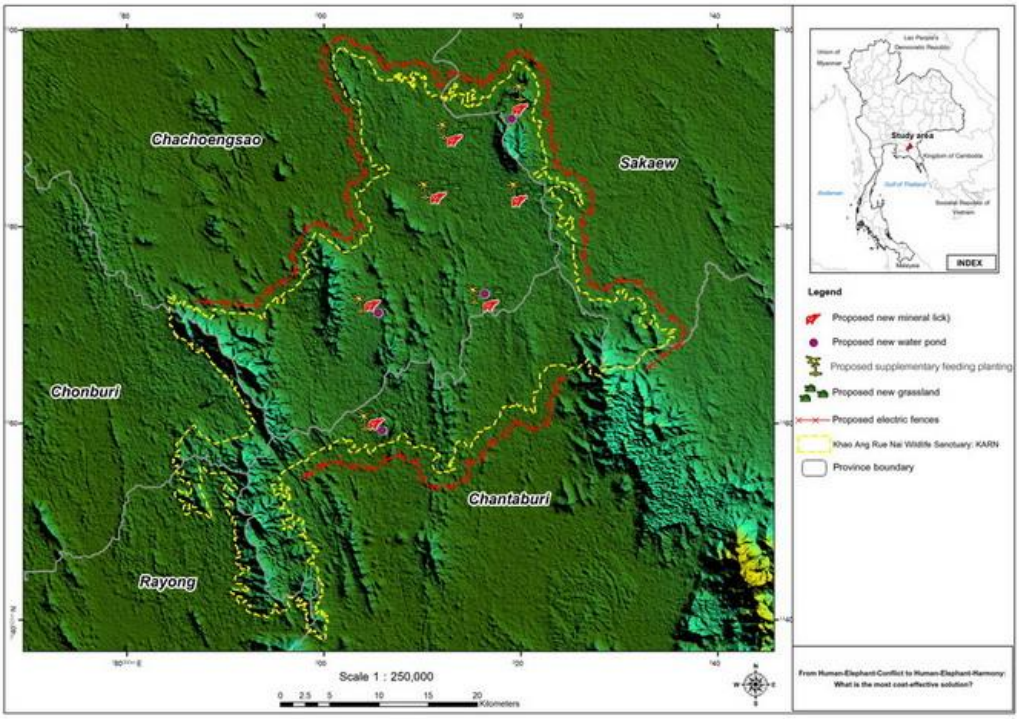
- The affected area by crop-raiding or a high risk zone is the area within 0.5 km of the boundary of the KARN sanctuary (the same areas of the red line which proposed the electric fences of the policy option 3 in Figure 5.4), which is about 220 km from the 460-km total boundary (KARN, 2010). The rest of 240-km boundary is the mountainous area that the risk of crop raiding by elephants is quite low. Therefore, the total area at risk is approximately 110 square kilometer or 68,750 rai[11];
- Based on household survey, the unit cost of damage cost is 34,825 baht per household per year and average agricultural area is 33.6 rai per household. Therefore, an average damaged area borne by household is accounted for 18% of the total agricultural areas. This scenario assumes that a damage cost is also accounted for 18% of the area in the high risk zone;
- Based on the Wanghongsa et al. (2008b)'s study, the growth rate of elephant population in KARN is 9.83 or approximately 10% annually. Therefore, this scenario assumes that damage costs are increased as the same proportion of the growth rate of an elephant population or 10% annually for the whole period of the project. However, crop-raiding damages may increase more or less than 10%. Therefore, the sensitivity analysis on the growth rate of crop-raiding costs was performed, namely 5%, 10% and 15%.

2) The protection costs by households: assumptions based on household survey to calculate protection costs can be described as follows:

[11] 1 square kilometer = 625 rai

- The unit cost of the protection cost borne by household is approximately 5,917 baht per household per year or USD197 per household per year;
- This analysis assumes that the protection costs by households are constant for the whole period of the project under an assumption that households cannot do anything more as they did.

Figure 5.4: Locations of proposed habitat improvement activities and electric fences



Source: the author

3) *The opportunity costs of time for crop guarding at night*: assumptions based on household survey to calculate opportunity costs of time can be described as follows:

- The average household income is approximately 183,950 baht per household per year and average household member is 4.2 persons. Then, the average per capita income is 43,798 baht per year or 120 baht per day per person;

- The average night of crop guarding is approximately 212 nights per household per year;
- It is hypothesized that households revealed value of time reflects the opportunity costs of time associated with a aspect of working (crop guarding) than resting (or sleeping) which measures the trade-off between work and leisure. However, households obtain benefits of crop guarding by reducing damage costs of crop raiding. Therefore, it might be overestimated to apply the full wage rates of households to be a proxy of opportunity cost of time. This analysis assumes that the opportunity cost of time of households to guard their crops, which leads to loss of sleep, is estimated only 30% of the total household income.
- This analysis assumes that only one family member guards crops at night;
- This analysis assumes that the opportunity costs of time are constant for the whole period of the project under an assumption those households cannot do anything more as they did and expect no increase in their wage or opportunity cost of time because this is subsistence farming, not wage income by itself.

5.1.2.2 Habitat improvement and contraception (HC)

Under this scenario, habitat improvement activities (construction of water ponds and mineral licks, conversion of invasive alien plants toward grassland, supplementary feeding plantation) and contraception of female elephants will be implemented. The Net Present Value (NPV) of this scenario is calculated from the following:

$$NPV = \sum_{t=0}^{19} \frac{B_t - C_t}{(1+r)^t}$$

where B_t = Avoided costs from the crop-raiding problem in the case of the status quo
- Residual costs from crop-raiding problem borne by households

Ct = Costs of habitat improvement activities and contraception

Avoided costs from crop-raiding problem in the case of status quo

= Increase in harvests due to less damage inflicted by elephants + avoided protection costs + avoided opportunity costs of time

Residual costs from crop-raiding problem borne by households

= residual damage costs, protection costs and opportunity costs of time

Assumptions based on scientific studies in the KARN and expert interviews for this scenario can be described as follows:

- Presently, only 36.61% of the total area or approximately 374 square kilometers is currently optimal forest habitat for elephants. To improve degraded forest habitat, which is about 63.29% of total area, can increase carrying capacity of KARN to support 332-498 elephants (Wanghongsa et al., 2008b). Therefore, this analysis assumes that the maximum carrying capacity of KARN for elephants is approximately 500 elephants if the proposed habitat improvement activities are employed.
- The habitat-improvement project by the Chachoensao Wildlife Research Station, found that the annual growth rate of elephant population within the KARN boundary, surveyed by a dung count method during 2001 – 2007, was approximately 2.38%; therefore, the rest of additional growth of elephant population or 7.45% annually would extend their forging area into the fringe of agriculture lands because it was found that the new dung-piles were detected near the periphery of the sanctuary (Wanghongsa et al., 2007b). The above information reveals that habitat improvement activities can

accommodate about 2% of the 10% growth rate of the elephant population in KARN. Therefore, we can employ this information as an effectiveness indicator of habitat improvement activities that may reduce the damage of crop raiding by elephants about 20%;

- At a 10% growth rate of the current elephant population in KARN, which is estimated at 250 in total, the elephant population will exceed the sustainable level (500 elephants) in the next 8 years. Therefore, contraception or birth control of female elephants is needed for 50 female elephants each year to control the herd size. Contraception will allow the herd size to stabilize at a steady state level. This means that the residual damages will be at a constant level for the years after the contraception takes effect, as is discussed below.

A monitoring procedure should be employed to check whether elephants come to use water ponds or mineral lick or not. If not, it needs to find the reasons why they did not. It may be because of the inappropriate location of water ponds and mineral licks or improper components of mineral licks. Then, necessary changes will be required. The details of the costs of each of these activities can be described as follows:

1) Costs of habitat improvement activities and contraception **(**Table 5.3):

A) Water ponds: the five water ponds will be constructed in the first year of the project period. The construction cost of water ponds is approximately 50,000 baht (USD 1667) per ponds. No maintenance of water ponds is required.

B) Mineral licks: the 260 mineral licks will be created in the first year of the project period. We need to create 260 mineral licks in the first place because we do not know where elephants would utilize the mineral licks. In the second year, approximately 130 mineral licks that elephants come to use will be deposited. Those 130-mineral licks will be developed to permanent mineral licks for elephants and other animals afterward. The construction cost of mineral licks and mineral deposit are equal, which is approximately 2,500 baht (USD83) per mineral lick.

C) Grassland conversion: the 30,000 rai or 48 km^2 of invasive alien plants toward grassland will be introduced by implementing 3,000 rai or 4.8 km^2 each year, therefore, 30,000 rai or 48 km^2 of grassland will be established in 10 years. In the eleventh year, the first 3,000-rai-plot of conversion will be needed to reconvert to grassland again because the invasive alien species will grow and cover of most grasslands. The second 3,000-rai-plot of conversion will be needed to reconvert to grassland in the twelfth year, and so on. Therefore, the cost of the conversion of invasive alien plants to grasslands is roughly 3,180,000 baht or USD 106,000 per year. The unit cost of the conversion is 1,060 baht/rai or USD 22083/km^2.

D) Supplementary feeding plantation for elephants: 500 rai or 0.8 km^2 of supplementary feeding plantation has been proposed. Provision of supplementary feeding (e.g. bananas) can attract crop-raiding elephants and keep them in the park. The cost of supplementary feeding plantation is 2,500 baht per rai (or USD 52083/km^2). Therefore, the annual cost of supplementary feeding plantation is approximately 1,250,000 baht per year or USD 41,667 per year. However, the supplementary feeding plantation will need to be replanted every two years.

E) Contraception or birth control: as mentioned before, the maximum carrying capacity of KARN for elephants is 500 elephants. The carrying capacity of KARN for elephants will be exceeded in the 8^{th} year, therefore, the contraception of female elephants will be introduced from the 8^{th} year. The cost of contraception is approximately 50,000 baht (USD 1667) per one female elephant. According to an expert interview, 50 female elephants need to have contraception each year. Therefore, the annual cost of contraception is approximately 2,500,000 baht (USD83333). Contraception is effective for about 10 years; therefore it needs to be introduced every 10 years.

F) Monitoring process: habitat improvement activities (water ponds and mineral licks) need to be monitored to make sure that elephants or other animals utilize them. The devices and human resources for the monitoring process can be described as follows:

F.1) Ten monitoring cameras: the unit cost of a camera at water ponds and mineral licks is approximately 12,500 baht (USD 417). Therefore, the cost of cameras for the first year will be 125,000 baht (USD 4167). However, cameras need to be changed to be the new ones every five year. Furthermore, the battery cost of camera is approximately 1,000 baht (USD 33) per year.

F.2) Five handheld GPS receivers: the unit cost of a handheld GPS receiver is approximately 20,000 baht (USD667). Therefore, the total cost for handheld GPS receivers is approximately 100,000 baht (USD3333). These five handheld GPS receivers can be used for the whole project period.

F.3) Two notebook computer: the unit cost of a notebook computer is approximately 30,000 baht (USD1000). Therefore, the cost of computers for the first year will be 60,000 baht (USD2000). However, notebook computers need to be changed to be the new ones every five year.

F.4) Two staff for monitoring activities: the salary to hire the wildlife technicians for monitoring process is approximately 10,000 baht (USD333) per month per person. The payment for wildlife technician is approximately 240,000 baht (USD8000) per year.

Table 5.3: Costs of activities to alleviate HEC

Activities (unit)	Costs per unit	Additional amount of activities required
Habitat improvement and contraception		
Water pond (pond)	50,000 baht (USD 1,667)	5 ponds
Mineral lick (mineral lick)	2,500 baht (USD 83)	260 mineral licks
Conversion of invasive alien plants to grasslands (rai)	1,060 baht (or USD 22083/km^2)	30,000 rai or 48 km^2
Planting supplementary feeding for elephants (rai)	2,500 baht (or USD 52083/km^2)	500 rai or 0.8 km^2
Contraception or birth control process (elephant)	50,000 baht (USD 1667)	50 female elephants for every 10 years
Monitoring activities after implementation		
Handheld GPS receiver (piece)	20,000 baht (USD 667)	5 pieces
Monitoring camera at water ponds and mineral licks	12,500 baht (USD 417)	10 cameras
Notebook computer (unit)	30,000 baht (USD 1000)	2 units
Staff for monitoring activities (baht/staff/month)	10,000 baht (USD 333)	2 staff

Source: an interview with Mr. Sawai Wanghongsa, the former head of Chachoengsao wildlife research station, 19 January 2011. Note: USD1 = 30 baht

2) The residual costs from crop raiding problem borne by households

Costs from crop-raiding problem borne by households are damage costs, protection costs and opportunity costs of time for crop guarding at night. Even the habitat-improvement activities and contraception are employed, the residual impacts still remain. Such mitigation measures cannot eliminate all impacts from HEC but it can alleviate it. Assumptions to calculate protect residual impacts can be described as follows:

- As mentioned earlier, this analysis assumes that activities of habitat improvement reduce the crop-raiding damage is about 20%;
- Under this scenario, residual damage costs of crop raiding will be increased until the 9th year of the project. The contraception is introduced in 8th year but it may have a one-year lag to be effective. Hence, from 9th year until end of the project, the damage cost of crop raiding will be constant;
- Regarding to protection costs and opportunity costs borne by households in this scenario, the estimation of these costs is based on assumptions and information as the status quo scenario. Also, both the protection and opportunity costs of households is assumed to be constant for the whole project under an assumption that households cannot do anything more as they did the same as the status quo scenario. Furthermore, it is expected no increase in their wage or opportunity cost of time because this is subsistence farming, not wage income.

5.1.2.3 Habitat improvement activities, contraception and land use change (HCL)

Under this scenario, habitat improvement and contraception of female elephants will be set up at the same scale as the second scenario. Furthermore, households who are in the area within 0.5 km of the boundary of the KARN sanctuary is considered a high risk zone (the same location of the red line which proposed the electric fences in Figure 4.1), will be asked to convert their traditional crops to unpalatable crops (e.g. rubber trees, teak etc.). Chong et al. (2005) recommended for buffer zones that are planted with palatable crops should be at least 5 meters in width. However, Mr. Sawai Wanghongsa, the former head of Chachengsao wildlife research station, recommended that it should be at least 0.5 km in width, which would be far enough for elephants not go further to search for foods in villages. Also, to implement the habitat improvement activities to increase food for elephants would encourage them to turn back to the park rather than go further to villages.

The NPV of this scenario is calculated from the following:

$$NPV = \sum_{t=0}^{19} \frac{B_t - C_t}{(1+r)^t}$$

where B_t =Avoided costs from crop raiding in case of status quo

C_t =(Cost of habitat improvement activities and contraception

+ Payment for farmers to convert from traditional crops to unpalatable crops)

Avoided costs from crop raiding in case of status quo

=Increase in harvests due to less damage inflicted by elephants + avoided protection costs + avoided opportunity costs of time

Assumptions used to calculate the payment/compensation rate for land-use change can be described as follows:

- The weighted average crop return in the study area (rice and cassava) is used to represent opportunity cost of land use change to unpalatable crops, which is about 7,431 baht per rai[12]or USD248 per rai;
- The total area of land use change is the high risk zone, which is approximately 110 square kilometer or 68,750 rai;
- The average damaged areas of household is accounting for 18% of the total areas;
- In this scenario in the expert view, there is no crop loss from crop raiding by elephants because the risky area will be converted to unpalatable crops.

12 The returns of rice and cassava in the study areas in 2010 were about 4,192 baht/rai and 8,820 baht/rai respectively. The areas of rice and cassava cultivations are 1,671 and 3,897 rai respectively.

5.1.2.4 Habitat improvement activities, contraception and electric fences (HCE)

Under this scenario, habitat improvement activities and contraception at the same scale as the second scenario will be implemented. In addition, electric fences will be erected on the edge of the KARN at the risky areas of crop raiding (0.5 km-area surrounding the KARN or the red line in Figure 5.3) in the first year of the project period. According to a field trip at the Salakpra Wildlife Sanctuary in Kanchanaburi province, one of the most-severe-HEC areas in Thailand, a park ranger explained that the fundamental rules to install the fences were needed to ensure that the fences were effective to prevent elephants across them. The fence is suggested to be about two meters high from the ground, with posts 10-m apart. Fences are maintained on a duty cycle of 24 hours. The 3 meters-area surrounding the fences for both sides is needed to be clear from the trees (Figure 5.5) to prevent elephants put trees on the fences and across them afterward. The voltage needs to be maintained at 220 volt to 8,000 volt. The maintenance requires daily inspection of fence for wire breaks, loosening, and current leakage from objects or plants touching the wires, replacing damaged posts, inspection of powering energizer.

Figure 5.5: Electric fences in the Salakpra Wildlife Sanctuary

Source: the author

The NPV of this scenario is calculated from the following.

$$NPV = \sum_{t=0}^{19} \frac{B_t - C_t}{(1+r)^t}$$

where B_t = Avoided costs from the crop-raiding problem in the case of the status quo

- Residual costs from crop-raiding problem borne by households

C_t = Construction and maintenance cost of electric fences

Avoided costs from crop raiding problem in case of status quo

= Increase in harvests due to less damage inflicted by elephants + avoided protection costs + avoided opportunity costs of time

Residual cost of crop raiding problem borne by households

= residual damage costs, protection costs and opportunity costs of time

The assumptions to calculate the costs of electric fences and residual impacts can be described as follows:

- According to the crop-protection trial project by elephant conservation network (ECN), the construction and maintenance costs of electric fence are approximately 150,000 baht per kilometer and 15,000 baht per kilometer respectively (Ritthirat et al. forthcoming);
- The ECN's research found that the electric fences could reduce the crop-raiding damages by elephant about 80%. Then, the estimation of residual cost from crop raiding problem borne by households (damage costs, protection costs and opportunity costs of time for crop guarding at night) was assumed to be reduced by 80%;
- Electric fences are needed to reconstruct in some parts of the fence during the project period because it might be possible the fence will be stolen or destroyed by villagers who want to enter the park. Therefore,

this analysis assumed that the villagers will need to reconstruct 40%, 30%, and 20% of the total fence at the 5th year, 10th year, and 15th years respectively. Assuming a decreasing rate of fence damages is under the hypothesis that villagers will learn the benefit of the fence, therefore, they would less damage the fences.

5.1.3 The Results of the Cost-Benefit Analysis

Table 5.4 illustrates the results of HEC mitigation options. For each sub-scenario, the three discount rates are used in the calculation of NPV, namely 3%, 5% and 8%. Also, three different growth rate of crop-raiding damage, namely 5%, 10% and 15%, were used because crop-raiding damage may increase at a rate higher or less than the growth rate of the elephant population. The NPVs in each policy option will be used as a proxy to rank the preferable policy option. The NPVs for the Status Quo option are negative, and that means the "to do nothing" option would be the case that households will bear the increasing levels of costs to agriculture from a rising elephant population. The NPVs in each policy option are sensitive to the rate of crop-raiding damage, especially Policy 1 (habitat improvement and contraception). At 5% growth rate of crop-raiding damage, the NPVs of Policy 1 for all discount rates are negative. This is because a lower rate of crop-raiding damage results, but there are also lower benefits from crop-raiding saved, whereas the activity costs of mitigation measures are unchanged. It can be interpreted that Policy 1 might be the only appropriate option at certain levels of crop-raiding damage.

Sensitivity tests were performed for the changes of the discount rate and growth rate of crop-raiding damage. The NPVs of Policy 3 (habitat improvement, contraception and electric fences) are highest amongst all the options. These analyses suggest that benefits are greatest for the full-scale project which is comprised of habitat improvement, contraception and electric fences. Policy 2 (habitat improvement, contraception and land-use change) ranks below the others even in the most favorable situation for crop damage, but it is the cost of compensation that drives this option to be negative. Furthermore, the costs of

Policy 2 would be higher if we include the transaction costs on negotiation processes with farmers for crop conversion. However, the reason that Policy 3 is preferable because of the effectiveness of electric fences on crop saved is high (about 80% reduced crop damage) that make the benefits of this option more preferable.

The results of NPV estimation therefore accord with the households' attitudes toward crop-raiding mitigation measures. According to the household survey, several respondents (32%) also think that the effective method to deal with HEC is electric fences or un-electric fences; whereas only 1 respondent thinks that it should be unpalatable crops. Furthermore, if we consider another factor, the acceptance of households, in comparing Policy 2 (habitat improvement, contraception and land use change) and Policy 3, Policy 3 is still more desirable because it is quite difficult to persuade households to change their land use. Households are likely to select their crop according to the market prices of crops. What the results of the NPV estimation indicate is that it would be more worthwhile for policy-makers to make efforts to apply Policy 3.

5.2 The Cost-Effectiveness Analysis of HEC Mitigation Strategies

The cost-effectiveness analysis of HEC mitigation was analyzed for the same three policy options as the CBA. The objective of the CEA is to provide the unit costs of effectiveness on each policy intervention which can also assist with decision making as another criterion to select policy intervention before deciding what strategy to implement. It should be noted that the CEA focuses on the costs of policy intervention and ignores the residual impacts borne by households, which are residual costs, protection costs, and opportunity cost of time.

