



United Nations Development Programme

Country: Thailand

PROJECT DOCUMENT

Project Title: Maximizing carbon sink capacity and conserving biodiversity through sustainable conservation, restoration, and management of peat swamp ecosystems

UNPAF Outcome(s): Effective Responses to Climate Change

UNDP Strategic Plan: Inclusive Growth and Sustainable Development

Expected CP Outcome(s): Thailand is better prepared to coherently address climate change and environmental security issues through the enhancement of national capacity and policy readiness.

Expected CPAP Output(s): 1: Improving protection of high conservation peat swamp forests and demonstrating their sustainable use within the broader landscape; 2: Avoided degradation of high nature value peat-swamp forests; 3: Effective national policy framework for management of peat-swamps address degradation threats and stipulating ecologically optimal management regimes for all peatlands in Thailand

Executing Entity/Implementing Partner: Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment (MONRE)

Implementing Entity/ Responsible Partner: ONEP, MONRE, and UNDP

Brief Description

The Kuan Kreng landscape (KKL) in south eastern Thailand contains the country's second largest peat swamp forest area. The peat swamps provide many ecosystem services ranging from livelihoods for local communities, acting as a rainwater and runoff reservoir, buffering from the impact of rains and floods, acting as a natural sediment filter before waters drain into Songkhla Lake, being a major store of carbon, and harboring important biodiversity including a number of globally threatened species. By some estimates, however, about 65% of the KKL remains under constant threat of degradation from various threats with the primary one being conversion to oil palm cultivation and associated drainage and forest fires. The area of natural peatlands that harbor biodiversity and sequester carbon is being reduced. The long-term solution is to change the trajectory of baseline approaches and facilitate a transformative shift from unsustainable to sustainable and integrated use of peat swamps in Thailand. The project proposes three components: the first focusing on improving effective protection of remaining natural peat swamp forests in the KKL; the second helping to implement innovative approaches to avoid drainage and restore peat swamps; and the third helping to improve national strategies for land use in peat swamps. In doing so it will improve the status of indicator species in KKL, demonstrate good peat swamp forest management practices, maintain the carbon pool, reduce emissions from peatlands, enhance institutional capacity to account for GHG emission reduction and increase in carbon stocks, and develop a national strategy to guide the management of peat swamps.

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Agreed by:

Date/Month/Year

Ms. Raweewan Bhuridej, Ph D
Secretary-General
Office of Natural Resources and Environmental Policy and Planning (ONEP)

Agreed by:

Date/Month/Year

Mr. Luc Stevens,
UN Resident Coordinator, and UNDP Resident Representative

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ACRONYMS

AGB	Aboveground Tree Biomass
ALRO	Agricultural Land Reform Office
AOO	Area of Occupancy
APR/PIR	Annual Performance Review/ Project Implementation Review
APRC	Asia Pacific Regional Centre
AWP	Annual Work Plan
BTOR	Back to Office Report
C	Carbon
CBD	Convention on Biological Diversity
CBFBM	Community Based Forest Biomass Monitoring
CBFCM	Community Based Forest and Catchment Management
CCM	Climate Change Mitigation
CEO	Chief Executive Officer (of the GEF)
CH ₄	Methane
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CO ₂	Carbon dioxide
CP	Country Program
CPAP	Country Program Action Plan
CPD	Country Program Document
DNP	Department of National Parks, Wildlife, and Plants Conservation
DOAE	Department of Agricultural Extension
DOC	Dissolved Organic Carbon
EEG	Energy and Environment Group
EF	Emission Factors
EIA	Environmental Impact Assessment
EPA	Environmental Protection Area
ERC	Evaluation Resource Center (of the UNDP Evaluation Office)
FAO	Food and Agriculture Organization
GEF	Global Environment Facility
GEF BD-1	Biodiversity Strategic Objective 1 (of the GEF)
GEF CC SO 5	Climate Change Strategic Objective 5 (of the GEF)
GEF-ADB	GEF unit of the Asian Development Bank
GEF-IFAD	GEF unit of the International Fund for Agricultural Development
GEFSEC	Global Environment Facility Secretariat
GHG	Greenhouse Gas
GIS	Geographic Information System
GMS	Greater Mekong Subregion
GWP	Global Warming Potential
Ha	Hectares
ID	Identifier
IEC	Information, Education and Communication
IP	Implementing Partner
IPCC	Inter-governmental Panel on Climate Change
IUCN	International Union for the Conservation of Nature
KK	Kuan Kreng
KKL	Kuan Kreng Landscape
LDD	Land Development Department
LULUCF	Land Use, Land Use Change and Forestry
METT	Management Effectiveness Tracking Tool
MOAC	Ministry of Agriculture and Cooperatives
MONRE	Ministry of Natural Resources and Environment
Mt	Million tons
N ₂ O	Nitrous Oxide

NBSAP	National Biodiversity Strategy and Action Plan
NEB	National Environmental Board
NEQA	Enhancement and Conservation of National Environmental Quality Act
NHA	Non Hunting Area
NIM	Nationally Implementing Modality
NRF	National Reserved Forest
NSP	National Strategy on Peat swamps
NST	Nakhon Si Thammarat Rajabhat University
ONEP	Office of Natural Resources and Environmental Policy and Planning
PA	Protected Area
PAC	Project Appraisal Committee
PAO	Provincial Administrative Organization
PB	Project Board
PES	Payments for Ecosystem Services
PIF	Project Identification Form
PIMS	Project Information Management System
PM	Project Manager
PMU	Project Management Unit
POC	Particulate Organic Carbon
PPG	Project Preparation Grant
PPR	Project Progress Report
PWG	Provincial Working Group
QPR	Quarterly Progress Report
RCU	Regional Coordination Unit
REDD+	Reducing Emissions from Deforestation and Forest Degradation+
RFD	Royal Forest Department
RID	Royal Irrigation Department
RSPO	Roundtable on Sustainable Palm Oil
RTA	Regional Technical Advisor
SBAA	Standard Basic Assistance Agreement
SE	South East
SFM	Sustainable Forest Management
SFM/REDD+	Sustainable Forest Management/ Reducing Emissions from Deforestation and Forest Degradation+
SOC	Soil Organic Carbon
SPCC	Strategic Plan on Climate Change
STAP	Scientific and Technical Advisory Panel
TAO	Tambon Administrative Organization
tCO ₂ -eq	Tons of Carbon Dioxide Equivalent
TISTR	Thailand Institute of Scientific and Technological Research
TOC	Total Organic Carbon
UEAP	Office of Urban Environment and Area Planning
UN	United Nations
UNDP	United Nations Development Programme
UNDP-GEF	United Nations Development Programme – Global Environment Facility
UNFCCC	United Nations Framework Convention on Climate Change
UNPAF	United Nations Partnership Framework
US\$	United States Dollar
USD	United States Dollar
VCS	Verified Carbon Standard
WG	Working Group
WL	Water Level
WT	Water Table

1. SITUATION ANALYSIS

1.1. Peatlands and their importance

Peatlands are one of the planet's major carbon pools. In addition, they provide irreplaceable habitat for threatened species; are a source of organic fertilizer, raw materials for chemistry, textiles, insulation materials, and balneological, therapeutic, and medical products; are natural providers of clean water; and regulate micro-climate, soil and hydrological conditions, thus providing effective means for controlling fires, erosion, floods, and contamination.

Globally, there are approximately 400 million hectares of peatlands (3% of the world's land area), containing up to 528,000 megatons of carbon (about 1/3rd of the global soil carbon). The largest area of tropical peatlands occurs in Southeast Asia, which alone has about 27.1 million hectares. Tropical peatlands, such as those in Thailand, have been accumulating carbon 4.5 times faster than temperate peatlands. They also store more carbon than other tropical forests that are on non-peat soils. A 10 m deep peatland in the tropics stores about 5,800 t C/ ha compared to 300-800 t C/ ha for tropical forests on other soils.

Estimates of peatlands in Thailand vary from 45,300 to 64,500 hectares (Ueda et al., 2000; Tanit 2003; Joosten 2009; Yoshino et al., 2010; Page et al., 2011; Nagano et al., 2013). Annex 1 provides the range of estimates and references. The recently developed *Action Plan of Peatland Management*¹ states that: "As for Thailand, a total area of 64,555 ha has been identified as peatlands. This is mainly located in the South of Thailand (63,982 ha), particularly in Narathiwat (30,969 ha), Nakhon Si Thammarat (18,946 ha), Songkla (4,828 ha), Choomporn (3,285 ha), Phattalung (2,768 ha), Surat Thani (1,542 ha), Pattani (1,205 ha), Yala (190 ha), Trang (85 ha), Phuket (62.5 ha) and Krabi (47 ha). Peatland are also found in the Eastern part of Thailand (572.5 ha), particularly in Trat (452.5 ha) and Rayong (120 ha). Of the total area of peatlands in Thailand, only 9,031.5 ha are considered intact peat swamp forests, especially in Phru Toh Daeng in Sungei Kolok, Tak Bai and Sungei Padi districts of Narathiwat province. The remaining area of 55,523 ha is considered degraded peat swamp forest (Jirasak et al, 1999)."

Peatlands are also referred to as peat swamps in Thailand. Nuyim (2005) provides a definition for peatlands/ peat swamps as follows. The word 'Phru' in Thai refers to a swampy and waterlogged area, filled with peat and very boggy when stepped upon (Thawatchai and Chavalit, 1985). 'Phru' is normally filled with organic matter because there is more organic matter accumulated than degraded (Gore, 1983). 'Phru' is often found in humid areas with high water content in the soil, but with a low level of bacterial activities (Reinikainen, 1976). The Thai word is synonymous with the following English words: peatland, mire, bog, fen, swamp and marsh. All of these words more or less denote the same meaning, but the usage of each word depends on differing features pertaining to geographical factors, soil nutrients, and plant species growing in the area.

¹ Ministry of Natural Resources and Environment. *Action Plan of Peatland Management*. Bangkok: Department of National Parks, Wildlife and Plant Conservation, 2014 (draft). Print. This action plan is developed as part of Thailand's participation in the Sustainable Management of Peatland Forests in Southeast Asia project that Thailand joined in January 2013. The document went through public consultation in 2013. It will now be presented for consideration to the National Committee on Wetlands and then to the National Environmental Board for endorsement.

Peat swamps in Thailand comprise a number of land cover classes – predominantly peat swamp forests, but also non-forested wetlands and swamp grasslands. A peat swamp forest is a type of wetland, waterlogged almost all year round, with plants growing on the peat surface. It is characterized by evergreen forest, a type of tropical rainforest. The forest is influenced by the edaphic factor in the soil, where the area has long been clogged with fresh water (Chamlong, Chavalit and Wiwat, 1991; Thawatchai and Chavalit, 1985).

Peat swamps are areas of high biodiversity and are unique as they contain many layers of dense interwoven plant species. The huge amount of life that these areas possess is demonstrated by the fact that there are more than 470 plant species found in Thailand's peat swamps.

Peat swamps contain a variety of economically valuable plants and trees, as well as a large number of rare plant species. Trees found in the peat swamp can be used for construction, for decoration, and as fruit producers in orchards. Palm and rattan plants can be used for making household tools, house repairs, and livestock fencing. Many of the plant species are consumed by wildlife, and can also be consumed as herbal medicine.

Peat swamp forests contain a large variety of other natural resources, in addition to trees and plants, which can be used by the communities that are located in and around the forest areas, including: fish for consumption and for sale as pets; organic soil from the forest can be used for tree nursery plots; and there are many grassy areas which can be used for livestock grazing. Many wild animal species, especially fish, can only be found in peat swamp zones.

Primary peat swamps and secondary peat swamps are home to Cajuput forests, fields, grey sedge fields, as well as breeding areas for a wide range of wild animal species. Many of these animal species are either listed as “near threatened” or “endangered” species. Therefore, it can be concluded that peat swamp areas contain both species richness and genetic diversity. Peat swamp zones are valuable for research and studies, which can reveal new information about plant and animal evolution, geologic changes, as well as changes in soil and air conditions over the ages.

Peat swamps are valuable carbon sink zones which contribute positively to the global ecosystem. These zones also act as natural large scale dams, by absorbing water flows and then gradually releasing the water over time for agricultural uses. Peat swamps also serve to protect against flooding and high winds. Lastly, these zones are useful for eco-tourism activities, as they contain multitudes of strangely beautiful features.

1.2. Kuan Kreng landscape in south-eastern Thailand

The Kuan Kreng landscape (henceforth, KKL) contains Thailand's second largest peat swamp forest area². According to Nuyim (2005) the **peat swamp forest area** for Nakhon Si Thammarat Province is 18,946 ha and for Phatthalung 2,767.5 ha. Thus, the total peat swamp forest area in the KKL can be estimated to be 21,713.5 ha. This is largely secondary, natural forests. A few patches of primary peat swamp forests remain such as in the Kuan Ki Sian Ramsar Site.

The area estimates for peatlands in the KKL, however, differ. According to Kyuma (1995, citing Vijarnsorn 1992) the **peatland area** for Nakhon Si Thammarat is 12,300 ha and for Phatthalung 446 ha. From this the total peatland area in the KKL can be estimated to be a maximum of 12,746 ha. The area of 12,300 ha of peatlands for Nakhon Si Thammarat is also given in Nagano et al. (2013, citing Vijarnsorn 1996).

² The largest peat swamp forest area in Thailand is in Narathiwat Province (30,969.50 ha).

There has never been a detailed survey on the peatland area of KKL³. However, a detailed survey on the peat swamp forest area has been undertaken by Chukwamdee et al. in the 1990s.

Therefore, one can be more confident of the area estimates for peat swamp forests. Peat swamp forests, however, are not always synonymous with peatlands (defined in Thailand as 40 cm peat at surface). Furthermore, the peat swamp forest survey focused on the forest, and not on the soil. Thus, the peatland area may be smaller than the peat swamp forest area. On the other hand, there could be peatlands located outside of peat swamp forests, (for example grassland, plantations, or rice paddies) that would not have been covered by the study of Chukwamdee et al. (1999).

More recent estimates of the peat swamp forest area in KKL by the Fire Protection Station in the Pak Panang Basin (Regional Office 5, Nakhon Si Thammarat province) provide a different picture. According to these estimates published in 2014, peat swamp forests in the KKL covered an area of about 42,573 ha in 2013. The estimates are based on a study of the forest map of KKL, particularly looking at the *Melaleuca* forest area. Arriving at a better understanding of the current extent of peat swamp forests and peatlands in the KKL is going to be one of the important contributions of this project.

The KKL peat swamps encompass all connected peat swamp forest areas in the Pak Panang basin. There are eight freshwater peat swamp forests in the KKL that fall within the two NHAs: (1) Kuan Kreng (including Kuan Ki Sian), (2) Baan Nailum-Baan Kumpae, (3) Klong Yaun, (4) Pa Keaw, (5) Don Sai- Pa Klong, (6) Klong Kong, (7) Tha Chang Kham, and (8) Kao Pra Bath. (1) to (3) fall within the NHA Thale Noi, and (4) to (8) fall within NHA Bor Lor. In addition, there are other peat swamp forest areas within the KKL but outside the NHAs. There are also two peat swamp forest areas that are not considered to be within the KKL but are adjacent to it (see Map 1 which depicts in red community forests that are a target of the project; there are other community forests in the KKL but only those targeted by the project are shown). The first is the Suan Som Dej Chao Fa Chulabhorn specially named after Her Royal Highness Princess Chulabhorn. This is adjacent to the KKL but the Royal Forest Department does not consider it as part of the KKL peat swamps in order not to override the Princess's name. The second is the Kuan Ngoen community peat swamp forest that is a small patch not connected to any other peat swamp forest in the KKL. These two community managed peat swamp forests, although not considered officially a part of the KKL peat swamp forests, present good practice of people's participation in peat swamp forest management.

In addition to the peat swamp forests, the KKL is comprised of water bodies, agricultural lands, and community settlements. The table below provides a summary of the component parts of the KKL (designation type and area). The map that follows depicts the KKL, Sathingpra peninsula, the 2 NHAs, Reserved Forests, and 3 of the community forests that are proposed pilot areas for the project. There are other community forests within the KKL but these are not shown. Discussions with stakeholders during the project development phase have further reinforced the importance of considering the entire KKL – irrespective of current conservation status (areas designated as NHAs and those not designated) or land cover type (peat swamp forests, swamp grasslands, paddies, other areas) – as a single unit if the area is to be effectively conserved.

About 78 percent of the KKL has been designated as a national “Non-Hunting” protected area or NHA. Non-hunting areas are a type of national protected area category governed by the Department of National Parks, Wildlife, and Plant Conservation (DNP) of the Ministry of

³ PPG Team in discussion with Pisoot Vijarnsorn (May 2014).

Natural Resources and Environment (MONRE). NHAs are IUCN Category IV protected areas. These are the Thale Noi and Bor Lor NHAs. Thale Noi NHA was declared in 1975 and includes the Kuan Ki Sian Ramsar site and Peninsular Botanic Garden Phatthalung that are zones of strict protection. The Bor Lor NHA was more recently declared in 2013. The rest of the area in the KKL is National Reserved Forest (NRF) under the jurisdiction of the Royal Forest Department (RFD), areas under the Agricultural Land Reform Office (ALRO), as well as those with settled and unsettled land ownership claims from local communities (see table above).

Table 1. Kuan Kreng landscape

Designation type	Area (hectares)
Thale Noi NHA (including Kuan Ki Sian Ramsar site and Peninsular Botanic Garden Phatthalung) and buffer zone	48,000
Bor Lor NHA	10,016
Peat swamps in National Reserved Forest (these are primarily pockets of land surrounding Bor Lor and some additional areas)	4,357
Agricultural land reform areas	9,085
Public land/ forest land	2,905
TOTAL	74,363

Source: Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the DNP, 2014

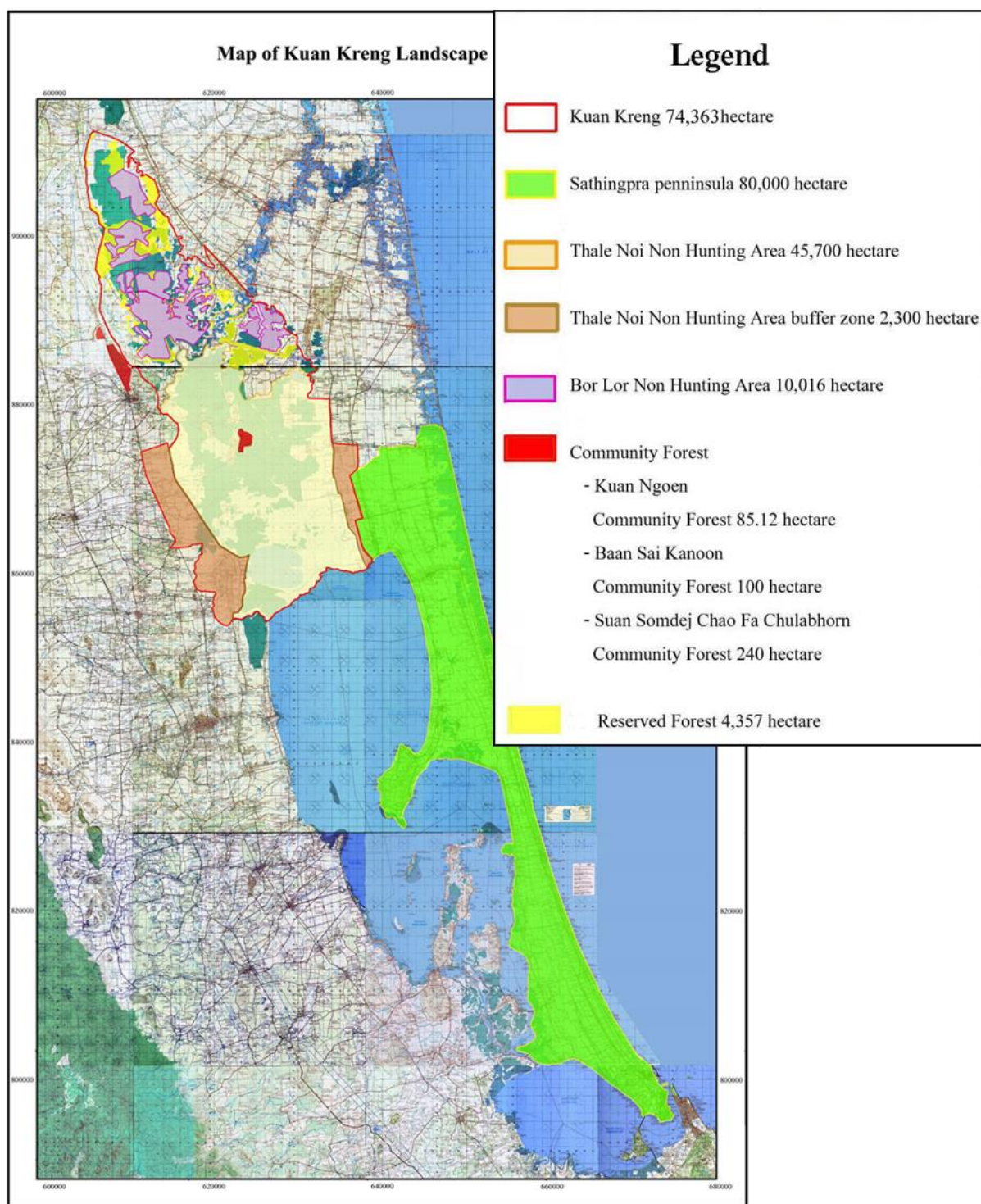
The levels of forest health in the KKL are extremely low. When considering swamp areas located in the Baan Nailum-Kumpae zone alone, between 65%-75% of those forests are degraded. Within the overall KKL, only 7% of the area contains rich peatland. The Kuan Ki Sian zone is considered to have the richest condition peatland with at least 85% untouched peatland areas. When the land area for all three areas is combined, 48% of the land area contains degraded forests, and 50% contains moderately degraded forests, leaving only 2% of the land area to be classified as being in good condition.⁴

Peat swamp forests in the KKL are fed by a large number of streams flowing through it and water inflows from neighboring zones. The swamp plays an essential role in maintaining the balance of the ecosystem by acting as a rainwater and runoff reservoir. They are a major source of water for ecosystems and human settlements in the Songkhla Lake Basin and Pak Panang Basin, supporting agricultural production while buffering from the impact of rains and floods. Additionally, it acts as a natural sediment filter before waters drain into Songkhla Lake.

Local communities gather fish, food, medicinal plants, and other non-timber forest products for handicraft production from the peat swamp forests. They also offer grazing areas.

The KKL represents a major store of carbon. There are areas with well-preserved peat and vegetation layers (predominantly secondary forest). Studies undertaken during the PPG estimate the carbon pool within the KKL to be 29 MtC (see Annex 3).

⁴ Thailand Institute of Scientific and Technological Research (TISTR). *Final Report of the Survey on the Status of Peat Swamps in Thailand*. Bangkok: ONEP, 2009.



Source: Adapted from Land Development Department, 2013

The KKL harbors important biodiversity including a number of globally threatened species. The landscape has 260 plant, 89 bird, 14 mammal and a number of key freshwater species, including the globally threatened Fishing Cat (*Prionailurus viverrinus*), and Smooth-coated Otter (*Lutrogale perspicillata*)⁵. It is home to dense forests of Cajuput trees. The swamp is also an enormous water reservoir that is home to a great variety of water flora species. Further details on the flora and fauna of the KKL, as well as information on land use are provided below.

1.2.1 Flora

260 species of flora from 198 genera and 95 families have been observed in the KKL including 10 families of ferns, 62 families of Dicotyledons and 23 families of Monocotyledons. There is only one species, *Terminalia citrina* (Gaertn.)Roxb. ex Fleming, identified as having rare status. Most plant species found here are from the following families:

- Cyperaceae family: *Eleocharis ochrostachys* Steud. and *Lepironia articulate*
- Myrtaceae family: *Eleocharis dulcis*
- Tree species: Those found are mostly *Melaleuca leucadendra*, *Melaleuca cajuputi*, *Syzygium gratum* (Wight) S.N. Mitra, *Alstonia macrophylla*, *Alstonia spathulata*, *Dolichandrone spathacea*, *Shirakiopsis indica* and *Mitragyna javanica*
- Aquatic plants: Those found are mostly *Hanguana malayana*, *Neptunia oleracea* and *Pandanus immerses*
- Ferns: Those found are mostly *Stenochlaena palustris* and *Lygodium microphyllum*

The dominant species in the area is *Melaleuca cajuputi*. After fire occurred in the area, this was the pioneer species in the succession of plant community recovering the area, transforming the peat swamp's plant communities. According to the local population, one of the native species that has been decreasing is the sago palm (*Metroxylon sagu*). This palm is one of the dominant species occurring in peat swamp forests, among other species. Sago palm is tolerant to low pH, high iron (Fe), aluminum (Al), and manganese (Mn) in the soil as well as heavy impervious clays. Traditionally, people in the area used sago for many years as a source of carbohydrates. The palm can also be used in different ways as a multi-purpose species in agroforestry. It has been reported that sago palm is one of the highest yielding crops in the world. Sago palm is being cut down and the land is being converted to cultivation of other agricultural crops, especially oil palm, which is not a native species. Sago palm plants assimilate carbon dioxide all year round. Thus, sago forests work as a carbon sink like other tropical rain forests. Sago palm plays an important role in the ecosystem by providing a good habitat and nursery for aquatic larvae, acting as a groundwater filter, and food bank that enhanced local food security. On the other hand, exotic mono-crop plantations such as oil palm or rubber plantations, which transform peat swamp forests to commercial agriculture, cannot provide ecosystem service like sago palm.

1.2.2 Fauna

152 different species of wildlife have been observed in the KKL, including 89 bird, 14 mammal, 32 reptile, and 17 amphibian species. Details on the abundance and conservation status of the wildlife based on the IUCN Red List of Threatened Species are in the tables below.

⁵ Thailand Institute of Scientific and Technological Research. *Final Report of the Survey on the Status of Peat Swamps in Thailand*. Bangkok: ONEP, 2009; and Sukmasuang, Ronglarp. *Report on the Effects of Forest Fires in Kuan Kreng Swamp on Wildlife in Nakhon Si Thammarat and Phatthalung Provinces*. Bangkok: Kasetsart University, 2013. Former reference was used for plant species and the latter for animal species.