The CEA compares options on the basis of the ratio of their costs but is not a monetized effectiveness measure. The objective of the CEA is to estimate the unit costs of each policy option. Therefore, the policy makers can use this information as supplementary data to make a decision. It should be noted that the CEA focuses on the costs of policy intervention and ignores the residual impacts

borne by households, which are residual costs, protection costs, and opportunity cost of time. The unit of output or effectiveness measure can be derived from the objective of the options is trying to achieve. In this case, the effectiveness is number of areas of crop damage saved. The cost effectiveness ratios can be calculated from the following (Broadman et al., 2001).

$$CE_i = \frac{C_i}{E_i}$$

where CE_i = Cost effectiveness ratio of policy i

C_i = Total costs of treatment or policy intervention

E_i = Effectiveness of the treatments = crop damage saved

The CE ratio can be represented as the average cost per unit of effectiveness. In general, the most cost-effectiveness scenario has the lowest average cost per unit of effectiveness. The policy options should be ranked from the most cost-effective (the smallest CE ratio) to the least cost-effective (the largest CE ratio). The sensitivity tests were conducted in CEA. The sensitivity parameters were discount rate, namely 3%, 5% and 8%, and growth rate of crop-raiding damage, namely 5%, 10% and 15%.

The assumptions under each scenario for estimation of cost effectiveness ratio are similar to assumptions used in the cost benefit analysis. The difference for cost effectiveness analysis is that the policy interventions have an effect on the areas of crop damage, not the costs of crop damages. The effectiveness can be measured in crop damage saved from crop-raiding by elephants. As mention earlier, the total area of the high risk zone is about 110 square kilometers or 68,750 rai. Average damaged area is accounted for 18% of total agricultural areas. Therefore, the affected area is about 12,375 rai or 19.8 square kilometer. The parameters for conducting sensitivity analysis for this study included discount rate, namely 3%, 5% and 8%, and growth rates of crop-raiding damage by elephants, namely 5%, 10% and 15%.

5.2.1 Description of Alternative Scenarios

5.2.1.1 Habitat improvement and contraception

Under this scenario, assumptions to calculate effectiveness can be described as follows:

- The habitat improvement activities can reduce the annual growth rate of the areas of crop damage about 20%;
- The contraception of female elephants will be started in the 8th year; therefore, the crop damage will be constant since the 9th year.

5.2.1.2 Habitat improvement, contraception and land-use change

Under this scenario, assumptions to calculate effectiveness can be described as follows:

- No crop is damaged under this scenario because all crops in high risk zone will be converted to unpalatable crops.

5.2.1.3 Habitat improvement, contraception and electric fences

Under this scenario, assumptions to calculate effectiveness can be described as follows:

- The habitat improvement activities can reduce the annual growth rate of the areas of crop damage about 20%;
- The contraception of female elephants will be started in the 8th year; therefore, the crop damage will be constant since the 9th year;
- The electric fences can reduce the crop damage by 80%.

5.2.2 The Results of the Cost-Effectiveness Analysis

The results of CE ratios can be interpreted as how much costs for policy intervention to save one unit of crop areas from crop-raiding by elephants. The results of CE ratios are illustrated in Table 5.5. The sensitivity tests on discount rates and growth rate of crop damages does not change the ranking of policy options. The results of CE ratios demonstrate that the CE ratio of Policy option 3

is most cost-effective option, which accords with the CBA results. Among three policy options, Policy 2 is the most expensive option; however, this option also can save all crops by raiding or no residual impacts in the expert view. As mentioned earlier, the costs of compensation/payment for crop conversion makes this policy less desirable. The CE ratios are also sensitive to the growth rate of crop-raiding damages. According to these sensitivity tests of the growth rate of crop-raiding damage, the CE estimation shows that the higher rate of crop-raiding damage results in the least cost-effectiveness ratio. This is because the higher rate of crop-raiding damage actually means the more crops saved, whereas the activity costs of mitigation measures are unchanged in each rate of crop-raiding damage.

According to household survey, the total HEC cost borne by households is about 48,374 baht/household and average crop area is about 33.6 rai. Therefore, the average HEC cost borne by household is about 1,440baht/rai. By comparing HEC cost borne by households and the unit costs of CE estimation, the unit costs of Policy 3 in all scenarios, which varies between 132 and 599 baht, are lower than the HEC costs. This information also makes Policy 3 more cost-effective compared to do "nothing".

5.3 Conclusion

This analysis shows that cost-benefit analysis (CBA) and cost-effectiveness analysis (CEA) are the tools to select the correct policy intervention for employing a pilot KARN-PES scheme. The scenarios of CBA and CEA considered were: 1) habitat improvement and contraception, 2) habitat improvement, contraception and land-use change and 3) habitat improvement, contraception and electric fences. However, it should be noted that the CBA conducted here probably underestimates the benefits of HEC reduction because it did not place the values of life saved for both human and elephants. This is because the current techniques to value life (e.g., VSL) are still controversial, and while inclusion of these values may have produced higher benefits, they may not change the ranking of the policy options. The results of CBA demonstrates that

Policy option 3 (habitat improvement, contraception and electric fences) gives the highest net present values (NPVs), therefore option 3 is a more efficient allocation of resources of society compared to the other 2 options. In addition, the results of CEA are consistent with the results of CBA, which is that option 3 is preferable to the other options. Furthermore, the results of CBA and CEA accord with households' attitudes from the household survey that many respondents suggest the use of electric fences/non-electric fences as the HEC mitigation measure.

Table 5.4: Net present values of the net benefits of the three policy options

Unit: million baht (million USD)

Scenarios	Discount rate								
	3%			5%			8%		
	Growth rate of crop-raiding cost			Growth rate of crop-raiding cost			Growth rate of crop-raiding cost		
	5%	10%	15%	5%	10%	15%	5%	10%	15%
Status quo	-582.5 (-19.4)	-786.9 (-26.2)	-1160.2 (-38.7)	-489.4 (-16.3)	-646.4 (-21.5)	-928.9 (-30.9)	-387.6 (-12.9)	-495.8 (-16.5)	-685.7 (-22.9)
Policy 1:Habitat improvement and contraception	-32.2 (-1.1)	97.8 (3.3)	373.9 (12.5)	-31.6 (-1.1)	65.6 (2.2)	270.2 (9.0)	-30.0 (-1.0)	34.0 (1.1)	167.0 (5.6)
Policy 2: Habitat improvement, contraception and land use change	-915.3 (-30.5)	-710.8 (-23.7)	-337.6 (-11.1)	-788.3 (-26.3)	-631.2 (-21.0)	-348.8 (-11.6)	-646.2 (-21.5)	-538.0 (-17.9)	-348.1 (-11.6)
Policy 3: Habitat improvement, contraception and electric fences	64.0 (2.1)	253.5 (8.4)	607.3 (20.2)	43.6 (1.5)	188.7 (6.3)	455.6 (15.2)	22.5 (0.7)	121.9 (4.1)	300.4 (10.0)

Source: The author

Note: USD1 = 30 baht

Table 5.5: Cost Effectiveness Ratios of the three Policy Options

Options	Discount rate		
	3%	5%	8%
1) Habitat improvement and contraception			
Total cost of treatment (baht)	88,628,390	74,347,413	58,723,759
Total cost of treatment (USD)	2,954,280	2,478,247	1,957,459
1.1 At 5% growth rate of crop-raiding damage			
Total crop damage saved (rai)	40,687	40,687	40,687
Total crop damage saved (sq.km)	65	65	65
CE ratio (baht/rai)	***2,178***	***1,827***	***1,443***
CE ratio (USD/sq.km)	***45,381***	***38,068***	***30,069***
1.2 At 10% growth rate of crop-raiding damage			
Total crop damage saved (rai)	282,130	282,130	282,130
Total crop damage saved (sq.km)	451	451	451
CE ratio (baht/rai)	***314***	***264***	***208***
CE ratio (USD/sq.km)	***6,545***	***5,490***	***4,336***
1.3 At 15% growth rate of crop-raiding damage			
Total crop damage saved (rai)	376,090	376,090	376,090
Total crop damage saved (sq.km)	602	602	602
CE ratio (baht/rai)	***236***	***198***	***156***
CE ratio (USD/sq.km)	***4,910***	***4,118***	***3,253***
2) Habitat improvement, contraception and landuse change			
Total cost of treatment (baht)	1,497,783,885	1,277,655,527	1,033,816,161
Total cost of treatment (USD)	49,926,130	42,588,518	34,460,539
1.1 At 5% growth rate of crop-raiding damage			
Total crop damage saved (rai)	409,191	409,191	409,191
Total crop damage saved (sq.km)	655	655	655
CE ratio (baht/rai)	***3,660***	***3,122***	***2,526***
CE ratio (USD/sq.km)	***76,257***	***65,050***	***52,635***
1.2 At 10% growth rate of crop-raiding damage			
Total crop damage saved (rai)	708,778	708,778	708,778
Total crop damage saved (sq.km)	1,134	1,134	1,134
CE ratio (baht/rai)	***2,113***	***1,803***	***1,459***
CE ratio (USD/sq.km)	***44,025***	***37,555***	***30,387***
1.3 At 15% growth rate of crop-raiding damage			
Total crop damage saved (rai)	1,267,739	1,267,739	1,267,739
Total crop damage saved (sq.km)	2,028	2,028	2,028
CE ratio (baht/rai)	***1,181***	***1,008***	***815***
CE ratio (USD/sq.km)	***24,614***	***20,996***	***16,989***
3) Habitat improvement, contraception and electirc fences			
Total cost of treatment (baht)	195,186,181	170,123,972	142,365,545
Total cost of treatment (USD)	6,506,206	5,670,799	4,745,518
3.1 At 5% growth rate of crop-raiding damage			
Total crop damage saved (rai)	325,590	325,590	325,590
Total crop damage saved (sq.km)	521	521	521
CE ratio (baht/rai)	***599***	***523***	***437***
CE ratio (USD/sq.km)	***12,489***	***10,886***	***9,109***
3.2 At 10% growth rate of crop-raiding damage			
Total crop damage saved (rai)	609,590	609,590	609,590
Total crop damage saved (sq.km)	975	975	975
CE ratio (baht/rai)	***320***	***279***	***234***
CE ratio (USD/sq.km)	***6,671***	***5,814***	***4,865***
3.3 At 15% growth rate of crop-raiding damage			
Total crop damage saved (rai)	1,079,510	1,079,510	1,079,510
Total crop damage saved (sq.km)	1,727	1,727	1,727
CE ratio (baht/rai)	***181***	***158***	***132***
CE ratio (USD/sq.km)	***3,767***	***3,283***	***2,747***

Source: the author

Note: 1) USD1 = 30 baht and 2) 1 square kilometer = 625 rai

CHAPTER 6

LEGAL FRAMEWORK FOR PES IN COSTA RICA, VIETNAM AND THAILAND

A successful PES implementation requires a supportive legal framework, instructions, and policies to define the environmental services, beneficiaries, service providers, financial mechanisms (Hoang Minh Ha et al., 2008). This chapter reviews the legal aspects of the PES implementation in Costa Rica which has a long experience in PES since 1997 and Vietnam where there is an advanced legal framework for PES implementation. Furthermore, Vietnam is the first country in Southeast Asia region with a national law on Payment for Environmental Services (PES) (McElwee, 2011). In addition, this chapter discusses the challenges for the legal framework for PES implementation in Thailand by focusing on the KARN-PES scheme.

6.1 The Experience in Legal and Institutional Framework from Costa Rica

Between 1950 and 1990, Costa Rica introduced an agricultural development policy by promoting land titling, technology, and subsidized credits for monocultures; as a consequence, deforestation in Costa Rica reached one of the highest rates in the world between 1973 and 1989, varying between 55,000 and 32,000ha/year (Navarro and Thiel, 2007) or about 35–40 percent of its forest cover (Pagiola, 2002). Payment for environmental services (PES) was not however the first incentive-based policy for forest protection in Costa Rica (Table 6.1; Daniels et al., 2010). The incentive-based policy of forest protection started in the 1970s with tax credits to offset costs of forest plantation and management. The tax credits were replaced by the Forest Credit Certificate (Certificado de Abono Forestal, CAF) under Forestry Law No. 7032 of 1986. Participation was also expanded through the Forest Credit Certificate with advances (Certificado de Abono Forestalpor Adelantado, CAFA), where land holders received the payments prior to investments in reforestation.

As can be seen in Table 6.1, the subsidy policies were applied to promote for the growth of forest covers in Costa Rica. However, since the financial crisis

in the early 1980s, the Costa Rican government was under pressure from the international to eliminate the subsidies, including those to the forest sector. Moreover, the Costa Rican government recognized that almost a half of forest covers that accounted for 44% of total forest covers in 2002 were private properties (Navarro and Thiel, 2007) (Table 6.2). If the government withdrew all forest subsidies, it would increase deforestation because the private land holders might end the conservation services to protect the forests in their lands. This reason explains why the PES was designed to address these externalities.

The PES mechanism, called Pago por Servicios Ambientales or PSA, was created in the fourth Forest Law No. 7575 in 1996 (Daniels et al., 2010).Forest Law No. 7575 changed the concept of incentives-based policy of timber production in plantation forestry and natural forest management, to a new concept of payment for environmental services, where land holders are paid for their sustainable conservation practices in natural forest, forest plantation and agroforestry systems (Navarro and Thiel, 2007). As mentioned earlier, before the PES was emerged, a payment system for forest reforestation and management in Costa Rica already was in place. However, the fourth Forest Law made two major changes to the payment system (Pagiola, 2008). First, the law adjusted the justification for payments from the subsidies for only the timber industry to the provision of environmental services. Second, it changed the source of finance from the government budget to earmarked tax and payments from the beneficiaries. But in practice, the PES mechanism in Costa Rica was similar in other aspects to the previous forest incentive-based policies. Most mechanisms of PES implementation, such as the payment system, were also carried over from previous incentive-based policies. Also, the CAF certificates were used as service providers in the PES scheme.

Forestry Law No. 7575 recognized four environmental services in the forest sector, which are comprised of biodiversity, watershed function, scenic beauty, and greenhouse gas mitigation through carbon storage and sequestration, and land holders can participate in more than one service including (a)

reforestation through plantations, (b) protection of existing forest, (c) natural forest regeneration, and (d) agroforestry systems (Daniels et al., 2010). Such law provides the regulation for the government to make a contract with land holders for the services they provide and has established a financial mechanism for this transaction in the form of the National Fund for Forest Financing (Fondo Nacional de Financiamiento Forestal: FONAFIFO) (Pagiola, 2002).

The PES scheme in Costa Rica is administered by FONAFIFO, a semi-autonomous agency with independent legal status (Pagiola, 2008). To provide secure demand for environmental services, FONAFIFO has assured agreements among water users as service buyers. The government board of FONAFIFO includes the three representatives of the public sectors, namely the Ministry of Environment and Energy, the Ministry of Agriculture, and the National Banking System, and two representatives from the private forest sector who were assigned by the board of directors of the National Forestry Office. Although the status of FONAFIFO is an autonomous agency which can make decisions, it is still under government regulation. For example, the budgets of FONAFIFO have to be approved by the Ministry of Finance, while the levels of payments are determined by executive decree. Though the Forest Law No.7575 admitted that the forest provided hydrological services, this law does not force beneficiaries to pay for services. FONAFIFO has acted as an intermediary to negotiate with water users to pay for the water services they obtain.

Table 6.1: Timelines of the incentive-based policies for forest protection in Costa Rica

Year	Incentive –based policy	Details of policies
1979	Income tax credits	Income tax credit given to the land owners who participate in restoration scheme to offset the costs of forest plantation (Decree No. 10521-AH, September 1979)
1983	Soft credits	International funding finances low-interest loans with long-period for reforestation (COREMA-AID project)
1986	Forest Payment Certification (CAF)	Landowners were compensated later thorough a tradable tax voucher (Certificado de Abono Forestal: CAF) for reforestation (Article 82 of the Second Forest Law No. 7032, La Gaceta 13: Circulo 84 – May 6, 1986)
1988	Advanced Forest Payment Certificate (CAFA)	Like CAF but compensation is given before reforestation investment (Decree No. 18691 – MIRENEM-H, December 1988)
1993	Forest Payment Certificate for Management (CAMA)	Scientifically-managed timber extraction could be eligible for tax vouchers (Decree No. 22452 – MIRENEM-H, 1993)
1995	Forest Protection Certificate (CBP)	Tax vouchers would be paid for natural forest protection, which equal to CAF vouchers paid for reforestation (Decree No. 23101 – MIRENEM-H, 1994, La Gaceta 74)
1996	Payments for Environmental Services (PSA)	Fourth Forestry Law (No.7575, Gaceta 72, Alcance 21-April 16, 1996) - Article 22 affirms continuation of tax vouchers for protecting natural forest along with other tax benefits. - Article 22 provides land owners voluntarily allowing forest regeneration are eligible for the same benefits. - Article 29 details tax benefits for plantation owners

Source: Daniels et al. (2010)

Table 6.2: Classification of land tenure for forest covers in Costa Rica in 2002

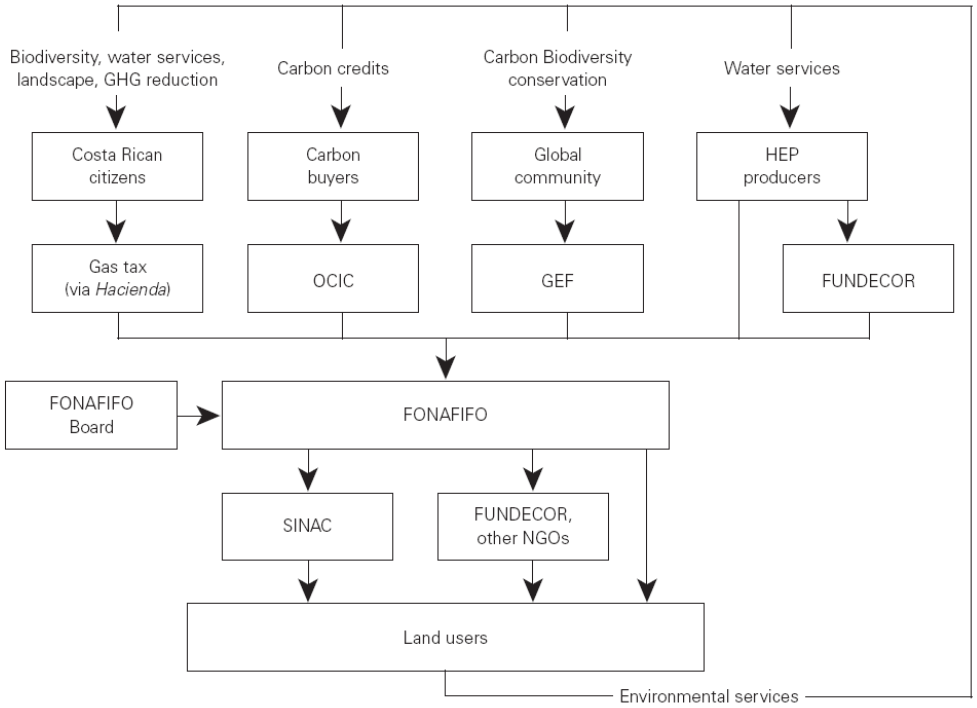
Management Category	State Property		Private Property		Total area (ha)
	Area (ha)	%	Area (ha)	%	
National Parks	481,190	85	86,751	15	567,941
Biological Reserves, National Monument, and National Absolute reserves	12,660	54	10,640	46	23,300
Protected Zones	37,687	24	119,410	76	157,097
Forest Reserves	73,107	26	209,553	74	282,660
National Wildlife Refugees	71,744	41	103,722	59	175,466
Wetlands	67,085	88	9,092	12	76,177
Total	743,473	56	539,168	44	1,282,641

Source: Navarro and Thiel (2007) citing Morales and Calvo (2002)

Figure 6.1 demonstrates the three fundamental functions of the institution for the PES program in Costa Rica (Pagiola, 2002). First, FONAFIFO acts as a mechanism with the support of other institutions, such as (Oficina Costarricense de Implementación Conjunta, OCIC) to collect and manage payments from service beneficiaries or service buyers. Second, SINAC and private professional foresters (e.g. FUNDECOR) are the agencies who contract service providers, pay them, and monitor their compliance. Third, a governing board from the three representatives of each three public sectors (the Ministry of Environment and Energy, the Ministry of Agriculture, and the national banking system) and the two representatives from the private sector who appointed by the board of the directors of the National Forestry Office. Furthermore, the PES scheme expected revenues from the potential for sales of carbon emission reduction credits, however, the

results were not as expected. Moreover, the scheme has also been assisted a grant from the Global Environment Facility (GEF) and a loan from the World Bank through the Ecomarkets project. Also, the water user such as a hydroelectric power (HEP) was another source of finance as a beneficiary or service buyer.

Figure 6.1: Institutional functions for PES program in Costa Rica



Note: 1. HEP = Hydroelectric power

2. OCIC = the Costa Rican Office of Joint Implementation

3. GIF = the Global Environment Facility

4. FONAFIFO =the National Fund for Forest Financing (Fondo Nacional de Financiamiento Forestal)

5. SINAC =Sistema Nacional de Areas de Conservación (National System of Conservation Areas)

6. FUNDECOR = Fundaciónpara el Desarrollo de la Cordillera Volcánica Central (Foundation for the Development of the Central Volcanic Cordillera)

Source: Pagiola (2002).

6.2 Experience from the Legal and Institutional Framework of Vietnam

The National Assembly of Vietnam has legislated a legal framework for natural resource and environmental management since 1990, which including the Land Law with its multiple revisions of 1993, 1998, 2000 and 2001, the Law on Forest Protection and Development of 1991 and the Law on Environmental Protection of 1991 (Wunder et al., 2005).Vu Thu Hanh et al. (2006) analyzed the Vietnam legal structure for PES implementation as follows:

1) Some environmental services are recognized in the laws but none of these laws describe such services in detail. In National Laws, which are the Law on Water Resources of 1998, the Land Law of 2003, the Law on Forest Protection and Development of 2004, and the Law on Environmental Protection of 2005, there is recognized some elements of environmental services (Table 6.3): biodiversity protection; landscape beauty; watershed protection; and carbon sequestration;

2) Under Vietnam's Civil Code of 2005, individuals or organizations can legally make contracts, but not for the communities. To make an agreement for PES, all stakeholders should have a legal right to enter into contracts. Vietnam's Civil Code of 2005 allows individuals or organizations to make contracts. However, communities have limited rights legally to enter into the contracts or civil legal relationship. The Civil Code specifies the four conditions that must be met for a legal entity to enter into a civil legal relationship (Article 84). First, it should be legally established. Second, it should have assets independently of other organizations and individuals. Third, it should responsible for those assets. Last, it should participate in legal relations independently and in its own name. Nevertheless, communities do not meet all of these conditions; therefore, they must enter into a civil legal relationship;

Table 6.3: Environmental Services in National Laws in Vietnam

Laws	Environmental Service	Details
The Law on Environmental Protection of 2005	Biodiversity	Biodiversity protection must be implemented based on the assurance of the rights and legitimate benefits of local communities (Article 30.1)
The Land Law of 2003	Coastal resources and landscapes	Coastal and "famous" landscapes are to be protected and managed (Articles 79, 98), while the Law on Environmental Protection of 2005 provides that natural landscapes are to be protected (Articles 6, 29, 31)
The Law on Water Resources of 1998	Water resources	Call for preventing the deterioration of water sources (Article 11). The Law on Environmental Protection of 2005 goes further, providing that river water and river basins must be protected and managed and benefits to communities ensured (Article 59), while the Law on Forest Protection and Development of 2004 stipulates that watershed protection is one of the purposes of protection forests (Article 4).
The Law on Forest Protection and Development of 2004	Carbon sequestration	Climate regulation is one of the purposes of protection forests (Article 4). The Law on Environmental Protection of 2005 does not specifically enable carbon sequestration, but does enable other economic and financial measures that would contribute to mitigating climate change, including international trading in greenhouse gas emissions (Article 84.2) and financial incentives for the development and use of clean and renewable energy sources (Article 33.2).

Source: Vu Thu Hanh et al., 2006

3) Rights and benefits of environmental services are defined in the laws. The Land Law of 2003 and the Law on Forest Protection and Development of 2004 recognized the rights of land users to manage lands. In addition, the Law on Forest Protection and Development of 2004 assures the rights of communities to manage forest land and to use forest products for both domestic and public reasons. Furthermore, the Land Law of 2003 also allows land users have rights to benefits from their management and use of resources. The land users have rights to enjoy the yield of their labor and investment in land;

4) The legal framework encourages using economic instruments or market-based mechanisms to support natural resources and environment conservation. The three main legal documents, Decision No. 256/2003.QD.TTg, Politburo Resolution No.41/NQ-TW; Decree 175-CP, 1994, allow and endorse to use market-based instruments for conservation. Even if the Law on Forest Protection and Development of 2004 allows setting the price only for forest products, this provision should include the pricing of environmental services, and fees and charges from environmental services. Moreover, under provisions of current laws, only the State can set rates, fees and charges, and all revenue is budgetary revenue of the State. Hence, it is still unclear whether communities or individuals can receive payment. However, individuals or communities may obtain the benefits from the sales of certain environmental products gained from their land where the State has allowed them. Moreover, the laws would be sufficient if the payments are based on market values and have the right to sell based on their market value. If the payments are considered as a charge, fee or tax, additional provisions must be appended to allow service providers receive the payment from the government agencies.

In 2010, The Vietnam Government introduced a Decree on Payment for Forest Environmental Services (PFES). No: 99 /2010/ND-CP was put into effect on September 24, 2010. This PES law is the first National legislation on PES implementation in Southeast Asia (McElwee, 2011). The Decree defined forest environmental services clearly, unlike the previous legislation discussed above, and included 1) soil protection, reduction of erosion and sedimentation, 2)

regulation and maintenance of water sources, 3) forest carbon sequestration and retention, prevention of forest degradation, 4) protection of natural landscape and conservation of biodiversity of forest ecosystems for tourism services, 5) provision of spawning grounds, sources of feeds, and natural seeds or use of water from forest for aquaculture (Article 4). The publication People and Nature Reconciliation (2011) discusses four new issues with the Decree as follows:

1) This is the first time that individuals and organizations that benefit from forest environmental services have to pay forest owners who are forest service providers (Article 5);
2) The Decree includes all special-use, protection and production forests as forest environmental service such as maintenance of water sources for clean water production, soil protection, reduction of erosion and services for regulation and maintenance of water sources for hydropower production, conservation of biodiversity of forest environmental services serving the tourism (Article 7);
3) The Decree give the owners of forest the right to be forest service providers (Article 8);
4) The Decree allows the beneficiaries from forest environmental service to pay directly through voluntary negotiated agreements between the service providers and beneficiaries or service buyers. In case the beneficiaries cannot make a payment directly, the beneficiaries can pay service providers indirectly through the Vietnam Forest Protection and Development Fund or through the provincial Forest Protection and Development Funds (Article 6).

6.3 Challenges of the legal framework for KARN-PES implementation in Thailand

The above discussion showed how comparable national systems have produced a legislative framework for PES. In this section the situation in Thailand is briefly compared and discussed. As proposed, environmental services for the KARN-PES scheme in Thailand are 1) increasing water supplies by building new water ponds, 2) converting alien species into grassland area, 3) creating mineral licks, 4) planting food for elephants, 5) contraception of female elephants and 6) fencing part of the sanctuary. The details of these environmental services for the KARN-PES scheme are described in Chapter 7. These environmental services need to be performed in the sanctuary. However, the scheme was designed that local villagers would serve as the service providers to gain two advantages. First, it is hoped that villagers would change their attitude that elephants will be a resource for them, not a pest as is the current situation. Second, the PES would be supplementary income for villagers.

This area has no irrigated land; agricultural practices depend on the level of rainfall every year so villagers can harvest their products only once a year. Furthermore, the private PES scheme as proposed here does not require a specific law beyond basic contract law (Greiber, 2009). However, to evaluate the KARN-PES scheme' position in the legal framework, any supporting laws should be considered thoroughly; from the Master Plans to subordinate legislation. Furthermore, after reviewing the related Thai laws, there are some legal frameworks to support the PES implementation (Table 6.4), whereas some current laws related to natural resources conservation also restrict a PES scheme's implementation, especially for the KARN-PES scheme (Table 6.5).

6.3.1 Supporting laws/Master plans for PES implementation

Constitution of the Kingdom of Thailand, B.E. 2550 (2007)

The Constitution of the Kingdom of Thailand, B.E. 2550 (2007) legislated about community, local community and traditional local community's rights in

collaborative management, preserving and the use of natural resources and environment topic, including State land policy, in section 66 and 85.

"*Section 66 Persons assembling as to be a community, local community or traditional local community shall have the right to conserve or restore their customs, local wisdom, arts or good culture of their community and of the nation and participate in the management, maintenance and exploitation of natural resources, the environment and biological diversity in a balanced and sustainable fashion."*

"Section 85 The State shall act in compliance with the land use, natural resources and environment policies as follows:

(1) preparing and applying the rule on the use of land throughout the country with due regard to the compliance with environmental condition, nature of land and water and the way of life of local communities, the efficient measures for preservation of natural resources, the sustainable standard for land use and opinion of the people in the area who may be affected by the rule on the use of land;

(2) distributing the right to hold land fairly, enabling farmers to be entitled to the ownership or the right in land for agriculture thoroughly by means of land reform or by other means, and providing water resources for the distribution of water to farmers for use in agriculture adequately and appropriately;

(3) preparing town and country planning, and developing and carrying out the plan effectively and efficiently for the purpose of sustainable preservation of natural resources;

(4) preparing systematic management plan for water and other natural resources for the common interests of the nation, and encouraging the public to participate in the preservation, conservation and exploitation of natural resources and biological diversity appropriately;

(5) conducting the promotion, conservation and protection of the quality of the environment under the sustainable development principle, and controlling and

eliminate pollution which may affect health and sanitary, welfare and quality of life of the public by encouraging the public, the local communities and the local governments to have participation in the determination of the measures."

It can be concluded from this that the Constitution of the Kingdom of Thailand has legislated to support natural resources and collaborative management of the environment between people, communities and government agencies, including balancing and sustaining use of natural resources, environment and biological diversity. These provisions agree with the implement of a PES project where people and communities manage natural resources and biological diversity as a service provider.

The Eleventh National Economic and Social Development Plan (2012-2016)

Regarding a strategy for environmental resource management under the eleventh National Economic and Social Development Plan (2012 – 2016) (NESDB, 2011b), the payment for ecosystem/environmental services (PES) is identified as the one mechanism to generate revenue from natural resources and biodiversity conservation. It shows that the PES approach has come to attention at the national level.

"*5.8.6 To generate revenue from natural resource and biodiversity conservation…. by creating the new mechanisms such as Payment for ecosystem services (PES) and Clean Development Mechanism (CDM).*"

The Draft Environmental Management Plan (2012 – 2016)

According to the Draft Environmental Management Plan (2012 – 2016) of Office of Natural Resources and Environmental Policy and Planning (ONEP, 2012), under Strategy No. 2 (the sustainable natural resource restoration and conservation) indicates that it should support the studies of the payment for environmental services (PES) and the Reducing Emissions from Deforestation and Degradation-Plus (REDD+) to develop mechanisms for forest bonds as a source of revenue for forest protection. Even this Master plan focuses only PES mechanism on forest protection; however, it is a good sign that PES approach is

receiving attention from the governmental agencies who are working for the natural resources and environmental management.

Enhancement and Conservation of National Environmental Quality Act, B.E. 2535(1992)

Chapter 2 Part 2 (Environmental Quality Management Planning) of the Enhancement and Conservation of National Environmental Quality Act, B.E. 2535 (1992) or the ECNEQ Act of 1992 also supports PES implementation as follows:

"Section 36 The Environmental Quality Management Plan pursuant to section 35 may be a short, intermediate or long-term plan, as appropriate, and should contain work plans and guidance for action in the following matters;

(1) Management of air, water and environmental quality in any other area of concerns.

(2) Pollution control from point sources.

(3) Conservation of natural environment, natural resources or cultural environment pertaining to aesthetic values.

(4) Estimation of financing to be appropriated from government budget and allocated from the Fund which is necessary for implementation of the Plan.

(5) Scheme for institutional arrangements and administrative orders by which co-operation and co-ordination among government agencies concerned and between the public service and private sector could be further promoted and strengthened, including the determination of a manpower allocation scheme which is required for implementation of the Plan.

(6) Enactment of laws and issuance of regulations, local ordinances, rules, orders and notifications necessary for implementation of the Plan.

(7) Scheme for inspection, monitoring and assessment of environmental quality by which the results of implementation of the Plan and enforcement of law related thereto can be evaluated objectively."

"Section 37 After the Environmental Quality Management Plan has been published in the Government Gazette, it shall be the duty of the Governor of the Province, in which there is a locality designated as environmentally protected area according to section 43, or as pollution control area according to section 59, to formulate an action plan for environmental quality management at Province level and submit it to the National Environment Board for approval within one hundred and twenty days from the date on which the Governor of that Province is directed by the National Environment Board to prepare the Province action plan for environmental quality management. If, however, there is a reasonable ground, the said duration may be extended as appropriate by the National Environment Board.

In preparing a Province Action Plan for the pollution control area according to section 59, the Governor shall incorporate into it the action plan for mitigation and elimination of pollution prepared by the local authority pursuant to section 60 and the local action plan shall form an integral part of the Province Action Plan.

In case there is any Province, in which no locality is designated as an environmentally protected area according to section 43, or as pollution control area according to section 59, that is nevertheless desirous to enhance and conserve the environmental quality within the limits of its territorial jurisdiction, the Governor of that Province may prepare a Province may prepare a Province Action Plan, within the framework of and in conformity with the requirements of the Environmental Quality Management Plan, and submit it to the National Environment Board for approval."

The ECNEQ Act of 1992 thus supports PES Implementation; section 36 (3) prescribes that it is the duty of all government agencies concerned to take actions within their powers and functions that are necessary for effective implementation of the Environmental Quality Management Plan. These are the conservation of natural environments, natural resources or cultural environments in a plan that maybe short, intermediate or long-term, as appropriate. In addition,

after the Environmental Quality Management Plan has been published in the Government Gazette, it shall be the duty of the Governor of the Province, in which there is a locality designated as environmentally protected area, to formulate an action plan for environmental quality management at Province level. Therefore, it is possible that a PES scheme will be a part of the Environmental Quality Management Plan as the Province action plan for environmental quality management. If a PES scheme can be a part of the Province action plan, the scheme will be legally implemented according to the Province action plan. The period of the action plan can be 1 year, 3-5 years or over 5 years, depending on the types of the action plan. If it is a long-term plan, the PES scheme will have much time for cultivating knowledge and understanding of its associates and to broaden the plan's collaboration with others agencies, and the benefit of the plan will be obvious and the PES scheme will be sustained.

Table 6.4: The current supporting law and Master plan for PES implementation

Related Laws/Master plans	Objective of Laws/Master plan	Supporting issues for PES implementation
1. Section 66 in the Constitution of the Kingdom of Thailand, B.E. 2550 (2007)	To protect the community rights	Local community shall have the right to conserve by participating in natural resources management
2. Section 85 in the Constitutions of the Kingdom of Thailand, B.E. 2550 (2007)	The proper land use, natural resources and environment policies	Local communities would be encouraged to participate in the conservation of natural resource appropriately
3. The strategy for environmental resource management under the Eleventh National Economic and Social Development Plan (2012-2016)	A mechanism for revenue generation from natural resource management	Supporting the PES scheme as one of mechanisms to generate revenues for natural resource management
4. Strategy No. 2: the sustainable natural resource restoration and conservation under the Draft Environmental Management Plan (2012 – 2016)	A mechanism for revenue generation from forest bonds as a source of revenue for forest protection	Supporting the PES scheme as one of mechanisms to generate revenues for forest protection
5. Chapter 2 Part 2 under the ECNEQ act of 1992	The responsibilities of all government agencies to take action within their powers and functions for the effective implementation of an Environmental Quality Management Plan	Supporting the PES scheme as one of mechanisms for Environmental Quality Management Plan

Source: the author

6.3.2 Legal constraints to implement the PES scheme in the case of the KARN-PES scheme

1) Restricted access to the KARN sanctuary to work for habitat improvement activities

- *The National Park Act, B.E.2504 (1961) and the Wildlife Preservation and Protection Act, B.E. 2535 (1992)*

The *National Park Act*, B.E.2504 (1961) is strict; the use of land for education and entertainment purposes is allowed by approval of the Director-General. But it is not allowed to hold or possess lands, including building, clearing or burning, collecting, taking out or doing by any means whatsoever things endangering or deteriorating plant, mineral or natural resources. It is also not allowed to take out animals or do by any means whatsoever things endangering the animals or deteriorating soil, rock, gravel or sand etc. However, an official can carry out any works for protection and maintenance of the national park for education or technical research, or for facilitating tourism or for public education.

Likewise for Wildlife Sanctuaries the Wildlife Preservation and Protection Act, B.E. 2535 (1992) legislated that no person shall, within a Wildlife Sanctuary, hunt wildlife, either preserved or protected wildlife, or collect or endanger any nest, except for educational purposes or scientific research and written permission must be obtained from the Director-General with the approval of the committee.

During the meeting of the legal framework for PES implementation in Thailand on 26th July 2011 at the Biodiversity-Based Economy Development Office (Public organization) or BEDO, the conclusion that the existing laws to run the pilot KARN- PES scheme in Thailand might be sufficient was reached and that a new specific law for allowing villagers to work in the sanctuary might not be required. Currently, Department of National Parks Wildlife and Plant Conservation (DNP) and BEDO jointly signed an agreement under the Memorandum of Understanding (MoU) of collaboration for undertaking of the natural resource and wildlife conservation. The reason for this effort is because

DNP is in charge of the conservation areas, whereas one of the mandates of BEDO is to support investments on the development of biodiversity-based economy. This MOU is supported and encouraged at institutional level of the two organizations to collaboration for natural resources and wildlife conservation in Thailand. Though the current laws do not authorize people to participate in natural resources preservation in a national park or the wildlife sanctuary, it can be performed by approval of the Ministry of Natural Resources and Environmental or Council of Ministers, in order that the Department of National Parks, Wildlife and Plant Conservation and villagers can collaborate and run the PES scheme. However, when the approval is granted at the beginning of the scheme for this pilot area, it would not necessary to ask for the approval every year because the approval would be granted based on the scheme period. Furthermore, the MOU between BEDO and DNP would encourage running the PES pilot scheme. In addition, it needs to indicate in the contract that the scheme will be started if only villagers involve in the PES pilot scheme in term of labor provision on habitat improvement activities to make sure that affected villagers will be involved in the scheme.

It might be concluded that KARN-PES implementation in National Parks and Wildlife Sanctuaries has some restrictions that acquire Ministry of National Resources and Environment's policy, or approval from the Council of Ministers, in order that the Department of National Parks, Wildlife and Plant Conservation can collaborate with villagers to run the KARN-PES scheme. In regard to legal impediment, as mentioned previously, the National Park Act, B.E.2504 (1961) and the Wildlife Sanctuaries, Wildlife Preservation and Protection Act, B.E. 2535 (1992) are the restriction but can find the solution as mentioned earlier. Other laws validate the process; PES implementation is possible under the present laws. In addition, none of the specific laws is required for the private PES scheme as a KARN-PES scheme except the basic contract law.

2) No supporting laws for a habitat credit trading system

An interesting development in terms of PES can be seen in the case of Australia, which has a Biobanking scheme resulting from the fact that most of the demand for biodiversity credits come from developers who are required (by law) to offset the negative impact of their development. The BioBanking system of NSW can work well because of strict enforcement of the laws. The framework for the scheme was established under Part 7A of the *Threatened Species Conservation Act* 1995. It is supported by the *Threatened Species Conservation (Biodiversity Banking) Regulation* 2008, which outlines the BioBanking Assessment Methodology and Compliance Assurance Strategy. However, while Thailand has parallel conservation laws, e.g. the *Wild Animal Reservation and Protection Act* of 1992 and the *Enhancement and Conservation of National Environmental Quality Act* of 1992. The difference is that the Thai law focuses on the command and control approach, not on a market-based approach and there is therefore no effort to create incentives for compliance and impose sufficient penalties for non-compliance. However, regarding this pilot project, developers can voluntarily create their own habitat credit system to offset their impacts on the environment or even to do "good" for conservation by participating on habitat credit system. The details of this system are described in Chapter 7 (Section 7.3.7).

Table 6.5: Legal constraints and their solutions for the PES scheme in KARN sanctuary

Related Thai Laws	Objective of laws	Restriction	Solution for this pilot project
1. Restricted access to the KARN sanctuary to work for habitat improvement activities			
1.1National Park Act of B.E.2504 (1992)	Protection and Maintenance of the National Park	Restrict access of villagers to work for habitat improvement activities in KARN sanctuary	Villagers would access the sanctuary if these activities are proposed as an *education and technical research* by coordination with Wildlife Sanctuary staff
1.2 Wildlife Preservation and Protection Act of B.E. 2535 (1992)	Wildlife protection		
2.No supporting laws for habitat credit trading system			
2.1National Park Act of B.E.2504 (1992)	Protection and Maintenance of the National Park	No channel by laws for developers to offset the negative impact of their development	But developers can *voluntarily* create their own habitat credit system
2.2 Wildlife Preservation and Protection Act of B.E. 2535 (1992)	Wildlife protection		

Source: the author

6.4 Conclusion

This chapter discussed the experiences of PES implementation from Costa Rica, where the PES scheme has emerged since 1997, from Vietnam which is the first country in Southeast Asia that introduced a PES law for the forest sector, and

related these in part to the KARN-PES Scheme. The PES scheme in Costa Rica did not begin from nothing; there were a number of prior incentive-based policies for forest conservation (Pagiola, 2008). The PES scheme of Costa Rica is one of the pioneering and well-known PES schemes. The Fourth Forest Law No. 7575 changed the concept of incentives-based policy (e.g. subsidies) of timber production in plantation forestry and natural forest management, to the concept of PES. This law allows the land holders to be paid for their sustainable managements in natural forest, forest plantation and agroforestry systems (Navarro and Thiel, 2007). The Vietnamese Government introduced a Decree on a policy for Payment for Forest Environmental Services (PFES) (No: 99 /2010/ND-CP), which was enforced on September 24, 2010. This law supports PES implementation in several aspects such as describing the environmental services from forest sustainable management clearly; making beneficiaries from forest environmental services contribute either direct or indirect payment to forest owners who are forest service providers.

Regarding environmental services for the KARN-PES scheme, the existing Thai laws are sufficient to perform the environmental services in the scheme (e.g. water supply, mineral licks, converting alien species into grassland area etc.). Even though the existing laws (the National Park Act, B.E. 2504 (1961) and the Wildlife Sanctuaries, Wildlife Preservation and Protection Act, B.E. 2535 (1992)) are strict about the access of villagers in the sanctuary, this can be managed by asking for approval from the Council of Ministers, in order that the Department of National Parks, Wildlife and Plant Conservation can collaborate with villagers to run the KARN-PES scheme together. But the Thai laws focus on a command and control approach; therefore, there is no channel by laws for developers to offset the negative impacts from their development as in the case of BioBanking scheme in Australia. However, developers also can voluntarily create a habitat credit system for doing “good” for conservation.