Table 2. Amounts, abundance and conservation status of wildlife in Kuan Kreng landscape⁶

Type	Species number	Relative Abundance			Conservation Status (IUCN Red List 2013)			
		VC	C	UC	LC	NT	VU	EN
1. Wild Birds	89	7	27	55	89	3	-	
2. Mammals	14		6	8	14	-	1	1
3. Reptiles	28		7	21	22	-	6	1
4. Amphibians	17		8	9	15	-	-	-
Total amount	148	7	49	92	140	3	7	2

Notes: VC = Very common, UC = Uncommon, C = Common, LC = Least concern, NT = Near threatened, VU = Vulnerable, EN = Endangered. VU and EN categories are considered "globally threatened".

Table 3. Endangered, near threatened, and vulnerable species of Kuan Kreng

Status	Species information
Endangered (EN) species are:	<p>Yellow-headed Tortoise (<i>Indotestudo elongata</i>): The elongated tortoise is an endangered species, and is in severe decline across its natural range. In their natural habitat these tortoises browse a wide variety of plants. Likewise in captivity, they require a very wide range of foods, not just one type of vegetable. Their diet is principally a range of vegetables and edible leaves, however they also consume meat, snails, eggs and other food types. This serves to supplement their diet. Vegetables alone are not sufficiently varied. They also require a constant water source, for bathing and drinking. Being reptiles, which cannot control their body temperature internally, they require a varied area in which they can access both sun and shade. This allows them to move around and thus to regulate and maintain constant body temperature.</p> <p>The Fishing Cat (<i>Prionailurus viverrinus</i>) is listed as 'Endangered' on the IUCN Red List of Threatened Species. It is strongly associated with wetland habitat and frequently enters water to prey upon fish. This cat has been extirpated from much of its former range across Southeast Asia, and is now rarely encountered. The main threat to the Fishing Cat is the destruction and degradation of its wetland habitat due to urban encroachment, drainage for agriculture, pollution and logging. The depletion of fish stocks from over-fishing is likely to be a significant threat. The fishing cat is included in CITES Appendix II. It is protected by national legislation over most of its range. Hunting is prohibited.</p>
Vulnerable (VN) species, high risk of endangerment in the wild, are:	<p>Smooth-coated Otter (<i>Lutrogale perspicillata</i>) is essentially a resident of lowlands and floodplains. Major threats to its Asian population are loss of wetland habitats due to construction of large-scale hydroelectric projects, reclamation of wetlands for settlements and agriculture, reduction in prey biomass, poaching and contamination of waterways by pesticides. Wetlands and waterways are polluted by eutrophication and accumulation of persistent pesticides. Increased pesticide use is not only regarded as a major obstacle to the development of rice-fish culture, but also poses a danger to all predators feeding on aquatic prey in the area. It is vulnerable to drainage, disturbance, pollution, agricultural conversion, hunting and collection of eggs and nestlings from colonies. A combination of these factors has probably caused the decline.</p> <p>King Cobra (<i>Ophiophagus hannah</i>)^{8,7} Striped New Guinea Softshell Turtle (<i>Pelochelys bibroni</i>) Southeast Asian Box Turtle (<i>Cuora amboinensis</i>) Malayemys subtrijuga</p>

⁶ Sukmasuang, 2013; Thailand Institute of Scientific and Technological Research (TISTR), 2009; List of Species for the Ministry of Natural Resources and Environment.

⁷ Sookmasuang, 2013

⁸ The species is listed in CITES Appendix II

Status	Species information
	Siebenrockiella crassicolis Giant Asian Pond Turtle (<i>Heosemys grandis</i>)
Near threatened (NT) species are:	Black-headed Ibis (<i>Threskiornis melanocephalus</i>) Black-bellied Malkoha (<i>Phaenicophaeus diardi</i>) Painted Stork (<i>Mycteria leucocephala</i>)

1.2.3 Fish

36 species of fish from 15 genera have been identified in the KKL, including 8 species which are commonly eaten by villagers and sold in local markets. Processed fish products such as, dried fish, fermented fish and fish sauce, are also produced locally. The conservation status of fish species in the KKL is briefly described below.

Snakeskin Gourami (*Trichopodus pectoralis*) occurs in swamps and peatlands, and occasionally in running waters. It is considered to be of Least Concern at present. This species can be used as an indicator for water quality because it is well adapted in impounded and man-made water bodies, but does not tolerate polluted waters. Pollution in wetlands, infrastructure development and wetland clearance impact the species.

Notopterus notopterus is of least concern status, well adapted in fresh and brackish waters, and appears to thrive well in lentic waters. This fish can only be found in wild waters or in fattening ponds in which large fish are present. It lays eggs in small clumps on submerged vegetation. This fish needs to live in swamps and peatlands. The other fish species of least concern status found in Kuan Kreng are as follows: Snakehead Murrel (*Channa striata*), Yellow Catfish (*Mystus nemurus*), Rice swamp eel (*Monopterus albus*), and Hard-lipped Barb (*Osteochineus hasselti*). *Anabas testudineus* is another species found here but its status is considered data deficient.

There are 2 species on the list of “Near Threatened (NT)” species under the IUCN Red List of Threatened Species (Version 2014.1). The first is the Broadhead catfish (*Clarias macrocephalus*) that is assessed as Near Threatened at present due to the scale of decline in suitable habitat, the impacts of introduced species and the extensive population decline. The species is also threatened by aquaculture (through hybridization and competition) and by escaped hybrids. The second is the Least Rasbora (*Boraras urophthalmoides*) that is assessed as NT on the basis of inferred decline of Area of Occupancy (AOO). Population and habitat trends require monitoring.

There is also one species listed on the “Threatened in situ (TI)” list: the Malay Fighting Fish (*Betta imbellis*). This species has been found in lower parts of rivers and wetlands such as in swamps and peat areas. These areas are heavily impacted by habitat degradation and conversion to oil palm and rubber plantation. This species is commonly used across much of its range for fish food in aquaculture.

Beside these threatened species, the slender walking catfish (*Clarias nieuhofii*), which is reported as once being abundantly found in the swamp, has not been reported to be found any more and appears to be extinct. The species inhabits blackwater habitats (swamps, streams, rivers) associated with peat swamp forests. The water in such habitats is very soft, highly acidic (pH ~3-4), and heavily stained with tannins (hence the term “blackwater”). Even though it is assessed as Least Concern classification, local people indicate that it is extinct in the area. It should be noted that the habitat of this species (blackwater peat swamp forests) has undergone large scale destruction and degradation (Yule 2008 cited in IUCN Red List version 2014.1), and the effects of such massive habitat loss on the species should be further studied. One explanation for the

disappearance of the slender walking catfish is the reduction of Satiow trees⁹ (*Ganua motleyana*) whose seeds produce oil that is a primary food source for this fish.

1.2.4 Land use in the Kuan Kreng landscape

The KKL spans 17 sub-districts and 7 districts in Nakhon Si Thammarat, Phatthalung and Songkhla provinces. Population density and demands for economic use are relatively high. There are 152 villages inside and surrounding the KKL, with a total population of around 148,087 people (73,594 males and 74,727 females) and 31,856 households¹⁰. The population is primarily engaged in rice farming, rubber tree and oil palm planting, and some fishery and livestock activities. These activities take place over an approximate area of 22,000 ha of drained peat swamps in the KKL, but close to secondary, natural peat swamp forest tracts.

Data for parts of the KKL namely, the Kuan Kreng, Baan Nailum-Baan Kumpae, and Kuan Ki Sian peat swamps (TISTR, 2009), indicate that in these sections, most of the land (more than 30% of the watershed areas of the eastern coast of southern Thailand) is used for rice production. The next most common land use (nearly 20%) is planted forests, for example, rubber and palm oil plantations. This is followed by healthy and rehabilitated forests over 17% of the land area, 11% of the land is covered by fruit orchards (including orange, durian, and coconut trees), 6% of land area is classified as lowlands, while 5% of the land is swamp zones. The remainder of the land area is used for livestock grazing, residential zones, or contains water features.

Recent data from the Fire Protection Station in Pak Panang Basin (Regional Office 5, Nakhon Si Thammarat) from 2014 indicate that, over the last decade or so, the predominant change in land use patterns has been conversion to oil palm plantations (see table below and map below shows land use based on this recent data). With the introduction of large scale agriculture practices such as oil palm plantations, and the expansion of the housing area for communities and government offices, the ecosystem has changed. Most of the reservoirs have become stagnant and that has affected small tributaries and streams throughout the swamp. The central reservoirs have become more shallow due to sedimentation and land-filling to gain illegal lands and the subsequent growing of economic crops. After the natural water flows have been obstructed, man-made canals are dredged with high banks to protect farmlands and plantations from flooding¹¹.

Table 4. Land use change in Kuan Kreng landscape (2002-2013)

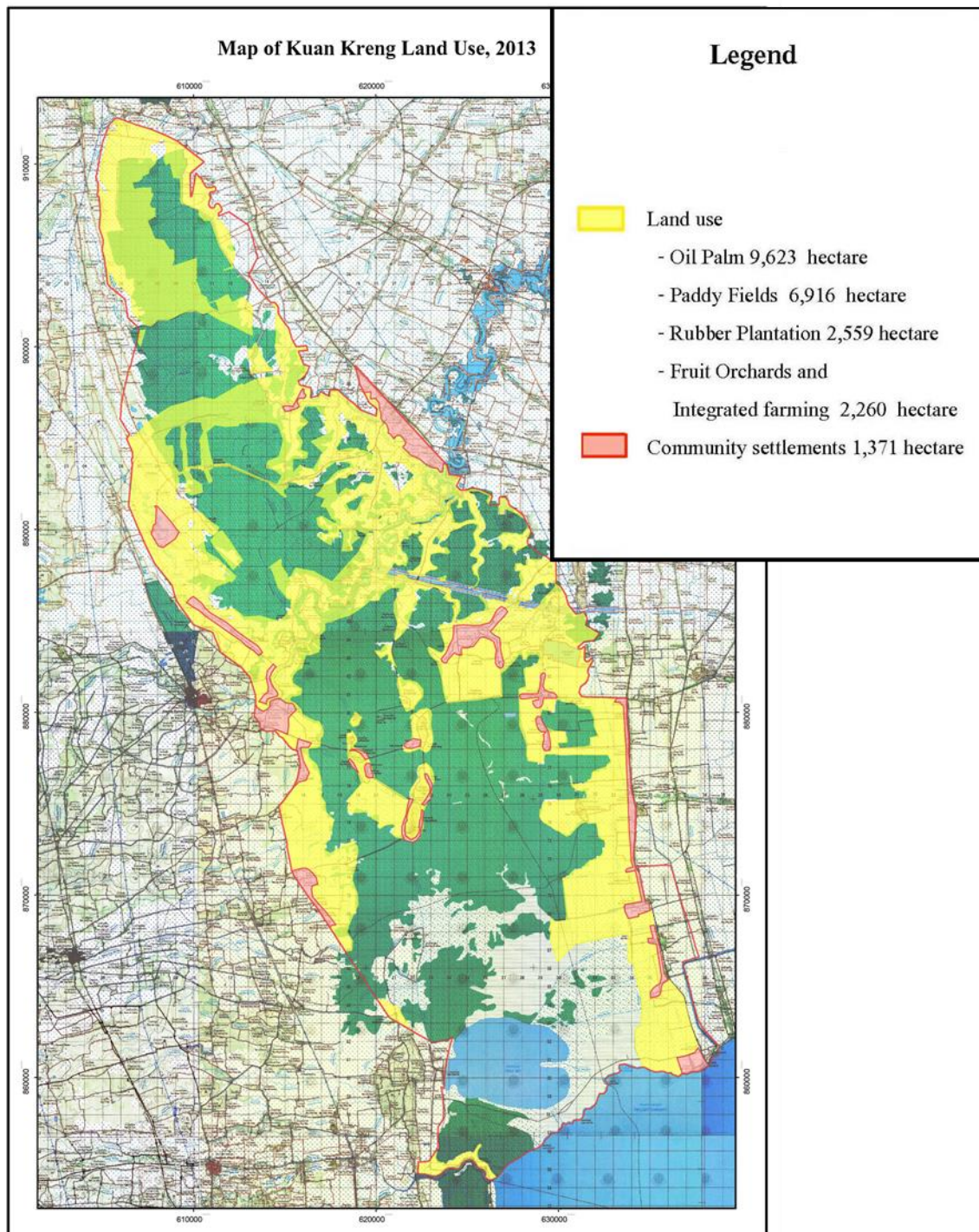
Land use type	Hectares (2002)	Hectares (2013)	% of total (2013)	Change from 2002 to 2013
Peat Swamps	49,690.49	42,572.93 ¹²	65%	-7,117.56
Oil Palm	2,200.48	9,622.82	15%	7,422.34
Paddy Fields	9,309.35	6,916.01	11%	-2,393.34
Rubber Plantation	1,892.33	2,559.44	4%	667.1
Fruit Orchards and Integrated farming	1,627.55	2,260.22	3%	632.67
Community settlements	1,043.29	1,370.71	2%	327.41

⁹ This species is not found in the list of flora species for the Kuan Kreng peat swamp.

¹⁰ TAO website, 2014

¹¹ Thailand Institute of Scientific and Technological Research. *Final Report of the Survey on the Status of Peat Swamps in Thailand*. Bangkok: ONEP, 2009. p. 17-26, 16-24 and 18-26

¹² As noted earlier in the document, these data indicate that the area of peat swamps in KKL (although reduced since 2002) are in the 40,000 ha range. Whereas, other published data from 2005 and earlier suggest peat swamp area in KKL (Nakhon Si Thammarat and Phatthalung Provinces) is in the 20,000 ha range. It was not possible to understand/ explain the difference during the PPG phase. Bringing greater clarification on this issue will be a key contribution of the project.



Source: Adapted from Land Development Department, 2013

1.3 Threats to the Kuan Kreng landscape and the related loss of carbon and biodiversity

In the beginning of the 20th century, the KKL was covered almost entirely by primary peat swamp forests¹³. After much of it was drained for economic use, the ecosystem was exposed first to storms (due to disrupted soil root zone capacities) and later to fires. During the 1950s almost 70% of the original primary tree vegetation, for example, *Eleiodoxa conferia*, *Ganua motleyana* and *Eugenia curtisii* was destroyed by storms, which was followed by a series of fires during periods of drought. During the fierce windstorms of 1962 and the heavy rains the following year, vast swaths of Cajuput trees were knocked down. After this, huge forest fires swept through the wetlands, including an intense three month long ground fire, especially in areas that were not often covered by water. Following these events, villagers collected the remaining felled trees for firewood and construction, and claimed the empty land for agricultural activities. Consequently, the primary peat swamp forest shrank, and even though some of the areas affected by storms and fires regenerated as secondary forest, they remain constantly under threat of further conversion and new fires.

By some estimates, about 65% of the KKL remains under constant threat of degradation from various threats¹⁴. The area of natural peatlands that harbor biodiversity and sequester carbon is being reduced due to a number of threats that are described below.

1.3.1 Encroachment of peat swamps by oil palm plantations

Peat swamp forests in Southeast Asia and Thailand have historically been drained and converted primarily to oil palm plantations. There is some conversion to rubber plantations but less so given that rubber plantations are not suitable to grow in peat swamp areas, preferring highland areas, while oil palm can be grown in peat swamps modified for that purpose. In the KKL alone, approximately 9,622.82 hectares have been converted to oil palm plantations¹⁵, both by large private investors and by small farmers.

After the 1962 windstorm that degraded large areas of peat forests, a lot of people encroached on the area for land invasion. The expansion of communities and increase in number of persons created a need for more land to be cleared for settlement and livelihood activities (agricultural activities including oil palm plantations, fishing, etc.). As per government policy, many NRF lands in and around KKL were divided into plots and transferred to the Agricultural Land Reform Office (ALRO) for redistribution. The government then needed to build canals to provide water and prevent further encroachment; however, these canals also drained away the natural wetlands in the central areas of the swamp. To address this issue, smaller check-dams were built, but these measures have only been able to slow down, not reverse, the adverse effects for the central wetlands.

Since 1987, lands in and around the KKL began to be sold at an accelerating pace, leading to more encroachment. These sales were usually facilitated by local brokers and influential persons including government officials, business owners, and local rice millers. These brokers would arrange for small adjacent plots to be consolidated as large plots and then sold to investors, while receiving a portion of the land or money as compensation for their services. Another method was

¹³ (1) TISTR 2009; (2) Interview with Mr. Charoen Maharaj, a representative from a community-based organization in Chian Yai District, Nakhon Si Thammarat Province, 27 February 2013.

¹⁴ TISTR, 2009.

¹⁵ Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the Department of National Parks and Wildlife Conservation (DNP), 2014

for local villagers to burn forests with the intention of selling the newly ‘degraded’ lands to outside investors for construction and large-scale palm plantations. In some of these cases, local villagers were hired for these tasks by local politicians and influential persons, or by outside political networks.¹⁶

No buffer zones have been established between oil palm plantations and remaining peat swamp forests, which produces a vicious cycle of peatland loss. The plantations’ drainage networks work as a constant draining effect on neighboring natural swamps, which continue to degrade as a result, and communities or investors find it easier to obtain permits to add new areas to their existing plantations by pointing out that these peatlands have degraded recently. Armed with permits, plantations further extend their drainage ditches that in effect initiate a new wave of degradation of additional peat swamps. In the driest seasons, the oil palm plantation owners use water from the drainage system for irrigation and that has a further draining effect on the neighboring peatlands.

Drainage for oil palm plantations has lowered the groundwater table to 20-70 cm below soil level, drying out the peatland and exposing peat to fires and mineralization. By conservative estimates of the authors of the IPCC 2013 Wetlands Supplement, CO₂ emissions from tropical peatlands drained for oil palm cultivation are 40.33 t CO₂-eq/ha/y (this is a rough, conservative estimate), as well as emissions of dissolved organic carbon through the drainage ditches.

In addition to the effect on GHG fluxes, the construction of numerous flood barriers, roads, canals, and other facilities associated with oil palm plantations results in the decrease of fish populations and lowers the biological diversity of the peat swamp forests. Many plant species have become threatened due to forest clearing through intentional fires. Continuous clearing of the forest is necessary to expand plantations. These fires have led to the disappearance of most of the naturally occurring organic matter. Most of the soil has become acidic, in which only few tree species, like the Cajuput Tree can thrive¹⁷.

The dredging of canals and landscaping in order to construct oil palm plantations, as well as the huge amounts of water inputs and intensive chemical fertilizer inputs required by the plantations are having large impacts on water levels and quality. These activities have also led to the emergence of shallow reservoirs. High earthen banks have been constructed along the canals to prevent flooding, but these also prevent fish from natural migration patterns during the monsoon season. Palm oil plantations have also caused a decrease in water and soil quality, which has affected other agricultural activities. According to a recent study¹⁸, high levels of ammonium, nitrogen, and phosphorus were present in the peat swamp during 2011.

1.3.2 Fires

Forest fires are the leading factor in wetland deterioration, both worldwide and in Thailand. Since much of the KKL has been drained, the area is extremely fire-prone because dry peat catches fire quickly. Fires can be unintentional or intentional such as fires set by encroachers to clear land, or burning by hunters to flush out prey. Deliberate man-made forest fires have become more common, as local villagers and outside investors use fires to clear the forest area

¹⁶ Pairin Ruikaw. *Dynamic of Peatswamp Utilization: Forest, Bird, Water to Oil Palm, Nakhon Si Thammarat*, 38-7, 2008.

¹⁷ Kuan Kreng Swamp Baseline Information Working Committee, Nakhon Si Thammarat Province (Working Group 2), year not provided; and Sukmasuang, 2013.

¹⁸ Neuangmujja et al., 2012

and claim barren land for planting trees and other agricultural activities, especially palm oil and rubber plantations¹⁹.

The result is devastating as they lead to large-scale peat fires, especially during the dry seasons (February to May). In 2010, in KKL alone, fires affected 3,200 hectares of peatlands. At present, the KKL is experiencing an increasing number and intensity of both surface and ground forest fires. Ground forest fires are especially destructive to the ecological health of wetlands, and these types of fires release vast amounts of carbon into the atmosphere. It is estimated that a wildfire on a drained tropical peatland results in a loss of a record 747.11 t of CO₂ per ha and of 9.21 t of CH₄ per ha (Page *et al.*, 2002; Ballhorn *et al.*, 2009; Christian *et al.*, 2003).

Furthermore, with the onset of climate change and greater amounts of carbon dioxide in the atmosphere, the amount and intensity of forest fires will only increase. Ecological systems, especially in wetland areas, will become more unbalanced as CO₂ levels and forest fires increase.

One of the main factors that has led to the increase in forest fires in KKL has been the decreasing water levels. Water levels have been decreasing due to a number of factors including: expansion of palm oil plantations and rice paddies in watershed areas; construction of high grounds for palm oil trees, which has led to greater runoff and less capacity for water retention during the monsoon season; dredging canals for irrigation purposes, which drains water out of the wetlands; and a lack of coordination and cooperation among relevant government agencies and officials.

Most recently, in August 2012, after a long period without any rainfall, the water level in the KKL dropped to a level of -0.2 meters. Soon after this, the largest forest fire in recent memory occurred, destroying 12,000 Rai (1,920 hectares) of forests in Nakhon Si Thammarat and Phatthalung provinces.²⁰

In order to most effectively prevent large scale forest fires like the one above from recurring, water management officials must ensure that wetland areas are covered with water during the dry season. To date, forest fire prevention and control in Thailand has had limited success, in spite of the government's efforts to establish Fire Prevention Units in each province, including in provinces containing wetlands.

1.3.3 Unsustainable use of peat swamps by local communities

This threat is of secondary importance and largely stems from low awareness of the value of peat swamps and lack of alternatives for “wet” use of these ecosystems. Currently, there are about 152 villages located within and adjacent to the KKL. The entire Kreng sub-district (Cha-uat District, Nakhon Si Thammarat Province) is located in the heart of the KKL (17,600 hectares), within the Thale Noi NHA. These communities reside within a government-administered protection zone.

The communities residing in and around the KKL have been using its natural resources to sustain themselves for many years. These natural resources include the Grey Sedge plant locally known as “krajood” (*Lepironia articulata*). Krajood is used to make traditional baskets, edible forest plants and wild fruits, trees for lumber and construction, natural grass areas for cows and water buffalo to graze in, and fish and other water species for food. The surrounding communities depend heavily on these resources for their continued survival.

¹⁹After using the newly cleared land for agriculture purposes, government supported irrigation development projects soon follow.

²⁰ Thai Post newspaper, 20 January 2009; <http://www.oknation.net/blog/print.php?id=828836>, October 2012

There are two main groups benefitting from the natural resources in the KKL – those who harvest the natural resources in a sustainable manner and in a rotational fashion, and those who do not use the natural resources in a sustainable manner. The first group consists of 40-50 honey gatherers, fisher folk, gatherers of krajood, and water buffalo herders. These persons are based in Kreng sub-district and nearby communities and rely on the natural resources of the peat swamps as both primary and secondary income sources, as well as for a local food source. Furthermore, about 80% of the community members weave baskets using krajood.

The second group consists of people who illegally gather the natural resources, including: businessmen who cut trees to sell to persons outside the communities; fishermen who use electricity or poisons to allow for easy harvesting of fish; and hunters who kill and sell animals that are protected. Sometimes, persons raising cows and water buffalos will burn the land in order to have new grass for their livestock to graze on during the dry season (February-May).

1.4 Root causes and barriers to addressing threats to the Kuan Kreng landscape

In order to reduce conversion and drainage pressures on peatlands from unsustainable land uses and to secure conservation and enhancement of carbon stocks, there needs to be a shift from the current unsustainable land use policies and practices to sustainable land and forest management that can be enforced overtime and adopted at a landscape level. This shift is impeded by a number of problems and barriers that are described below.

1.4.1 Barrier 1: Inadequate protection of primary and secondary natural peat swamps

Peatlands are represented in the national protected areas system (see table below). Of the total area of peatlands in Thailand (64,555 ha), approximately 30% is included in Thailand's protected areas system as part of National Parks, Wildlife Sanctuaries, Non-Hunting Areas, and Botanical Gardens. The rest of the peatlands, although not a part of the protected areas system, fall under the National Reserved Forests designation. Thus, in effect, all peatlands are under some form of protection on paper.²¹ However, these areas are not receiving effective protection owing to poor patrolling and conservation capacities of the protected area and forest administrators. In addition, management of these protected areas is not integrated with land use management in surrounding areas. Engagement of communities in co-management of peatlands has also been ad hoc, supported primarily by NGOs, and not expanded systematically to peatland protected areas. There is a need to find a balance between effective protection of the remaining healthy patches, rehabilitation of degraded areas, improving the water regime, and better land use management to enhance sustainable utilization.

Table 5. Protected areas that include peatland ecosystems

Name of protected area	Area in hectares
1. Ang-ka Laung, located in Doi Intanon National Park	5.44
2. Mae-Rampeung, Forest Park	299.2
3. Nong Thung-Thong NHA	4,333.12
4. NHA Thale Noi and NHA Bor Lor	55,715.84
5. Toh Dang, Wildlife Sanctuary	20,100
Total	80,453.6

Source: 1, 2, and 3 from Thailand Institute of Scientific and Technological Research (TISTR), 2009; 4, 5 from DNP, 2014.

²¹ DNP Regional Office 5 in Nakhon, Jirasak Chookwamdee, and Tanit Nuyim in discussion with UNDP-Thailand, September 2014.

The situation in the KKL, in terms of securing protection for peatlands, mirrors this national situation. The urgency for obtaining more effective protection of peatlands in the KKL is increasing since a part of the KKL is under a land reform scheme, the status of which remains unsettled, and this is attracting the interest of large-scale land developers. While villagers in the Thale Noi NHA seem in agreement with proposals to enhance protection, some are concerned that their access to the land would be restricted. Under the baseline scenario, the existing government program on protected areas does not have sufficient resources to enable more effective protection of peatlands in the KKL.

Protected zones in the KKL include (i) two NHAs (Thale Noi established in 1975 and Bor Lor established in 2013), which are administered by DNP under the 1992 Wildlife Protection Act; and (ii) the National Reserved Forest Zone, which is administered by the RFD under the National Reserved Forest Act of 1963. There is one Ramsar Site (Kuan Ki Sian) included within the Thale Noi NHA. In addition, there is a proposal for designating the Songkhla Lake Basin Environmental Protection Area (EPA). However, this only includes the Thale Noi NHA part of the Kuan Kreng landscape because this area falls within the Songkhla Lake Basin, whereas the upper part of Kuan Kreng is part of the Pak Panang Basin.