CHAPTER 7

DESIGN OF A PES SCHEME FOR HUMAN-ELEPHANT-CONFLICT MITIGATION

This chapter is comprised of four main components. First, the introduction on the background of the HEC problem and how the PES scheme can be a potential solution is presented in brief. Second, there is reference to the debate on why the PES scheme is a promising idea compared to other tools (e.g. command-and-control and subsidy). Third, the design of the PES scheme for HEC mitigation measures in the KARN sanctuary is outlined with respect to proposed environmental services, the potential service providers and buyers, the intermediaries and monitoring and evaluation. The fourth section discusses the potential limitations of PES implementation, which are demand for environmental services, legal issues, transaction costs, leakage and the permanence of the scheme. The last section is the conclusion.

7.1 Introduction

As mentioned in Chapter 1, the human-elephant conflict (HEC) in Thailand has been reported since the late twentieth century when the export-oriented policy was promoted (Srikrachang, 2008). This policy created an incentive for farmers to encroach into the forests where the elephant habitats were. The HEC events have occurred more frequently with higher intensity among 24 protected areas (Wanghongsa et al. 2008a). The impacts of HEC in Thailand are not only crop raiding and property damage but also loss of life and injuries for both human and elephants. Using the death rate of human and elephant as criteria, three protected areas, namely Salakphra Wildlife Sanctuary, Huai Kha Khaeng Wildlife Sanctuary, and Khao Ang Rue Nai (KARN) Wildlife Sanctuary, are ranked as the most severe areas of HEC in Thailand (Wanghongsa et al., 2006a).

This study explores the opportunity to establish a PES scheme in Khao Ang Rue Nai Wildlife Sanctuary (KARN) in the Eastern Region of Thailand, where villagers who are living in the areas surrounding KARN have been affected

by the human-elephant conflict problem. The growth rate of the wild elephant population in KARN is about 9.83% per annum, but only 36.61% of the sanctuary is appropriate as elephant habitat resulted in the shortage of food and water in the sanctuary (Wanghongsa et al., 2008b). Hence, this is a reason why wild elephants often come out of the sanctuary to raid cropland. While the related government agencies have made investments to revive the degraded ecosystem and to make an elephant barrier, investments are not adequate for the required scale. This is why the idea of PES was considered as a potential solution.

The main objective of the PES scheme is to alleviate Human-Elephant-Conflict by reviving the ecosystem in the sanctuary and performing the HEC mitigation measures, not as an elephant conservation project itself. To revive the ecosystem in the sanctuary will mitigate the conflict by reducing the incidents of crop raiding, reduced damage costs to crops and property and reduction of risks and fear. Furthermore, the HEC mitigation measures proposed here are not new approaches but rather current mitigation activities. The idea of PES was proposed to be a solution to solve the problem of budget constraints which is an important barrier to implement the mitigation measures.

7.2 Why is PES thought to be a promising solution?

The advantages of a PES system over current conservation measures are discussed in the literature. For example, PES can be considered for both demand-side and supply-side innovation as suggested by Wunder et al. (2008). According to a demand-side innovation, conservation is often viewed as a responsibility of governments which most people do not want to pay for. However, governments are frequently not aware that environmental services are important. Even if governments realize how important environmental services are, budgets for conservation need to fight with other demands with limited resources, especially politically important demands. Furthermore, PES can be seen as a supply-side innovation of directly buying conservation. Because conservation activities that are desirable for the society often are viewed as unattractive to the service

providers such as farmers who act as direct ecosystem managers, PES can deal directly with this different view between the society and service providers. In addition, one important feature that makes PES different from other conservation approaches is the quid pro quo feature: those who can provide environmental service should be compensated only if they do provide those environmental services.

It might be argued that the command-and-control approach or protected area establishment surrounding the sanctuary would have much lower transaction costs than a PES scheme but their implementation costs may be higher because they require asking people to relocate and buying land from current owners. The payment needs to compensate the land owners for their loss from the total flows of the benefits that can generate from their lands, as shown in the costs of land-use change scenario in Chapter 5. Furthermore, buying land may not be politically possible or may not be desirable for land owners because of the need to relocate to somewhere else (Pagiola et al., 2004). In addition, the PES approach is considered as more efficient than the command-and-control approach (Engle et al., 2010). A command-and-control approach (e.g. protected area establishment) requires conserving the whole forest area regardless of the level of benefits they provide or the costs of conserving them, whereas PES would more flexible which trying to find out the higher value of environmental services and lower costs of conservation implementation.

Even though PES acts like an environmental subsidy, there are some characteristics of PES that make it different (Engle et al., 2010). First, it is more difficult to design a subsidy that achieves the additionalities and avoids paying on what would happen without the subsidy, whereas PES needs to assess carefully the baseline for activities before payment. While a subsidy could establish a baseline, they do not tend to be designed that way because the subsidies typically apply to whole classes of activities rather than the one-for-one trade that occurs under PES. However a PES system must still be carefully designed to ensure there

is additionality. Second, a subsidy may create perverse incentive to expand the destructive activities to get higher subsidies.

There is an argument from the behavioral economics view that conditional monetary PES (pay if the service is actually delivered) may have the opposite effects by "*crowding out*" the intrinsic motivation to do the good thing for society or people receive a monetary payment for doing something that they would have done anyway, their motivation for doing it without payment will decline, and they might stop doing it if payment halts (Frey and Jegen, 2001; Vatn, 2010). However, Farley and Costanza (2010) argued that the service providers who receive the payment might feel an intrinsic obligation of *"reciprocity"* if they thought that payments was fair compared to the costs of undertaking the desired activities. There was an evidence for this argument by Bolton and Katok (1998). They found the evidence that people receive some value motivated from the act of voluntary gift-giving (or called impure altruism). Therefore, the presence of impure altruism prevents complete crowding out the intrinsic motivation to do the good thing for society. This is an empirical issue and suggests careful study of the cultural and value systems of the communities is important in establishing a PES system.

However, it does not mean that other conservation policies (e.g. command-and-control regulation) will be replaced by PES but it means where the market failure exists, a combination of policies is needed. PES can be proposed to be another form of market-based policy to internalize positive externalities by creation of a parallel environmental-service market with other conservation policies such as command-and-control and educational approaches. Without the PES mechanism for this case, it seems unlikely that there can be policy intervention at limited scale. Public resources would only support some measures, and the local inhabitants would only be able to prevent and protect their crops, their property within limited means they have. On the other hand, by combining natural resources restoration and mitigation measures for the HEC reduction under the PES framework, it may be possible to reach the dual objectives of natural

resources management and HEC alleviation without having to make these trade-offs.

7.3 How to Design PES for HEC Mitigation

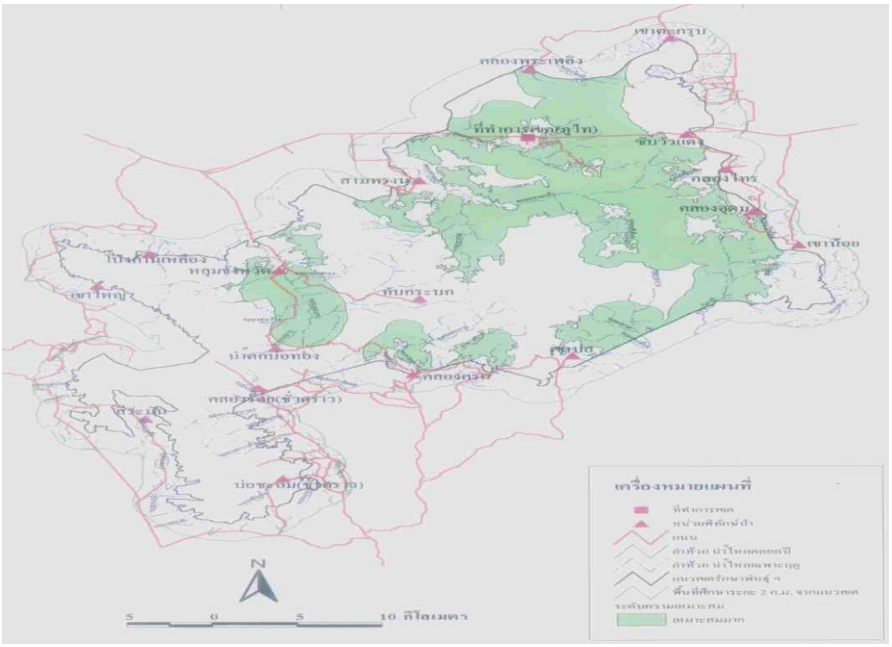
The PES scheme for HEC mitigation is designed under a 20-year project period. To design the PES scheme, there are several components that need to be concerned. These include defining the environmental services, service providers, service sellers, baselines, additionalities, monitoring and enforcement. The details of each issue can be described as follow:

7.3.1 What are the proposed environmental services (ES) for a PES scheme?

According to scientific information, the KARN sanctuary is clearly degraded which only 36.61% of the total area or approximately 374 square kilometers (the green area in Figure 7.1) is an optimal forest habitat for elephants (Wanghongsa et al., 2004). The rehabilitation measures (e.g. increasing water resources and conversion of invasive species into grassland) are not only the HEC reduction[13], but also flow of services, particular water service.

[13] To improve degraded forest habitat, which is about 63.29% of total area, can increase carrying capacity of KARN to support 332-498 elephants (Wanghongsa et al., 2008b).

Figure 7.1: The optimal forest habitat for elephants in KARN



Note: the green area is the optimal forest habitat for elephant which accounted for 36.61% of total area in the KARN wildlife sanctuary

Source: Wanghongsa (2004).

In addition, the improvement of habitat in KARN sanctuary can also generate the potential use value of eco-tourism activities. There are also the intangible benefits in the form of the indirect use value from the rehabilitation of the ecosystem as well as the non-use value of wild elephants, which has symbolic, historical and cultural significance in the Thai society. Through consultation with the wildlife experts, the staff of the KARN wildlife sanctuary and the results of cost-benefit analysis and cost-effectiveness analysis that suggested the policy option 3 (habitat improvement, contraception and fence) was more desirable to society than other options, therefore, the following number of environmental services have been proposed (the details of each activities are described in the later section):

1) Increasing water supply available within the sanctuary to reduce the need for elephants to exit the sanctuary to search for water.

2) Converting alien species into grassland area within the sanctuary. A substantial part of the sanctuary faces problem of rapid expansion of invasive species.

3) Creating mineral saltlicks within the sanctuary as a source of food for wildlife such as elephants and deer.

4) Planting food for elephants (e.g. banana plantation) within the sanctuary to reduce elephants exit the sanctuary.

5) Contraception of female elephants to control birth rate of elephants not exceeds 500 elephants in total which is the maximum capacity of the KARN. According to wildlife expert interview, the 50 female elephants need to do the contraception each year.

6) Fencing part of the sanctuary that erected on the edge of the KARN at the risky areas of crop raiding or about 220 km from the 460-km total boundary of the KARN.

From these environmental services, the expected benefits include (i) positive effect on stream flow from restoration of the habitats, (ii) reduction of damage costs from HEC, (iii) a job creation for local people, particular affected households from HEC can work on habitat improvement activities in sanctuary and (iv) the possibility of creating revenue from wildlife eco-tourism in the long run. In addition, the environmental services of PES scheme and PES mechanism can be explained as positive externalities and a Pigouvian subsidy respectively as one can encourage the generators of positive externalities by subsidizing them as marginal benefits they provide (Baumol and Oates, 1998). The details are as follows:

Environmental Services as Positive Externalities

In the classical PES case for a watershed protection, farmers in the upstream watershed conserve the forest habitat for their own agricultural benefits; however, their activities also create the external benefits or positive externalities

for downstream water users (e.g. water purification). Also, above environmental services create the positive externalities. For example, clearing invasive alien plants into grassland area could not only increase the grassland which is a source of food for elephants to reduce them to exit the sanctuary, but also address the effect of invasive alien plants to water resource. A number of studies reported that invasive alien plants have a negative impact on stream flow that the level of stream flow reduction can be quantifiable linked with the types and density of invasive alien species (Turpie et al., 2008).Therefore, the conversion of invasive alien species as one of HEC mitigation activities would have positive effect on stream flow or may increase the level of stream flow compared to the current situation. As mentioned in Chapter 1, the study area, namely KARN, is also the watershed of Bang Pakong River and Prasae River, which are the main sources of surface water supply for residential areas, industries and agricultural production in the downstream area. Hence, the conversion of invasive alien species in KARN can be called as positive externalities for downstream water users.

Furthermore, KARN wildlife sanctuary has a rich biodiversity which includes 132 mammal species (e.g. gaur, banteng and elephant), 395 bird species, 107 reptile species (e.g. freshwater crocodile) and 32 amphibian species[14]. Hence, other habitat improvement measures for HEC mitigation (e.g. increasing water ponds and mineral licks) are not only provide foods for elephants, but also for other wildlife such gaur, banteng, wild boar and deer. In addition, other HEC mitigation strategies such as fences can reduce the confrontation between villagers and elephants that may lead to reduction of loss of human and elephant lives due to HEC. These HEC mitigation measures provide the positive externality as environmental services associated with non-use values of elephant conservation for the general public who value wildlife, particular elephants.

[14] http://www.5provincesforest.com/index.php?lay=show&ac=article&Id=538728119&Ntype=1 (2 January 2012)

Payment for Environmental Services as a Pigouvian Subsidy

Payment for environmental service (PES) is an incentive-based policy intervention as a Pigouvian subsidy to internalize positive externalities through creation of an environmental-service market. The PES classical case, Upstream-Service Providers and Downstream-Service Buyers, provides an economic incentive to service providers or farmers in the upstream watershed for this case to adopt the beneficial management practices to watershed conservation. The payment from the scheme financed voluntarily by the beneficiaries of the environmental services or the downstream water users. The downstream water users can encourage the service providers in the upstream watershed for positive externalities by subsidizing them as marginal social benefits they provide (conditionality criterion defined by Wunder (2005)). Such subsidy can be called as a Pigouvian subsidy. The Pigouvian subsidy internalizes the positive externalities or social benefits to the service providers' utility functions by providing them incentives to better maintain of watershed conservation compared to the current situation.

This theoretical framework can also applied to the payment scheme for HEC mitigation measures. Under PES scheme, the service providers of the HEC mitigation measures will be rewarded as marginal external benefits from environmental services (e.g. labor provision for habitat improvement activities in KARN) they provide. For example, HEC affected villagers can be the service providers for habitat improvement activities. In household survey of affected households from HEC, the respondents were asked whether they are willing to volunteer to work for habitat improvement in KARN. The result indicated that 93 percent of respondents are willing to volunteer to work for habitat improvement activities in KARN because they thought that they had to pay for their own HEC mitigation costs anyway. If these measures can mitigate the impacts, they are willing to do so. In this case, even though the villagers are willing to work for habitat improvement activities for their own indirect benefits, they also create the external benefits for ecosystem in KARN. Another external benefit is the hope

that villagers may change their attitude toward elephants that do not think elephants as a pest but as a resource for their income instead. The beneficiaries who receive benefits from HEC mitigation measures can help to make the PES scheme be more attractive for service providers by subsidizing them. In the presence of positive externalities, service providers would produce undersupplied levels compared to the social optimal level, however, this Pigouvian subsidy would provide an incentive for service providers to produce more.

7.3.2 What are the proposed activities for HEC mitigation?

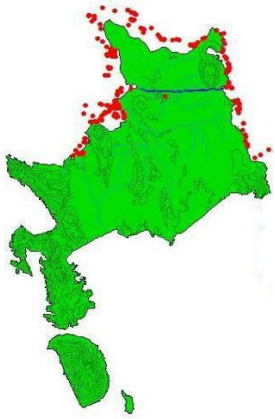
Increasing water supply available within the sanctuary

Figure 7.2 shows that water resources for wildlife in the KARN sanctuary are drying up in the dry season. In addition, Figure 7.3 illustrates the location of artificial water ponds constructed by villagers near the sanctuary boundary. When water resource in sanctuary is scarce, elephants try to search for water outside the sanctuary. The water ponds constructed by villagers near the sanctuary are another factor to attract elephants out of the sanctuary. These explain why the HEC incidents likely were occurred in the area near the artificial water ponds constructed by villagers. Therefore, to increase the water supply in the sanctuary is needed. Figure 7.4 shows the locations of the proposed artificial water-ponds.

Figure 7.2: The condition of water resources in KARN sanctuary in a dry season

Source: The Chachoengsao Wildlife Research Station

Figure 7.3: the location of artificial water ponds constructed by villagers

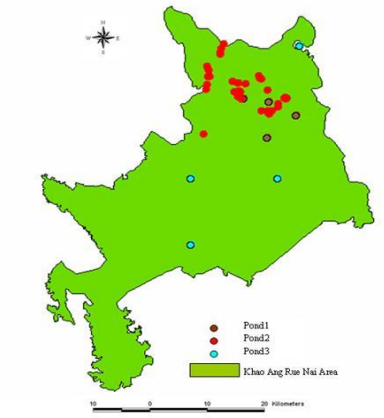


Note: 1. The red plot shows the artificial water ponds constructed by local villagers

2. the survey was conducted in 2005

Source: The Chachoengsao Wildlife Research Station

Figure 7.4: Location of proposed artificial water-ponds



Note: 1. The brown plots indicate the locations of natural water ponds

2. The red plots indicate the locations of existing artificial water-ponds

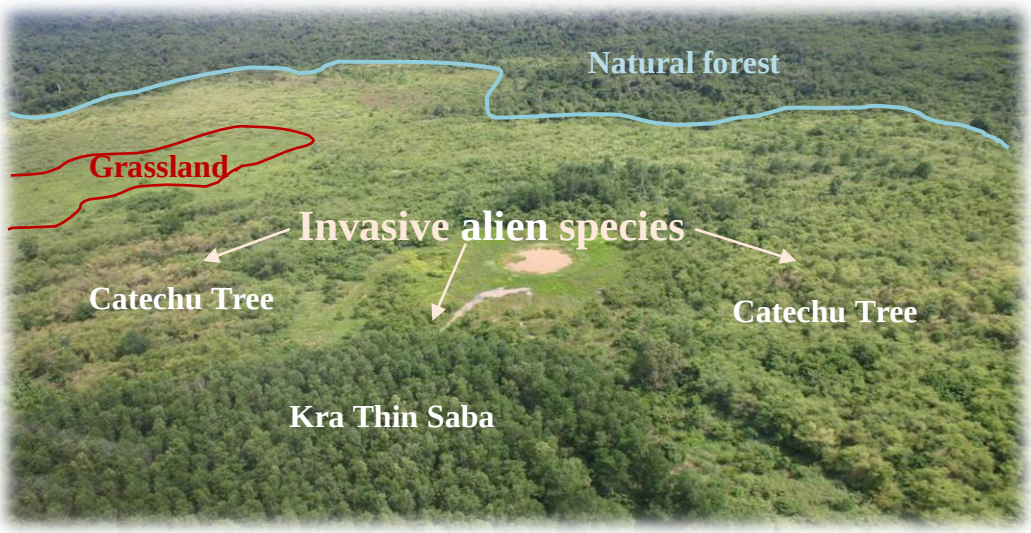
3. The blue plots indicate the locations of proposed artificial water-ponds

Source: The Chachoengsao Wildlife Research Station

Converting invasive alien species into grassland area within the sanctuary

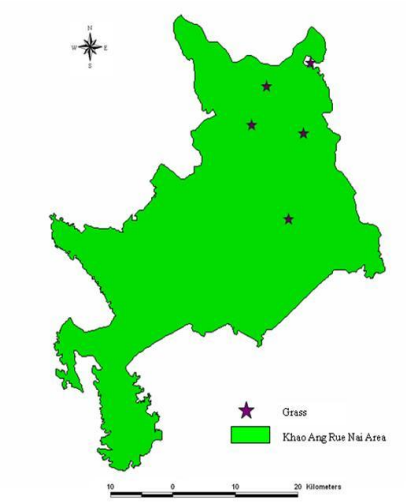
In fact, the appropriate habitat for elephants should be grassland, not dense forest. The expansion of invasive alien species in sanctuary, such as Catechu tree and Kra Thin Saba, has negative impacts on grassland area which is a source of wildlife's foods. As shown in Figure 7.5, the expansion of invasive alien species replaced native species and also grassland. This activity is to clear the invasive species and replace them with species of grass (e.g. wild sugarcane). Figure 7.6 illustrates the locations of the proposed new grassland area. The total area to convert invasive alien species into grass species is approximately 112 square kilometers or accounted for 11 percent of total area of the sanctuary.

Figure 7.5: The expansion of invasive alien species in KARN sanctuary



Source: The Chachoengsao Wildlife Research Station

Figure 7.6: Location of proposed new grassland

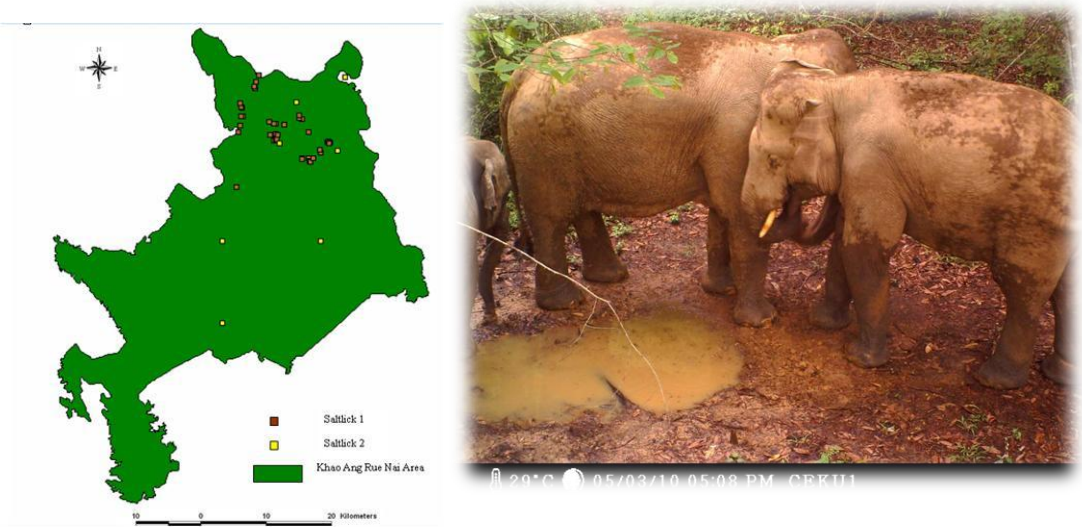


Source: The Chachoengsao Wildlife Research Station

Creating artificial mineral licks within the sanctuary

A mineral lick or salt lick is not only a source of food for elephants, but also for other wildlife such as deer, boar, gaur and banteng. The 260 mineral licks (Figure 7.7) are needed to be created in the first year because we do not know where wildlife will utilize the mineral licks. However, only 130-mineral licks will be developed to be the permanent mineral licks. Besides costs for construction, to create a mineral lick also needs to maintenance costs to deposit a mineral every year.

Figure 7.7: Locations of proposed mineral licks



Note: 1. The brown plots indicates the current mineral licks

2. The yellow plots indicates the proposed new mineral licks

Source: The Chachoengsao Wildlife Research Station

Planting food for elephants within the sanctuary

Supplementary feeding plantation for elephants in the sanctuary such as banana plantation will be planted near the proposed location of new mineral licks. Then, elephants can eat mineral and food and do not need to walk further to search food outside the sanctuary.

Contraception of female elephants

As mentioned earlier, the growth rate of elephants in KARN sanctuary is approximately 10 percent per annum. Currently, only 36.61 percent of KARN sanctuary is optimal forest habitat for elephants. If KARN sanctuary can be improved to be 100-percent optimal forest habitat for elephant, the carrying capacity of elephants in KARN sanctuary will be 500. Without contraception, the elephant population will be exceeded 500 elephants in the next eight years. Therefore, the contraception of female elephants should be introduced in the next eight years. The wildlife expert, Mr. Sawai Wanghongsa, suggested that the

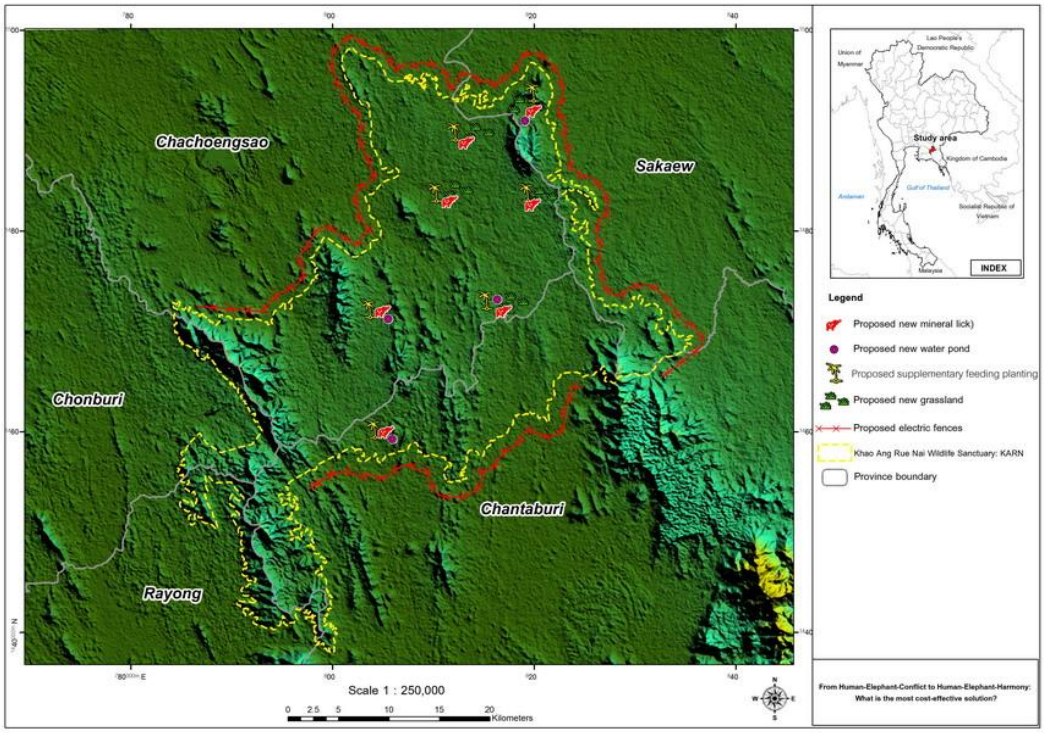
contraception of the 50 female elephants would be needed each year after the next eight years. The contraception is effective only 10 years; therefore, it needs to be introduced every 10 years.

Fencing part of the sanctuary

The objective of fencing is to restrict elephants in the sanctuary. The electric fences will be proposed in the risky area (the red line in Figure 7.8) which is about 220-kilometer from the 460-kilometer total boundary of KARN sanctuary. Electric fences do not cause physical harm to elephants but gives an unpleasant electric shock when elephants contact them (Fernando et al., 2008). Electric fences have been tried to against elephants in Thailand, for example, electric fences in the Salakpra Wildlife Sanctuary in Kanchanaburi province, Sap Langka Wildlife Sanctuary in Lopburi province and Kui Buri National Park in Prachuap Kiri Khan province.

Figure 7.8 illustrates the locations of proposed habitat improvement activities (mineral licks, water supplies, grassland, supplementary planting) and electric fences in KARN sanctuary. These all measures will be proposed as a package of mitigation measures. Only electric fences without habitat improvement activities would not restrict elephants in the sanctuary because they would try to break the fences into the villages for searching the food.

Figure 7.8: Locations of proposed habitat improvement activities and electric fences



Source: the author

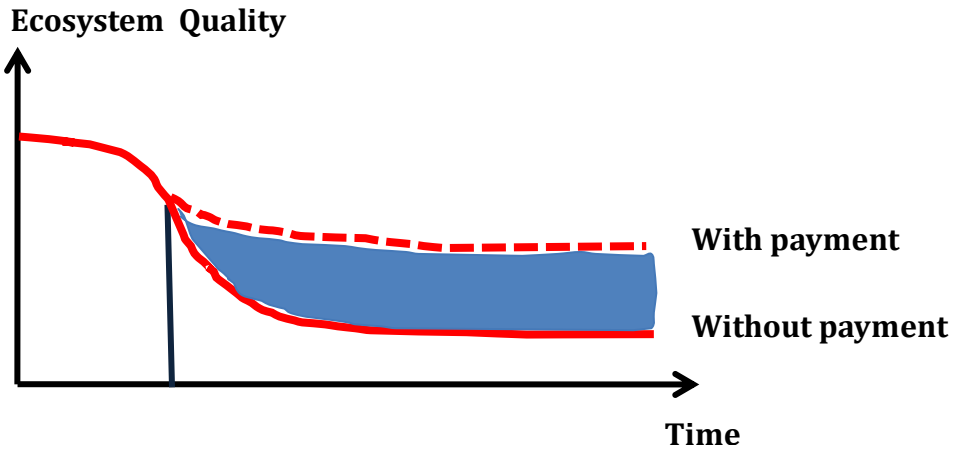
7.3.3 What are the Baselines and Additionalities?

To measure the benefits and risks of the scheme, the "baseline" or "current situation" of environmental services needs to be defined to track the delivery of environmental services to beneficiaries or service sellers (Forest Trends et al., 2008). This baseline must be established carefully because we may pay for the activities that happened anyway (Smith et al., 2006; Wunder, 2005). The payment scheme has to make a difference compared to business as usual situation (status quo) or the scheme must provide "additionalities" relative to a baseline (Forest Trends et al., 2008). Ideally, payments would be made as the marginal benefits service providers provide as defined by Wunder (2005) or called "output-based payment". In the case of watershed services, the output-based payments are hardly possible because the level of environmental service provision cannot be observed by land users that prevent them to manage land properly, whereas most payment

schemes in practice adopt the "input-based payments" by paying as the amount of input such as number of tree planted or working hours spent for clearing exotic species (Engel et al., 2010) or based on the costs of environmental service provision rather than the values of environmental services (Wunder et al., 2008).

In the case of the payment scheme for habitat improvement activities that can alleviate the HEC problem afterward, the baseline scenario as adapted by Wunder (2005) can be illustrated in Figure 7.9. The current situation of ecosystem quality in KARN sanctuary has been declined. To revive ecosystem would then qualify for additionalities. The choice of baseline is important for PES efficiency because the scheme might pay for conservation that would have happened anyway (Wunder, 2005).

Figure 7.9: The baseline scenario for habitat improvement activities



Note: ■ = additionalities

Source: Adapted from Wunder (2005)

Additionalities can be evaluated in each activity as shown in Table 7.1. The indicators of the baseline and additionalities can be classified in 2 categories, which are 1) a short-run indicator and 2) a medium or long-run indicator. The short-run indicator, a change of wildlife population that come to utilize mineral licks, water ponds, and food represents the short-run output of each habitat improvement activity that can evaluate immediately after each activity is implemented, whereas the medium-term indicator, a change of HEC impacts, can

be evaluated after PES implementation at least 1 year afterward. According to short-run indicators (a change of wildlife population that come to utilize the food and water), the baselines of these indicators need to be collected before implementing PES scheme as follows:

1) Number of wildlife population that come to utilize the new grassland before PES implementation
2) Number of elephant population that come to consume food at the targeted areas
3) Number of wildlife population that come to utilize the new mineral licks before PES implementation
4) Number of wildlife population that come to utilize the new water ponds before PES implementation

However, the baselines for the medium indicator (a change in HEC impacts) can be obtained from household survey in 2011. The baselines of each activity as follows:

1) A baseline of HEC incidents: 180 incidents/year.
2) A baseline of HEC damage costs: 34,825 baht or USD1161/household/year.
3) A baseline of HEC protection costs: 5,917 baht or USD197/household/year.

Table 7.1: Baselines and additionalities of each mitigation measures

Activities	Baselines	Additionalities
1. Converting alien species into grassland area within the sanctuary 2. Planting food for elephants within the sanctuary 3. Creating artificial mineral licks within the sanctuary 4. Increasing water supply available within the sanctuary	1) A short-run indicator: Number of wildlife population that come to the targeted areas to utilize mineral licks, water ponds, grassland and supplementary food without PES implementation 2) A medium-term indicator: Number of HEC impacts without PES implementation which can be obtained from household survey in 2011 1. A baseline of HEC incidents: the average incident is 180 incidents/year. 2. A baseline of HEC damage costs: 34,825 baht or USD1161/household/year. 3. A baseline of HEC protection costs: 5,917 baht or USD197/household/year.	1) A short-run indicator: Additional number of wildlife population to utilize mineral licks, water ponds, grassland and supplementary food in the targeted areas with PES implementation 2) A medium-term indicator: A change in HEC impacts with PES implementation 1. A change in number of HEC incidents with PES implementation 2. A changes in damage costs due to HEC with PES implementation 3. A change in protection costs due to HEC with PES implementation
5. Fencing part of the sanctuary	Medium or long-run indicator: Number of HEC impacts without PES implementation which is the same indicator as above.	Medium or long-run indicator: Number of HEC impacts with PES implementation which is the same indicators as above.

Source: the author

7.3.4 How much cost for proposed HEC mitigation activities?

The costs for proposed HEC mitigation activities can be categorized to be two main categories, which are the investment cost (fixed cost) and the maintenance cost. The fixed costs and maintenance costs of each activity can be shown in Table 7.2 and 7.3 respectively. In addition, Table 7.2 also indicated the additional amount of activities required or target needed to be achieved in each activity. Furthermore, the costs for monitoring whether wildlife comes to utilize the activities are also presented, which are handheld GPS receivers, monitoring cameras, computers, and monitoring staff (details of monitoring activities are described in the next section). The estimated total costs of mitigation measures (habitat improvement activities, contraception and electric fences) for 20-year period range from 142 million baht or USD4.7 million to 195 million baht or USD6.5 million according to the discount rate.

Table 7.2: The fixed costs and amount required of each HEC mitigation activity

Activities (unit)	Costs per unit	Additional amount of activities required (Targets)
Habitat improvement, contraception and electric fences		
Water pond (pond)	50,000 baht (USD1667)	5 ponds
Mineral lick (mineral lick)	2,500 baht (USD83)	260 mineral licks
Conversion of invasive alien plants to grasslands (rai)	1,060 baht (or USD22083/km^2)	30,000 rai or 48 km^2
Planting supplementary feeding for elephants (rai)	2,500 baht (or USD52083/km^2)	500 rai or 0.8 km^2
Contraception or birth control process (elephant)	50,000 baht (USD1667)	50 female elephants for every 10 years
Installation of electric fence (kilometer)	150,000 baht (USD5000)	220 kilometers
Monitoring activities after implementation		
Handheld GPS receiver (piece)	20,000 baht (USD667)	5 pieces
Monitoring camera at water ponds and mineral licks	12,500 baht (USD417)	10 cameras
Notebook computer (unit)	30,000 baht (USD1000)	2 units
Staff for monitoring activities (baht/staff/month)	10,000 baht (USD333)	2 staff

Note: USD1 = 30 baht

Source: an interview with Mr. Sawai Wanghongsa, the former head of Chachoengsao wildlife research station, 19 January 2011.

Table 7.3: The maintenance costs of each HEC mitigation activity

Activities	Unit cost
1. Water ponds	No maintenance cost
2. Mineral licks	2,500 baht or USD83/unit/year
3. Conversion of invasive alien plants to grasslands	1,060 baht/rai/year or USD22083/km^2/year
4. Planting supplementary feeding for elephants	1,250 baht/rai/year or USD26042/km^2/year
5. Electric fences	15,000 baht or USD500/km/year

Note: USD1 = 30 baht

Source: an interview with Mr. Sawai Wanghongsa, the former head of Chachoengsao wildlife research station, 19 January 2011.

Table 7.4: Estimated total costs of HEC mitigation at different discount rates

Options	Discount rate		
	3%	**5%**	**8%**
Habitat improvement, contraception and electric fences			
Total cost of treatment (baht)	195,186,181	170,123,972	142,365,545
Total cost of treatment (USD)	6,506,206	5,670,799	4,745,518

Note: USD 1 = 30 baht

Source: the author

7.3.5 Who are the potential service providers?

Apart from identifying the habitat improvement activities, information on quantities required and the unit costs, the service providers for the pilot project have been identified, these being the six villages where HEC is high, namely Na Yao, Na Isan, Lum Tha Sang, Tha Ten, Na Ngam, and Klong Toey. If PES scheme in this six pilot villages succeed, the scheme will be developed to cover all villagers where are affected from HEC. In this situation, the concept of Payment for Environmental Services which attempts to provide economic incentives to villagers maybe the win-win solution by providing employment and income for the poor and at the same time more sustainable conservation.

According to the household survey, for these households the HEC costs which is comprised of damage costs from crops and property damage and medical expenses, protection costs, opportunity costs of time to guard crops at night was approximately 23 percent of their average household income. The evidence to confirm that villagers would be interested to be service providers is from the results of household survey when asked them whether they will be interested in participating in the activities to revive the ecosystem in KARN sanctuary. The 93 percent of the 200-respondents said that they would be volunteer the labor even if there was no payment. However, this result was not beyond expectations because these villagers were already spending money to protect their crops and property; therefore, any measures that would reduce crop raiding incidences would reduce their current expenses.

For that reason, the villagers are beneficiaries as well as service providers. However, a free riding might occur if some villagers do not want to work in the sanctuary but still get the benefits from mitigation measures in term of less damage from crop-raiding. Nevertheless, since most villagers (93% of 200-respondents) agree to volunteer labor without payment, it is expected that most villagers would participate in the scheme and this free-riding problem would be slim. In addition, the service providers from the six villages will also be involved in monitoring activities. This is essential for PES project which is to provide an

evidence of the improvement of the ecosystems and especially for HEC mitigation in this pilot site, the reduction in the incidences of crop raiding, reduced damage costs to crops and properties. Villagers will be involved in data collection of HEC impacts (more details in section 7.3.10).

7.3.6 What are the opportunity costs of the service providers?

At the first stage of this project, the auction method was chosen to be a technique to search for willingness-to-accept (WTC) of service providers, or affected villagers for this case, for their opportunity costs. However, there was an argument during the focus group discussion that an auction would lead to a conflict between villagers because they would receive the payment unequally. This evidence also shows that villagers value equity and there is cultural norm that they do not want to see someone get more benefits of pay more than others. Therefore, the cultural norm in the villages would pressure people to work for habitat improvement activities and the free-riding problem would be less relevant for this case. In case of Upstream-Service Providers and Downstream-Service Buyers, the opportunity costs of service providers, or Up-stream-Service Providers, are not only the opportunity cost of time for their labor contribution, but also the opportunity cost of their land-use change. The auction method would be proper methodology to value the WTC of the case of the Up-stream-Service Providers. Unlike the case of Upstream-Service Providers and Downstream-Service Buyers, the opportunity cost of service providers in this case is only the opportunity cost of time to contribute their labor for habitat improvement activities because all activities will be implemented in the sanctuary. Therefore, villagers have no opportunity cost of land-use change.

Someone may argue that it should apply the total economics value (TEV) of ecosystem services flows. Wunder (2005) argues that if we pay for the full economic valuation, the funding may be wasted on something that would have happened anyway and opportunity cost would be helpful for this concern. Furthermore, Farley and Costanza (2010) argue that ecosystem resources are immeasurably valuable resources; therefore the level of the PES payment should

be considered by costs of supply, not monetary estimate of benefits. Hence, it is reasonable to use the opportunity cost of time of villagers' incomes from a household survey, which was approximately 120 baht per day or USD4 per day[15], as a proxy of a lower bound of their opportunity cost of the service providers. However, the payment rate may depend on the difficulty of each activity and also whether all stakeholders can make an agreement. Furthermore, the service providers, which are affected villagers in this case, would obtain another long-run benefit of crop damage saved if the mitigation measures function effectively. It means that their crop damages will be reduced or they will have more income due to lower crop damage level. Table 7.5 illustrates the benefits (or crop damage saved) from HEC mitigation measures (habitat improvement, contraception and electric fences) in different assumption of growth rates of crop-raiding damages. According to household survey, the average crop return is about 7,431 baht per rai or USD 154,812 per square kilometer. The total benefit or crop damage saved from mitigation measure to affected households for the 20-year project period of 3% discount rate ranges from 2,410 million baht or USD80 million to 8,022 million baht or USD267 million, which depend on the assumption of growth rate of crop-raiding damages.

[15] USD1 = 30 baht

Table 7.5: Benefits (or avoid damage costs) from HEC mitigation measures at 3% discount rate in different assumption of the growth rate of crop-raiding damages

Options	Crop damage saved
Habitat improvement, contraception and electirc fences	
1.1 At 5% growth rate of crop-raiding damages	
Total crop damage saved (rai)	325,590
Total crop damage saved (sq.km)	521
Total crop damage saved (baht)	2,419,462,541
Total crop damage saved (USD)	80,648,751
1.2 At 10% growth rate of crop-raiding damages	
Total crop damage saved (rai)	609,590
Total crop damage saved (sq.km)	975
Total crop damage saved (baht)	4,529,866,879
Total crop damage saved (USD)	150,995,563
1.3 At 15% growth rate of crop-raiding damages	
Total crop damage saved (rai)	1,079,510
Total crop damage saved (sq.km)	1,727
Total crop damage saved (baht)	8,021,835,391
Total crop damage saved (USD)	267,394,513

Note: 1) USD1 = 30 baht and 2) 1 km2 = 625 rai

2) All values are in 2010 prices

Source: the author

7.3.7 Who are the potential service buyers?

The service buyers refer to the stakeholders who obtain benefit from environmental service that service providers (service sellers) provide. Perhaps the most challenging part of launching the PES project, especially for this case, is to identify the buyers because there are several beneficiaries from restoration activities for both direct and indirect beneficiaries. Some potential service buyers for this case can be shown in Table 7.6. Apart from the service providers or villagers who also directly benefit from the ecosystem restoration that will be implemented, the beneficiaries of the ecosystems service are also for those who rely on water supply from the Bangpakong River and Prasae River. The major user is the East Water Company, a private company that showed an interest in

being a service buyer. In a meeting organized to discuss the objectives of the KARN-PES Pilot project, the representative of the East Water company pointed out that there was a need to know the on-going development projects being funded both by government agencies and private companies as part of their CSR investments within KARN sanctuary. Such information would be helpful in planning processes to identify overlaps and gaps of investments.

However, only one single buyer may not be adequate for the initial investment and maintenance costs. During the initial period, there was high expectation that it would be possible to mobilize contributions from the private sector in a part of CSR budget as the KARN-PES Pilot Project offers an opportunity that they could do 'good' for conservation and earn CSR publicity. However, private companies may pay attention only on quick and tangible effects. Hence, there is essential for a formal institutional framework to create tangible incentives for the private sectors to be involved.