Limitations of Non-hunting Forest Areas (NHAs, IUCN Category IV). NHAs are designated by the Director-General of DNP according to the 1992 Wildlife Conservation and Protection Act. The first step in the process is to clearly demarcate the boundaries of the zone and the communities located within, including a list of households and sub-district location. The next step is to issue a map that indicates which areas can be utilized by community members and which areas cannot be encroached upon. Boundaries of the NHAs must be constructed, for example, by digging water channels, in order to protect the areas within. The person responsible for the demarcation of these boundaries is the Head of the NHA.

Thale Noi NHA covers an area that includes 50 villages located in 10 sub-districts, 5 districts and 3 provinces. These communities have land rights and land use rights over a total of 16,900 hectares (full land rights over 11,084.80 hectares and land occupation without full rights over 5,812.20 hectares), accounting for nearly 37% of the total area in the Thale Noi NHA. The Thale Noi NHA was declared under the 1960 Forest Conservation and Protection Act. This legislation only serves to protect wildlife, and does not provide any land use or rights provisions or recognition. Therefore, many of the areas declared to be non-hunting forest zones actually contained residents and communities at the time they were designated. Originally, there were few land disputes or conflicts in the non-hunting areas, but later, after the amended 1992 Wildlife Conservation and Preservation Act came into effect, land disputes increased, due to the fact that this Act contains clauses restricting land occupation and use in NHAs. Therefore, communities residing in these areas were now declared to be guilty of trespassing and subject to arrest and detention. This impasse can only be addressed through a dialogue with these stakeholders on land use planning, zoning and management as part of an overall strategy to manage peatlands in the KKL, a dialogue that is currently lacking.

In the Bor Lor NHA, which has very recently been established, there are no communities located within the boundaries, since the communities left the area after it was formally declared. Even though there is no community living within, the farmlands and plantations of communities are adjacent to the NHA and impact it. Bor Lor NHA has 227 hectares of land that overlaps with agricultural land reform areas and 160 hectares that overlap with undocumented plantation. This situation of communities residing within and near the NHAs makes it particularly challenging to

balance conservation needs with pressures for conversion of peatlands to oil palm production or small scale farming. Similar to Thale Noi NHA, a dialogue with stakeholders on land use planning and management to prevent further peatland degradation is absent.

Limitations of National Reserved Forest Zones. The KKL has areas designated as National Reserved Forest (NRF) zones. Only 4,357 hectares remain as NRF under the Royal Forest Department (RFD) with the rest being considered degraded forests and being transferred to the Agricultural Land Reform Office, Ministry of Agriculture and Agricultural Cooperatives. NRF areas provide the least amount of environmental protection among all the protected forest classifications. The administrative responsibility for the reserved forest is under the Provincial Environmental Office, which lacks adequate manpower and resources to enforce the regulations, resulting in frequent violations of reserve forest regulations. The agricultural land reform areas cover an area of about 9,085 hectares.

Ramsar Site designation not realized. The other means for elevating the conservation importance of an area is through designation as a Ramsar Site²². In the KKL there is one existing Ramsar Site – Kuan Ki Sian of the Thale Noi Non-Hunting Area Wetlands that was established in 1998. It is possible to establish Ramsar Sites in both NHAs and NRFs. Designation as a Ramsar Site is beneficial for local communities as a tool to help them protect their rights. It also allows for greater dissemination of knowledge and raising public awareness, especially during International Wetlands Day (February 2nd). Furthermore, Ramsar Site status will mean that a provincial-level committee will be established to look after the site.

In Thailand, 116 sites have been identified and listed on national and international registers. Of these, currently there are 14 declared Ramsar Sites that include wetland zones (including Kuan Ki Sian from the KKL that was designated in 1998). Other peat swamps in the KKL appear on this list but have not yet been designated as Ramsar Sites. There are 3 areas in the KKL that could be designated as such according to the Cabinet Decree of November 3, 2009. These are the Thale Noi NHA, the Bor Lor NHA, and the Peninsular Botanic Gardens Phatthalung.

Thailand's Ramsar Site locations are officially designated via a Cabinet Decree. For example, on August 1, 2000 and May 3, 2009 Ramsar Sites were officially proclaimed nationally and internationally with the establishment of a wetlands management subcommittee consisting of academics and government officials under the National Environmental Committee. Therefore, it should not be difficult to add the KKL to this existing list and subcommittee mechanism. The guidelines for establishing a Ramsar Site are listed below:

- Setting up a Provincial Land Administration Committee with the Governor as the Head and relevant departments as committee members.
- An environmental impact study must be conducted prior to any changes to or construction on the land.
- A clear plan must be developed and all information must be reviewed.
- There will be continuous follow-up and checking on the progress.

The list of Thailand's potential Ramsar sites has been submitted for consideration to an academic committee (under the National Environmental Board). The next step will be to receive approval

²² Thailand became the 110th member to sign onto the Ramsar Convention on September 13th, 1998. The Office of Natural Resource and Environmental Policy and Planning (ONEP) under MONRE is the National Focal Point responsible for the implementation of the convention's guidelines.

from the cabinet for Ramsar Site declaration²³. ONEP has been mandated to produce the information sheet about wetland areas. This sheet needs to be compiled within one year and must include data about forest and wildlife ecology, biodiversity, and a detailed map. The final step is to receive feedback and approval from the local authorities, which includes the provincial governors.

1.4.2 Barrier 2: Technologies to avoid peatland degradation are not available and there are major gaps in knowledge of carbon value of peatlands

International research on co-existence of peatlands with economic use areas has demonstrated the need to put in place certain hydrotechnical measures that separate areas where drainage occurs from the surrounding landscape, thus eliminating or minimizing the cycle of draining effects and resulting fires. However, in the KKL a clear understanding of the processes controlling the water level at the project sites is lacking. Rivers and canals are maintained and regulated by the national Irrigation Department, but the regulation does not usually meet the requirements of peat swamp forests conservation. The expertise and resources of the baseline program run by the Irrigation Department (mentioned in the Baseline sub-section below) is unlikely to be sufficient to take into account the full complexity of the hydrology of KKL and design a system that would uniformly rewet all dry peatland areas that are most prone to fires. Furthermore, there is no cooperation between the Irrigation Department and the local stakeholders. Local NGOs have implemented ad hoc restoration projects, which can be effective on a small scale. However, these projects have not used research on calibrating water tables with sluices and dykes. In many cases, NGOs have used sandbags as drain blocks, instead of regulated sluices. The expertise to design and implement solutions of the complexity that Kuan Kreng requires has not yet been available in Thailand.

Further to this, the lack of precise data on carbon fluxes from tropical peatlands remains one of the most significant international knowledge gaps recognized by the IPCC. This conclusion came from the process of preparation of the 2013 IPCC Wetlands Supplement. There is very little data on GHG fluxes in tropical peatlands overall. There is limited Thailand-specific data on fluxes, all from Narathiwat. PPG studies have helped clarify this gap. Annex 2 gives an overview of the knowledge on CO₂, CH₄, N₂O and DOC emissions from Bacho and To Daeng, and draws conclusions for KKL. Lack of data makes it hard to make strong arguments to government decision makers and to communities as to why peatlands conservation is important from the climate change perspective.

1.4.3 Barrier 3: Inadequate and unclear land use standards and policies specifically related to peat swamps

Being fragile ecosystems due to their dependence on water table fluctuations, peat swamps require clear standards on the types of resource use allowed, so that the carrying capacity of the ecosystem is maintained. While Thailand has developed a National Wetlands Action Plan as part of its Ramsar Strategy, it does not include specific standards and enforcement mechanisms for sustainable use of peat swamps. This lack of clear standards on sustainable peat swamp use leads to a number of problems, most notably the following:

- The expansion of oil palm plantations – a key threat – has been the result of a vacuum in national policies on sustainable use of peatlands. Plans for establishing oil palm

²³ This committee was established on November 3rd, 2009 to monitor Ramsar sites and report to the Conference of the Contracting Parties (COPs) every four years.

plantations are not required to go through an Environmental Impact Assessment. Hence, there is no requirement for oil palm investors to establish buffer zones or embankments to curb the obvious draining effect on surrounding peatlands. Oil palm plantations in peat swamp areas require modification of the land in ways that cause water drainage; the best option is to zone peat swamp areas for no oil palm plantations.

- Similarly, there have been inconsistencies in policies on community forest management. How community forests can be established and managed in a way that does not lead to peatland degradation are issues that have not been clarified nor codified. Local communities must participate in and contribute to development of rules on community forest use and they must understand the long term benefits. These aspects of community involvement and education have not been properly addressed.
- Conflicts and misunderstandings prevail between local communities and state officials regarding the use of peat swamps by communities that were already residing within areas that are now declared as conservation zones. When the Thale Noi NHA was established in 1975, there was no eviction of the communities residing within the boundaries (a non-hunting zone only protects against hunting of animals, and no other issues)²⁴. When new regulations have been adopted for the Thale Noi NHA, it has caused great conflict with those communities already residing in the area, and has led to less cooperation between community members and government officials. According to the Cabinet Decree of June 30, 1998, there needs to be a survey of communities that existed in conservation zones before these zones were formally established. However, the decree does not clearly state the procedures that need to be followed and the rights that need to be recognized for these communities. This has led to an inability to enforce policies at the local level.

There are many overlapping and conflicting rules, regulations and policies for the different land and forest classifications in the KKL²⁵. This has led to great confusion, and has caused land tenure and land use problems, as illustrated in the points below:

- According to the Agricultural Land Reform policy, persons receiving lands from the Agricultural Land Reform Office can use these lands for agricultural activities, including palm oil and rubber plantations. In order to grow these types of trees, drainage canals are dug and water then flows to other neighboring zones, including non-hunting and reserved forest zones, which causes difficulties for water and land management in these areas.
- Misunderstanding among government officials that peatlands are wasted or useless areas that need to be drained and developed in order to be more useful and productive for society prevail. These officers fail to see or disregard the many valuable ecological benefits of these wetlands, especially the ability to serve as a carbon sink. Officers think they are providing a necessary and useful service to society by issuing ALRO land titles (Sor Por Kor 4-01) to allow lands to be changed into agricultural plots.
- Agricultural training and extension work in the KKL encourages mono-cropping, mostly palm oil plantations, which are harmful to the ecological health of the peat swamps.

²⁴ In the case of NHA Bor Lor, communities residing within moved out of the area when the NHA was designated as such.

²⁵ The classifications being: (i) Non-Hunting areas, (ii) Land Reform areas, (iii) Reserved Forest Land, and (iv) Residential and Agricultural Zones.

- The development of canal draining systems has led to a decrease of water levels in the peat swamp, and, therefore, a large increase in the number and size of forest fires that have been difficult to maintain or manage.

1.5 Baseline activities/ programs and scenario without GEF support

Several baseline programs are addressing the threats and barriers described above, and hence serve as a foundation for this UNDP-GEF project. However, under the business-as-usual scenario, they will not be sufficient to afford full protection for peat swamps in the KKL, nor to demonstrate more sustainable management. These are briefly described below, alongside their business-as-usual scenarios.

1.5.1 Protected area management

MONRE spends about US\$ 44 million annually on nature conservation activities, with the allocation being primarily for covering recurrent activities of protected area administrations and partly for equipment renovation. However, the total budget for protected areas in peat swamp forests is only a small fraction of this – approximately US\$1.5 million annually. The baseline program also includes recent activities to declare the Songkhla Lake basin EPA. Under the business-as-usual scenario, funding available under this baseline program will not be sufficient to provide more effective protection in the KKL. Zoning of the KKL will not take place, and as such no integration of key conservation areas in wider landscapes will happen. Further degradation of peat swamp forests in KKL will continue due to encroachment and resulting peat mineralization and fires.

Under the business-as-usual scenario, other than the two NHAs in the KKL, the remaining land area – consisting of NRFs, agricultural land reform areas, public land, and residential zones – will not receive PA status and will not be managed as a unit in ways that take peatland conservation into account, and this will continue to lead to the following conservation problems:

- *The Bor Lor NHA contains zones that are not connected to each other.* This has caused water management issues, as the areas between the Bor Lor NHA can be used for water draining projects. The loss of water from the wetlands has led to an increase of forest fires (due to the high levels of organic matter from dense plant and forest growth) and an inability to extinguish them due to the lack of water.
- *Lack of knowledge about good wetland land management techniques.* Activities conducted by government officers include digging trenches to demarcate land and as firebreaks. When digging these trenches, there is no consideration of water management issues. Likewise, when planning activities, there isn't any consideration of greenhouse gas emissions. The government officers must spend a great deal of time and resources to prevent encroachment and control forest fires, which leaves them with little time to learn about proper water management systems and techniques.
- *Obstacles to establishing conservation zones in lands which are not yet officially protected areas.* According to the Environmental Protection Act of 1992, there are standards and guidelines for environmental well-being of lands that have not yet been officially declared as protected zones. The Office of Urban Environment and Area Planning (UEAP), which is under ONEP, was given the responsibility for ensuring this Act is implemented according to the MONRE order. Bureaucratic delays in gaining legal environmental protection is one part of the problem. The other part is gaining the support of local communities who will have to surrender some rights when conservation zones

are established. Through demonstration activities at pilot sites it is important to encourage the participation of communities in the process, help them understand the policy on property rights and natural resource management, and demonstrate better security and other benefits through sustainable peat swamp use.

1.5.2 Rewetting to avoid fires on peatlands

In order to rehabilitate the wetlands and reduce vulnerability to fires, one of the most critical issues is maintaining both below ground and surface water levels throughout the year. This will protect the wetlands against destructive forest fires. The minimal water level necessary to keep ecological health is -0.20 meters. If water management and control structures are constructed, the water levels could be safely maintained at +0.30 to 0.50 meters. If the water level is maintained at these levels, during the dry season, when water levels drop an average of 1 cm/ day, there would still be surface water for 2-3 months until the level declines to -0.20 meters.

Currently, water level management in the KKL depends on a network of canals, reservoirs, and gates that covers nearly the entire area, including: Wipach Water Gate, Klong Kong Water Gate, Pak Panang Reservoir, and Klong Chauad-Phraek Muang Water Gate. The network is managed by the Office of the Special Committee for Coordination with Royal Initiative. This network controls water flow into the Gulf of Thailand. It also controls water flow from the Huay Nam Sai Reservoir into the river. These canals and reservoirs have prevented groundwater levels from drying up completely, but the successful method to maintaining water levels is the construction of small earthen dams to slow down water flow rates.

Since 2013, water channels 5 meters wide and 2 meters deep have been dredged at a cost of 200,000 Baht/ kilometer. Currently in Bor Lor NHA, 50 kilometers of a planned 200 kilometers of water channels have already been dredged.

In 2013, after a series of large-scale fires in previous years²⁶, DNP and the Royally-Initiated Pak Panang River Basin Development project launched consultations with the Irrigation Department of the Ministry of Agriculture and Agricultural Cooperatives (MOAC) to study the water table in Kuan Kreng to avoid fires. The focus is on the upper zone of KKL and water management for the Cha-uat River. The estimated budget of this proposed program is USD 200,000 for an initial study of the water regime. This study is expected to update available information that DNP collected 20 years ago. The water regime study is being conducted by Prince of Songkhla University and is expected to be complete in 2015.

Under the business-as-usual scenario, the expertise and resources of this baseline study is unlikely to be sufficient to progress beyond a water regime study to design a system that would uniformly rewet all dry peatland areas most prone to fires. Based on historical dynamics of peatland loss in Thailand, most of these areas, but conservatively at least 25% of the remaining secondary, natural wet peat swamp areas in the KKL, are going to be lost to drainage and fires in the next 6 years. With the support of this UNDP-GEF project, international expertise would be made available to national specialists in designing a truly effective rewetting plan that would stop peat oxidization and help avoid fires.

²⁶ The irrigation system created by the RID for agricultural purpose led to drainage of peat swamps and forest fires.

1.5.3 Local sustainable development programs

Sub-district level government units (referred to as Tambon²⁷ Administrative Offices or TAOs) support natural resource and environmental management works related to peat swamp conservation and rehabilitation. Activities include conservation camps for local youths, establishment of community volunteer groups for prevention of wildfires, establishment of small areas for fish conservation, establishment of community forests, and efforts to raise awareness on nature conservation through the curriculum in local schools and through other means.

For the three sub-districts that are pilot areas for this project namely, Baan Tul, Cha-uat, and Kreng sub-districts (in Cha-uat District of Nakhon Si Thammarat province), the TAOs have a 3 year development plan (see table below). This UNDP-GEF project will integrate project activities with the TAO development plans, especially water management, community forest management, and land use zoning and management activities.

Table 6. Allocations from TAO Development Plans to sustainable peat swamp use

TAO	Amount (USD)	Comments
Kreng	93,750	11 % of the total budget in the Local Development Plan (2014- 2016)
Cha-uat	122,031.25	1.8% of the total budget in the Local Development Plan (2012-2014)
Baan Tul	889,250	5.7% of the total budget in the Local Development Plan (2014-2016)
Total	1,105,031.25	

Notes: (1) @32 THB = 1 USD; (2) Baan Tul's budget is quite big in terms of amount, as it is a big TAO and also receives some additional support from Provincial Administrative Organization (PAO) for peat swamp conservation.

Under the auspices of the 3 year Development Plan, the communities in Baan Tul have established and conserved the 564 Rai (90 Hectare) “Kuan Ngoen” Community Forest since 1989. They refuse to allow state officials to issue private land holding certificates for this area and have received 100,000 Baht from the Sub-district Administration Organization to dig canals, which serve as barriers against encroachment, help rewet peat swamps, and prevent forest fires. They also receive a budget from district forestry officials to maintain and rehabilitate swamp forests in this area.

Cha-uat Sub-district has conserved the wetland areas in the “Princess Chulabhorn Garden”, which covers 1,500 Rai (240 Hectares), since 1988-1989. The establishment of this area required a great deal of coordination and cooperation among local community members, and resulted in the registration of the community forest with the RFD in 1999. Community members have dug water channels to demarcate the community lands, as well as to protect against forest fires and encroachment. They have also developed sustainable forest use regulations, which have resulted in protection against fires and encroachment, as well as providing income-generation opportunities for community members.

One of the community forestry groups in the KKL has established a committee to manage water resources. This group has drawn up local water management regulations that incorporate the diverse needs of the ecosystem and the communities residing in them. Activities conducted by this group have included: dredging water channels; collecting garbage in watershed areas; and checking water quality levels.

²⁷ Tambon is Thai for sub-district; district is *amphoe* and province is *changwat*.

Another initiative in the baseline that aims to improve sustainable local livelihoods is under the Royally-Initiated Pak Panang River Basin Development Project²⁸, but the scope does not encompass the KKL. Improved livelihoods among the communities residing in these areas is to be realized through the implementation of two master plans. The first of these master plans is the 2007-2016 Environmental Development Master Plan, which contains four strategies: Conservation and Rehabilitation of Watershed Ecology; Sustainable and Holistic Use of Land and Water Resources; Pollution Prevention and Control; and Participation among all Sectors and Actors. The second is the 2013-2016 Livelihood Development and Income Generation Master Plan, which consists of four strategies: Zonal Development to increase security; Agricultural Security; Build and Disseminate Successful Livelihood Models; and Increasing Efficiency of Administration and Management. Six land area classifications were identified: aquatic animal raising coastal areas; rice production for trade areas; palm oil areas; rice growing for consumption areas; fruit orchard and rubber tree areas; and forest conservation and rehabilitation areas.

Under the business-as-usual scenario, these local efforts at promoting sustainable use of peat swamp resources will remain ad hoc, disparate efforts. They will not be developed and implemented as part of a comprehensive landscape approach to conservation and sustainable use of the KKL. These programs also would not be able to influence policies for peatland use and conservation at the national level.

²⁸ This is a royal project initiative implemented during 1995-2004 to provide increased irrigation and to protect against brackish water and natural disasters.

2. STRATEGY

2.1. Rationale and summary of GEF alternative

The long-term solution sought is to change the trajectory of the baseline approaches in order to facilitate a transformative shift from unsustainable to sustainable and integrated use of peat swamps in Thailand. The project strategy is to address the three barriers described above through incremental outcomes organized into three components: the first component focusing on improving effective protection of remaining natural peat swamp forests in the second-largest peat swamp landscape of Thailand; the second one helping to implement innovative approaches to avoid drainage and restore peat swamps; and the third component helping to improve national strategies for land use in peat swamps. In doing so it will influence the production practices employed by local economic actors and will support measures to avoid GHG emissions from peat degradation and fires, and demonstrate approaches to increase sequestration through afforestation. This would result in global benefits in the climate change, biodiversity and SFM focal areas, both in the short and long term, as described in the table below.

Table 7. Summary of global environmental benefits

State of ecosystems under baseline	Summary of GEF incremental interventions	Global benefits
Protection status of peatlands in KKL		
Only 2 NHAs in KKL; these are not effectively managed because land uses detrimental to maintaining healthy peat swamps continue within boundaries; areas of the KKL that fall outside NHAs also afflicted by land uses that lead to further degradation of peat swamps.	<p>Increase the legally protection status of peat swamp areas in the two landscapes, combining multiple layers of protection approaches</p> <p>Demonstration of how to align sub-district land use plan with EPA zoning</p> <p>Community Forestry Management and livelihoods support based on use of peat swamps in wet state</p> <p>Associated capacity building</p>	<p>Biodiversity:</p> <p>Improvements in Ecosystem Health Index at 2 NHAs</p> <p>Sustainable Forest Management:</p> <p>Good management practices demonstrated at 1,995 ha of community peat swamp forests in KKL</p>
Condition of peatlands affected by drainage and fires in KKL		
Poor understanding of hydrology of KKL and limited experience with maintaining water levels to prevent peat mineralization and fires	<p>Comprehensive study of peat swamp hydrology at pilot sites within KKL</p> <p>Design and implementation of hydrotechnical measures to maintain wet conditions</p> <p>Reforestation with native tree species at pilot sites</p> <p>Design and implementation of carbon flux monitoring system</p>	<p>Climate Change:</p> <p>Emissions reduction (avoided emissions and sequestration) at pilot sites of 834,000 tCO₂-eq (Annex 4)</p> <p>Sustainable Forest Management:</p> <p>Enhanced institutional capacity to account for GHG emission reduction and increase in carbon stocks</p>
National policies governing land and resource use related to peatlands		
Government stakeholders view peat swamps as wastelands that need to be drained	Cross-sectoral working group engaged in discussions on national policy and strategy on peat swamp use	<p>Biodiversity, SFM, Climate Change:</p> <p>SFM principles integrated in NSP</p> <p>Peat swamp biodiversity conservation principles integrated in NSP</p>

State of ecosystems under baseline	Summary of GEF incremental interventions	Global benefits
and developed to be of value	Economic valuation of ecosystem services of KKL peat swamps Criteria for evaluating full ecosystem values of peat swamps Full inventory of peat swamps in Thailand National Strategy for peat swamps (NSP) that provides recommendations on use of Thailand's peat swamps and standards for each use	Good management practices in LULUCF integrated in NSP Principle of restoration and enhancement of carbon stocks in peat swamps integrated in NSP and elevated to national agenda

2.2 Project consistency with GEF focal area strategies

The project will generate multiple global environmental benefits by demonstrating improved conservation and sustainable management of peat swamps and strengthening national strategies for peatland management and use. Under the climate change focal area, the project will generate benefits by avoiding degradation of and restoring peat swamp forests, which will result in avoidance of GHG emissions and carbon sequestration. These project benefits are in line with the expected outcomes of GEF CC SO-5 (*Restoration and enhancement of carbon stocks in forests and non-forest lands, including peatlands*). The GEF's CCM tracking tool has been completed to monitor these benefits.

The project generates benefits under the biodiversity focal area insofar as it will improve the protected area status of peat swamps in the KKL as well as improve management effectiveness. Thus, the protected area status of the KKL will improve from the current 2 NHAs to a wider area that encompasses the entire KKL under the increasing of legally protection status, developing a management plan and zoning for the KKL, the project will be able to not only improve conservation effectiveness within the two already existing NHAs but also ensure that land uses outside these NHAs are better aligned with conservation of peat swamps by creating sustainable use zones around key conservation sites. This, in turn, will help integrate the protected areas in the wider landscape. Increasing legally protected status such as EPA designation, expanding NHA and stipulated local regulations is complementary to NHA status in that it enables a landscape approach to management of protected areas and the outlying areas, strengthening the protection of the core areas, while putting in place clearer rules for sustainable use as well as livelihoods support. This approach is in line with GEF BD-1 (Improving management of existing PAs and expanding protection of under-represented ecosystems within the PA system).

Under the GEF's Sustainable Forest Management focal area, the project will develop a model for the sustainable management of peat swamp forests as "community forests" and provide incentives to communities to use peat swamp forest ecosystems in their wet state, without draining them. In addition, under the second component, the project will set up a carbon monitoring system which addresses multiple international and local gaps in understanding the true value of peat swamp forests.

2.3 Project consistency with national strategies and plans or reports and assessments under relevant conventions

This project is in line with Thailand's *Strategic Plan on Climate Change (SPCC 2008-2012)*. Component 2 of the project pilots hydrotechnical peatland rewetting measures for GHG

mitigation which speaks to SPCC Strategy I (Protect, conserve and add values to natural resource base, and protect, conserve and improve environmental quality and the quality of living from climate change impacts; promote activities such as water and forest conservation and restoration, infrastructure improvement and land use change to reduce vulnerabilities in hot spot areas), and Strategy 2 (Promote greenhouse gas mitigation activities based on sustainable development which focuses on increased carbon sinks; and sustainable forest conservation, afforestation and reforestation to increase carbon sinks). The project tackles some of the key barriers mentioned in the SPCC, namely lack of scientific knowledge base on climate change to support policy formulation and evaluation, and decision making; lack of public awareness; lack of capacity among relevant agencies; and lack of clear direction and continuity towards international cooperation. The role of ecosystems in carbon storage in Thailand has been also noted in Thailand's *Second National Communication (2010)*, which noted the importance of forestry as a win-win policy in Thailand for GHG emission reduction and for other ecosystem services and hence the need to promote such an approach in the country.