Experiences from other country's initiatives, such as habitat credits for federal governments or private companies in United States who want to offset impacts on habitat and gopher tortoise populations (Gartner, 2010) and the New South Wales Biodiversity Banking and Offsets Scheme (BioBanking Scheme) for developers who want to offset the negative impact of their development (DECC, 2007), can be lessons to create markets or tangible incentives for private companies to conserve natural resources. Voluntary habitat credit system can be created for habitat improvement activities. Each credit is a unit of trade on habitat improvement and can be voluntarily bought by the private sectors to offset impacts on their development. Habitat credit assessment is required to determine either the number of habitat credits that can be created at KARN sanctuary or required at a development site. All habitat improvement activities will be converted to habitat credits for trade. The price of biodiversity credits may be based the cost of each activity. For example, one water pond and one mineral lick can be converted to be 1,000 and 50 credits, respectively. Developers can

voluntarily use this habitat credit system to offset their impacts on the environment or even to do “good” for conservation.

Other capacities of service buyers can be the general public who receive the external positive benefits from the use and non-use values of the biodiversity resources in the sanctuary where the elephant is the umbrella species, for example, people may be willing to pay for a visit the sanctuary in the future (option value) or to pay for maintain a good in existence (existence value) or to pay for the next or future generations to make use of these biodiversity services (bequest value).

In the medium-term or long-term solution, eco-tourism can be another capacity source of contribution into the scheme after ecosystem restoration. By installation of the wildlife viewing tower outside the KARN sanctuary (e.g. at the community forest near the boundary of KARN sanctuary located in Tha Ten village), tourists can watch wildlife from the tower when wildlife come to eat food or water at the water ponds or mineral licks. The reason to install the tower outside the KARN sanctuary is to make sure that local villagers would be the ones who organize the wildlife viewing. Furthermore, without special permission, villagers are not allowed to enter the sanctuary to do any activity. The wildlife viewing will generate supplementary income for local villagers. When villagers obtain the benefits from wildlife, particularly elephants, this kind of benefits for villagers might change their attitudes toward elephants that an elephant is a resource for them, not as a pest. Apart from benefits of wildlife viewing revenues, changing attitudes towards elephants of affected villagers would be another external benefit that may lead to HEC reduction in the future.

Table 7.6: Potential service buyers and their expected benefits

Potential service buyers	Benefits they will obtain
1. The water user (the EAST Water company)	Direct benefits from ecosystem restoration that leads to increase water runoffs and the company would get their reputation for biodiversity conservation
2. Private companies who want to buy the biodiversity offsets (e.g. BioBanking or Market-based habitat credit trading system as in the USA or Australia)	Direct benefits from biodiversity offsets
3. The general public	Use and non-use values of the biodiversity resources(e.g. option, existence and bequest values)
4. Tourists (medium-term or long-term solution)	Wildlife viewing (a recreational value)

Source: the author

7.3.8 Are intermediates needed?

The scheme is efficient if the net benefit of the scheme is positive or environmental services conserved in the long term are greater than the usage costs of resources. Generally speaking, a transaction cost is one of significant costs of the PES scheme: the more stakeholders there will be, the higher the costs of negotiating and implementing an agreement. It would be more efficient to negotiate with one intermediary than with many stakeholders. The intermediary can be an institution to help reduce transaction costs of the PES scheme and connect between service buyers and service providers (The Forest Trend et al., 2008). The objective of intermediary is to bridge the gap between the service buyers who benefit from the ecosystem services and service providers who

provides the ecosystem services to achieve the optimum level by reducing transaction costs with less number of stakeholders involved (Pirard et al., 2010b).

The Biodiversity-Based Economy Development Office (BEDO) was proposed as the main intermediary for the PES scheme. The BEDO is the public organization founded by Royal Decree on (B.E. 2550) on July 17, 2007, and received funds allocated by the government to start this operation. The budget of the organization has been provided by the government and some part of it has been subsidized from donation by private sectors. The roles of BEDO[16] can be described as follows:

1. To promote, support and implement measures for the development of biodiversity-based economy;
2. To promote and support the conservation of biodiversity resources and the traditional knowledge of communities and local communities;
3. To collate information, conduct studies, analyze data and assess needs for the development of biodiversity-based economy in order to make policy recommendations and propose measures to the Cabinet;
4. To compile information and develop an inventory of plants, animals and micro-organisms which originate from, or which can be found in the country as well as local and community knowledge; such database will be used for monitoring the utilization of biodiversity resources and the traditional knowledge of communities and local communities for economic uses;
5. To promote and support research which makes use of the existing knowledge on utilization of biodiversity resources and the traditional knowledge of communities and local communities for commercial purposes;
6. To promote and support investments on the development of biodiversity-based economy;

16 http://www.bedo.or.th/bd05_History.aspx (20 June 2012).

7. To promote and support dissemination of knowledge, provide access to utilize biodiversity resources and the traditional knowledge of communities and local communities;
8. To promote, support and take initiatives on registration for biodiversity resources and the traditional knowledge of communities and local communities in order to protect such resources under relevant pieces of legislation; protect and address problems concerning violation of those rights;
9. To operate as the Center for monitoring and coordinating with government offices and private agencies both in and outside the country to ensure that there are linkages and consistency with the prevailing Cabinet policies;
10. To undertake any other tasks as required by the Cabinet and Committees appointed by the Cabinet that concern the development of biodiversity-based economy.

There are three reasons to support the idea that BEDO would be an appropriate intermediary in the beginning stage of the PES scheme. The first reason is the credibility of the intermediary of the scheme. From the service buyer's point of view, BEDO would have more credibility compared to an organization managed solely by villagers. The second reason is the networking of ability of BEDO. According to its roles, the BEDO has been working with the conservation organizations for both government agencies and non-governmental organizations (NGOs). Regarding its network, it would be easier for BEDO to work with related government agencies, NGOs and local government units compared to other government conservation agencies which focus on command and control measures. The third reason is the administrative cost. In the beginning stage of the scheme, administrative costs can be reduced because some staff of BEDO can work on it. When the scheme is settled down, the new independent organization might be a better option to implement the scheme in the long term.

The establishment of the KARN Ecosystem Restoration Fund was operated by BEDO in the beginning, as a channel of payment from service buyers. Regarding the possibility of corruption, there are some independent organizations who work on auditing and controlling public finance of government agencies and public organizations including BEDO (e.g. Office of the Auditor General of Thailand (OAG) and Office of the National Anti-Corruption Commission (ONACC)), and this should lower these concerns.

In this case, the three main roles of intermediaries are identified (Table 7.7). First, a negotiation and contact process is needed between service providers and service buyers. The BEDO and local government units can act as an intermediary to negotiate and make an agreement. The contracts would be two types of contract (Figure 7.10). Both types of the contracts do not require a specific law beyond existing contract law.The first one is the contract between the service providers and BEDO where BEDO and villagers act as the service buyer and service providers for habitat restoration activities in KARN, respectively. However, this type of the contract may be the group contract between BEDO and villagers in the same village; therefore, it may reduce the transaction costs and complicated process. Even though the existing laws (the National Park Act, B.E. 2504 (1961) and the Wildlife Sanctuaries, Wildlife Preservation and Protection Act, B.E. 2535 (1992)) limit villagers' access to the sanctuary, this can be managed by asking for approval from the Council of Ministers, in order that the Department of National Parks, Wildlife and Plant Conservation can collaborate with villagers to run the KARN-PES scheme together. Therefore, the existing laws are sufficient to facilitate the PES scheme without a new law being required.

Another type of the contract is an agreement between the service buyers and BEDO where BEDO and private companies act as the service provider and service buyers, respectively. What are being purchased are the habitat improvement activities (e.g. water ponds, mineral licks, grasslands) which will be converted to be a habitat credit. The reason that the arrangement needs two types of contract is to reduce the transaction costs and make it less complicated in

practice. Second, BEDO acts as the clearing house or an intermediary between service providers and service buyers. The role of the clearing house is to provide clearing and settlement services for financial and commodities transactions. However, the clearing house may be changed to run by a new independent organization in the future when everything is settled down and BEDO may turn their role to monitor instead. In this pilot project, the contract period of the first type of the contract between BEDO and villagers can be 20-year period as corresponded to the cost estimation of habitat improvement activities in the cost-benefit analysis.

Third, the performance of service providers who are the villagers for this case needs to be monitored every year by the KARN Wildlife Sanctuary and the Chachoengsao Wildlife Research Station. If service providers fail to meet their commitments under the scheme, penalties can be applied, or even contract can be withdrawn by BEDO. For example, the contract can be an agreement on what activities villagers will provide, how to monitor, what penalty if the villagers failed to meet the commitments, when payment will provide, how much price of each activity and contract period, and so on. Regarding the second type of the contract between BEDO and private companies, the contract can be on how to assess habitat credit for both habitat improvement activities in the KARN sanctuary and development sites, how many habitat credits being bought, what payment system is, how much price of each habitat credit and contract period, and so on.

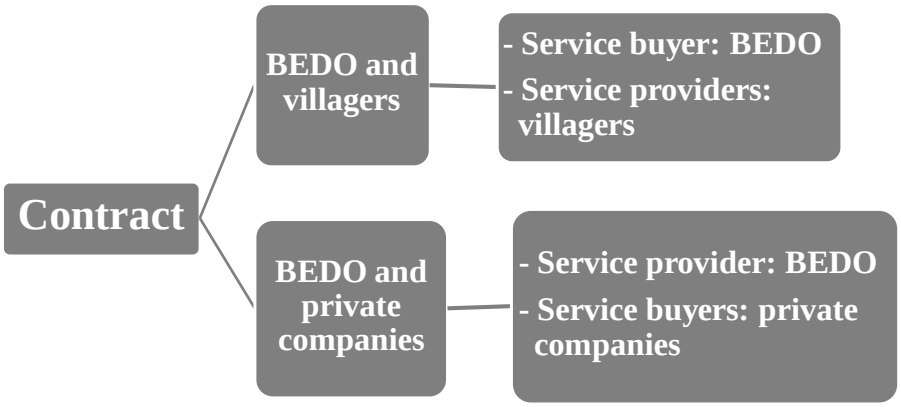
Table 7.7: Roles of the intermediaries

Roles	Intermediaries
1. Negotiation and contract	BEDO, local government unit (LGU)
2. Clearing house	BEDO
3. Monitoring of compliance	the KARN Wildlife Sanctuary and the Chachoengsao Wildlife Research Station

Note: BEDO = the Biodiversity-Based Economy Development Office

Source: the author

Figure 7.10: Types of the contract



Source: the author

7.3.9 How can the PES scheme be monitored and evaluated?

It should be clear who performs monitoring and evaluating activities thorough the whole period of a PES agreement (Forest Trends et al., 2008). The monitoring and evaluating activities are assessed by the performance indicators as mentioned earlier. The monitoring and evaluating activities can be conducted through two methods (Smith et al., 2006):

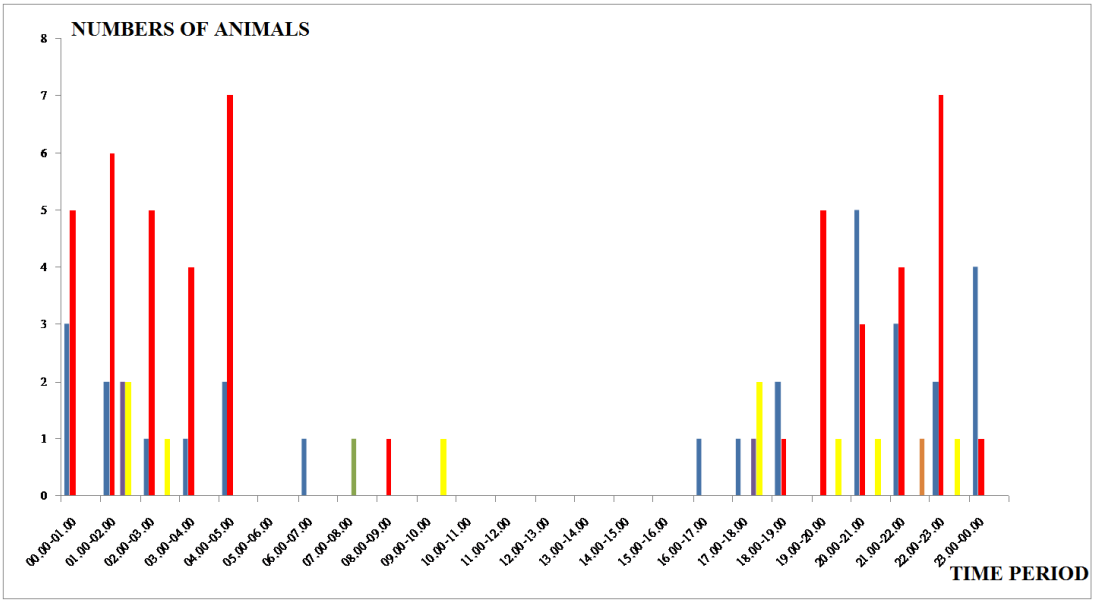
- *Field inspections*: the monitoring cameras will be installed near the targeted new water ponds and mineral licks to make sure elephants and other wildlife come to utilize them. Monitoring wildlife activities has been done before in this sanctuary by the staff of the Chachoengsao Wildlife Research Station; therefore, these monitoring tasks can be cooperation works between staff of the Chachoengsao Wildlife Research Station and the KARN Wildlife Sanctuary. Figure 7.11 shows the example of a monitoring camera at the water ponds in Salakpra Wildlife Sanctuary. By installing cameras at the locations of the water ponds and the mineral licks and the use of GPS systems, it can collect data on the number, timing and type of wildlife that benefit from the water and mineral licks provided. The camera can record pictures of animals that come to utilize water ponds or mineral licks; therefore, we can have data on how many animals get benefit from them. Figure 7.12 illustrates the frequency of animals came to utilize an artificial mineral licks in KARN sanctuary. These kind of data provides information whether locations of water ponds and mineral lick is workable or not. Also, such data can be used as short-run indicators of additionalities compared to the baseline.
- *Desk reviews*: the reviews of the report on HEC impacts recorded by villagers are required to make sure the scheme pay for additionalities but not for activities that would have happened anyway. The reviewers can be intermediaries as mentioned earlier, staff of the Chachoengsao Wildlife Research Station and KARN wildlife sanctuary. Villagers will

be trained by the HEC experts such as staff from the Elephant Conservation Network (ECN) or the Wildlife Conservation Society (WCS) in Thailand on how to record the HEC data, for example, location of each incident, the area of crop damaged, the quality and age of the crops, and the severity of the damages; therefore, they will be able to undertake these routine but very important tasks. The form of HEC impact assessment should be provided as a standardized format. It is important to collect the same kind of data each time; therefore, it can be compared how changes of the HEC impacts are in different areas. The example of crop-damage report form from the IUCN Species Survival Commission's African Elephant Specialist Group (AfESG) (Parker, et al., 2007) is shown in Figure 7.13. The collected data will be compared to the baselines of these data that obtained from household survey in 2011 to measure additionalities.

Figure 7.11: A monitoring camera in Salakpra Wildlife Sanctuary

Source: the author

Figure 7.12: Frequency of animals that come to utilize an artificial mineral lick



Note: ■ = elephants, ■ = deer, ■ = baking deer, ■ = gaurs, ■ = bantengs, ■ = wild boars

Source: Chachoengsao Wildlife Research Station

Figure 7.13: Standard AfESG Crop Damage Report Form

WILDLIFE DAMAGE REPORT FORM FORM No. _____/_____
DISTRICT_____WARD_____VILLAGE _____
Date of Damage _____ Date of Report _____
Exact Location Reference (MAP) _____or (GPS) _____
Complainant(s)_____
Enumerator Name _____
CROP DAMAGE ASSESSMENT: USE PACES – MEASURE LENGTH X WIDTH

			APPROXIMATE LENGTH X WIDTH (PACES)				
CROP TYPE	**Quality* G/M/P**	**Stage** S/I/M**	**Area Grown**	**Damage Area 1**	**Damage Area 2**	**Damage Area 3**	**Damage Area 4**

*** Good /Medium /Poor ** Seedling / Intermediate / Mature**

OTHER TYPES OF DAMAGE (tick and give brief detail)
Food store_____
Water supply_____
Direct threat to human life_____
Human injury/ death _____
Livestock injured / killed_____
Other (specify)

PROBLEM ANIMAL SPECIES (1) (2) (3)
Number **Tracks seen or Animals seen (tick one)**
Estimated Group Size Total _____
Males (if known) _____
Females & young (if known) _____

YOUR COMMENTS
_____ (continue on back)

WAS THIS REPORT FORWARDED FOR ACTION? YES / NO
To Whom?
_____
Where? _____When? _____ How ? _____

Source: Parker, et al., 2007

7.3.10 Does each Party agree with the proposed HEC measures and PES scheme?

The key informant (KI) interviews, focus group discussion (FGD) and workshops were arranged in order to get information for both proposed HEC measures and pilot PES scheme (Table 7.8). The results from KI, FGD and workshops can be useful information to categorize the key parties on the pilot PES scheme to alleviate HEC problem into three main groups according to the role of the PES scheme (Table 7.9): 1) affected villagers as service providers; 2) private sectors, general public and tourists as service buyers; 3) BEDO, LGUs and conservation organizations for both government agencies and non-governmental organizations (NGOs) as intermediaries. Each party has their own interests. Affected villagers pay attention to any measure can reduce their impacts from HEC, whereas the private sector, which is the East Water company in this case, is interested in their benefits on stream flow. The general public might interest in wildlife conservation or recreation values of the sanctuary. Conservation organizations for both government agencies and NGOs and LGUs focus on the HEC reduction and wildlife conservation.

However, all parties agreed that no measure could eliminate HEC, but rather that it was only possible to *reduce* the conflict and damage. The wildlife experts from the three areas (KARN sanctuary, Kui Buri National Park in Prachuap Khiri Khan Province and the Elephant Conservation Network (ECN) in Kanchanaburi province) suggested that the habitat improvement activities are the first priority. In addition, the wildlife experts and villagers also agreed that an elephant barrier such as an electric fence was the preferable option for HEC reduction. The proposed measure that the wildlife expert concerned was the contraception of elephants. It seems that this idea is unacceptable to the Thai people. It would require the dissemination of information on the HEC situation to help the Thai people to understand the problem.

Furthermore, more than 90% of 200 villagers interviewed in the household survey said that they would be willing to volunteer their labor to work for habitat improvement activities in the sanctuary even if there was no payment as

mentioned in Chapter 4. Besides, during the focus-group discussion with affected villagers in Tha Ten village which is one of the study areas, villagers agreed that the electric fences would be effective but they suggested that they should be built in the sanctuary because they do not want to lose any of their farmland. This evidence proves the acceptance by the affected villagers of the proposed mitigation measures.

Regarding the legal constraint that does not allow the local villagers to access the sanctuary, the legal expert and staff of the Department of National Parks, Wildlife and Plants (DNP) suggested during the workshop that exemption could be allowed either at the Departmental or Ministerial level as mentioned in Chapter 6. In addition, the legal expert suggested that the new laws might not be required and that the existing laws would be sufficient, but it might need some special permission within this framework. Also, the expert said that the contract between the service buyers and providers did not require a specific law beyond existing contract law. In the context of Thailand, it would be more appropriate to try to perform a pilot PES scheme under the existing laws since the PES scheme would not be carried out in Thailand if the people have to wait for the new law since implementation always takes a long time.

During the workshops, conservation organizations for both government agencies and NGOs paid attention to the PES concept and thought that it could be a new source of funding for conservation. However, the most challenging part of launching the PES project is the identification of the buyers. Regarding the KI with the private sector, the East Water company, who rely on water supply from the River originating from the KARN sanctuary, showed considerable interest in being a service buyer. Furthermore, the staff of the KARN sanctuary suggested that there was a demand for wildlife viewing in the sanctuary, therefore, tourists could be another service buyer. Currently, a video that is 8 minutes long that tells the story of the KARN-PES scheme has been posted in You-Tube to raise awareness of the public who want to be a part of this pilot scheme. Additionally, the LGUs in the study areas also agreed with this concept because HEC is also

their problem. This evidence reveals that all parties do agree with the PES concept and HEC measures, except only in the case of the contraception requirement, which needs to be understood by the people in the HEC situation.

Table 7.8: Key Informant Interviews and Workshops for the Pilot KARN-PES scheme

Date	Location	Objectives of interviews/workshops	Participants
August 11, 2010	KARN sanctuary	An interview with the wildlife expert on the appropriate measures for HEC reduction in KARN sanctuary	The wildlife expert, representatives of BEDO and a research team
September 2, 2010	Kui Buri National Park	An interview with the wildlife expert on their experience on HEC in Kui Buri National Park	The wildlife expert, representatives of BEDO and a research team
February 21, 2011	Petroleum Authority of Thailand (PTT)	An interview with the PTT for their interest on a service buyer	The PTT representatives and a research team
March 3, 2011	EAST WATER company	An interview with EAST WATER company for their interest on a service buyer	The EAST WATER representatives and a research team
February 25, 2011	BEDO	A workshop to discuss the potential service buyers from a private sector	The wildlife experts, representatives of BEDO, related government agencies, ECN, private sectors and a research team
March 24-25, 2011	ECN	An interview with the wildlife expert on their experience on HEC in Salakpra wildlife sanctuary	The wildlife expert, representatives of BEDO and a research team
July 28, 2011	Chachoensao province	A workshop to disseminate the idea of PES on HEC reduction for public and related government staff and to get information on their opinions	The wildlife experts, representatives of BEDO, related government agencies, villagers, local NGOs, private sectors, LGUs and a research team

Note: 1. BEDO = Biodiversity-based Economy Development Office

2. ECN = Elephant Conservation Network
3. LGUs = Local Government Units
4. IUCN = International Union for Conservation of Nature
5. NGOs = Non-governmental Organizations

Source: the author

Table 7.9: the key parties and their interests in the pilot KARN-PES scheme

Roles in the PES scheme	The key parties	Their interests
Service providers	Affected villagers	HEC reduction on crops and property damages
Service buyers	1) Private sector (EAST WATER company)	1) Positive effects on stream flow
	2) General public	2) Non-use value on wildlife conservation
	3) Tourists	3) Recreation values
Intermediaries	1) BEDO and LGUs (negotiation and contracting) 2) Conservation organizations for both government agencies and NGOs (monitoring of compliance)	- HEC reduction - Wildlife conservation

Note: 1. BEDO = Biodiversity-based Economy Development Office

2. LGUs = Local Government Units

3. NGOs = Non-governmental Organizations

Source: the author

7.4 Potential Limitations of PES implementation

In this section, the key limitations to PES implementation are discussed, which are difficulties for limited demand for environmental services, legal issues, transaction costs, leakage and permanence. The details of each issue can be described as follow

7.4.1 Limited Demand of Environmental Services

The biggest challenge for the PES concept to work for the KARN case study may be how to create effective demand for ecosystem services. This will be easier where there are direct users of environmental services and also if those direct users recognize the link between the actions undertaken by the service providers and incremental tangible benefits as the case of Upstream-Service Providers and Downstream-Service Buyers of watershed protection. In reality, in most cases, such direct links may be technically difficult to establish. Without such clarity, it will be challenging to convince buyers of the expected benefits and hence their reasons for paying. Additionally, many private sectors are unwilling to pay for environmental services because they believe that the public sector should do it (Farley and Costanza, 2010). For example, during the visit with one of the petroleum companies in Thailand to seek for potential buyers of the PES scheme, it was found that they were not interested to contribute their CSR (Corporate Social Responsibility) budget to the PES-KARN scheme. They may have no connection to the region and therefore do not want to pay for the habitat restoration and reduction of HEC. However, the single water user, the East Water Company, that relies on water supply from the Bangpakong River and Prasae River in the KARN sanctuary, showed an interest in being a service buyer. This evidence showed it would be more difficult to convince a private company to contribute such scheme if they do not realize any tangible benefits they would receive.

7.4.2 Legal issues for PES implementation

The private PES scheme as proposed here (between an intermediary and private companies and an intermediary and local villagers) does not require a specific law beyond basic contract law (Greiber, 2009). Furthermore, after reviewing the related Thai laws as described in Chapter 6, there are some legal frameworks to support the PES implementation, whereas some current laws related to natural resources conservation also restrict the PES scheme to implement, especially for KARN-PES scheme.

Though Thailand has no the specific PES law as Vietnam and Costa Rica, there are some laws and Master plans that support the PES implementation that make the PES approach a potential mechanism for conservation, which are the Constitutions of the Kingdom of Thailand, B.E. 2550 (2007), the Eleventh National Economic and Social Development Plan (2012-2016), the National Environmental Quality Act, B.E. 2535 (1992) or the ECNEQ Act of 1992 and the Draft Environmental Management Plan (2012 – 2016). All these laws and Master plan support the PES implementation as a mechanism for natural resources management. On the other hand, some laws (the National Park Act, B.E. 2504 (1961) and the Wildlife Sanctuaries, Wildlife Preservation and Protection Act, B.E. 2535 (1992)) are strict about the access of villagers in the sanctuary but it can be dealt by asking for approval from the Council of Ministers, in order that the Department of National Park, Wildlife and Plant Conservation can cooperate with villagers to perform the KARN-PES scheme together. The approval will be granted based on the scheme period; therefore, the approval is not necessary to ask for approval every year. In addition, the Thai conservation laws focus on the command and control approach and no effort to create incentives for compliance as the case of BioBanking scheme in Australia. However, in this pilot scheme, the Thai developers can voluntarily participate in the habitat credit system to offset their negative impacts on the environment where they can do “good” and earn CSR publicity.

7.4.3 Transaction Costs

Apart from the actual payment for investments of mitigation measures, there is another cost to set up the scheme called transaction costs. The transaction costs are frequently high when many parties involve (Smith et al., 2006; Wunder, 2008; Jindal and Kerr, 2007b). For example of transaction costs in the case of the ScolelTe in Mexico, a community carbon sequestration project, was greater than USD1.3 million and accounted for 33% of the total budget (Jindal and Kerr, 2007b). Therefore, the PES scheme that contracts with a few stakeholders would have lower transaction costs than those that deal with a large number of service providers. In this situation, to create the intermediaries as mention earlier can help to facilitate transaction and reduce transaction costs (Smith et al., 2006; Pirard et al., 2010b; Forest Trend et al., 2008). Transaction costs can be classified into two types: 1) ex ante or initial costs of reaching an agreement, and 2) ex post or costs of implementing after an agreement is in place (Jindal and Kerr, 2007b). The examples of transaction costs are persuading service buyers and service providers to involve the scheme, negotiations, contracting and monitoring.

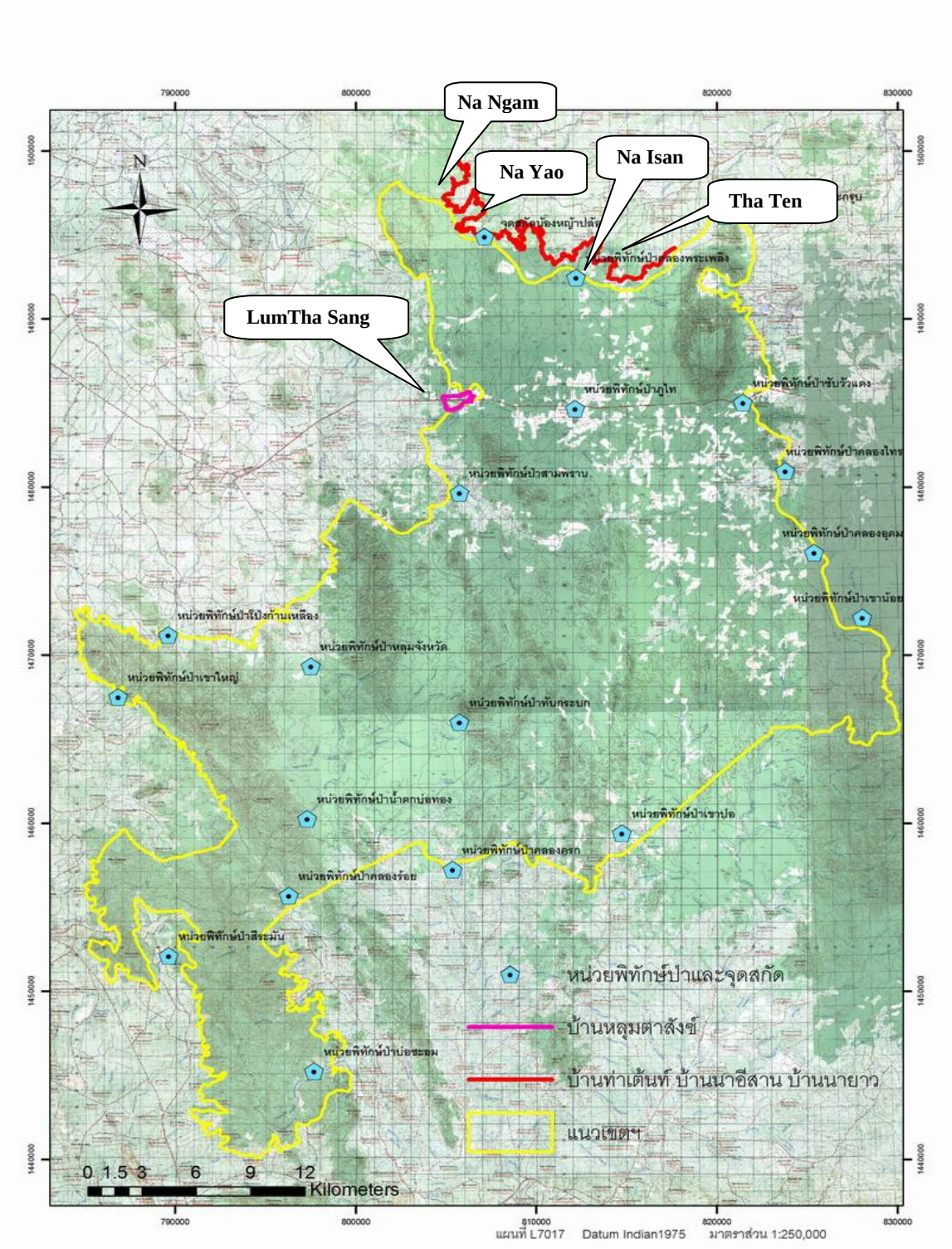
The monitoring cost is also a significant element. The design of the KARN-PES scheme tries to reduce the transaction cost by proposing the village-based volunteers from affected villages to be trained to take field measurements of HEC incidents. Also, the wildlife monitor at water ponds/mineral licks will be cooperate with staff of the Chachoengsao Wildlife Research Station and the KARN Wildlife Sanctuary that would be lower cost than rely on the external expert. Economies of scale can lower the transaction cost; therefore, working in the groups of service providers rather than individuals for negotiation and contract processes would reduce the transaction cost. It might be a single contract with one representative of one village. In addition, the scheme also must ensure that the poor members gain equally from group-based contract (Jindal and Kerr, 2007b). However, this concern may not be a problem for KARN-PES case because the payment rate for each habitat improvement activity would be equally in term of

fixed payment for each habitat improvement activity (e.g. uniform payment of wage rate).

7.4.4 Leakage

One way to ensure that the PES scheme will be efficient is to prevent "leakage" where environmental damages reduced are displaced elsewhere (Smith et al., 2006; Forest Trends et al., 2008; Wunder et al., 2008). In the beginning of the pilot scheme, it may create the leakage of HEC impacts because the habitat improvement activities and electric fences will start in the area near the study areas (Figure 7.14). Elephants may go to raid crops somewhere else surrounding the KARN sanctuary; however, after the whole planned electric fence (220 km) is completed, there should be no leakage because food and water would be sufficient for 500-elephants as controlled by contraception. Electric fences would keep elephants in the sanctuary because this scheme plans to erect the fences all risky areas, which is approximately 220 km surrounding the KARN sanctuary.

Figure 7.14: Location of the electric fences in the beginning of the pilot PES scheme



Source: the author

7.4.5 Permanence

A PES scheme should try to establish a long-term basis or called "permanence" (Smith et al., 2006; Wunder et al., 2008). Permanence is a concern in PES implementation because most PES schemes are under a contract period. Service provision would be ended when the payments are terminated. Regarding user-financed programs, the scheme period depends on the satisfaction of users for environmental services that they are receiving, whereas the government-financed programs, it depends on continued budget allocations (Wunder et al., 2008). Moreover, permanence is not guaranteed. However, the KARN-PES scheme as a user-financed program was designed to prevent an unsecured scheme. In the KARN-PES scheme, the contribution of the EAST Water company as a part of their CSR budget would create the financial resources for the upfront costs for mitigation measure investment. Contributions from a voluntary habitat trading system and the general public would provide contributions for a medium-term period of the scheme. The idea of voluntary habitat trading system was proposed in the belief that the system would be carried on as long as there will be development activities to offset their negative impacts. However, to strengthen the habitat trading system, it would require improving related legal tools which already exist to create effective demand for conservation services in the same way that the BioBanking scheme has established for New South Wales. In addition, wildlife-viewing tourism could be launched after proposed habitat improvement activities are completed. This source of contribution would be a potential source of fund to implement the KARN-PES scheme on a long-term basis.

7.5 Conclusion

This chapter described the design of the KARN-PES scheme in four main areas. First, the background of the HEC problem was provided briefly again. Second, comparison between the PES scheme and other approaches was discussed. Third, the design of the KARN-PES scheme on its core components, which are environmental services, service providers, service sellers, baselines,

additionalities, intermediates, monitoring and compliance was described. Lastly, the potential limitations of PES implementation and their solutions were presented (limited demand for environmental services, legal constraints, transaction costs, leakages and permanence).

CHAPTER 8

DISCUSSION AND CONCLUSION

This chapter is comprised of two main sections. First, discussion of two issues is presented; 1) the critiques of the conventional definition of PES by Wunder (2005); and 2) the logic of the KARN-PES scheme. Second, the conclusion and some lessons learned from this KARN-PES study are described. Last, recommendations for further research are also presented.

8.1 Discussion

8.1.1 The Critiques of the Conventional Definition of PES

When the environmental services are private goods or club goods (as in the case of watershed conservation), it is possible to identify the direct beneficiaries and service providers (Engel et al., 2010). However there are many PES schemes that are not unidimensional but have a range of environmental services they provide as in the case of the Vittel (Nestlé Waters) program in north-eastern France. This scheme are not linked to water quality but based on new farm investment and the cost of adoption of new farming practices (Perrot-Maître, 2006). Therefore, from the example of the Vittel case, it may be argued that the conventional definition of the PES by Wunder (2005) that agents who benefit from a service should pay as the value of that service may be too strictly defined. If the scheme lacks conditionality, it would be fail to deliver the environmental service provision. Consequently, the resources allocated in the scheme also would have useless. However, the strict conditionality often requires high costs of enforcement and monitoring. Conditionality is a required condition for the PES scheme but it might not need to be a strict conditionality (Tocconi, 2012). Furthermore, there are very few PES schemes accomplished the conventional definition of PES by Wunder (2005) (Pirard and Billé, 2010; Farley and Costanza, 2010; Muradian et al., 2010). Moreover, Farley and Costanza (2010) even argued that the five criteria of PES definition by Wunder may be not only unaccomplished, but also is improper because generating sufficient financial

resources may need non-voluntary schemes such as compulsory services charges or taxes. They also suggested that payment levels would be considered by costs of supply for the case of immeasurably valuable resources, not by monetary estimate of benefits. In addition, Pirard et al. (2010) explained that the economic valuation may not be appropriate to value the ecosystem because it is difficult to create the scenario where the service buyer and provider make an agreement on estimated value because the ecosystem is regularly highly uncertain. The current ecological understanding is still inadequate to classify environmental services in most PES scheme (Muradian et al., 2010). Hence, Pirard et al. (2010) proposed that the payment level would be as opportunity costs of service providers for not exploiting a resource, or to exploit it less, or reserve/restore an environmental service.

8.1.2 Logic of the KARN-PES scheme

The logic of PES scheme to revive ecosystem and initiate mitigation measures for Human-Elephant-Conflict (HEC) reduction in the KARN wildlife sanctuary can be described in Figure 8.1. At the current situation (business as usual), only 36.61 percent of the sanctuary is appropriate as elephant habitat resulted in the shortage of the food and water for elephant, this reason explains why elephants often come out of the sanctuary to raid the crops. The related government agencies have tried to apply some mitigation measures to alleviate the impacts of HEC including the habitat improvement activities, however, the level of these measures fall short of the scope and scale of measures to reduce the HEC. The scales of these measures have been limited by the availability of financial resources. As the current conservation level, there are three groups of people even now affected from HEC impacts and ecosystem degradation of the sanctuary. Firstly, the affected HEC households are confronted with direct HEC costs (crop losses, protection costs for mitigation measures and opportunity costs of time to guard crops at night). Secondly, the water users (e.g. the EAST Water company) also face up to the watershed degradation that would reduce water supply in the

future. Lastly, the losses of human and elephant lives would cost the welfare of Thai society.

To perform the conservation at the necessary scale would benefit affected households, water users and general public in terms of HEC reduction, water security and human and elephant saved respectively. A payment from beneficiaries (e.g. water users and general public) who receive advantage from mitigation measures can increase the scale of conservation measures. Even though the affected households are beneficiaries of the scheme who should act as service buyers, they are poor and would not afford to pay for these environment services. Therefore, the KARN-PES scheme is proposed as the asset-building scheme defined by Wunder (2005), which identifies affected villagers payment to work in for habitat improvement activities in the sanctuary as service providers. Furthermore, when households obtain the benefits from elephants in form of payment for habitat improvement activities, they might change their attitudes towards elephants as the resources for them and not as a pest. This may lead to HEC reduction in the future.

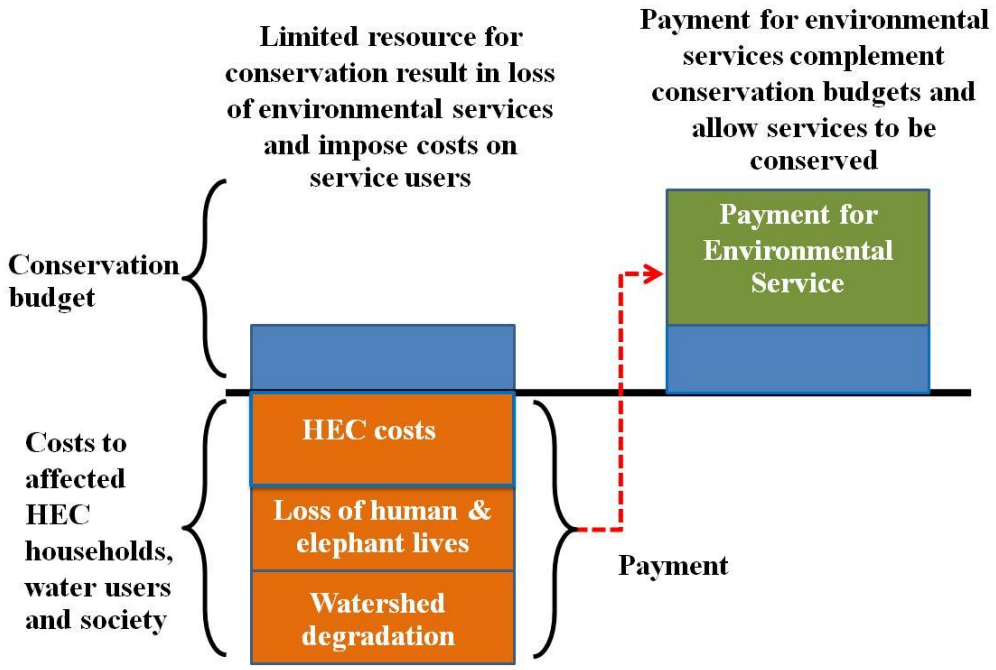
The KARN-PES scheme is also considered as "Potential Pareto Improvement (PPI)". Figure 8.2 shows utility levels of the two groups of people in the society: 1) the service buyers which are the water users and general public and 2) the service provider which is affected HEC households. Because resources are limited, and then only the resources inside of the DOU area are available. At E, C and P represent the allocations of the scenario of current situation (business as usual), the scenario of ecosystem restoration without PES and the scenario of PES scheme respectively. Moving from point E (business as usual) to C (ecosystem restoration), the water users and general public saves their external costs of environment degradation in terms of water security (for water users) and human and elephants saved (for general public) equal to "B" level, whereas the affected HEC households are confronted with their opportunity costs of time (or

income forgone by not working in their crop field) to perform the habitat improvement activities for ecosystem restoration equal to "A" level.[17]

The PES scenario is the second-best option where the water users and general public, who act as the beneficiaries or service buyers, can compensate a part of their welfare gain as: 1) a payment (equal to "A" level) to affected households for their labor contribution as the service provider who losses in welfare from income forgone by not working in their crop field and 2) investment costs for habitat improvement activities and mitigation measures through PES mechanism. However, the payments for both investment costs and compensation for households should not higher than "B" level which is the benefits from ecosystem restoration. As a result, a movement from point E to P represents a Potential Pareto Improvement (PPI) or increase in economic welfare for all actors.

[17] The conditionality of the payment from service providers relates to working the specified contractual activities that would be expected to contribute to environmental service provision as the case of the South African Working for Water program (Turpie et al., 2008).

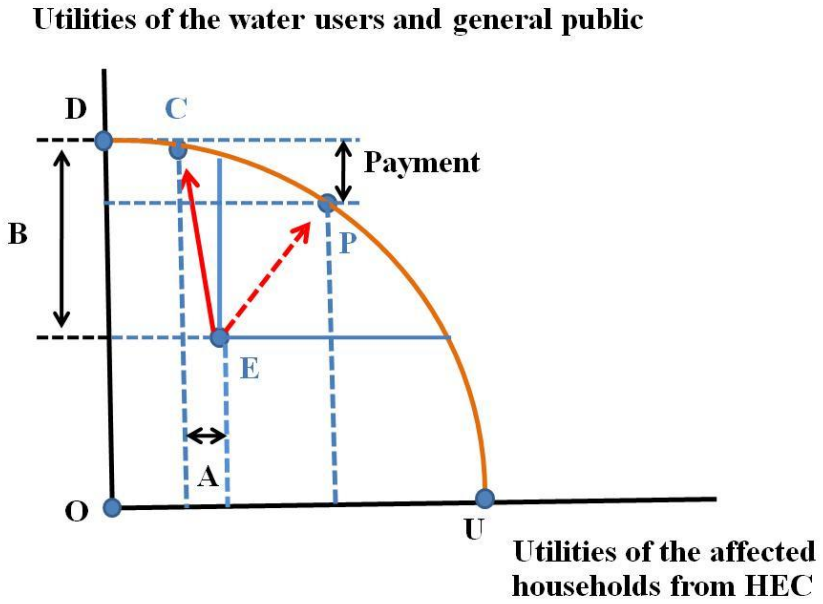
Figure 8.1: The Logic of PES for Human-Elephant-Conflict Mitigation and Habitat Improvement Activities



Note: HEC = Human Elephant Conflict

Source: Adapted from Georgieva et al. (2003)

Figure 8.2: Potential Pareto Improvement of a PES scheme for Human-Elephant-Conflict Mitigation and Habitat Improvement Activities



Note:

A = opportunity costs of time of affected HEC households to perform habitat improvement activities or income forgone by not working in their crop field

B = the external benefits of water users and general public from HEC mitigation measures and ecosystem restoration

Source: Adapted from FAME (2011).