Thailand's National Report on the Implementation of the Convention on Biological Diversity (2009) has noted the diversity of peatland ecosystems in Thailand, including those in the lowlands of Southern Thailand. Thailand has 14 declared Ramsar Sites that include wetland zones, while the National Biodiversity Strategy and Action Plan has a goal to have at least 35% of wetland areas (most of which are peat swamps) "restored and conserved". By obtaining EPA status for the entire KKL and promoting a landscape-level management and zoning approach that enhances conservation within existing NHAs in the KKL and aligns land uses outside the NHAs with conservation and sustainable use of peat swamps, this project contributes in a significant manner to Thailand reaching national objectives for restoring and conserving peatlands. The project will also directly support the achievement of the Aichi Targets' Strategic Goal B (Reduce the direct pressures on biodiversity and promote sustainable use) and particularly Target 5 (By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced); and Strategic Goal D (Enhance the benefits to all from biodiversity and ecosystem services) and particularly Target 15 (By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including prevention of degradation of natural ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification).

The importance of peatlands as wetlands is also being recognized in Thailand. In this respect, the project will support the implementation of Thailand's Action Plan (2009-2014) for Wetland Conservation which focuses on five goals: the utilization of wetlands; wetlands with significant international importance; international cooperation; institutional performance and efficiency; and full membership of the Ramsar Convention by 2014. A Cabinet Resolution from a meeting on November 3, 2009 approved several measures for wetlands conservation, including the principles of protection of ecosystem services and rehabilitation of degraded wetlands.

The project will also support implementation of the forthcoming Action Plan of Peatland Management (2014-2020), which is in the process of being endorsed by the NEB. The action plan focuses on zoning, land use plans, fire protection and management of water level, community participation in peatland conservation and sustainable use, and improving knowledge, understanding, and awareness of climate change mitigation and adaptation. By developing a new National Strategy for Peat swamps (Component 3) this project will extend

current efforts under the Thailand Action Plan and complement it with missing conservation standards and inventories.

In addition, Thailand's 5th National Biodiversity Strategy and Action Plan (NBSAP 2014-2017), which is in the process of endorsement by the Cabinet, also highlights actions to improve participatory management of peatlands as one of the priorities towards achieving the Aichi Targets. The project's work on enhancing community participation in peat swamp conservation and sustainable use in the KKL is in line with this.

2.4 Project objective, outcomes and outputs

The objective of the project is to conserve and restore peatlands to increase their capacities to act as carbon sinks, as habitats for globally important species, and as sources of ecosystem services for improved livelihoods. This objective will be realized through the following outcomes and outputs.

Outcome 1: Expanding protection of high conservation value peat swamp forests and demonstrating their sustainable use within the broader landscape.

This outcome focuses on: (i) strengthening protection measures to create the link between the protected areas and non-protected areas in KKL (ii) improving the management effectiveness of the protected areas. The project will deploy a landscape approach for more integrated management of the KKL, with some parts being under strict protection and others under a systematic management plan for sustainable use. In addition, this outcome will build the capacity of responsible authorities to monitor and manage land use, water levels, and fires in the KKL. The government program on protected area management will constitute the baseline for this project outcome, and will contribute USD 1.2 million for aspects such as the feasibility studies and regular PA staff support.

Output 1.1: Improve Protection Status of the Kuan Kreng Landscape

The project will facilitate community consultation and agreement to improve the protection status of the Kuan Kreng Landscape by project end.

In the table below, approximately 7,262 ha is largely peat swamp forests (i.e. NRF and Public Land/forest land). The rest is under ALRO, which is mainly plantation, agriculture, and rice paddies. All of these areas need to be taken into consideration if effective conservation of the remaining peat swamp area in the KKL is to be realized. Bor Lor NHA is in fact an attempt to bring under protection the patches of remaining peat swamps forests (12-13 patches) and the NHA authority is interested in linking these islands of peat swamp forests together under a common management and zoning plan that includes reforestation, rewetting, and better protection.

Table 8. Protection Status in the Kuan Kreng landscape by project end

	Name of Area	Area (ha)
Songkhla Lake Basin Landscape	Songkhla Lake Basin Landscape	128,000 ²⁹
	Sathingpra Peninsula (80,000 ha)	
	Thale Noi NHA (45,700 ha) and Thale Noi buffer zone (2,300 ha)	
Kuan Kreng Landscape	Bor Lor NHA	10,016
	Peat swamps in reserve forest (these are pockets of land surrounding Bor Lor)	4,357
	Agricultural land reform zones (ALRO)	9,085
	Public land/ other land outside ALRO	2,905

The project will work to increase the legally protection status of peat swamp areas in the two landscapes, combining multiple layers of protection approaches: including environmentally protected area designation according to the Article 43 or Article 45 in the NEQA 1992; expanding the non-hunting areas to cover the remaining landscapes; and stipulating local regulations to management the community forest under each TAO's jurisdiction. The project will ensure that the process of enhancing more protection of peat swamps landscapes are carried out in a consultative and participatory manners.

As a first step, Ramsar Site designation of the landscape will be secured by the second year of the project. The Ramsar site designation documentation (Information Sheet) will be prepared and this will be submitted to the National Wetlands Management Committee. Once designation is approved, the project will provide support for following the national guidelines for establishing a Ramsar Site which include:

- Setting up a Provincial Land Administration Committee with the Governor as the Head and relevant departments as committee members.
- An environmental impact study must be conducted prior to any changes to or construction on the land.
- A clear plan must be developed and all information must be reviewed.
- There will be continuous follow-up and checking on the progress.

The process of securing Ramsar designation requires time and background work because it is essential to ensure that local people and related government agencies understand the concept of a Ramsar site. The National Environmental Board has a resolution that requires completion of a participatory process before proclaiming a Ramsar Site. For securing Ramsar designation, the project will undertake a site study (and associated data collection and analysis) for Bor Lor NHA, as well as update the existing study that has been prepared for the Thale Noi NHA. The project will also take a lead role in facilitating peoples' participation in the process. Following Ramsar designation, the project will make an effort to improve the protection status by law of the the Kuan Kreng Landscape by project-end.

Output 1.2: Participatory management plan for Kuan Kreng Landscape

²⁹ After the project approval, the policy direction has changed; it is no longer viable to have Songkla Lake Basin designated as EPA. New peat swamp areas, with equal value and importance will be selected to replace EPA Songkla Lake, during the Inception Phase. The preliminary assessment indicates that Cherg Sae Peat swamp in Songkla Province, Ban Nailum-Kumpae Peat swamps in Nakhon Si Thammarat Province, and the peat swamp areas in the Queen Sirikit's Botanical Garden in Patthalung Province could constitute the new target areas.

Management plans will be developed for the Kuan Kreng Landscape such that economic activities in areas surrounding high conservation and carbon value sites are revised to exclude activities that might cause ecosystem degradation, such as large-scale unregulated drainage, oil palm plantations, and any expedient burning activities. The restrictions on economic activities will be reflected in the new zoning arrangement in the KKL. Zoning will include: (1) core zone where only conventional uses that do not affect water levels will be allowed, (2) buffer zone where community forestry for local community use and management will be permitted, and (3) transition zone where residential and community areas will be permitted. It is important to note that conventional peatland uses, such as fishing and honey collecting, do not destroy peatland.

Coordination across administrative boundaries will be particularly important. The Landscape is in a transition area, geographically speaking, between the Pak Panang Basin and the Songkhla Lake Basin, including areas in 3 provinces: Songkla, Patthalung, and Nakhon Si Thammarat.

The zoning will be discussed and developed in collaboration with the local communities and local government organizations, the NHA administrations, ONEP, forest administrations, Irrigation Department and other relevant branches of the Ministry of Agriculture and Agricultural Cooperatives. Zoning and demarcation of the different areas/ zones (i.e. core area for rehabilitation and conservation, buffer zone and transition area) will be undertaken.

Output 1.3: Kreng sub-district land use plan adjusted to reflect the new zonation.

This output will focus on demonstrating how to align land use plans of the TAOs with the conservation needs of the new landscape zonation. The project will pilot this land use plan for the Kreng sub-district, which falls entirely within the Thale Noi NHA.

A working group will be established to develop this Land Use Plan that ensures biodiversity conservation and carbon sink considerations are taken into account in delineating areas for different uses. Drainage, arable agriculture, and large-scale oil palm will be excluded from permissible activities, while alternative uses (krajood grass harvesting, fishing, sustainable NTFPs) will be permitted. A land use satellite map for Kreng sub-district will also be developed, building on the existing satellite map by updating it and developing it to a more detailed scale. A series of public consultation meetings will be organized to obtain consensus agreement among all stakeholders on the Land Use Plan. Based on the agreed and approved Land Use Plan, local rules and regulations will be established for the use of land, water, and other natural resources from peat swamp forests. Inputs will be obtained from a scientific advisor and from communities on the rules and regulations. Finally, the capacity of the Kreng TAO will be developed for monitoring and enforcing the new land use plan through in-field training sessions, study visits, and workshops. The scientific advisor will help identify training needs and develop the training curriculum.

Representatives from 5 other sub-districts (Baan-Tul, Cha-uad, Mae Jao Yoo Hua, Suan Luang, and Kuan Pang) will be invited to participate in various stages of the process and build their capacity, so that replication post-project can be facilitated.

Output 1.4: Training workshops to increase capacity of the administrators and TAOs for patrolling, monitoring water levels, fire protection, and enforcement

Each NHA is headed by a chief, who reports to the Wildlife Conservation Office at the central level of DNP. The NHAs in KKL also report to the Regional Office of DNP (Regional Office 5)

located in Nakhon Si Thammarat. The administrative units lack the capacity for effective patrolling and community engagement to deal with land dispute issues.

Training workshops under this output will target the administrators as well as the TAOs in all sub-districts. A number of training sessions will be provided, including study visits. For government officials, training will be provided on patrolling, monitoring water levels, fire protection, and law enforcement; for the TAOs, training will focus on maintaining water levels through managing waterways and measures for fire protection. Staff from fire protection units will also be included in the capacity development workshops. Equipment to support effective patrolling, water level monitoring, and fire protection and law enforcement will also be provided. Associated with the training workshops, the project will develop data systems and learning tools on effective management of peat swamps. It will do so by building on and improving existing learning/ information facilities in Thale Noi NHA, Bor Lor NHA, and Peninsular Botanical Garden in Phatthalung. Although there is a real gap in information/ data on peat swamps in the KKL, there is no need to build new facilities, and the focus needs to be on improving on the existing learning/ information centers.

Output 1.5: Community forestry management strengthened and support scheme in place

Under this output, community forestry management will be strengthened within the KKL. The project will focus on 4 areas in the Baan Tul, Cha-uad, Kreng and Kanthulee sub-districts covering 1,995 ha (table below). The project will focus on strengthening the community forestry committees, promoting sustainable livelihoods, and education. These 4 sub-districts have been chosen to develop and test peat swamp forest participatory management plans for the following reasons: Kreng, Cha-uad, and Baan Tul sub-districts are representative of the landscape; the entire area of the Kreng sub-district is located in the Thale Noi NHA; and finally, there are existing community forestry committees in these sub-districts that present good practice on people's participation in management of peat swamp forests that can be further strengthened (except for the Kreng sub-district).

Kanthulee is being included in this demonstration of community forestry, even though it is not within the KKL but nearby, because community interest is strong, the condition of the peat swamp forest is good, and there is an existing forestry committee. For these reasons, during PPG discussions, stakeholders felt this is a good site to include in the pilots so the project can develop experiences that apply to diverse situations ranging from peat swamp forests in good condition to those in a more degraded state. Kanthulee Community Forest, which is located in another peat swamp landscape in an adjacent province (Surat Thani) covers approximately 65 ha. In 2009, Kanthulee was declared a wetland of international and national significance. The Kanthulee Conservation Group was established in 1987 by local people, and has played a significant role in conservation and management of the forest. For example, villagers share the forest area to protect and prevent outsiders from unsustainable use or misuse of peat swamp. In 1992, Kanthulee was protected from forest fire by digging a canal to divert water from an irrigation canal in to the swamp area. It has received support from local government, NGOs, university, and the private sector.³⁰ In this project, Kanthulee will be taken as a benchmark area of good practice for communities in KKL to learn from and exchange experiences with. The site will also be used as a reference point of primary peat swamp forest in the carbon monitoring system.

³⁰ Apiradee Hanpongkittikul, 2014, Inland Fisheries Research and Development Bureau Department of Fisheries, Thailand

Table 9. Community forestry management pilot sites

Site name	Area (ha)	Status	Sub-district	Province
Community Forest Kuan Ngoen	90	Public land	Baan Tul	Nakhon Si Thammarat
Community Forest Suan Somdej Chao Fa Chulabhorn	240	Reserve forest	Cha-uad	
Community Forest Baan Sai Kanoon ³¹	1,600	Reserve forest	Kreng	
Kanthulee	65	Public land	Kanthulee	Surat Thani
Total area of community forests	1,995			

Peat swamp forest participatory management plans will be developed for these community forests, including ground water table standards that would need to be maintained to reconcile ecosystem stability requirements on the one hand and local community use needs on the other. In the sub-districts that already have established community forestry committees (Cha-uad, Baan Tul, and Kanthulee), the forest committee will be responsible for the development of the participatory management plan. For Kreng sub-district, the project will establish a community forestry committee (with a detailed management mandate and functions), which will then be tasked with developing a participatory management plan.

A series of participatory meetings and workshops will be conducted with relevant stakeholders namely the TAOs and other government agencies at sub-district level (Cha-uad, Kreng, Baan Tul and Kanthulee sub-districts) and provincial levels (Nakhon Si Thammarat and Surat Thani Provinces). The purpose of the consultations will be to share the draft peat swamp forest management plans with all stakeholders and to specifically obtain consensus agreement from community members, which, in turn will be community-level endorsement of the management plan for implementation. The management plan will additionally be endorsed by the TAOs as a TAO regulation.

Building on the community forestry management plan and the regulations therein, the project will provide support to communities for livelihoods that can be implemented in natural peat swamps or grasslands without disrupting the hydrological regime or vegetation cover. This support will be provided through a community forestry support scheme, provided they adhere to land use standards so that the hydrological regime in the peatlands, the vegetation cover and biodiversity remain intact or regenerate within their natural regeneration capacities.

A review of sustainable livelihoods that are within the carrying capacity of the KKL was undertaken during the PPG phase (see Annex 6). Based on this initial assessment a detailed plan will be developed to promote these alternative livelihoods based on sustainable use of peat swamp forests. Occupational groups related to these alternative livelihoods will be supported in all pilot sub-districts. Support will be provided on how to add value to sustainably harvested resources through value-added processing and product design. The target communities already have processing facilities, and need support with making value-added improvements to their products. Training and technical assistance will be provided to study the market potential and return for value-added products.

Finally, the project will develop a learning hub in each pilot sub-district to collate and disseminate project lessons and experiences. Local curriculum and Information, Education and Communication (IEC) materials on conservation and sustainable use of the KKL will be developed for use in 18 target schools. These are 7 primary schools and 1 secondary school in

³¹ At present the registered area is 100 ha; to be expanded to 1,600 ha under project

Kreng sub-district, 5 primary schools in Cha-uad sub-district, and 5 primary schools in Baan Tul sub-district.

Outcome 2: Implementing technologies to avoid peat swamp forest degradation and restore degraded peat swamp forests.

This outcome aims to address existing gaps in knowledge of the carbon flux for KKL (gaps outlined in Annex 2), and on implementing specific measures to rewet and maintain water levels in an area of 4,600 ha within the KKL and avoid conversion to oil palm cultivation. This, in turn, will help reduce GHG emissions from mineralizing peat and fires. Details on calculations of GHG emissions in the baseline and project scenarios for the pilot sites are in Annex 4; details on whether IPCC 2014 emission factors are applicable to the pilot sites of the project are in an addendum to Annex 4; details on pilot sites are in Annex 7. The Royally-Initiated Pak Panang River Basin Development project and its work on water table regulation aimed at fire prevention will constitute the baseline for this project outcome.

Kanthulee is being included in this demonstration of hydrotechnical measures to maintain peat swamp hydrology, even though it is not within the KKL but nearby, because the condition of the peat swamp forest is good and it therefore provides a good control site/ reference point for carbon flux measurements. The community in Kanthulee will therefore be an important partner and participant in capacity building related to carbon monitoring.

Output 2.1: Hydrotechnical measures implemented in pilot sites to prevent drainage and fires

The target area for this output is secondary peat swamp forests at approximately 4,600 ha within the KKL and an additional 65 ha in Kanthulee (control site). In this target area, the project will prevent land conversion to oil palm plantation at 100% of the area. It will also improve the hydrological situation over the entire area by putting in place hydrotechnical measures. The sites are located within NHA Bor Lor, Don Sai Forest, Community Forest Kuan Ngoen, Community Forest Suan Somdej Chao Fa Chulabhorn, Community Forest Baan Sai Kanoon, and Reserve Forest/ public land in the KKL (details on sites are in Annex 7).

The project will identify hydrotechnical measures and models that are appropriate for maintaining water levels at the sites, together with the already existing hydrotechnical facilities for management of the KKL. Currently, there are some canal dredging activities in Bor Lor NHA but there is no scientific information. In Cha-uad sub-district, some hydrotechnical measures have been developed with the use of local knowledge and there is some scientific information. For Kreng sub-district, there are no measures in place to control water levels.

At present, there is no clear understanding of the processes controlling the water level at the project sites. The hydrology at most, if not all, project sites at Kuan Kreng is connected to rivers and the floodplain regime. Rivers and canals are maintained and regulated by the national Irrigation Department, but the regulation does not usually meet the requirements of peat swamp forests conservation. Low summer water levels in most of Kuan Kreng are most likely not only because of intensive evapotranspiration but also due to artificial increased runoff due to deepening and straightening of rivers and digging canals. Closing canals may help decrease runoff but the data on the hydrological system of Kuan Kreng is not sufficient to draw conclusions. Furthermore, there is no cooperation between the Irrigation Department and the local stakeholders.

A detailed study on the hydrological system at the above sites will, therefore, be carried out. The main purpose is to improve the understanding of the hydrology of the KKL and to develop and strengthen the cooperation between the Irrigation Department and local stakeholders including nature conservation stakeholders. During the PPG, it became evident that there is no national expertise on peatland hydrology and the design of hydrotechnical measures/ models to maintain the natural hydrology of Thailand's peat swamps. Therefore, the project will need to tap into international expertise to develop local capacities in this field. International expertise would be made available to national specialists in conducting this study and carrying out the other activities listed below, so that a truly effective rewetting plan to stop peat oxidization and avoid fires can be designed.

Based on the study, the project will identify and implement hydrotechnical measures suited for the targeted areas. The project will design the hydrological rehabilitation plans with the aim to maintain and establish permanently wet conditions in the target areas (which will help to stop peat oxidization and fires). Given that there is no elevation model and no spatial hydrological data for the 4,600 ha, it is not possible to calculate accurately the effect of closing ditches and decreasing runoff by rivers and canals on the water level in the pilot sites. It is unlikely that the project can establish year-round water levels that are close to the ground surface over the entire 4,600 ha. This is possible only for very flat areas, or by flooding. The target areas have a gentle relief of about 1-2 m, with some areas being slightly higher than others. To install a water level that is year-round at or above the ground surface the land would probably need to be flooded. This is unrealistic as it would cause adjacent fields to be flooded as well. There is a need to find a balance between the needs of the communities and that of the peatlands. Another issue is the high evapotranspiration that, in addition to drainage, is responsible for the water level drop in the dry season. It is not clear how deep the water level will drop after closing ditches and decreasing runoff in the dry season. Thus, it is conservatively assumed that at least 25% of the area will be effectively rewetted with year-round high water levels that do not drop more than 20 cm below the ground surface. In the rest of the area, water levels will improve but may not reach the threshold high water level (20 cm) that is required to classify an area as falling under the IPCC 2014 land use category "tropical rewetted organic soils".

The plans will be designed upon careful study of the area, peat accumulation history and peat depth mapping, hydrology, topography, vegetation and precipitation regimes, engaging local government engineers, Irrigation Department of Ministry of Agriculture, Ministry of Natural Resources and Environment, and international experts.

In each of the pilot sites, key stakeholders will be involved in implementing the hydrotechnical measures including the Irrigation Department, local scientific and academic experts, and fire protection units. In NHA Bor Lor, the NHA office will lead implementation while, in the sub-districts, TAOs will lead and maintain the system. The hydrotechnical measures will be monitored and assessed for replication in other areas. Based on discussion with stakeholders during the PPG phase, it is estimated that the techniques demonstrated at pilot sites can be replicated to an additional 3,000 ha within the KKL (pockets of land surrounding Bor Lor and some additional areas, and public land/ forest land). To ensure effective implementation, the project will provide training to build the capacity of staff from the NHAs and the sub-districts on various aspects of the hydrotechnical measures.

In addition, a national workshop on peat swamp hydrology will be conducted, using the example of the KKL. The aim is to increase knowledge on utilizing hydrotechnical measures for peat

swamp management. Discussions and outcomes from the workshop will form the basis for a guidebook on peat swamp rehabilitation and management in Thailand that will include the findings of the research on the KKL hydrological system, proposed hydrotechnical measures, as well as general guidelines for managing peat swamp hydrology. The aim is to reach out to all stakeholders involved in peat swamp conservation, management and use, both from the conservation side and production side. Thus, the target audience will include, technical officers involved in irrigation works, hydrotechnical experts/ specialists, academics and scientists, protected area staff, agricultural staff. To raise awareness of potential investors about the conservation importance of the KKL and associated regulations, in particular those related to the hydrology of the peat swamps and the importance of maintaining water levels, members of the Nakhon Si Thammarat Integrated Provincial Committee will also be included. This Provincial Committee includes representatives from the local Chamber of Commerce and the local Federation of Thai Industry.

Output 2.2: Native tree reforestation of areas damaged by storms and fires in Kreng sub-district.

In addition to the hydrological restoration under Output 2.1, approximately 300 ha of forest that has degraded in the past due to fires (in the Baan Sai Kanoon forest), will be regenerated through planting of native species. Annex 5 has further details on the estimation of the carbon sink created through this reforestation. During the PPG, a list of potential native species have been identified that can be used for reforestation. These are *Macaranga pruinosa*, *Eugenia kunstleri*, *Eugenia oblata*, *Sterculia gilva*, *Baccaurea bracteata*, *Calophyllum sclerophyllum*, *Compnosperma coriaceum*, *Sandoricum eccarianum*, *Alstonia spathulata*, *Ixora grandifolia*. The project will evaluate, test and select species for reforestation based on their value in terms of carbon sequestration and their value in terms of sustainable income generation for local people.

In conjunction with RFD and other research institutes, the project will provide support with acquiring seeds of the selected native trees from potential sources, identifying the area to use as a native tree nursery, and training the community on reforestation with these species (latter will be linked to the community forestry support scheme under Output 1.5). Finally, the project will identify opportunities for replicating reforestation work in Thale Noi and Bor Lor NHAs.

Output 2.3: Peat swamp carbon flux monitoring system set up

The project will set up a peat-swamp carbon monitoring system, looking at both above ground and below ground carbon sequestration. Further details on this system are in Annex 8. It will help to clarify and communicate to scientists, the public and politicians the true value of peatlands, the cost of degradation and carbon market opportunities related to peatland conservation and rehabilitation. In order to fill international and local gaps in knowledge on carbon fluxes in tropical peat swamp forests and reduce the current high fluctuation in the expert assessment on some of the coefficients, the project will facilitate establishment of 3-4 site-based carbon measurement (subsidence, cameral measurements of CH₄, measurements of dissolved organic carbon, possibly test application of the “vegetation proxy” method) stations to measure carbon fluxes (CO₂, N₂O and CH₄) at degraded drained soil (oil palm plantations), and secondary wet peat-swamp forests. In addition to the KKL, the carbon monitoring system will also cover the Kanthulee peat swamp in the adjacent province, where most of the areas are still primary peat swamp forests, to provide comparative data.

A gas analytical laboratory and a team trained in its use is necessary to measure and analyze GHG emissions at the project sites. The project will draw on existing experience in Thailand in this regard and further build this capacity. The Department of Land Development in Bangkok has analyzed methane and carbon dioxide from chamber measurements in 1993 and 1994, and has some experience and equipment. Additional young scientists from Thailand need to be trained in modern methods to monitor GHG emissions and form a team. The team could be located at the above-mentioned Institute or closer to the project sites in Nakhon Si Thammarat facilitating regular field visits. There is a local academic institute that can provide technical backstopping on monitoring methodology (including laboratory testing). The Rajamangala University of Technology Srivijaya is located in Nakhon Si Thammarat province. The university has some expertise on the study of sago palm in the KKL and also on other issues relevant to the KKL. It also has laboratory equipment appropriate for carbon sequestration analysis. The project will assess different options and provide technical support for the establishment of this team that will manage the carbon flux monitoring system.

Communities will be trained to participate in this carbon flux monitoring system. A Community Based Forest Biomass Monitoring (CBFBM) tool will be used to include the local community in measuring the biomass carbon pool. CBFBM is an approach that allows communities to monitor their forest biomass using simple techniques. Outside experts will provide technical support to the local community to carry out a forest inventory, using a simple tool and program to assess and calculate above ground carbon. Carbon sequestration is calculated using a stock-based approach. The information generated will be used by the communities in making decisions about community forest management thus maintaining the carbon sequestration capacity of the peat swamp. Staff from TAOs and NHAs will also receive training on the carbon flux monitoring system.

Finally, the project will develop a database for keeping a record of carbon sequestration measurements at different periods. It will enable GHG emission monitoring and reporting from the pilot sites.

Outcome 3: Improving policies, standards and enforcement mechanisms for conservation and sustainable use of peat swamp forests.

This outcome will focus on creating an enabling environment for a landscape approach to management of peat swamp areas, wherein threats and associated management responses are considered at the landscape level and land use is not driven solely by short-term economic needs but also by needs of biodiversity conservation, soil conservation, and minimization of carbon emissions. Given that peat swamp areas are used by many stakeholders for agriculture, forestry, recreation, nature conservation, scientific research, and meeting the needs of local communities, multiple stakeholders need to be involved in developing this landscape approach. Therefore, this outcome will focus on creating a platform for cross-sectoral dialogue on a landscape approach to management of peat swamp areas, developing associated awareness and capacities within the different entities responsible for peat swamp area management, developing the tools to support ecologically optimal decision-making on the use of peat swamp areas, and securing approval of a strategic plan on peat swamp area management namely, the National Strategy on Peat Swamps (NSP). The key baseline program on which this outcome will build is the *Action Plan of Peatland Management* that is being developed as part of Thailand's participation in the Sustainable Management of Peatland Forests in Southeast Asia project that Thailand joined in January 2013.

Output 3.1: Working Group for promoting a landscape approach to management of peat swamp areas

A Working Group (WG) will be set up comprising of key stakeholders from government and non-government sectors. The WG will be under the coordination of the Office of Natural Resources and Environmental Policy and Planning (ONEP), and will consist of leading experts and specialists from the Department of National Parks, Wildlife and Plants Conservation (DNP), Royal Forest Department (RFD), Royal Irrigation Department (RID), Land Development Department (LDD), Department of Agricultural Extension (DOAE), Agriculture Land Reform Office (ALRO); and representatives from environmental NGOs.

Cross-sectoral dialogue will be critical for the development and implementation of a landscape approach to peat swamp management. Such a dialogue will help to ensure (i) coordination and information-sharing among the sectors related specifically to the development and implementation of the NSP, (ii) that technical expertise from each government line agency/sector is made available to the process, (iii) that planning by each individual sector is in line with the recommendations of the NSP on the use of peat swamps, (iv) identification of any jurisdictional overlaps, (v) identification and resolution of conflicting interests, and (vi) harmonization of sector-based actions to remove duplication of effort.

The WG will meet at least three times a year and it will be responsible for reviewing, providing inputs, and approving the various outputs produced under this outcome namely, the criteria and methodologies for assessment of peat swamp state, functions and services; inventory of peat swamps; and the NSP.

Output 3.2: Specific criteria and methodologies for assessment of state, functions and services of peat swamps developed and approved based on an economic valuation of ecosystem services provided by peat swamps in the KKL

The prevailing view among policy makers is that peat swamp areas are wastelands that need to be drained and developed in order to be more useful and productive for society. This output will focus on highlighting the full range and value of ecosystem services provided by peat swamps. It will do so by undertaking an economic valuation of ecosystem services provided by peat swamps in the KKL (including carbon sequestration potential, economic value from sustainable use of peat swamps in wet conditions, hydrological services, habitat support for animals and plants, resilience capacity, soil quality maintenance, etc.). This will be an important tool to convince stakeholders, ranging from government entities to local communities, of the economic benefits from maintaining peat swamps in their wet state.

Based on the framework and findings of the above study in the KKL, the project will develop general criteria and methodologies that can be used to assess the state of peat swamps, and the full range of functions and services they provide. Potential climate change impacts will also be taken into consideration in developing the criteria. The criteria will be used as guidance for other peat swamp areas in Thailand that are developing their management plans.

Specialists with extensive experience in peat swamp research and their protection and use will be involved in developing the criteria and methodologies, in collaboration with experts from other scientific, project and government organizations working in this area. The criteria and methodologies will be discussed at meetings of the WG (established under Output 3.1) with final approvals being obtained from the NEB.

Output 3.3: Comprehensive inventory and database of Thailand's peat swamp areas

The existing study in Thailand is focused on wetlands, while peat swamp areas are a type of wetland. Therefore, a comprehensive inventory and database of peat swamp areas will be completed as an important input for the NSP. The first step will be to undertake an inventory of peat swamp areas in Thailand using GIS technology and satellite images (boundaries and areas will be documented). The second step will be collection of data on the current state of these peat swamp areas (dominating biotopes, degree of degradation, ecosystem stability) through field observations and data analysis. Each peat swamp area will then be evaluated against the criteria developed in the previous Output. Thus, the peat swamp areas' importance for biodiversity conservation (for example, the presence of rare species and biotopes), for carbon sequestration, for local people, and importance in terms of hydrological services, etc. will all be evaluated. The comprehensive study and inventory will help confirm the area and location of peat swamp areas in Thailand.

Output 3.4: National strategy for peat swamp areas drafted for government approval

The area of peat swamps in Thailand has been declining rapidly due to conversion to oil palm plantations and other farm land. At the same time, government agencies have different levels of understanding about the peatland ecosystem and its services and functions. As a result, it is important to develop a national peatland management strategy that elevates peatland conservation onto the national agenda and secures legal protection for peatlands, while educating and involving all relevant government agencies in the process.

Based on the criteria and methodology for assessing the state, function, and ecosystem services of peat swamps (Output 3.2) and on the inventory (Output 3.3), a National Strategy for Peat swamps will be designed. The NSP will adopt a landscape approach to addressing threats to peat swamps and will emphasize ecologically optimal management regimes for all peat swamp landscapes. The NSP will include (a) an overall description of peat swamps' state and evaluation of their use, (b) a list of all peat swamps in Thailand with recommendations on their further use and specific standards and management regimes that must be met by each recommended use, and (c) identification of institutional roles for planning, financing and management of peat swamps with the objective of streamlining the institutional context of peat swamp management in the country.

The recommendations on peat swamp use will be based on an analysis of all economic and ecological strengths, weaknesses, opportunities and threats for each peatland included in the inventory. Potential climate change impacts will be taken into consideration in making these recommendations on peat swamp use. Recommended uses will range from nature conservation (areas of strict protection), areas for sustainable use of peat swamp resources by local communities, to residential and community areas. In peatlands that are private lands, plantation agriculture such as oil palm cannot be prohibited, but standards for avoidance and mitigation of the draining effect from plantations will be recommended³². The NSP will be an important tool for building awareness about the status of different peatlands and the need for adhering to recommended uses. For example, if a peatland falls within a protected area such as an NHA, rules and regulations outlined in the National Park Act must be adhered to for that area.

³² Recent work by the Roundtable on Sustainable Palm Oil (RSPO) that reviews the environmental and social impacts of oil palm cultivation on tropical peat be drawn on in defining the limits on use of peat swamps for oil palm cultivation.

2.5 Socio-economic benefits including gender dimension

By designating the EPAs and improving management effectiveness within the KKL, the project will secure the livelihoods of local people that are based on the natural resources provided by the peat swamps.

The majority of the population living in the KKL is involved in agricultural work including oil palm, rubber, rice paddy fields, vegetable gardens and fields, and fruit orchards (mangosteen, longan, lime, rambutan, durian, and other fruits). In addition, some villagers work as short-time informal workers, government officials, and traders. The average income (as of 2012-2013) is 45,000- 90,000 Baht per year per person. Most of this income (about 60%) comes from agricultural activities.

Most of the rice grown in the KKL is used for household consumption, with left over quantities being sold. Rice is grown in both traditional ways (once a year, with water from rainfall filling the paddy fields) and in more intensive ways (twice a year, with water coming from rainfall, natural water sources and man-made irrigation systems). Currently, the area used for growing rice is decreasing due to flooding, poor soils, brackish water and an increase in cash crops (rubber and palm) being grown in previous rice planting areas.

Fishing and aquaculture is another important livelihood in the KKL. Every household has equipment to catch fish and aquatic animals, and villagers enjoy eating fresh fish and prawns regularly. Excess fish is processed and preserved (for example, dried shrimp, fermented fish, and shrimp paste), which can be eaten or sold. Fish production from the KKL is 3,585 tons per year, which is approximately 179,212,500 Thai Baht per year in value. These products are consumed locally or processed for sale at local markets and for tourists.

Livestock rearing – especially cows and water buffalos – is decreasing in the KKL. The increase in modern tractors and harvesters has reduced the need for large animals traditionally needed during tilling and harvesting. Furthermore, many of the areas previously used for rice growing have been converted to rubber and palm oil plantations, which means that there are less areas available for grazing.

Vegetables are grown for both household consumption and for income generation. Commonly grown vegetables include chilies, Chinese kale, and long beans. Most often these vegetables are grown in the fields after rice is harvested, in the ditches of oil palm plantations, or near kitchens or water sources.

Krajood is an important natural resource provided by the KKL. Local handicraft products made from krajood provide villagers with supplemental income. Local people have been increasing their income from krajood through harvesting, handicraft-making, and serving as middlemen for krajood. This is especially the case for villagers from the Kreng sub-district who have been improving their well-being, and supporting their children's education because of this income. Compared with other jobs, income from krajood processing provides the highest income in the villages. Krajood harvesting provides around 300 baht per day for a family, and krajood processing provides around 5,000 to 20,000 baht per month for a family. The use of krajood is based on local knowledge and practices, and villagers have joined to form groups to make krajood products. However, naturally occurring krajood is decreasing, so villagers are beginning to cultivate it to use and sell. Therefore, the project's efforts to ensure sustainable management and use of krajood through the management and zoning activities (under Outputs 1.2 and 1.3), as

well as support for community forestry and value-added processing (through Output 1.5) will be important in improving the socio-economic situation.

Water buffaloes are another important economic resource for local people. Raising buffaloes is a way for local people to gain interest on their money akin to putting money in the bank. An adult buffalo is about 10,000 to 30,000 Baht.

Peat swamp forest products such as krajood, honey, fish and water buffaloes (that are harvested/raised for sale) can provide 150,000- 300,000 Baht/ year for the entire community. Resources such as insects and wild plants are harvested for self-consumption.

Women are the most frequent users of peat swamps, especially for harvest of krajood. They harvest it, prepare it for weaving (bleaching with mud, drying, etc.), process it into products and sell the products. Krajood users at the peat swamps can be grouped into two groups: 1) harvesting krajood for making products, and 2) harvesting it for sale to krajood processing groups. Every village (11 villages) in Kreng sub-district has a women's group for krajood processing. Some villages have more than one group. There are all together at least 20 groups in this sub-district. Each group has around 30 to 50 members. There are many organizations, such as district community development office, agricultural cooperative, provincial commerce office and Supanimit foundation, which have provided support in setting up the groups since 1979.

2.6. Cost-effectiveness

The objective of the project is to conserve and restore peat swamps in the KKL and put in place sustainable management. This, in turn, will help conserve the biodiversity harbored in the KKL, reduce CO₂ emissions from peat mineralization, and promote sustainable management of peat swamp forests. To realize this objective in the most cost-effective manner, project design has been shaped by the following principles:

- Combining policy prescriptions (NSP) with on-the-ground demonstrations at pilot sites so that one can inform the other.
- Developing a national strategy – NSP – that will provide recommendations on the most optimal use of peat swamps in Thailand based on both economic and environmental considerations and this is expected to steer the allocation of peat swamps to their best use. The project will undertake an economic valuation of ecosystem services of the KKL peat swamps which will highlight the economic value of a range of ecosystem services. Further, in pilot sites, it will demonstrate sustainable uses of peat swamps (krajood harvesting and products, honey, products from *Melaleuca*, and processed fish products). Together, this will help build the case that in some instances conservation and restoration of peat swamps could be the most cost-effective land use choice.
- Selecting pilot sites where project objectives can be demonstrated in the most cost-effective way: For example, one of the main criteria in selecting pilot sites was the interest from communities and NHAs to contribute to the project's objective and the ability to secure cofinancing from partners to maximize the impact of GEF resources. In addition, site selection has also been driven by the ability to generate multiple benefits through the limited project sites. Thus, while the carbon benefit at a particular site was an important consideration, so also was how the site fit into the landscape approach to ensure habitat extension opportunities for threatened species (e.g., connecting separate patches of the Bor Lor NHA) and promoting improved community forestry management.

- From the climate change mitigation cost-effectiveness perspective, the total investment in Component 2 of the project (investments leading to direct life time emissions avoided or carbon sequestered) of US\$7,292,214 (GEF financing and co-financing) will conservatively generate total carbon benefits (emissions avoided plus carbon sequestered) amounting to 834,000 tCO₂-eq over a 20-year time horizon (see Annex 4). The unit cost of mitigation is therefore a little under US\$ 9/ tCO₂-eq, which is below the IPCC recognized ceiling of USD 20/ tCO₂-eq for low-cost technologies.

2.7. Innovativeness, sustainability and potential for scaling up

The project demonstrates many approaches for the first time in Thailand, including zoning for different land uses in peat swamps, implementing hydrotechnical measures to prevent the drainage effect from oil palm encroachment and associated fires, and carbon monitoring. While this is a relatively small investment, its replication potential goes far beyond the target areas. The second component of the project includes a tropical peatland carbon flux monitoring system, both above and below ground. While the system is going to be implemented at the project target sites it will be applicable in similar ecosystems in Thailand and neighboring countries. At present, data on emissions of GHGs, and especially CH₄, from drained or rewetted tropical peatlands has been extremely scarce at the international level. IPCC has encouraged more site-based pilot projects that would enable precise assessment of GHG fluxes in these ecosystems. Peat swamps in Thailand are similar to those in Indonesia, Malaysia and other Southeast Asian nations, and this project would therefore create valuable input to the discussions on the IPCC Wetlands Supplement. It will also facilitate better planning of peat swamp conservation and restoration projects, focusing on carbon mitigation, in tropical and subtropical regions.

With respect to sustaining project results in-country, the third component of the project is about developing a national strategy on the use of peat swamps that would curb further encroachment and degradation of these areas. Further, component 3 will streamline the institutional context of peat swamp management in the country and will define management regimes for different peatland areas so that ecosystem resilience is retained in the long-term. The second component of the project will pilot specific ways to regulate water tables in peat-swamps so as to achieve ecosystem sustainability and avoid fires.

2.8. Stakeholder analysis

In Thailand several individuals, organizations and sectors are involved in the use and management of peatlands with instances of overlapping jurisdictions. The project's emphasis on technical support and studies, demonstration of sustainable use of peatlands at pilot sites, and developing an overarching national peatland management strategy offers a way to bring together the different stakeholders. The project will ensure that these stakeholders are involved early and throughout project. This will be achieved through the central project management structures, the proposed technical working groups, and through formal and informal consultation meetings with government, non-government and local community representatives. The project will also run a number of awareness raising, training and consultation workshops to help increase engagement from a broader range of stakeholders and promote learning around the project's activities and outcomes. Within the project management arrangements, different stakeholder groups will be engaged in the advisory committee/ board. The following table provides a breakdown of stakeholders.

Table 10. Project stakeholders

I. STAKEHOLDERS with DIRECT ROLE in IMPLEMENTATION

Stakeholders	Relevant roles
MONRE- ONEP	ONEP will be the Implementing Partner of this project through its Biodiversity and Climate Change Coordination Offices. ONEP is the focal point for UNFCCC, CBD and Ramsar Conventions. The Urban Environment and Area Planning Office and the Natural Resources and Environmental Management Coordination Division under ONEP will also be involved to provide guidance and supports in relation to the environmental protected areas. ONEP will link the project to other divisions and offices within MONRE and among other line ministries. It will play an important role in reaching out to local communities and, in coordination with Irrigation Department and forest administrations.
MONRE-DNP	DNP (Department of National Parks, Wildlife, and Plant Conservation) is responsible for the NHAs and will be engaged in activities under components 1 and 2. This will include the engagement of the Thale Noi NHA administration, including the Thale Noi Nature and Wildlife Education Centre; Bor Lor NHA administration, Protected Area Regional Office 5 Nakhon Si Thammarat, and Protected Area Regional Office 6 Songkhla and Phatthalung. DNP will be actively involved in the establishment of the EPA and zoning.
MONRE-RFD	RFD (Royal Forest Department) is responsible for the National Reserve Forest Areas, which constitute a large part of KKL. It will be engaged particularly in the outcomes with regards to zoning and sustainable utilization including the establishment of community peat swamp forests.
Royal Irrigation Department (RID), MoAC	The role of the RID, which is in charge of planning hydrotechnical projects for fire prevention in peat swamps, is important, as they provide the baseline for the second project component and they will be a key partner for it.
Land Development Department (LDD), MoAC	<p>The Land Development Department (LDD) was established by three Acts of Parliament on 23rd May 1963 under the purview of the Ministry of National Development. The acts were published in the Government Gazette on 22nd May 1963</p> <p>In 1972, the government dissolved the Ministry of National Development and restructured the administration by a Revolutionary Proclamation. On 29th September 1972 the Land Development Department was transferred to the Ministry of Agriculture and Cooperatives. The Land Development Department Act was published in the Government Gazette on 6th October 1983. The Act was amended in 2008, and the amended Act was officially published in the Government Gazette on 5th February 2008</p> <p>Under the 2008 Act, the Land Development Department has the duty to conduct soil surveys and analyses as a basis for establishing land classification and utilization maps, land development, and to define land use areas, and soil and water conservation areas according to a land census. Under the Act, the Land Development Department is responsible for collection of statistics as a basis for conducting land censuses.</p> <p>LDD is responsible for soil survey and classification, soil analysis, land use planning, conduct experiments and carry various aspects of land development, assist farmers in soil and water conservation practices and soil improvement, seed production for cover crops and soil improvement materials, transfer technology from its research of soil development and soil science for multiple purpose use. LDD will be a key partner in Component 3, Output 3.3.</p>
Agriculture Land Reform Office (ALRO), MoAC	ALRO is engaged for all three components. ALRO has the authority to allocate peatlands for agricultural purposes or give it back to RFD as reserve forest. Their participation is important insofar as it will improve ALRO's understanding of the importance of peatlands and lead to better land allocation practices, both at the policy and site levels.
Pak Panang River Basin Royal Development project	This project is under the umbrella of the Royal Project Foundation and covers both the Pak Panang Watershed and KKL. Activities conducted by the project include: construction of water gates to manage water levels, building irrigation canals, and reservoir construction. This project cooperates with the Irrigation Department and also has a role in local communities' livelihood development. The environment and natural resources work has had difficulties due to the poor condition of the forest and ecosystem. For water resource management issues, an administrative and coordination center has

Stakeholders	Relevant roles
	been established to serve as the center point for all related agencies and organizations. Pak Panang Project would have an important role to collaborate for peatland hydrological plan and technical support.
Tambon Administrative organizations (TAOs) and local communities which they represent	The three TAOs in the demonstration areas will be focal points for local peat swamp management through various intervention including policy & planning, capacity building, local collaboration and partnership, etc. The local government units (TAOs) are responsible for local sustainable development. They also coordinate actions of different agencies and facilitate the resolution of land-use conflicts; they will need to be involved in the process of establishing the Songkhla Lake EPA and the Kuan Kreng EPA; and oversee and allocate budgets that communities may access for funding livelihood projects and other development work. TAOs will be involved throughout the establishment of the EPA, but also to design and implement hydrotechnical measures to prevent degradation of secondary, natural peat swamp forests, proposed under Component 2. They are also primary beneficiaries of those project activities which deal with community forestry management. These TAO include TAO Kreng located in NHA Thale Noi, TAO Cha-uat, and TAO Bann Tul next to NHA Bor Lor. TAOs will take lead role and responsibility to develop participatory community forestry management plans and environment education plan.
Local communities that use natural resources	Members of this group include: wild beekeepers, Grey Sedge grass collectors, water buffalo herders, and fisher folk. Special attention should be given to the women working to collect the Grey Sedge and produce baskets, as this group is often overlooked during community natural resource management decisions.
Civil Society Organisations (CSOs)	The Love Homeland Association (located in ChianYai District, Nakhon Si Thammarat Province) supports community based natural resource management practices in Cha-uat and Baan Tul Sub-Districts (both in Cha-uat District, Nakhon Si Thammarat Province). The Association will provide support for coordinating and facilitating local participation and implementation of the project.
Nakhon Si Thammarat Rajabhat University	Nakhon Si Thammarat University is located in Nakhon Si Thammarat Province, which is the province that contains most of the area of the Kuan Kreng peat swamp. In 2012, the Research and Development Institute of NST University conducted research titled “Sustainable Use and Management of Kuan Kreng Swamp’s Resources”. There are 9 sub-research topics that should be conducted by this institute, which will provide academic support for our project. University would be project advisory member and facilitate peatland study and knowledge management.
Rajamangala University of Technology Srivijaya, Nakhon Si Thammarat Campus	Research and Development Institute of the Rajamangala University of Technology Srivijaya is located in the Trang Campus. Their strategy for science and technology includes research for conservation and use of local biodiversity. They will be partners in the carbon flux monitoring system.
The Prince of Songkhla University	The Prince Songkhla University in Songkhla Province will provide technical assistance and capacity building to local stakeholder groups located in the three pilot sub-districts, particularly on local hydrology and hydrotechnical measures to improve water levels in the KKL.
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II. STAKEHOLDERS with SUPPORTING ROLE

Stakeholders	Relevant roles
Department of Agriculture Extension (DOAE), MoAC	The Department of Agricultural Extension (DOAE) is one of the core agencies in the Ministry of Agriculture and Cooperatives which is directly responsible for the undertakings of agricultural extension and which works closely with farmers. The DOAE was established on October 21, 1967 by a Royal Decree published in the Government Gazette special issue dated October 20, 1967.

	In 2002, the DOAE restructured its organization in line with the Bureaucratic Restructuring Act (3 October 2002) and Ministerial Regulation (9 October 2002) and has been tasked to perform duties to increase farmer's potential in terms of agricultural production, processing, and value-added; to identify measures and guidelines for agricultural extension; to control the product quality; and to transfer agricultural technology to farmers so as to generate income and security in their farm occupation. DOAE will be actively involved at the national level in the development of the NSP and at the level of pilot sites in ensuring agricultural land use is in line with the zoning and management plans.
Department of Local Administration, Ministry of Interior	Ministry of Interior's Department of Local Administration's main responsibility is to support the work of the local government organizations through advice on the development of local development plan, personnel administration, finance and administration in order to increase the capacity and efficiency of the local government organizations in public service provision. The responsibility and structure of the Department of Local Administration have been specified in the Ministerial Regulation on the Organization of the Department of Local Administration, Ministry of Interior, B.E. 2551 (2008). It will be involved in all interventions that require participation of local authorities at provincial, district and sub-district levels.

2.9. Coordination with other initiatives

The project will ensure coordination with the GEF project "Integrated community-based forest and catchment management through an ecosystem service approach (CBFCM)". Information exchange with their work on bio carbon assessment methodology for ecosystems and promotion of PES related to bio carbon and other ecosystem services will be useful. The peatlands project proposed herein, if approved, is going to generate data that would strengthen the case for PES application in Thailand.

This project will also benefit from the results and experience of another GEF project "Catalyzing sustainability of Thailand's Protected Area System". Specifically, the mechanisms for community involvement and sustainable financing options put in place by this project will be considered when designing community forestry schemes under Component 1. Furthermore, the experience of that GEF project will be used for building the capacities of the staff at NHAs in the KKL.

Both of the above projects are under implementation by MONRE, and the Ministry will ensure coordination and sharing of lessons as well as establish working level contacts between the implementation teams working on these projects.

Outside of GEF, the project will ensure strong cooperation with the Pak Panang River Basin Project initiated by His Majesty the King of Thailand to support local environmental management and local livelihoods. The project has supported a number of local actions to maintain water level in the fen peat lands in the northern part of the country through construction of small-scale infrastructure, amongst other things, and also seasonal flood management. These aspects will be carefully considered in the design of the hydrotechnical measures proposed by this project under Component 2. The Pak Panang Project will be invited to be a member of the provincial working committee of the project.

This project will also establish contacts and information exchange with the IFAD-GEF regional project “Rehabilitation and Sustainable Use of Peat land Forests in South-East Asia”, that is operational in Malaysia, Indonesia, Philippines, Vietnam, Singapore, and Brunei.

Another project of relevance is the GEF-ADB Greater Mekong Subregion Forests and Biodiversity Program that is working “to increase investments and improve the management and climate resilience of high priority forest biodiversity conservation landscapes including protected area systems of the Greater Mekong Subregion (GMS), recognizing the pressures on these landscapes from development and climate change” in several Greater Mekong countries, including Thailand. Its work on carbon accounting systems and protocols, information sharing on good practice for forest carbon management and finance and sustainable protected area, forest and watershed management will be directly relevant to this proposed project. Close cooperation will therefore be maintained. The ADB project will be kept informed through the Thematic Working Group on Sustainable Development among UN agencies in Thailand.