8.1.3 Analysis of the efficiency of the KARN-PES scheme

To achieve efficiency the scheme needs to make the privately unprofitable returns but socially-desirable activities into profitable returns for the service providers (Engel et al., 2008). In addition, the efficiency of the PES scheme is not considered only by the incremental environmental services provided, but also by the cost of the scheme including (1) the opportunity cost of the benefits forgone from alternative land-use; (b) the implementing and maintaining costs of the scheme and (3) the transaction costs of the scheme (Wunder et al., 2008). In Cost-Benefit Analysis (CBA) on HEC mitigation measures that is used to propose mitigation measures on the KARN-PES scheme, the analysis excluded the transaction costs because of the limitation of available data. However, the PES mechanism is designed to reduce the transaction costs which were explained in Section 7.4.3 above. For example, a uniform rate of the payment for working in each habitat improvement activity in the sanctuary would help to reduce the transaction costs and the Biodiversity-Based Economy Development Office (BEDO) and local government units can act as intermediaries to bridge the gaps between service buyers and providers for negotiation and making an agreement as a bundled contract to reduce number of the stakeholders which would also decrease transaction cost.

Therefore, if we assume that the transaction costs are low, we can use the results of the CBA on HEC mitigation measures as the CBA of the KARN-PES scheme. In this case the scheme is efficient when the costs of proposed mitigation measures are lower than the benefits of such measures. The results of CBA in Chapter 5 show that the HEC mitigation measures on policy option 3 (habitat improvement activities, contraception of female elephants and electric fences), which is the proposed option in the KARN-PES scheme, generate the highest net benefits at different discount rates as shown again for convenience in Table 8.1. Thus this option produces positive externalities for society. Therefore, the KARN-PES scheme would be the case A in Figure 2.3 (Chapter 2) as suggested by Engel et al. (2008) that the scheme tries to generate privately unprofitable but socially

positive externalities, become profitable to individual service providers. Hence, it would be an incentive for them to perform the mitigation measures.

Table 8.1: Net present values of the net benefits of the proposed mitigation option (habitat improvement activities, contraception of female elephants and electric fences)

Unit: million baht (million USD)

Growth rates of crop-raiding by elephants	Discount rate		
	3%	**5%**	**8%**
5%	64.0 (2.1)	43.6 (1.5)	22.5 (0.7)
10%	253 (8.4)	118.7 (6.3)	121.9 (4.1)
15%	607 (20.2)	455.6 (15.2)	300.4 (10.0)

Note: USD1 = 30 baht

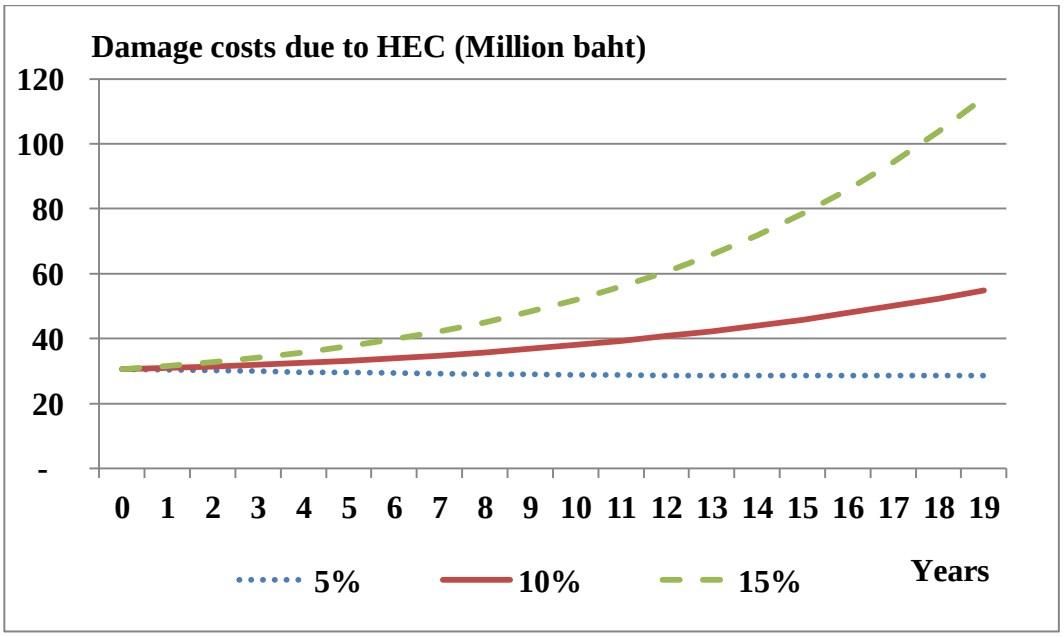
Source: the author

In addition, the distributional issue is also another key concern for the feasibility of the PES scheme. Even though the PES scheme is advocated as an efficiency scheme, if the scheme has an unfair distribution of benefits and costs for stakeholders, there is less chance that it would be accepted and feasible to implement (Muradian et al., 2010). For example, the PES scheme in Cambodia demonstrated that villagers were not motivated enough to conserve the key wildlife, although the payment level was high (Clements et al., 2010). This is because only a few individuals get benefits; therefore, they felt as the scheme was unfair. The KARN-PES scheme also takes the fairness consideration in PES design, the uniform payment for the labor contribution of service providers to

work for habitat improvement activities was proposed to avoid social conflicts. In fact, the payment for working on habitat improvement activities is not only economic incentive for HEC affected villagers, but also the additional crop due to HEC mitigation are another motivation for villagers. Therefore, affected villagers act as the service providers and beneficiaries simultaneously. Furthermore, the KARN-PES scheme can be considered a rural development as a part of the scheme proposes eco-tourism (wildlife viewing), which may be a sustainable source in the long run. This may be seen as the win-win situation because with the revenues from tourism, affected villagers might change their attitude towards wild elephants to see that they are a resource, not a pest. This may lead to HEC reduction in the future.

Furthermore, Wunder (2005) suggests that PES efficiency also depends on establishing the baselines of counterfactual environmental service and ensuring the scheme provides additionalities. He also suggested that to apply the wrong baseline might lower PES efficiency or waste all money if no additional environmental service is provided beyond what would occur without the PES. The baselines of the scheme on HEC mitigation measures were set carefully based on the status quo scenario of the CBA. The baseline choice would be the deteriorating baseline scenario as classified by Wunder (2005) because the impacts of HEC would be increasing over time as estimated in status quo scenario of the CBA in Chapter 5. Figure 8.3 demonstrates the baselines of the scheme on the indicators of HEC impacts under assumption of the growth rates of the crop-raiding by elephants over 20-years period.

Figure 8.3: The baselines of the scheme on HEC impacts at different growth rates of crop-raiding cost, namely 5%, 10% and 15%



Note: 1. Damage costs due to HEC are comprised of 1) crop loss, 2) protection cost and 3) opportunity costs of time to guard crop at night

2. Damage costs due to HEC are calculated under the assumption of the growth rate of crop-raiding are 5%, 10% and 15%.

Source: the author

8.2 Conclusions

Sustainable development is essential to human well-being and relies on sound policy intervention in ecosystem management in response to the dynamic interaction between humans and ecosystems. But we are faced with the degradation of ecosystems and falling ecosystem services due to rising consumption, demographic changes, and failure of our economic systems to incorporate ecosystem services into our choices (Millennium Ecosystem Assessment, 2005). Governments have been unable to allocate large enough amounts of their budgets to protect ecosystems and because of externalities people acting alone cannot ensure enough conservation. Payment for environmental

services (PES) is an incentive-based mechanism for conservation that has promise in helping to sustain our ecosystem and human wellbeing. PES is as a type of Pigouvian subsidy to internalize positive externalities through creation of a parallel environmental-service market with non-market policies such as command-and-control measures. The idea of PES is based on the Beneficiary-Pay-Principle (BPP), the reverse of Polluter-Pay-Principle (PPP), that subsidies are financed directly and voluntarily by beneficiaries of environmental services. The logic of the PES approach is that those who provide environmental services should be compensated or rewarded for their services and that those who obtain the services should pay for their benefits.

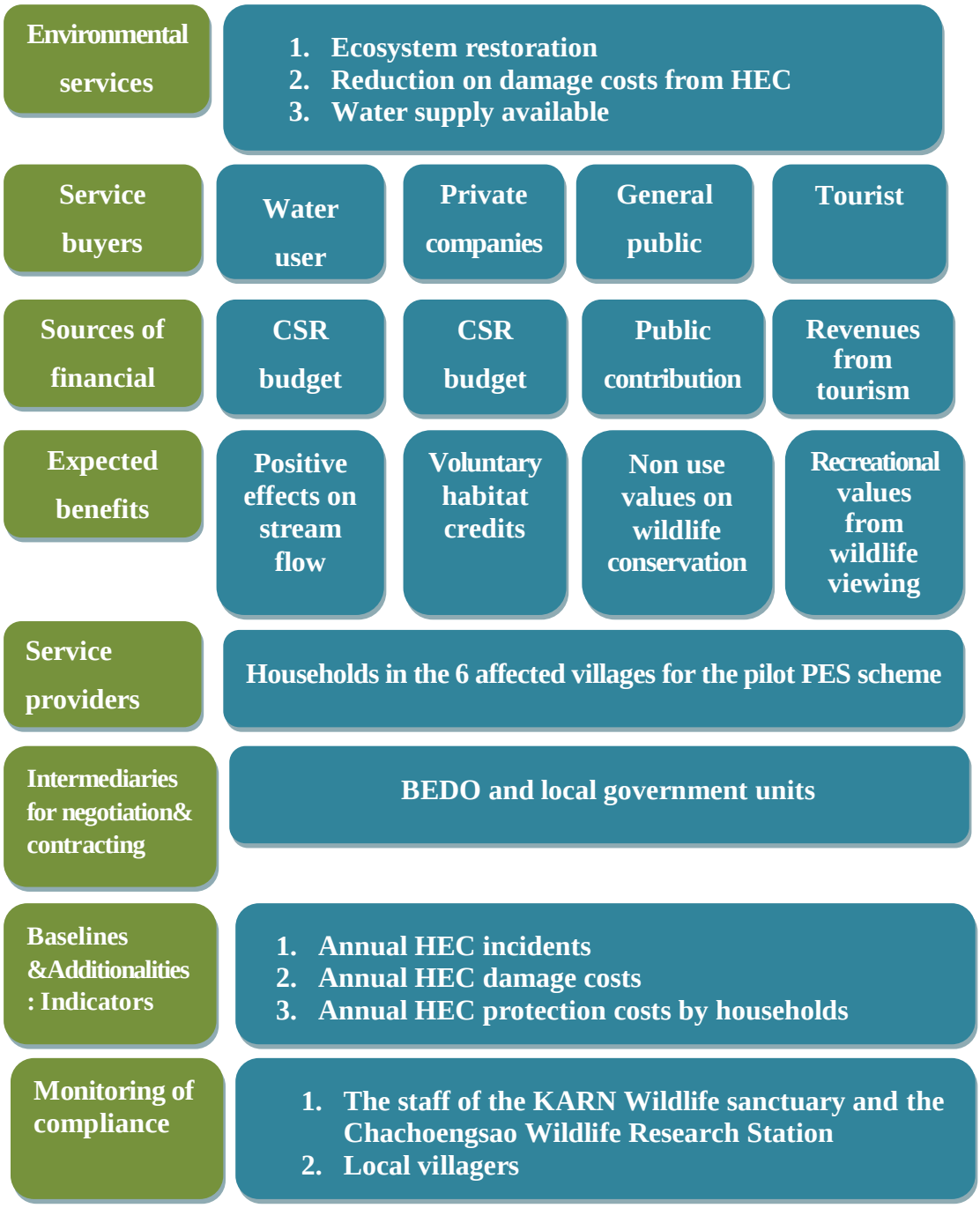
Figure 8.4 outlines the PES mechanism for HEC mitigation in the KARN Wildlife Sanctuary. The ultimate environmental services from the activities[18] in scheme are 1) ecosystem restoration; 2) reduction of HEC impacts and 3) water supply available. The potential service buyers can be 1) the main water user of watershed in KARN sanctuary which is the EAST Water company; 2) the private companies who would like to do "good" for conservation and earn CSR publicity on conservation by offsetting their development with voluntary habitat credits; 3) the general public who obtain the external positive benefits from both use and non-use values of ecosystem restoration and wildlife conservation, especially elephants; and 4) tourists who would like to enjoy wildlife viewing, which administered by villagers. Furthermore, the selected six villagers who affected from HEC were identified as service providers to work on habitat improvement activities in sanctuary. This might change the attitudes of affected villagers towards elephants as a resource, not a pest, and it is a job creation for local villagers. The Biodiversity-Based Economy Development Office (BEDO) and local government units can act as an intermediary to negotiate and make a contract between service buyers and providers. The indicators for baselines and

[18] The proposed activities in the scheme are 1) increasing water supply; 2) converting alien species; 3) creating mineral licks; 4) planting food for elephants; 5) contraception of female elephants and 6) fencing part of the sanctuary.

additionalities can be compared between with and without a PES scheme. The indicators for the medium-term or long-term periods are the data indicating the reduction of HEC impacts, which are 1) HEC incidents; 2) HEC damage costs and 3) HEC protection costs by households. However, the indicators on habitat improvement for the short-term period can be number of wildlife that comes to utilize the new grassland, water supply and mineral licks. Regarding monitoring of compliance, the staff of the KARN wildlife sanctuary and the Chachoengsao wildlife research station can monitor the number of wildlife that comes to utilize the new grassland/water supply/mineral licks compared to the baselines data without PES scheme. In addition, the local villagers who are affected from HEC will be trained to record the HEC data by staff from the Elephant Conservation Network (ECN) or the Wildlife Conservation Society (WCS) in Thailand.

The potential limitations on PES implementation can be summarized as five issues; 1) limited demand for environmental services, a major challenge to establishing the PES scheme; 2) legal constraints: for example, villagers are not allowed to access in the sanctuary, however, it would be the special permission in the case of educational purposes or scientific research by coordination with the Wildlife Sanctuary staff; 3) transaction costs: the bundled contracts or group-based contracts between service providers and buyers were proposed and it was expected it would be lower transaction costs; 4) leakage: the scheme will be implemented for the whole area of the KARN wildlife sanctuary and it expected there would be no leakage of HEC to somewhere else; and 5) permanence: the habitat trading system was expected to be the long-term basis for financial resources as in the belief that the system would be carried on as long as there will be development activities to offset their negative impacts.

Figure 8.4: The PES mechanism for HEC mitigation in KARN wildlife sanctuary



Source: the author

It should be noted that this study does not suggest that the PES scheme proposed replace other conservation measures (e.g. command-and-control or education approaches). This mechanism is rather proposed as a parallel environmental market with other conservation policies. However, this study can draw some lesson learned of the pilot PES study as follows:

1) Even though Thailand has several natural resources and wildlife protection laws (e.g. the National Park Act of 1961 and the Wild Animal Reservation and Protection Act of 1960), these only focus on command and control measures. Moreover, there is an effort to push the economic instrument approach on pollution controls into the Thai law. If this Act was passed, it would be the first Environmental Tax Act in Thailand. In 2007, the Fiscal Policy Office at the Ministry of Finance prepared a draft of the Financial Measures for Environment Act[19] which allows the environmental protection agencies to use the proper economic instruments for environmental management (Kaosa-ard et al., 2008). In October 2010, Abhisit Vejjajiva's government accepted the principle of the draft but required to made amendment of the Act in details (THUPP, 2010) However, this effort to implement the Financial Measures for Environment Act did not succeed because the Cabinet of Yingluck Shinawatra's government rejected it in August 2011. Though legislating a new specific law for the proposed PES scheme in this study is unnecessary, it would be more effective if Thailand would have a law using the economic instruments as tools to preserve natural resources and environment as the case of BioBanking system in Australia because it was proved that only command-and-control measures could not be an effective measure for sustainable managements for both pollution control and natural resource conservation;

2) It would be more attractive for general public or private sectors if the government can provide incentives for their contribution on the scheme. One of the fundraising methods is to sell services widely to people at the price they can afford (e.g. 2,500 baht or USD83 for one mineral lick) and not limit only to a few

[19] http://www.tuhpp.net/files/E6.pdf, 18 February 2012.

buyers or people in that province, but try to expand the selling widely through the country. The idea is no matter where the buyers are, they can be a part of natural resources and biological diversity preservation as wildlife, especially elephants, and biodiversity are the resources for the country and even for the world. It would increase the incentive to participate if some measures could be added; such as a tax deduction for the value of bought service. This kind of measure helps people who do not have time or resources but are interested in natural resources and biological diversity preservation to collaborate with the government and support the program. At this moment, a video that is 8 minutes long that talks about the KARN-PES scheme has been produced and has been posted on You-Tube to deliver information of this study to the general public. It is hoped that this video can increase awareness and willingness of public who want to be a part of this pilot scheme;

3) The identification of the service buyers may be the greatest challenge to establish the PES scheme as mentioned earlier. In the early stage of the study, there was high expectation that it would be possible to mobilize the contribution from private sectors via their CSR budgets, since the KARN-PES scheme provides the opportunity for private sectors could do "good" and earn CSR publicity. But the private companies may place more weight on quick-tangible results. There is therefore the need for a formal institutional framework to create tangible incentives for private sectors to participate. The formal network could be through institutions such as the Federation of Thai Industries and the Thai Chamber of Commerce rather than individual private companies;

4) This pilot PES scheme proposed here may be slightly different from the other PES schemes in term of the role of the actor. The affected villagers in the KARN-PES scheme are the beneficiaries as well as service providers. However, this situation would provide at least two advantages in that the scheme creates job for low-income households and reduces HEC simultaneously. The PES system has the potential to turn the human-elephant-conflict into human-elephant-harmony as it helps turn elephants from a pest to a valuable resource to be protected;

5) Since 93 percent of the 200-repondents agreed to volunteer to work for habitat improvement activities for free but we would like to pay villagers for their opportunity costs of time. Therefore, it is possible to propose an additional strategy to be an incentive compatible and cost saving of the KARN-PES scheme simultaneously. For example, the villagers will get paid for one hour under the condition that they have to work voluntarily one more hour or the working hours are double what they will get paid. Therefore, if the villagers would like to get paid for 10 hours, they have to work for 20 hours in total.

In summary, the HEC mitigation measures in the KARN sanctuary that provides the highest net-benefit option is the policy option 3 (habitat improvement, female elephant contraception, and electric fences). In addition, the policy option 3 also provides the most cost-effective option, which the unit cost of this policy option varies between 2,747 and 12,489 US dollar per square kilometre. The PES mechanism to reduce HEC in the KARN sanctuary was designed as in Figure 8.4. Furthermore, the opportunity cost of service providers and costs of proposed mitigation measures were estimated to be used as information of financial needs for PES scheme. Also, a private sector, general public and tourists were anticipated to contribute as service buyers. This study finds that there are some potential limitations of PES implementation which are limited demand of environmental services, legal constraints, transaction costs, potential leakage and permanence of the PES scheme. Lastly, this research has provided information and analysis that can be used as the PES model in similar HEC situation in the future.

8.3 Recommendations for Further Research

This research covers the design of a pilot PES scheme. When the scheme is begun the research on monitoring and compliance would be pursued to make sure that service providers comply with their contracts. In addition, the proposed activities (e.g. water resources and mineral licks etc.) need to be monitored for use by wild animals. If they do not, research on the reasons why they do not use these facilities needs to be undertaken (e.g. the ingredients of the mineral licks may be

proper for animals). In addition, the present study did not estimate the transaction costs of a PES scheme due to data availability. Therefore, when the scheme is implemented, a transaction cost estimation of the scheme will be needed. This information is not only to create an example for a future PES scheme, but for the KARN-PES scheme itself to adjust or adapt its procedures in order to reduce transaction costs during the period of the scheme.

Further, the study of distributional aspects on the impacts of the KARN-PES scheme would provide useful information on which groups of participants obtain positive impacts (benefits) or negative impacts (costs) from the scheme, which could then be used to adjust the procedure of the scheme. Additionally, a study on who the actual participants are and what barriers prevent some of them to participate in the KARN-PES scheme would be useful information to adjust the scheme or even to design a new PES scheme in the future.

Furthermore, the proposed HEC mitigation measures here are a medium-term solution. In the future, even though the habitat in the sanctuary will be enhanced to its full capacity, the sanctuary will still be unable to maintain the increasing elephant population according to the current growth rate. The translocation of the entire herd has been suggested by wildlife experts. The research on the cost-benefit analysis of the appropriate area for elephant translocation will thus be needed to look at what might be the negative impacts (costs) and positive impact (benefits) of this measure for alternative locations. Also, research on public attitudes to elephant translocation will be needed because translocation is not currently acceptable for Thai people.

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