3. PROJECT RESULTS FRAMEWORK

This project will contribute to achieving the following Country Programme Outcomes as defined in the 2012-2016 CPD for Thailand: Thailand is better prepared to address climate change and environmental security issues through the enhancement of national capacity and policy readiness.					
Country Programme Outcome Indicators: Indicator 1: Number of national and local (networking) platforms supported and/or strengthened. Baseline: As of 2011, there are few (networking) platforms fully operated by the Thai Government and participated by communities and stakeholders. Target: At least 3 national and local platforms developed with UNDP support by 2016. Indicator 2: Number of climate-related policies and model actions established applied and/or replicated by national and local partners; as well as exchanged in south-south cooperation forums. Baseline: As of 2011, no strong climate-related national policies and model actions established, applied and/or replicated by national and local partners. Target: At least 3 climate-related policies and model actions established, applied and/or replicated by 2016 with support by UNDP. At least 3 south-south exchange forums conducted addressing the three outputs and other key issues (e.g. mitigation, adaptation, environmental security, climate fiscal framework, etc.)					
Primary applicable Environment and Sustainable Development Key Result Area: 1. Mainstreaming environment and energy					
Applicable GEF Strategic Objective and Program: <u>Biodiversity Focal Area Objective 1:</u> Improve Sustainability of Protected Area Systems; Outcome 1.1: Improved management effectiveness of existing and new protected areas <u>Climate Change Focal Area Objective 5:</u> Promote conservation and enhancement of carbon stocks through sustainable management of land use, land-use change, and forestry; Outcome 1: Good management practices adopted both within the forest land and in the wider landscape; Outcome 2: Restoration and enhancement of carbon stocks in forests and non-forest lands; Outcome 5.3: GHG emissions avoided and carbon sequestered <u>Sustainable Forest Management/ REDD+ Focal Area Objective 1:</u> Reduce pressures on forest resources and generate sustainable flows of forest ecosystem services; Outcome 1.2: Good management practices applied in existing forests; Outcome 2.1: Enhanced institutional capacity to account for GHG emission reduction and increase in carbon stocks					
Applicable GEF Outcome Indicators: BD-1 Indicator 1.1: Protected area management effectiveness score as recorded by Management Effectiveness Tracking Tool CCM-5 Indicator: Hectares of peatlands restored to enhance carbon stocks; GHG emissions avoided and carbon sequestered in tones of CO ₂ equivalent SFM REDD 1 Indicator: 1.3 (a): Forest ecosystem services generated in peatland forest pilot sites					

Project Strategy	Objectively Verifiable Indicators	Baseline	Target (by project end)	Source of verification	Risks/ Assumptions					
The long-term goal to which the project will contribute is the conservation and sustainable use of all peatlands in Thailand to maintain the range of ecosystem services they generate										
Project Objective: To conserve and restore peatlands to increase their capacities to act as carbon sinks, as habitats for globally important species, and as sources of ecosystem services for improved livelihoods	Extent of peat swamp area under effective management (IUCN Category IV, V) in KKL, under the framework of a National Strategy for Peat swamps (NSP)	Currently there is no NSP; there are 2 NHAs (IUCN category IV) as follows: <table><tr><td>Thale Noi NHA and buffer zone</td><td>48,000 ha</td></tr><tr><td>Bor Lor NHA</td><td>10,016 ha</td></tr></table>	Thale Noi NHA and buffer zone	48,000 ha	Bor Lor NHA	10,016 ha	154,363 ha comprising the following classified as EPAs (IUCN Category V)		Project Reports; Independent mid-term and final evaluations	Government continues to support sound management of peatlands in line with the principles and criteria enshrined in the NSP
			Thale Noi NHA and buffer zone	48,000 ha						
			Bor Lor NHA	10,016 ha						
			EPA Songkhla	Sathingpra Peninsula	80,000					
				Thale Noi NHA and buffer zone	48,000					
				Sub-total	128,000					
			EPA Kuan Krung	Bor Lor NHA	10,016					
				Peat swamps in reserved forests around Bor Lor	4,357					
				Agricultural land reform zones, ALRO	9,085					
Public land/ other land outside ALRO	2,905									
Sub-total	26,363									
Total		154,363								
Outcome 1: Expanding protection of high conservation value peat swamp forests and demonstrating their	Peat swamp forests in KKL under protection	Thale Noi NHA – 48,000 ha Bor Lor NHA – 10,016 ha	Additional 16,347 ha brought under EPA status consisting of areas that are important for maintaining carbon in the peat layer and connecting patches of peat swamp forests (peat swamps in reserved forests around Bor Lor, areas under ALRO and public land outside ALRO)		Reports from Provincial Committee in charge of Kuan Krung EPA	Stakeholder support is secured for the creation and management of protected areas				

Project Strategy	Objectively Verifiable Indicators	Baseline	Target (by project end)	Source of verification	Risks/ Assumptions
sustainable use within the broader landscape	Area covered by EPA Management Plans that will result in the release of pressures on the 29 million tC pool	0	154,363 ha	Reports from Provincial Committees in charge of Kuan Kreng and Songkhla Lake EPAs	National plan to declare the Songkhla EPA remains unchanged. ONEP has the mandate to process declaration of EPA
	Enhanced management effectiveness at existing PAs (NHAs) and new PAs (EPA Songkhla and EPA Kuan Kreng) as measured by METT	Thale Noi NHA: 64 Bor Lor NHA: 42 EPA Kuan Kreng: 12 EPA Songkhla: 19	Thale Noi NHA: 75 Bor Lor NHA: 70 EPA Kuan Kreng: 20 EPA Songkhla: 30	METT Scorecard	There is cooperation between communities and relevant government agencies at sub-district level.
	Incidence of violations of NHA regulations	NHA	Baseline number of violations		Reports from NHA administrators
			2013	2014 (up to Sept.)	
		Bor Lor	2 (1 cutting tree, 1 invasion)	1 (invasion)	
		Thale Noi	21 (4 cutting tree, 17 burning forest for land)	15 (1 cutting tree, 14 burning forest for land)	0 No tree cutting, Less than 6 invasions
	Incidence of fires	Wildfires burning on average 680 ha per year (0.91%) of KKL	Wildfires burning on average 408 ha per year KKL		Reports from Fire Department
	Number of units trained for patrolling, managing water levels, fire protection, and enforcement of regulations	0	6 units in Thale Noi NHA 2 units in Bor Lor NHA 3 units in in Kreng, Cha-uad and Baan Tul sub-districts		Project reports on training workshops, training evaluations by participants
	Area of peat swamp forests in Kuan Kreng landscape under participatory community forestry management plans	495 ha under some form of community forestry as follows: Community Forest Kuan Ngoen (90 ha; Baan Tul) Community Forest Suan Somdej Chao Fa Chulabhorn (240 ha; Cha-uad) Baan Sai Kannon (100 ha; Kreng sub-district) Kanthulee (65 ha; Kanthulee)	495 ha under improved peat swamp forest participatory management plans Additional 1,500 ha established as community forest with management plan as follows: Community Forest Baan Sai Kannon (1,500 ha; Kreng sub-district)		Documentation in TAO, PAO and NHAs

Project Strategy	Objectively Verifiable Indicators	Baseline	Target (by project end)	Source of verification	Risks/ Assumptions
	Ecosystem Health Index (EHI) ³³ monitoring system for monitoring peatland health is developed and in place for 2 NHAs in order to ensure good quality habitat for Yellow-headed Tortoise, Fishing Cat	No EHI monitoring system in use	System applied at 2 NHAs	Reports from Heads of NHAs	
Outcome 2: Implementing technologies to avoid peat swamp forest degradation and restore degraded peat swamps forests	Peat swamp area in KKL that is under effective water table management regime	0 ha	4,600 ha	Report of experts from monitoring plots	Government cofinancing for the project is provided in a timely manner for implementing the project strategy at pilot peatland sites where hydrological regime is to be improved Restoration activities undertaken in pilot peatland sites are not undermined by climate changes such as more frequent drought, warmer summers and winters
	Water levels at 4,600 ha of peat swamp forest (pilot sites where hydrotechnical measures are to be implemented)	20-90 cm below surface during dry season. To be confirmed by detailed study on the hydrological system at the pilot sites under Output 2.1	Drainage will be stopped or significantly reduced and the water level will substantially increase for all project sites. At least for 25% of the area (1,150 ha) the water level will never drop more than 20 cm below surface.	Report of experts from monitoring plots	
	GHG emissions at 4,600 ha of peat swamp forest (pilot sites where hydrotechnical measures are to be implemented)	2.793 Mt CO ₂ -eq	1.959 Mt CO ₂ -eq	Carbon monitoring reports produced by the project	
	Carbon sequestration through reforestation at 300 ha with native species	0	129,000 tCO ₂ eq		
Outcome 3: Improving policies, standards, and enforcement mechanisms for conservation and sustainable use of peat swamp forests	Cross-sectoral WG for promoting a landscape approach to peatlands conservation and sustainable use	Cross-sectoral platform exists in the form of National Wetland Management Committee, but no specific working group on landscape approach to peatlands conservation and sustainable use	Working Group formed by Year 1	Minutes of meetings	Government cofinancing for the project is provided in a timely manner for development of the peatland inventory, and NSP
	Criteria and methodologies for assessment of peatlands' state, function and services that take into account full range of ecosystem services	No documented criteria exist	Criteria and methodology endorsed by Year 2 and includes ecological criteria	Endorsement of criteria by National Technical	

³³ Draft outline of EHI scorecard was developed during the PPG (see Annex 13). Scorecard will be completed in the first year of the project for the 2 NHAs and targets for end of project developed.

Project Strategy	Objectively Verifiable Indicators	Baseline	Target (by project end)	Source of verification	Risks/ Assumptions
				Wetland Committee	
	Inventory of all peatlands	Outdated listing of peatlands exists and it is spotty (not comprehensive)	Current and comprehensive listing of peatlands status, functions, services (based on above criteria) by Year 3	Database with GIS maps	
	National Strategy for Peat swamps	None	New 20-year strategy that takes economic and ecological benefits into account in determining use of peatlands	Strategy approved and adopted by NEB	

Note: Further explanation of how the project will mitigate risks is in Annex 9 on Risk Analysis.

4. TOTAL BUDGET AND WORK PLAN

Atlas Award ID and Project ID		Atlas Award ID: 00084475 Project ID: 00092458			Project Title:	Maximizing carbon sink capacity and conserving biodiversity through sustainable conservation, restoration, and management of peat swamp ecosystems					
PIMS #:		4951				Implementing Partner (NIM agency)	Office of Natural Resource and Environment Policy and Planning (ONEP)				
Business Unit:		THA10									
GEF Outcome/Atlas Activity	Implementing Agent/Responsible Party	Fund ID	Donor Name	Atlas Budget Account Code	ATLAS Budget Description	Amount Year 1 (USD)	Amount Year 2 (USD)	Amount Year 3 (USD)	Amount Year 4 (USD)	Total (USD)	Budget Note
Outcome 1: Expanding protection of high conservation value peat swamp forests and demonstrating their sustainable use within the broader landscape	ONEP	62000	GEF	71300	Local Consultants	45,000.00	45,000.00	45,000.00	45,000.00	180,000.00	1
				71600	Travel	1,200.00	1,200.00	1,200.00	1,200.00	4,800.00	2
				72100	Contractual Services-Company	125,000.00	125,000.00	125,000.00	125,000.00	500,000.00	3
				72500	Supplies (Stationery, Office)	1,000.00	1,000.00	1,000.00	1,000.00	4,000.00	4
				72200	Equipment & Furniture	1,000.00	1,000.00	1,000.00	1,000.00	4,000.00	5
				74200	AV and Print Production Costs	-	4,550.00	4,550.00	4,550.00	13,650.00	6
				74500	Miscellaneous	550.00	500.00	500.00	1,000.00	2,550.00	7
				75700	Training and workshops	66,500.00	71,500.00	71,500.00	81,500.00	291,000.00	8
TOTAL OUTCOME 1						240,250.00	249,750.00	249,750.00	260,250.00	1,000,000.00	
Outcome 2: Implementing technologies to avoid peat swamp forest degradation and restore	ONEP	62000	GEF	72100	Contractual Service Companies	38,000.00	70,000.00	70,000.00	50,000.00	228,000.00	9
				71300	Local Consultants	32,500.00	32,500.00	32,500.00	32,500.00	130,000.00	10
				71600	Travel	4,250.00	4,250.00	4,250.00	4,250.00	17,000.00	11

degraded peat swamp forests				72100	Contractual Services-company	245,500.00	245,500.00	245,500.00	245,500.00	982,000.00	12
				72500	Supplies (Stationery, Office)	1,500.00	1,500.00	1,500.00	1,500.00	6,000.00	13
				72200	Equipment & Furniture	30,000.00	25,000.00	-	-	55,000.00	14
				74500	Miscellaneous	500.00	500.00	500.00	500.00	2,000.00	15
				75700	Training and workshops	20,000.00	20,000.00	20,000.00	20,000.00	80,000.00	16
TOTAL OUTCOME 2						372,250.00	399,250.00	374,250.00	354,250.00	1,500,000.00	
Outcome 3: Policy framework and institutional capacities for a landscape approach to peatlands management are in place	ONEP	62000	GEF	71200	International Consutant		18,000.00	-	18,000.00	36,000.00	17
				71300	Local Consultants	39,000.00	49,000.00	39,000.00	59,000.00	186,000.00	18
				71600	Travel	2,000.00	2,000.00	2,000.00	2,000.00	8,000.00	19
				72100	Contractual Services-company	50,000.00	50,000.00	50,000.00	50,000.00	200,000.00	20
				72500	Supplies (Stationery, Office)	1,500.00	1,500.00	1,500.00	1,500.00	6,000.00	21
				72800	IT Equipment	55,000.00	5,000.00	5,000.00	5,000.00	70,000.00	22
				74200	AV and Print Production Costs	1,000.00	1,000.00	1,000.00	1,000.00	4,000.00	23
				74500	Miscellaneous	500.00	500.00	500.00	500.00	2,000.00	24
				75700	Training and workshops	13,500.00	15,928.00	15,929.00	13,500.00	58,857.00	25
TOTAL OUTCOME 3						162,500.00	142,928.00	114,929.00	150,500.00	570,857.00	
Project Management	UNDP	62000	GEF	71400	Contractual Services-Individual	32,000.00	32,000.00	32,000.00	32,000.00	128,000.00	26
				74100	Professional Services (micro assessment + audit)	3,100.00	-	6,000.00	-	9,100.00	27
				74599	Direct Project Cost	4,200.00	4,200.00	4,200.00	3,843.00	16,443.00	28

Total Project Management	39,300.00	36,200.00	42,200.00	35,843.00	153,543.00	
PROJECT TOTAL	814,300.00	828,128.00	781,129.00	800,843.00	3,224,400.00	

Budget notes:

Budget Note	Explanation:
1	A national Protected Areas policy expert to conduct feasibility study and prepare the relevant documents for designation of Songkhla Lake basin as EPA and assist in preparation of Information Sheet for Kuan Kreng peat swamps to be declared as Ramsar site by year 2 and EPA by year 4; Land Use Planning Expert will work closely with the Provincial Coordination Unit and the Provincial Sub-committee for development of the management plan with functional zones, with the Kreng sub-district community forestry committee to ensure alignment of sub-district land use planning framework with these management plans; Forest Conservation Curriculum Development and Training Expert will provide support to the PMG for development of the training curriculum focusing on patrolling, monitoring water levels, fire protection and law enforcement, and assist in identifying the training experts and also conduct relevant training and ensure that the training is in line with the curriculum.
2	This will cover travel under output 1.4 of NHAs officers, TAOs and provincial committee to attend in the relevant activities for patrolling, monitoring water levels, fire protection and enforcement such as training workshops, site visit etc., within Thailand.
3	The contractual services are for local institution and organization responsible for Output 1.3 and 1.5 over the course of 4 years. The contractual service is for two: (1) Local Academic Institute: The local academic institute/organization will be responsible for assisting in the process of development of integrated management plan for Kuan Kreng (Output 1.2) and the development of Kreng sub-district land use plan to reflect the zones (Output 1.3), including the purchase of satellite map and GPS equipment; (2) Local Non-Government Organization: The Local NGO will work closely with three sub-district committees in KKL and community forestry committee in Kanthulee for the implementation of the community forestry support scheme (Output 1.5)
4	This will cover supplies for training purposes under Output 1.4
5	This will cover the training materials and equipment under Output 1.4
6	This will cover the cost of developing information materials be developed under Outputs 1.1.
7	This has been budgeted for any unforeseeable developments during project implementation that require adaptive management actions that cannot be finance through the existing planned budget to account for inflation, currency rate exchanges
8	This will provide for a number of workshops and meetings for inception workshop, conducting the feasibility study and prepare the document for EPA and Ramsar (Output 1.1) as well as conduct series of participatory meetings and workshops for participatory management plans (Output 1.2) and conduct public consultation meetings on the Land Use Planning of Kreng (Output 1.3). It will also support meetings and workshops in relation to the community support scheme (Output 1.5).
9	International institution to work in partnership with local institution (contractual service under #12) in the set up of carbon flux monitoring system and conduct regular monitoring both under ground and above ground carbon monitoring ; including capacity building programme (trainings and exchanges), and engaging in knowledge and technology transfer on carbon flux monitoring techniques.
10	Hydrologist/ hydro-technical Expert will work closely with local academic institute (Output 2.1) for the study and research on hydro-technical measures for peat-swamp management in Thailand with the focus on KKL; Facilitation and Documentation consultant at field level.
11	To cover travel of consultants to and within project pilot sites for monitoring purposes (Output 2.1, 2.2, 2.3)
12	Contractual services for local academic institute or technical university to implement hydrotechnical measures to avoid peat swamp degradation for 4 years in pilot sites, including the study and research of hydrological system for peat-swamps, testing hydro-technical measures, capacity building of NHA staff, TAOs, conducting national workshop on hydro-technical measures for peat swamps, developing guideline for peat-swamp hydro-technical management (Output 2.1); contractual services for reforestation of 300 ha of native trees in Kreng sub-district over 4 years @ USD 50,000 /year for 42 months (Output 2.2); contractual services of local institution (USD 200,000) to work with international institution (#9) on setting up and monitor the carbon monitoring system provided by (including laboratory test) and development of database for carbon monitoring, and the local institute leads on training of NHAs and TAOs on monitoring of carbon flux and collection, collation and analysis of data (Output 2.3). This also includes the cost of equipment to set up such a system (USD 174,260)

Budget Note	Explanation:
13	This will cover supplies for Field Coordination Office at pilot sites
14	This includes the construction of hydro-technical facilities (Output 2.1) as well as to purchase for the equipment for reforestation of native tree purpose (e.g. tree nursery) (Output 2.2)
15	This has been budgeted for any unforeseeable developments during project implementation that require adaptive management actions that cannot be finance through the existing planned budget to account for inflation, currency rate exchanges
16	To provide for a number of training workshops and meetings for capacity building for the monitoring of carbon flux, and cost of meetings of action research for reforestation with native trees.
17	To cover fees for international consultant for midterm review (Year 2) and final evaluation, inclusive of travel.
18	Natural Resource Economics Expert responsible for the study and research on economic valuation of ecosystem services provided by KKL peat swamps inclusive of travel of 24 weeks throughout 4 years; M&E Consultant (1) and Outreach and Communication Consultants (2) to support the work at pilot sites; national consultant for midterm review (Year 2) and final evaluation (Year 4) inclusive of travel.
19	Travel of consultants (Field Coordination Office) to and within project pilot sites for monitoring purposes.
20	Contractual services provided by an organization and/or company to assist in collection, collation, analysis of data and information to develop standards and criteria for assessment of peat swamp value as well as develop national guidelines for value assessment of peat-swamps in Thailand (Output 3.2), development of comprehensive inventory of peat-swamps in Thailand (Output 3.3), and development of NSP (Output 3.4).
21	This will cover supplies for Field Coordination Office at pilot sites
22	Allocation is for purchase of software for updating information on peat-swamps as clearing house information including the maintenance and updating of the software programme (Output 3.3)
23	This covers materials required for Working Group (Output 3.1) for promoting landscape approach to peat swamp conservation.
24	This has been budgeted for any unforeseeable developments during project implementation that require adaptive management actions that cannot be finance through the existing planned budget to account for inflation, currency rate exchanges
25	This will provide for a number of training workshops, meetings and forums for Working Group, Provincial Working Group and, Committee to discuss and advocate for a national policy framework on peat swamps management.
26	Full-time project manager @ 2,000 USD/ month for 48 months and a full-time project assistant @ 666 UD/ month for 48 month
27	For third-party financial capacity and internal control assessment (Year 1) and Audit (Year 3)
28	Cost to UNDP for providing support services for project implementation, in hiring project personnel/consultants, and in facilitating the transfer of fund for the implementing partners (ONEP). The cost will be incurred on actual transactions, based on UNDP's Universal Price List. Drafted LOA for UNDP support services will be prepared and submitted at DOA stage.

Summary of Funds

FUNDING SOURCE	Type	Amount	Amount	Amount	Amount	Total
		Year 1	Year 2	Year 3	Year 4	(USD)
GEF	Cash	814,300	828,128	781,129	800,843	3,224,400
ONEP – Ministry of Natural Resources and the Environment	In-kind	2,780,000	2,780,000	2,780,000	2,780,000	11,120,000
DNP-MONRE	In-kind	215,170	215,170	215,170	215,170	860,680
UNDP	In-kind	50,000	50,000	100,000	100,000	300,000
Kreng TAO	In-kind	3,750	30,000	30,000	30,000	93,750
Baan Tul TAO	In-kind	86,250	300,000	300,000	200,000	886,250
Cha-uat TAO	In-kind	22,031	40,000	40,000	20,000	122,031
TOTAL		3,971,501	4,243,298	4,246,299	4,146,013	16,607,111

5. MANAGEMENT ARRANGEMENTS

The project will be executed through UNDP's National Implementation Modality (NIM) with the Office of Natural Resources and Environmental Policy and Planning (ONEP) as the Implementing Partner (IP).

Implementing Partner: Following the programming guidelines for national implementation (NIM) of UNDP-supported projects, ONEP will sign the project document with UNDP. The implementing partner shall be accountable for the disbursement of funds and the achievement of the project objective and outcomes, according to the approved work plan. In particular, ONEP, as the Implementing Partner (IP), will be responsible for the following functions: (i) coordinating activities to ensure the delivery of agreed outcomes (ii) certifying expenditures in line with approved budgets and work-plans; (iii) facilitating, monitoring and reporting on the procurement of inputs and delivery of outputs; (iv) coordinating interventions financed by UNDP with other parallel interventions; (v) preparation of Terms of Reference for consultants and approval of tender documents for sub-contracted inputs; and (vi) reporting to UNDP on project delivery and impacts.

The project will establish a Project Board (PB) and a Project Management Unit (PMU) within ONEP. The PB and PMU will be responsible for communicating the lessons/ outcomes of actual site work to relevant central bodies and make use of them in developing new policies. Existing local coordinating bodies will be utilized, enhanced, and/ or expanded so as to ensure coordination of activities at the site level and the participation of important stakeholders.

The government will appoint a high level official within ONEP who will serve part time as the Project Director and focal point to the project. S/he is accountable to Government and UNDP for the implementation of the project in line with the signed project document. S/he is the approving officer for the project and will be responsible for providing government oversight and guidance for project implementation. The project director will not be paid from project funds, but will represent a Government in-kind contribution to the project. Among the duties and responsibilities of the Project Director are the following³⁴:

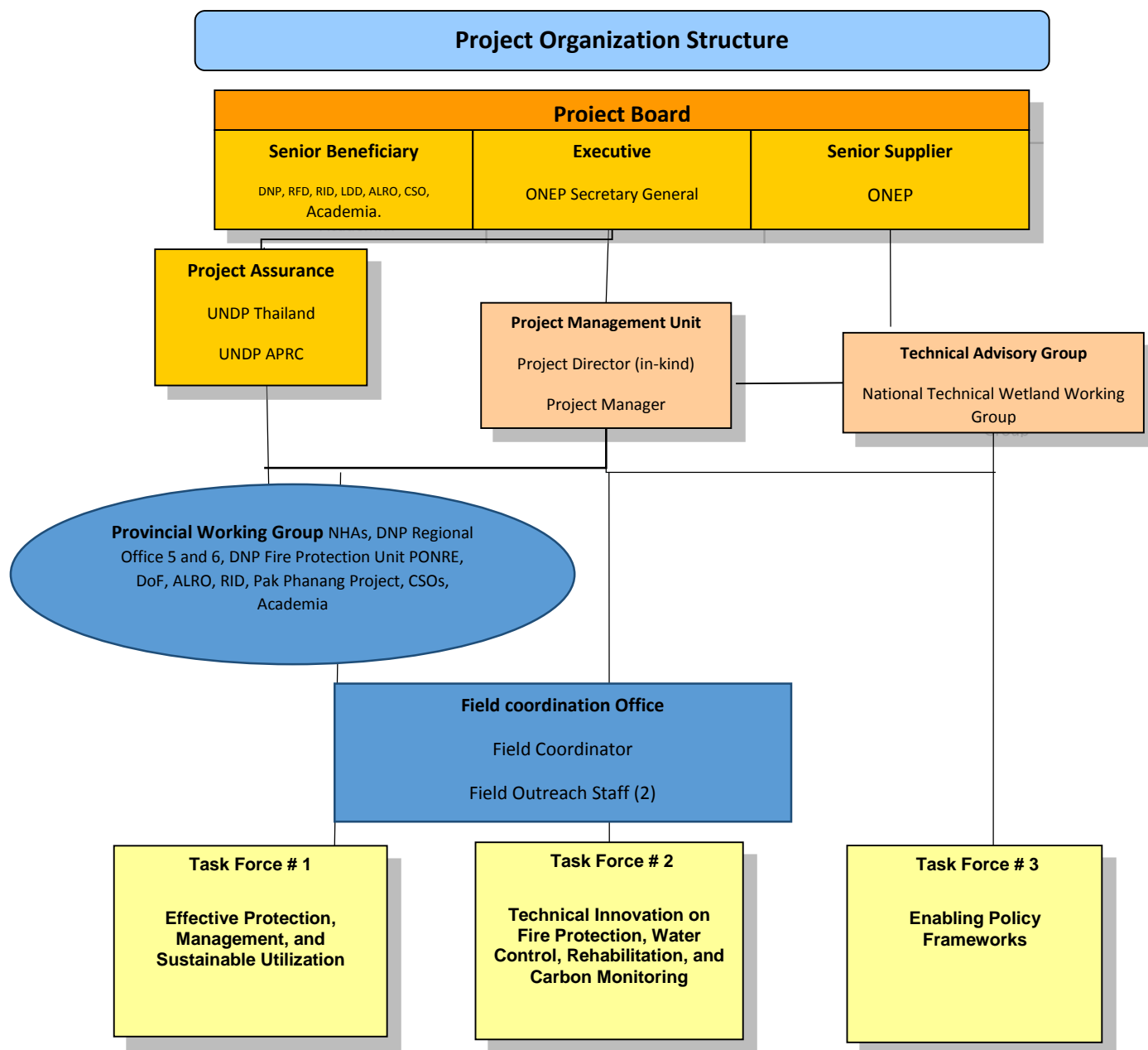
- Assumes overall responsibility for the successful execution and implementation of the project toward achieving the outcomes and outputs.
- Ensures the proper use of project resources.
- Serves as a focal point for coordination of the project with implementing agencies, UNDP, Government and other partners
- Ensures that Government inputs for project are available.
- Leads and coordinates partners in the selection of the Project Coordinator.
- Supervises the Project Coordinator and facilitates the work of the Project Coordinator and all staff.
- Ensures that the required project work plan is prepared and updated in consultation and agreement with UNDP and distributed to the Government (Counterpart Ministry)
- Leads and arranges the recruitment of project professional and support staff in line with laid out recruitment process.

³⁴ See UNDP Bureau of Management (2003) Country Office Support For Effective Project Management: Working Paper #3- National Project Directors Manual

- Authorizes commitments of resources for inputs including staff, consultants, goods and services and training. May appoint an alternate that can support the project work in the absence of the government focal point (Project Director).
- Will represent the National Executing Agencies at project meetings and annual reviews.
- Will lead efforts to build partnerships for the support of outcomes indicated in the project document.
- Will support resource mobilization efforts to increase resources in cases where additional outputs and outcomes are required.

The project will hire a **Project Manager (PM)** who will work under the supervision of the Project Director and UNDP Environment Programme Office to ensure cost efficient, technical and administrative project operations. The PM will be supported by a technical consultant who will provide advice and support on any technical aspects, in particular the reviewing and drafting of Terms of Reference and reviewing the outputs of consultants and other subcontractors.

Working closely with and through the PB, the UNDP Country Office (UNDP-CO) will be responsible for: (i) providing financial and audit services to the project; (ii) recruitment of project staff and contracting of consultants and service providers; (iii) overseeing financial expenditures against project budgets approved by PB; (iv) appointment of independent financial auditors and evaluators; and (iv) ensuring that all activities including procurement and financial services are carried out in strict compliance with UNDP/GEF procedures. A UNDP staff member will be assigned with the responsibility for the day-to-day oversight and control over project deliveries. The overall management structure of the project is shown below:



Organization structure at the Central Level

A Project Board (PB) will be designated by ONEP and will serve as the project's governance and decision-making body. The PB, will comprise representatives of ONEP, DNP, RFD, RID, LDD, ALRO, UNDP and other relevant agencies. Representatives of civil society and academia will also be present on the PB. The PM will also be in attendance at PB meetings. It will meet as necessary, but not less than once every 6 months, to review project progress, approve project work plans (including budgets) and approve major project deliverables. The PB is responsible for ensuring that the project remains on course to deliver products of the required quality to meet the outcomes defined in the project document. The PB's role will include: (i) overseeing project

implementation; (ii) approving all project work plans and budgets, as put forward by the PM, for submission to the UNDP Country Office, and the GEF Unit in New York; (iii) approving any major changes in project plans or programmes; (iv) providing technical input and advice; (v) approving major project deliverables; (vi) ensuring commitment of resources to support project implementation; (vii) arbitrating any conflicts within the project and/or negotiating solutions between the project and any parties beyond the scope of the project; and (viii) overall project evaluation.

A Project Management Unit (PMU) will be set up to provide the day-to-day coordination and administration of the project. It will comprise the Project Manager (PM) and the Project Assistant. The project staff will be recruited using standard UNDP recruitment procedures. The PM, will assume the lead responsibility for the upstream elements of the project (primarily Outcome 3), as well as provide oversight and coordination of site-level actions, in close collaboration with the Field Coordination Team.

The PMU, while assuming responsibility for the upstream activities, will provide advice, support and coordination for all project activities. The PM will liaise and work closely with all partner institutions to link the project with complementary national programmes and initiatives. The PM is accountable to the PB for the overall quality, timeliness and effectiveness of the activities carried out, as well as for the use of funds. The PM will collate the input from the key task forces and produce Annual Work and Budget Plans to be approved by the PB at the beginning of each year. These plans will provide the basis for allocating resources to planned activities. The PM will further produce collated quarterly operational reports and Annual Progress Reports (APR/PIR) for submission to the PB. These reports will summarize the progress made by the project against the expected results, explain any significant variances, detail the necessary adjustments and be the main reporting mechanism for monitoring project activities.

Technical Advisory Group will provide technical advice and guidance to the PMU and task forces as well as to support the project board's decision specific issues. The project will ask the existing structure of the National Technical Wetlands Working Group under the National Wetland Management Committee to assume this role to create synergy and policy linkages. Representatives from the GEF project "Integrated community-based forest and catchment management through an ecosystem service approach (CBFCM)", the GEF project "Catalyzing sustainability of Thailand's Protected Area System", the Royally-Initiated Pak Panang River Basin Development project, the IFAD-GEF regional project "Rehabilitation and Sustainable Use of Peat land Forests in South-East Asia", and the GEF-ADB Greater Mekong Subregion Forests and Biodiversity Program will be invited to meetings of the Technical Advisory Group.

Project Assurance function will be performed by UNDP Thailand and UNDP Asia Pacific Regional Centre (APRC). The function supports the Project Board by carrying out objective and independent project oversight and monitoring functions. The role ensures appropriate project management milestones are managed and completed. Project Assurance has to be independent of the Project Manager; therefore the Project Board cannot delegate any of its assurance responsibilities to the Project Director or the Project Manager. UNDP will be responsible for Project oversight, ensuring milestones are achieved. It will undertake financial and technical monitoring, as part of its oversight functions. In addition, UNDP will be responsible for: (i) coordinating with UN Country Team in Thailand with a view to mainstreaming in their interventions at the country level and funding as appropriate; (ii) establishing an effective networking between project stakeholders, specialized international organizations and the donor

community; (iii) facilitating networking among the country-wide stakeholders and south-south exchange.

Organization structure at the Site Level

A **Field Coordination Office** will be established to be responsible for site-level activities under Outcome 1 and Outcome 2 with the support, guidance and overall coordination of the PMU. The office will comprise 1 Field Coordinator, 2 Field Outreach Staff, and 1 Field Assistant. The Field Coordinator will be reporting to the Project Director and Project Manager.

A **Provincial Working Group** (PWG) will be set up, consisting of representatives from Thale Noi NHA, Bor Lor NHA, Fire Protection Unit, DNP Regional Office 5 and 6, RID, The Royally-Initiated Pak Panang River Basin Development, Provincial MONRE of Nakhon Si Thammarat, Phatthalung, and Songkla Provinces, Provincial ALRO (Nakhon Si Thammarat), Provincial MOAC (Nakhon Si Thammarat), CSOs, and Local Academic Institutions. In addition, the Integrated Provincial Committee (IPC) in Nakhon Si Thammarat and Songkhla Provinces (where the EPAs will be established), will be engaged in the project from the start as an advisory body to the provincial working group. The PWG will be chaired by the Governor of Nakhon Si Thammarat Province or his designee, as it is where the majority of the KKL is. But the representatives on the PWG will be from the adjacent provinces as well. The working group will serve as a coordination platform to guide and support the field coordination office and the works of Task Force # 1 and Task Force # 2. Members of PWG will also work on the two task forces in accordance with their organizational mandates and responsibilities.

6. MONITORING FRAMEWORK AND EVALUATION

The project will be monitored through the standard M&E activities and allowances have been made for this in the M&E budget as in the table below.

The Inception Phase

A Project Inception Workshop will be held within the first two months of project start with the participation of those with assigned roles in the project organization structure, the UNDP country office and, where appropriate/feasible, regional technical policy and programme advisors as well as other stakeholders. The Inception Workshop will serve to explain the Logical Framework to stakeholders, build ownership for the project results and plan the first year annual work plan. The **Inception Workshop** will address a number of key issues including:

- Assist all partners to fully understand and take ownership of the project. Detail the roles, support services and complementary responsibilities of UNDP CO and RCU staff vis à vis the project team. Discuss the roles, functions, and responsibilities within the project's decision-making structures, including reporting and communication lines, and conflict resolution mechanisms. The Terms of Reference for project staff will be discussed again as needed.
- Based on the project results framework and the relevant GEF Tracking Tool if appropriate, finalize the first annual work plan. Review and agree on the indicators, targets and their means of verification, and recheck assumptions and risks.
- Provide a detailed overview of reporting, monitoring and evaluation (M&E) requirements. The Monitoring and Evaluation work plan and budget will be agreed and scheduled.

- Discuss financial reporting procedures and obligations, and arrangements for annual audit.
- Plan and schedule Project Board meetings. Roles and responsibilities of all project organisation structures will be clarified and meetings planned. The first Project Board meeting will be held within the first 12 months following the Inception Workshop.

The Inception Workshop Report will serve as a key reference document and will be prepared and shared with participants to formalize various agreements and plans decided during the meeting.

Monitoring and Reporting Responsibilities and Events

On a quarterly basis –

- Progress made will be monitored in the UNDP Enhanced Results Based Management Platform.
- Based on the initial risk analysis submitted, the risk log will be regularly updated in ATLAS. Risks become critical when the impact and probability are high. As this is a UNDP GEF project, all financial risks associated with financial instruments such as the proposed microfinance scheme for AIGs, are automatically considered as critical on the basis of its innovative nature (high impact and uncertainty due to no previous experience justifies classification as critical).
- Based on the information recorded in ATLAS, a Project Progress Report (PPR) will be generated in the Executive Snapshot.
- Other ATLAS logs will be used to monitor issues, lessons learned, etc. The use of these functions is a key indicator in the UNDP Executive Balanced Scorecard.

On an annual basis –

Annual Project Review/Project Implementation Reports (APR/PIR): This key report will monitor progress made since project start and in particular for the previous reporting period (30 June to 1 July). The APR/PIR combines both UNDP and GEF reporting requirements.

The APR/PIR includes, but is not limited to, reporting on the following:

- Progress made toward project objective and project outcomes - each with indicators, baseline data and end-of-project targets (cumulative)
- Project outputs delivered per project outcome (annual).
- Lesson learned/good practice.
- AWP and other expenditure reports
- Risk and adaptive management
- ATLAS QPR
- Portfolio level indicators (i.e. GEF focal area tracking tools namely the Management Effectiveness Tracking Tool, Tracking Tool for Climate Change Mitigation Projects, and the Tracking Tool for SFM/REDD-Plus Projects).

Periodic Monitoring through site visits –

UNDP CO and the UNDP RCU will conduct visits to project sites based on the agreed schedule in the project's Inception Report/Annual Work Plan to assess first hand project progress. Other members of the PB may also join these visits. A Field Visit Report/BTOR will be prepared by

the CO and UNDP RCU and will be circulated no less than one month after the visit to the project team and PB members.

Project Terminal Report

During the last three months, the project team will prepare the Project Terminal Report. This comprehensive report will summarize the results achieved (objectives, outcomes, outputs), lessons learned, problems met and areas where results may not have been achieved. It will also lay out recommendations for any further steps that may need to be taken to ensure sustainability and replicability of the project's results. The Project Terminal Report will be available, at least in draft, for the Terminal Evaluation.

Learning and knowledge sharing

Results from the project will be disseminated within and beyond the project intervention zone through existing information sharing networks and forums.

The project will identify and participate, as relevant and appropriate, in scientific, policy-based and/or any other networks, which may be of benefit to project implementation through lessons learned. The project will identify, analyze, and share lessons learned that might be beneficial in the design and implementation of similar future projects.

Finally, there will be a two-way flow of information between this project and other projects of a similar focus.

Communications and visibility requirements

Full compliance is required with UNDP's Branding Guidelines. These can be accessed at <http://intra.undp.org/coa/branding.shtml>, and specific guidelines on UNDP logo use can be accessed at: <http://intra.undp.org/branding/useOfLogo.html>. Amongst other things, these guidelines describe when and how the UNDP logo needs to be used, as well as how the logos of donors to UNDP projects needs to be used. For the avoidance of any doubt, when logo use is required, the UNDP logo needs to be used alongside the GEF logo. The GEF logo can be accessed at: http://www.thegef.org/gef/GEF_logo. The UNDP logo can be accessed at <http://intra.undp.org/coa/branding.shtml>.

Full compliance is required with the GEF's Communication and Visibility Guidelines (the "GEF Guidelines"). The GEF Guidelines can be accessed at: http://www.thegef.org/gef/sites/thegef.org/files/documents/C.40.08_Branding_the_GEF%20final_0.pdf. Amongst other things, the GEF Guidelines describe when and how the GEF logo needs to be used in project publications, vehicles, supplies and other project equipment. The GEF Guidelines also describe other GEF promotional requirements regarding press releases, press conferences, press visits, visits by Government officials, productions and other promotional items.

Where other agencies and project partners have provided support through co-financing, their branding policies and requirements should be similarly applied.

Independent Evaluations and Audits

Mid-term of project cycle – The project will undergo an independent Mid-Term Evaluation at the mid-point of project implementation. The Mid-Term Review will determine progress being made toward the achievement of outcomes and will identify course correction if needed. It will focus on the effectiveness, efficiency and

timeliness of project implementation; will highlight issues requiring decisions and actions; and will present initial lessons learned about project design, implementation and management. Findings of this review will be incorporated as recommendations for enhanced implementation during the second half of the project's term. The organization, terms of reference and timing of the mid-term evaluation will be decided after consultation between the parties to the project document. The Terms of Reference for this Mid-term evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF. The management response and the evaluation will be uploaded to UNDP corporate systems, in particular the UNDP Evaluation Office Evaluation Resource Center (ERC).

The relevant GEF Focal Area Tracking Tools (namely the Management Effectiveness Tracking Tool, Tracking Tool for Climate Change Mitigation Projects, and the Tracking Tool for SFM/REDD-Plus Projects) will also be completed during the mid-term evaluation cycle.

End of Project – An independent Terminal Evaluation will take place three months prior to the final PEB meeting and will be undertaken in accordance with UNDP and GEF guidance. The final evaluation will focus on the delivery of the project's results as initially planned (and as corrected after the mid-term evaluation, if any such correction took place). The final evaluation will look at impact and sustainability of results, including the contribution to capacity development and the achievement of global environmental benefits/goals. The Terms of Reference for this evaluation will be prepared by the UNDP CO based on guidance from the Regional Coordinating Unit and UNDP-GEF.

The Terminal Evaluation should also provide recommendations for follow-up activities and requires a management response which should be uploaded to PIMS and to the UNDP Evaluation Office Evaluation Resource Center (ERC).

The relevant GEF Focal Area Tracking Tools namely the Management Effectiveness Tracking Tool, Tracking Tool for Climate Change Mitigation Projects, and the Tracking Tool for SFM/REDD-Plus Projects will also be completed during the final evaluation.

M&E Work plan and Budget

Type of M&E activity	Responsible Parties	Budget US\$ <i>Excluding project team staff time</i>	Timeframe
Inception Workshop and Report	<ul style="list-style-type: none"> PM UNDP CO, UNDP GEF 	Indicative cost: US\$ 10,000	Within first three months of project start up
Setting of Baselines and end of project Targets together with Means of Verification of project results	<ul style="list-style-type: none"> UNDP CO/PM will oversee the hiring of specific surveys, studies and institutions, and delegate responsibilities to relevant team members. 	To be finalized in Inception Phase and Workshop	Start, mid and end of project (during evaluation cycle) and annually when required.
Measurement of Means of Verification for Project Progress on <i>output and implementation</i>	<ul style="list-style-type: none"> Oversight by PM Project team 	To be determined as part of the Annual Work Plan's preparation.	Annually prior to ARR/PIR and to the definition of annual work plans
ARR/PIR	<ul style="list-style-type: none"> PM and team UNDP CO UNDP RTA UNDP EEG 	None	Annually
Periodic status/ progress reports	<ul style="list-style-type: none"> PM and team 	None	Quarterly

Type of M&E activity	Responsible Parties	Budget US\$ <i>Excluding project team staff time</i>	Timeframe
Mid-term Review	<ul style="list-style-type: none"> PM and team UNDP CO UNDP RCU External Consultants (i.e. evaluation team) 	Indicative cost: US\$ 18,000	At the mid-point of project implementation.
Final Evaluation	<ul style="list-style-type: none"> PM and team UNDP CO UNDP RCU External Consultants (i.e. evaluation team) 	Indicative cost : US\$ 18,000	At least three months before the end of project implementation
Project Terminal Report	<ul style="list-style-type: none"> PM and team UNDP CO 	None	At least three months before the end of the project
Micro Assessment	<ul style="list-style-type: none"> UNDP CO PM and team 	Indicative cost per year: US\$ 3,100	Year 1
Audit	<ul style="list-style-type: none"> UNDP CO PM and team 	Indicative cost per year: US\$ 6,000	Year 3
Visits to field sites	<ul style="list-style-type: none"> UNDP CO UNDP RCU (as appropriate) Government representatives 	For GEF supported projects, paid from IA fees and operational budget	Yearly
TOTAL indicative COST Excluding project team staff time and UNDP staff and travel expenses		US\$ 55,100	

7. LEGAL CONTEXT

The Royal Thai Government and the United Nations Special Funds have entered into the Agreement to govern assistance from the Special Fund to Thailand, which was signed by both parties on 04 June 1960. Pending the finalization of the Standard Basic Assistance Agreement (SBAA) between UNDP and the Government, the Agreement will govern the technical assistance provided by UNDP Thailand under the Country Programme Document (2012-2016).

Under the UNDP-funded programmes and projects, the responsibility for the safety and security of the implementing partner and its personnel and property, and of UNDP's property in the implementing partner's custody, rests with the implementing partner in accordance with the aforementioned Agreement between the UN Special Fund and the Government of Thailand concerning Assistance from the Special Fund 1960.

The implementing partner shall:

- put in place an appropriate security plan and maintain the security plan, taking into account the security situation in the country where the Programme is being carried;
- assume all risks and liabilities related to the implementing partner's security, and the full implementation of the security plan.

UNDP reserves the right to verify whether such a plan is in place, and to suggest modifications to the plan when necessary. Failure to maintain and implement an appropriate security plan as required hereunder shall be deemed a breach of this agreement.

The implementing partner agrees to undertake all reasonable efforts to ensure that none of the UNDP funds received pursuant to the Programme Document are used to provide support to individuals or entities associated with terrorism and that the recipients of any amounts provided by UNDP hereunder do not appear on the list maintained by the Security Council Committee

established pursuant to resolution 1267 (1999). The list can be accessed via <http://www.un.org/Docs/sc/committees/1267/1267ListEng.htm>. This provision must be included in all sub-contracts or sub-agreements entered into under this Programme Document.

8. AUDIT CLAUSE

The Audit will be conducted in accordance with UNDP Financial Regulations and Rules and applicable audit policies on UNDP projects.

ANNEX 1: AREA ESTIMATES OF PEATLANDS IN THAILAND

Peat Swamp Forest: 64,554.62 ha (Nuyim 2005, citing Chukwamdee et al. 1999)

Tropical peatland: 638 km² (Page et al. 2011, citing Urapeepatanapong and Pitayakajornwute 1996)

Tropical peat swamp lands: 56,475 ha (Yoshino et al. 2010, based on satellite images)

Peatlands (organic layers more than 40 cm thick): 453 km² (Nagano et al. 2013)

Peat swamp: 453 km² (Ueda et al. 2000, citing Vijarnsorn 1996)

Peatlands (peat layer \geq 30 cm): 631 km² (Joosten 2009) (Joosten 2009 gives the number of 680 km² for 1990, and 631 km² for 2008.

Pre-development area of Tropical Peatlands: 68,000 ha (Rieley et al. 2008, citing Rieley et al. 1996)

Organic soils: 680 km² (Andriesse 1988, citing Bord na Mona 1984)

Peat swamps: 640 km² (Vijarnsorn and Liengsakul 1986, citing Soil Survey Division. 1976), but authors give the number of 453 km² for 1996

Posa *et al* (2011) state that the current precise extent and condition of tropical peatlands in Southeast Asia is still unclear, as accurate delineation of peat soil is difficult and many areas have already been lost or degraded. Using published estimates from various sources, they calculated that a maximum of 36.8% of the historical peat swamp forest area remains (*Table 1*).

Table 1. Estimates of major peat swamp forest area (in ha) in SE Asia (Posa et al., 2011).

Region	Initial Area (ha)	Remaining (ha)	% remaining	Protected (ha)	% Protected
Indonesia					
Sumatra	8.252.500	2.562.200	31.1	721.200	8.7
Kalimantan	6.787.600	3.160.600	46.6	763.200	11.2
Sulawesi	311.500	1.800	0.6	30.000	9.6
Malaysia					
Peninsular	984.500	249.200	25.3	44.400	4.5
Sabah and Sarawak	1.746.000	632.800	36.2	98.400	5.6
Brunei	104.000	87.300	83.9	21.800	21.0
Thailand	68.000	30.400	44.7	20.600	30.3
SE Asia Total*	18.254.100	6.724.300	36.8	1.699.500	9.3

Page *et al* (2010) have also published their best estimates of peat area, thickness and volume as shown in *Table 2*.

Table 2. Best estimates of peat area, mean thickness and volume of peat in tropical Southeast Asia

Country	Peat area (ha)	Peat thickness (average) (m)	Volume (m ³ *10 ⁶)
Indonesia	20.695.000	5.5	1138225
Brunei	90.900	7	6363
Malaysia	2.588.900	7	181223
Myanmar (Burma)	122.800	1.5	1842
Papua New Guinea	1.098.600	2.5	27465
Philippines	64.500	5.3	3418.5
Thailand	63.800	1	638
Vietnam	53.300	0.5	266.5

References (including those cited by the authors above)

- Andriesse, J.P., 1988. Nature and management of tropical peat soils. FAO Soils Bulletin 59. FAO, Rome, 179 pp. (<http://www.fao.org/docrep/x5872e/x5872e00.htm#Contents>)
- Bord na Mona. 1984. Fuel peat in developing countries. Study report for World Bank, Dublin.
- Chukwamdee J, Anansiriwat A, Meepol W, Jintanugool J, Havanon S. 1999. Study on Distribution of Peat Swamp Forests in Thailand. J. Thai Forestry Research 1: 23-32. (in Thai, cited by Nuyim 2005)
- Joosten, H., 2009. The Global Peatland CO₂ Picture. Wetlands International, Ede, 33 pp. (https://unfccc.int/files/kyoto_protocol/application/pdf/draftpeatlandco2report.pdf)
- Nagano T, Osawa K, Ishida T, Sakai K, Vijarnsorn P, Jongskul A, Phetsuk S, Waijaroen S, Yamanoshita T, Norisada M, Kojima K. 2013. Subsidence and soil CO₂ efflux in tropical peatland in southern Thailand under various water table and management conditions. Mires and Peat 11 (06): 1–20.
- Nuyim T. 2005: Manual on Peat Swamp Forests Rehabilitation and Planting in Thailand. (in English. Thai-version published in 2003)
- Page S, Wust R, & Banks C 2010 Past and present carbon accumulation and loss in southeast Asian peatlands. In: Scientific Highlights: Peatlands Pages News. Vol 18, No 1.
- Page SE, Rieley JO, Banks CJ. 2011. Global and regional importance of the tropical peatland carbon pool. Global Change Biology 17: 798–818.
- Posa M R C, Wijedasa L S, & Corelth R T 2011. Biodiversity and Conservation of Tropical Peat Swamp Forests. BioScience 61: 49-57. doi: 10.1525/bio.2011.61.1.10.
- Rieley, JO, Ahmad-Shah, A-A, Brady, MA 1996. The extent and nature of tropical peat swamps, In Tropical Lowland Peatlands of Southeast Asia, Proceedings of a Workshop on Integrated Planning and Management of Tropical Lowland Peatlands, Cisarua, Indonesia, 3-8 July 1992, Maltby, E, Immirzi, CP, Safford, RJ (eds.), IUCN, Gland, Switzerland, x + 294 pp.
- Rieley JO, Wüst RAJ, Jauhiainen J, Page SE, Wösten H, Hooijer A, Siebert F, Limin SH, Vasander H, Stahlhut M. 2008. Tropical peatlands: carbon stores, carbon gas emissions and contribution to climate change processes. In: Peatlands and Climate Change (ed. Strack M), pp. 148–181. International Peat Society, Jyväskylä, Finland.
- Soil Survey Division. 1976. Soil Survey Report of Narathiwat Province. Soil Survey Div., Dept. of Land Development, Bangkok, Thailand (in Thai).
- Uraepatanapong C, Pitayakajornwute P. 1996. The peat swamp forests of Thailand. In: Tropical Lowland Peatlands of Southeast Asia, Proceedings of a Workshop on Integrated Planning and Management of Tropical Lowland Peatlands, Cisarua, Indonesia, 3–8 July 1992 (eds Maltby E, Immirzi CP, Safford RJ), pp. 119–128. IUCN, Gland, Switzerland.
- Vijarnsorn and Liengsakul. 1986. Formation and characterization of the peat swamps in Narathiwat Province, Peninsular Thailand. Department Of Mineral Resources.
- Vijarnsorn P. 1996. Soil ecosystem of the coastal wetlands in Thailand. NODAI Research Institute, Tokyo University of Agriculture, Tokyo
- Yoshino K, Ishida T, Nagano T, Setiawan Y. 2010. Landcover Pattern Analysis of Tropical Peat Swamp Lands in Southeast Asia. International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science, Volume XXXVIII, Part 8, Kyoto Japan: 941-946.

ANNEX 2: GREENHOUSE GAS EMISSIONS FROM KUAN KRENG PEATLANDS – KNOWLEDGE AND GAPS

The area estimates for the peatlands of Thailand differ between 453 km² and 645 km² (Kyuma 1995; Nuyim 2005; Joosten 2009; Yoshino et al., 2010; Page et al., 2011; Nagano et al., 2013). Peatland in Thailand is restricted to regions with more than 2000 mm annual precipitation and more than eight humid months per year, i.e. Tart and most of the southern provinces from Chumphon to Narathiwat (Kyuma, 1995, Nuyim 2005, Pfeffer 2013). The largest peatland areas are in Narathiwat, followed by Nakhon Si Thammarat, at the transition between tropical monsoon climate and tropical rainforest climate (Kyuma, 1995). Peatlands in Narathiwat formed when the sea level dropped and lagoons became dominated by freshwater and overgrown first by herbaceous plants and later by swamp forest (Vijarnsorn 1986, Kyuma, 1995).

Since the 1970's peat swamp forests have been logged, drained, and converted to agricultural land (Vijarnsorn 1986; Kyuma 1995). Today only 90 km² of them are still undisturbed, situated mainly in To Daeng, Narathiwat (Nuyim 2005). First international research programs started in the 1990's addressing the impact of peatland degradation on vegetation, soil, and matter dynamics, including Greenhouse gases, and ways to restore the peat swamp forests (Vijarnsorn et al., 1995; Nuyim, 2005). Most studies were conducted in the largest peatlands of Narathiwat; Bacho (drained and prepared for agriculture since 1975) and To Daeng (mostly not drained, protected peat swamp forest). A first Thai-Japanese research project in Kuan Kreng started recently, focusing on economical, ecological and climate change mitigation aspects of *Melaleuca cajuputi* production (Norisada 2014, pers. communication).

Kuan Kreng is only about 260 km north from Bacho and To Daeng, has similar climatic conditions and seems also to have been developed from closed lagoons. The seasonal change between flooded and dry conditions is found for secondary peat swamp forest in both regions. Lacking detailed studies on GHG emissions from peatlands in Kuan Kreng it therefore obvious to learn from the research projects in Bacho and To Daeng. Miyajima et al. (1997) state that the peatlands in Narathiwat have been originally (before drainage) ombrotrophic, i.e. bogs. Kuan Kreng, in contrast, is a lowland reminding on a huge floodplain, intersected by numerous rivers and channels, and it is difficult to think of bogs having been found here in former times. Tropical bogs are restricted to perhumid conditions, they can still occur in regions with dry season (monthly precipitation < 100 mm) of two months, but four months with precipitation < 100 mm, as found in Narathiwat and Kuan Kreng landscape, is not suitable for bogs (Dommain 2014, pers. communication). So, peatlands of Narathiwat and Kuan Kreng are probably all minerotrophic (fens), supporting the decision to learn from Bacho and To Daeng for the Kuan Kreng peatlands.

In the following paragraphs we give an overview on the knowledge on CO₂, CH₄, N₂O and DOC emissions from Bacho and To Daeng, and draw conclusions for Kuan Kreng.

Carbon dioxide (CO₂)

Annual peat subsidence rates have been monitored since 1983 at Bacho peatland five locations and show a clear relation with mean annual water levels; i.e. 2.6 cm yr⁻¹ for the driest (mean WT = -29.7 ± 38.0 cm) and 0.7 cm yr⁻¹ for the wettest (mean WT = 8.0 ± 26.8 cm) site (Nagano et al.

2013). Based on a mean bulk density of 0.18 g cm^{-3} , organic matter fraction of 0.8 g g^{-1} , and carbon of organic matter fraction of 0.5 g C g^{-1} (Nagano et al. 2013) this equals emission rates of $18.72 \text{ t CO}_2\text{-C ha}^{-1} \text{ yr}^{-1}$ from the driest and $5.04 \text{ ha}^{-1} \text{ yr}^{-1}$ from the wettest site. The lower value is similar to that given by IPCC (2014) for “Forest Land and cleared Forest Land (shrubland), drained”, and the higher one for “Plantations, drained, unknown or long rotations”. A relation between mean annual water table depth and subsidence rates was also found by Hooijer et al. (2012) for peat domes in Indonesia. At Kuan Kreng peatlands water levels are very different between dry and wet seasons and a mean annual water level may not be sufficient to serve as proxy for subsidence rates and annual CO_2 emissions. This is indicated by short term measurements of soil CO_2 efflux by Nagano et al. (2013) at Bacho showing that CO_2 efflux from soil was very low during flooding, increased more than seven times when the water level dropped to -30 cm , but did not further increase when the water level dropped deeper. From this relation Nagano et al. (2013) developed a model to calculate CO_2 efflux from peat mineralization when water level, bulk density and soil organic carbon content are known. This works surprisingly well for the long time record of subsidence and water level measurements at Bacho, despite the fact, that several land-use types with probably different CO_2 emission rates occurred in this period at Bacho and recent short term soil CO_2 efflux cannot be regarded representative for the total period. Hooijer et al. (2012), for example, found that relations between annual water level and CO_2 emissions were different for deforested sites, drained forests and plantations. However, both studies show that water levels can be used in the GEF project as proxy for CO_2 emissions when calibrated with subsidence and CO_2 emission data for the peatlands at Kuan Kreng. Subsidence measurements can also help to quantify soil CO_2 emissions from wildfire (Nagano et al. 2013). For baseline and project emissions calculations we did not to use the numbers of Nagano et al. (2013), because of differences in land-use and wildfire between Bacho and Kuan Kreng. Instead we applied IPCC (2014) values which are averages of a significant number of measurements and site types.

Net CO_2 exchange rates of a pristine peat swamp forest (To Daeng) and secondary peat swamp forest (Bacho) were measured continuously with the concentration gradient method and periodically with the relaxed eddy accumulation method by Suzuki et al. (1999). Both forest types were similar carbon sinks, the pristine, mature peat swamp forest sequestered $5.32 \text{ t CO}_2\text{-C ha}^{-1} \text{ yr}^{-1}$, and the young *Melaleuca cajuputi* secondary forest $5.22 \text{ t CO}_2\text{-C ha}^{-1} \text{ yr}^{-1}$. The relation between measured CO_2 exchange and solar radiation did not differ for the primary forest between season, while it was changing for secondary forest between rainy, dry, and intermediate season, pointing again to the importance of the water level. The results strongly depend on the actual tree growth (Suzuki et al. 1999) and can therefore not easily be transferred to Kuan Kreng. Separation of the annual balance between tree and soil CO_2 exchange is beyond the applied methods and require additional monitoring of biomass growth and heterotrophic respiration (cf. Lohila et al. 2007; Mäkiranta et al. 2007).

CO_2 emission measurements with chambers (Vijarnsorn et al. 1995) at pristine peat swamp forest (To Daeng) and secondary peat swamp forest (Bacho) resulted in large emissions at both ($6.7\text{--}17.9 \text{ t CO}_2\text{-C ha}^{-1} \text{ yr}^{-1}$ for pristine and $2.7\text{--}3.3 \text{ t CO}_2\text{-C ha}^{-1} \text{ yr}^{-1}$ for secondary peat swamp forest). At least for the pristine peat swamp forest this is not plausible and probably caused by not excluding autotrophic respiration from tree roots.

Methane (CH₄)

Vijarnsorn et al. (1995) studied 1993 and 1994 methane emissions from primary peat swamp forest (To Daeng), secondary peat swamp forest (Bacho), and a loamy paddy field (Pikurnthong) and arrived at very high values of 125 to 309 kg CH₄-C ha⁻¹ yr⁻¹, 118 to 177 kg CH₄-C ha⁻¹ yr⁻¹, and 72 to 99 kg CH₄-C ha⁻¹ yr⁻¹, respectively. This is much higher than the IPCC EF for rewetted tropical peatlands, what is 41 (7 – 134) kg CH₄-C ha⁻¹ yr⁻¹ (IPCC 2014). It is not clear where the differences come from. Therefore we decided to use the IPCC (2014) default values for the project and baseline emission scenarios but recommend to study methane emissions at Kuan Kreng during the main project.

Nitrous oxide (N₂O)

According to IPCC (2014) nitrous oxide (N₂O) emissions are low in tropical peatlands. There are no published N₂O emission values for peatlands of Thailand but it cannot be excluded that N₂O emissions from Kuan Kreng peatlands differ from the IPCC (2014). The dry-wet seasonal cycle has a strong impact on N₂O production indicated by strongly increasing concentrations of dissolved N₂O in the Bang Nara River (draining To Daeng) in the beginning of the flooding period (Boontanon et al. 2000).

For project- and baseline emission scenarios we used IPCC (2014) default values but recommend to conduct measurements of N₂O (simultaneously with CH₄) emissions at Kuan Kreng peatlands.

Dissolved organic carbon (DOC)

Dissolved organic carbon (DOC) forms in most peatlands the largest component of waterborne carbon export and should be accounted for in emission estimates (IPCC 2014). DOC export from pristine and rewetted tropical peatlands is similar for both, but lower as compared to drained peatlands (IPCC 2014). There are no studies on DOC export from peatlands in Thailand, but much higher DOC concentration in surface water of Bacho than of To Daeng (Yoshioka et al. 2002) indicate that lateral carbon losses are higher in drained as compared to wet peatlands. According to the findings of Moore et al. (2013) in the Sebangau River basin (Borneo) DOC export is higher in the rainy season as compared to the dry season. We suggest to regularly measure DOC concentrations in rivers draining Kuan Kreng to estimate the importance of DOC export and the impact of the seasonal wet-dry cycle.

References

- Boontanon N, Ueda S, Kanatharana P, and Wada E. 2000. Intramolecular Stable Isotope Ratios of N₂O in the Tropical Swamp Forest in Thailand. *Naturwissenschaften* 87:188–192.
- Hooijer A, Page S, Jauhiainen J, Lee WA, Lu XX, Idris A., Anshari G. 2012. Subsidence and carbon loss in drained tropical peatlands. *Biogeosciences* 9: 1053–1071.
- IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland.

- Joosten, H., 2009. The Global Peatland CO₂ Picture. Wetlands International, Ede, 33 pp.
(https://unfccc.int/files/kyoto_protocol/application/pdf/draftpeatlandco2report.pdf)
- Kyuma K. 1995. Climate, Landform, and Soil Conditions of the Narathiwat Province as the Background of the Swamp Forest Project. In: Vijarnsorn P, Suzuki K, Kyuma K, Wada E, Nagano T, and Takai Y (eds.) 1995. A Tropical Swamp Forest Ecosystem and Its Greenhouse Gas Emission. Reports of a New Program for Creative Basic Research Studies of Global Environmental Change with Special Reference to Asia and Pacific Regions, vol II-1. Nodai Research Institute, Tokyo University of Agriculture, Tokyo. pp. 9-16.
- Lohila A, Laurila T, Aro L, Aurela M, Tuovinen J-P, Laine J, Kolari P, and Minkkinen K. 2007. Carbon dioxide exchange above a 30-year-old Scots pine plantation established on organic-soil cropland. *Boreal Environment Research* 12: 141–157.
- Mäkiranta P, Jytönen J, Aro L, Maljanen M, Pihlatie M, Potila H, Shurpali NJ, Laine J, Lohila A, Martikainen PJ, and Minkkinen K. 2007. Soil greenhouse gas emissions from afforested organic soil croplands and cutaway peatlands. *Boreal Environment Research* 12: 159-175.
- Moore S, Evans CD, Page SE, Garnett MG, Jones TG, Freeman C, Hooijer A, Wiltshire AJ, Limin SH, Gauci V. 2013. Deep instability of deforested tropical peatlands revealed by fluvial organic carbon fluxes. *Nature* 493: 660-664.
- Miyajima T, Wada E, Hanba YT, and Vijarnsorn P. 1997. Anaerobic mineralization of indigenous organic matters and methanogenesis in tropical wetland soils. *Geochimica et Cosmochimica Acta* 61 (17): 3739-3751.
- Nagano T, Osawa K, Ishida T, Sakai K, Vijarnsorn P, Jongskul A, Phetsuk S, Waijaroen S, Yamanoshita T, Norisada M, Kojima K. 2013. Subsidence and soil CO₂ efflux in tropical peatland in southern Thailand under various water table and management conditions. *Mires and Peat* 11 (06): 1–20.
- Nuyim T. 2005: Manual on Peat Swamp Forests Rehabilitation and Planting in Thailand. (in English. Thai-version published in 2003)
- Page SE, Rieley JO, Banks CJ. 2011. Global and regional importance of the tropical peatland carbon pool. *Global Change Biology* 17: 798–818.
- Pfeffer K-H. 2013. Thailand's diverse landscapes. Gebrüder Borntraeger. Stuttgart. (in German)
- Suzuki S, Ishida T, Nagano T, Waijaroen S. 1999. Influences of Deforestation on Carbon Balance in a Natural Tropical Peat Swamp Forest in Thailand. *Environ. Control in Biol.* 37(2): 115-128
- Yoshioka T, Ueda S, Miyajima T, Wada E, Yoshida N, Sugimoto A., Vijarnsorn P, Boonprakub S. 2002. Biogeochemical properties of a tropical swamp forest ecosystem in southern Thailand. *Limnology* 3: 51–59.
- Vijarnsorn and Liengsakul. 1986. Formation and characterization of the peat swamps in Narathiwat Province, Peninsular Thailand. Department Of Mineral Resources.
- Vijarnsorn P, Suzuki K, Kyuma K, Wada E, Nagano T, and Takai Y (eds.) 1995. A Tropical Swamp Forest Ecosystem and Its Greenhouse Gas Emission. Reports of a New Program for Creative Basic Research Studies of Global Environmental Change with Special Reference to Asia and Pacific Regions, vol II-1. Nodai Research Institute, Tokyo University of Agriculture, Tokyo.
- Vijarnsorn P, Boonprakub S, Ueda S, Yoshioka T, Miyajima T, Sugimoto A, Yoshida N, and Wada E. 1995. Radiatively Active Gases in Tropical Swamp Forest and Wetland Soils III: Seasonal Variation in Narathiwat, Thailand in 1993 and 1994. In: Vijarnsorn P, Suzuki K, Kyuma K, Wada E, Nagano T, and Takai Y (eds.) 1995. A Tropical Swamp Forest Ecosystem and Its Greenhouse Gas Emission. Reports of a New Program for Creative Basic Research Studies of Global Environmental Change with Special Reference to Asia and Pacific Regions, vol II-1. Nodai Research Institute, Tokyo University of Agriculture, Tokyo. pp. 99-107.
- Yoshino K, Ishida T, Nagano T, Setiawan Y. 2010. Landcover Pattern Analysis of Tropical Peat Swamp Lands in Southeast Asia. *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Science*, Volume XXXVIII, Part 8, Kyoto Japan: 941-946.

ANNEX 3: CARBON POOL CONTAINED IN THE KKL PEAT SWAMPS

To estimate the soil organic carbon contained in the Kuan Kreng peat swamps we calculated

1. SOC density (g cm^{-3}) from SOC (wt%) and Dry Bulk density (g cm^{-3}),
2. SOC per horizon (g cm^{-2} horizon) by multiplying SOC density with horizon thickness (deep mineral layers without SOC data were excluded from this calculations),
3. SOC (t ha^{-1}) by summarizing the SOC of all horizons per site and extrapolating this to one ha
4. SOC (t site^{-1}) by extrapolation of SOC (t ha^{-1}) for site areas
5. SOC per ha for additional KK peat swamps were area averaged from the other sites, assuming that the area distribution of SOC will be similar for them
6. The total area of peat swamps in KKL is taken to be 42,572.93 ha which is the 2014 estimate provided by the Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the DNP.

Table 1: soil organic carbon in Kuan Kreng peat swamps

site	area (ha)	Soil description	Sample depth (cm)	SOC (wt%)	Dry Bulk density (g cm^{-3})	SOC density (g cm^{-3})	SOC per horizon depth (g cm^{-2})	SOC (t ha^{-1})	SOC (t site^{-1})
Kuan Ngoen 1	45	0-60 cm white fine sand	10	3.19	1.24	0.04	2.37	237	10652
		60-80 cm clay and silt with orange-brown patches					?		
Kuan Ngoen 2	45	0-40 cm mineral, loamy	10	3.25	1.39	0.05	1.81	181	8137
Suan Somdej Chao Fa Chulabhorn	240	0-20 cm peat with roots & leafs	10	41.45	0.22	0.09	1.84		
		20-60 cm peat with charcoal	35	64.84	0.20	0.13	5.29	1597	383194
		60-140 cm peat with wood	60	46.23	0.24	0.11	8.83		
Don Sai Forest	100	0-10 cm dark fine sand	5	5.37	1.03	0.06	0.55		
		10-30 cm grey loamy soil	20	1.41	1.43	0.02	0.40		
		40-80 cm brown loamy. organic	70	9.23	0.82	0.08	3.04	595	59480
		80-150 cm grey clay	140	3.14	0.89	0.03	1.95		
Grass Land	100	0-13 cm dark silt	5	5.16	0.82	0.04	0.55		
		13-26 cm dark silt with plant remains	20	4.82	0.78	0.04	0.49	284	28449
		26-51 cm organic rich clay	35	14.82	0.49	0.07	1.81		
NHA Bor Lor	600	0-15 cm organic with clay	5	32.01	0.25	0.08	1.20		
		15-60 cm dark organic with wood	20	35.62	0.21	0.07	3.37	457	274279
Baan Sai Kanoon	1600	0-8 cm dark organic with living roots	5	51.38	0.27	0.14	1.09		
		8-50 cm brown organic with wood	15	60.19	0.23	0.14	0.98	743	1189529
			30	48.71	0.21	0.10	3.53		
		50-75 cm dark peat	60	46.51	0.16	0.07	1.83		
		75-90 cm grey silt, fine sand, with plant remains					?		
		90-110 cm light grey/blue clay					?		

site	area (ha)	Soil description	Sample depth (cm)	SOC (wt%)	Dry Bulk density (g cm ⁻³)	SOC density (g cm ⁻³)	SOC per horizon depth (g cm ⁻²)	SOC (t ha ⁻¹)	SOC (t site ⁻¹)
Kuan Ki Sian Ramsar 1	215	0-15 cm clay-rich organic	5	13.70	0.61	0.08	1.26	733	157500
		15-70 cm organic, silty	30	12.95	0.57	0.07	4.09		
	850	70-80 cm dark, mineral with silt & clay					0.74		
		80-100 cm peat with wood	90	31.53	0.20	0.06	1.23		
		100-120 cm light grey, almost blue fine sand					?		
Kuan Ki Sian Ramsar 2	215	0-23 cm organic with sand, wood, charcoal	15	17.61	0.54	0.10	2.20	316	67931
		23-30 cm grey fine sand					0.67		
	850	35-38 cm black, organic, burned wood?					0.29		
		>38 cm light grey, silt, clay, sand					?		
Peninsular Botanical Garden Phatthalung	850	0-20 cm dark grey organic with clay, silt, and plant remains	5	5.27	0.65	0.03	0.34	670	569443
			10	5.82	0.69	0.04	0.40		
	850	20-40 cm dark, organic	30	15.63	0.51	0.08	1.60		
		40-60 cm peat with wood					1.25		
		60-110 cm peat	65	37.86	0.16	0.06	3.12		
remaining KK peat swamps	38562.93	110-120 cm clay-rich organic					?	685	26432368
total	42572.93								29180960

Total soil organic carbon in Kuan Kreng peat swamps: **29 Mt**

Without any site information we would estimate the carbon pool of 42572.93 ha tropical peatlands using literature values. Accordingly to Page et al. (2011) there are 0.032 Gt carbon in Thailand's peatlands. Page et al. (2011) calculated this from a total area of 638 km², a mean thickness of 1 m, bulk density of 0.09 g cm⁻³ and a carbon content of 56 wt%, what gives a carbon density of 0.0504 g SOC cm⁻³. Per ha this makes 504 t carbon, and for 42572.93 ha 21 Mt. The reason for the difference to our estimate is that the carbon density of 0.0504 g SOC cm⁻³ applied by Page et al. (2011) was lower as compared to most of our sample sites at Kuan Kreng landscape (Table 1). The high carbon density is probably also the reason for our estimate to be higher as compared to the value of 24 Mt given in the PIF.

Reference

Page SE, Rieley JO, Banks CJ. 2011. Global and regional importance of the tropical peatland carbon pool. *Global Change Biology* 17: 798–818.

ANNEX 4: BASELINE AND PROJECT SCENARIOS AND CALCULATION OF EMISSIONS AVOIDED BY THE PROJECT

Current situation

Project and baseline scenarios were developed starting from the present situation of the project sites (Table 1). This is:

- Of the 4,600 ha of the pilot sites, *Melaleuca cajuputi* forest cover 4300 ha, and cleared forest land from wildfire covers 300 ha
- Organic soils at most of the pilot sites with the exception of some areas such as Kuan Ngoen and Don Sai Forest
- Water level for most of the area and time more than 20 cm below surface, only during rainy season (November – February) above ground surface
- Wildfires burning on average 680 ha per year (0.91%) of the Kuan Kreng landscape (Table 2)
- IPCC 2014 Land-use category: Forest Land and cleared Forest Land (shrubland), drained

Table 1: Site characteristics

Site	Area (ha)	tree AGB (t C ha ⁻¹)	SOC in upper 30 cm (%)	SOC in upper 30 cm (t ha ⁻¹)	Water level	IPCC Land-use category
NHA Bor Lor	300	22.52	33.81	232.33	higher than 20 cm below surface	Tropical Rewetted organic soils
Don Sai Forest	100	33.30	2.73	95.69	eight months more than 20 cm below surface, four months (Nov-Feb) above surface	Forest Land and cleared Forest Land (shrubland), drained
Kuan Ngoen	90	39.81	3.22	126.99		
Suan Somdej Chao Fa	240	70.98	49.24	316.61		
Baan Sai	1300	12.21	57.84	417.18		
additional KK	2270	22.95	48.14	349.27		
Reforestation sites	300	0.00	57.84	417.18		

Remarks: AGB for Ngoen Kuan is the mean of two samples, each representing half of the area. Site characteristics at additional KK sites are similar to the other sites, and have been calculated as their area weighted averages. Reforestation sites are patches in Baan Sai Kanoon, i.e. the total of Baan Sai Kanoon is 1300 ha + 300 ha = 1600 ha.

Table 2: Fire Occurrences in Kuan Kreng landscape (74363 ha) during the past 10 years

Year	Rate Number	Area)ha(Months
2005	79	653.44	Aril - Sep
2006	15	44.48	Aug - Sep
2007	75	75.36	Aug - Sep
2008	28	61.76	Feb - Sep
2009	115	385.12	Jan - Sep

2010	330	3,049.44	Mar - Sep
2011	1	0.48	Aug
2012	120	1,900	Mar - Sep
2013	17	61.44	June - Sep
2014	85	566.8	Mar - Sep

Source: Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the Department of National Parks and Wildlife Conservation (DNP), 2014.

Baseline scenario

Without protection measures taken by the project the 4,600 ha will be subject to land-use changes, the most important being drainage, and land clearance for cultivation of oil palms. Between 2002 and 2013 the area of oil palm plantations increased from 2,200.48 to 9,622.82 hectares, i.e. by 10% of the Kuan Kreng landscape, while peat swamps decreased by about the same area (Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the Department of National Parks and Wildlife Conservation (DNP), 2014). This trend is increasing because of the growing demands in palm oil. At least 25% of the project area of 4600 ha is expected to become transformed to oil palms in the next 20 years. Reclamation of land for fruit orchards, integrated farming, and rubber plantation are also taking place, but on smaller levels. We did not include them, as well as drainage effects on adjacent areas and increased susceptibility of the land to wildfires in the baseline assessment, because these processes are difficult to quantify. By not including these threats we underestimate baseline emissions, resulting in conservative estimates of emissions avoided by the project. The baseline scenario is as follows:

- 25% of 4600 ha are drained, cleared and cultivated by oil palms, gradually, by 1.25% of the area per year, attaining 1150 ha in year 20.
- Fires are not expected to occur on oil palm plantations.
- Oil palm plantation carbon stock for every year that palms are present is 44 t C ha^{-1} , what is the time-average above ground C stock of 36 t C ha^{-1} plus $1/4 (8 \text{ t C ha}^{-1})$ below ground C stock (Agus et al. 2013).
- The share of not reclaimed land decreases during 20 years by 1.25% per year and will be 75% (3,450 ha) after 20 years.
- The situation at the not reclaimed land will not change, but will remain as described above (present situation). We did not include biomass increase in the baseline, though most forests are quite young, because of limited data on tree growth rates. This again leads to conservative estimates because forest is removed in the baseline at 25% of the land, but not in the project scenario (see below) and consequently carbon uptake by the forest in the project scenario would have been larger as compared to the baseline scenario.

Emission factors for baseline scenario

In the baseline there are two IPCC 2014 Land-use categories:

- Tropical Forest Land and cleared Forest Land (shrubland), drained
- Tropical Plantations, drained, oil palm

During the rainy season, when the land is flooded for four months, methane emissions are assumed to increase and therefore EFs for the land-use category Tropical Rewetted organic soils were used for all sites during that period, as recommended by IPCC (2014).

Project scenario

The project will prevent land conversion to oil palm plantation at 100% of the area. It will also improve the hydrological situation over the entire area such that at least for 25% of the area water levels do not drop more than 20 cm below the ground surface. This is the threshold water level (20 cm) that is required to classify an area as falling under the IPCC 2014 land use category “tropical rewetted organic soils”. For the remaining 75% of the area, rewetting measures will also increase water levels but it is not possible to confirm that it will reach this threshold water level to be classified as the said IPCC land use category. The reasons are as follows. There is no elevation model and no spatial hydrological data for the 4,600 ha. Therefore it is not possible to calculate the effect of closing ditches and decreasing runoff by rivers and canals on the water level in the pilot sites. It is also unlikely that the project can establish year-round water levels that are close to the ground surface at the entire 4,600 ha. This is possible only for very flat areas, or by flooding. The target areas have a gentle relief of about 1-2 m, with some areas being slightly higher than others. To install here a water level that is year-round at or above the ground surface would be possible probably only by flooding of the land, but this would cause adjacent fields to be flooded as well. It is important to find a balance between the needs of the communities and that of the peatlands. Another complication is the high evapotranspiration that is, additional to drainage, responsible for the water level drop in the dry season. It is not clear how deep the water level will drop after closing ditches and decreasing runoff. Therefore, for estimating GHG emissions it cannot be assumed that the entire area can be classified as the IPCC 2014 land use category of “tropical rewetted organic soils”. It can be assumed that this desired water level (and hence desired land use category) can be realized at 25% of the pilot area of 4,600 ha. For the remaining 75%, rewetting measures will also increase the water level but it cannot be said with certainty that it will meet the 20 cm threshold water level. There will be some areas having water levels that are only slightly more than 20 cm below ground, and others, where it will be much deeper, and again others in between of both, i.e. a range of water levels. According to IPCC 2014, all would have the same emissions i.e., emission factor for drained tropical forested peatlands because it is below the 20 cm threshold. But in reality the emissions at a site with water levels 30 cm below surface will be lower as compared to a site with 90 cm deep water level. At the moment we do not have the basis to distinguish between both, but emission studies and calibration of water levels as proxy for GHG emissions under project component 2 will allow to estimate GHG emissions in more detail. Therefore, for estimating emissions in the project scenario it is assumed that only 25% of the pilot sites will reach this 20 cm water level threshold, even though measures to improve water levels will be placed at the entire 4,600 ha.

Melaleuca cajuputi is adapted to high water levels and will not die. Wildfires, however, cannot be excluded and are assumed to continue at pre-project rates, but they will only burn tree biomass, not the water saturated soil at the effectively rewetted 25% of the area. The situation on

the remaining 75% is expected to be the same as presently. Increasing tree biomass is only accounted for at the 300 ha reforestation area (see Annex 5: Carbon dioxide sink created by reforestation of 300 ha with native tree species), while the increase of the currently present *Melaleuca cajuputi* carbon stock is not included because of limited data on tree growth rates.

Emission factors for project scenario

In the project there are two IPCC 2014 Land-use categories:

- Tropical Forest Land and cleared Forest Land (shrubland), drained
- Tropical Rewetted organic soils

Table 3: IPCC Land-use categories and Emission Factors of the project area for baseline and project scenarios (IPCC 2014)

IPCC Land-use category	CO ₂ EF (t CO ₂ -C ha ⁻¹ yr ⁻¹)	DOC EF (t CO ₂ -C ha ⁻¹ yr ⁻¹)	CH ₄ EF (kg CH ₄ ha ⁻¹ yr ⁻¹)	(kg CH ₄ -C ha ⁻¹ yr ⁻¹)	N ₂ O EF (kg N ₂ O-N ha ⁻¹ yr ⁻¹)	Wildfire (drained peat) t d.m. ha ⁻¹
Tropical Forest Land and cleared Forest Land (shrubland), drained	5.30	0.82	4.90		2.40	353.00
Tropical Rewetted organic soils	0.00	0.51		41.00	0.00	0.00
Plantations, drained, oil palm	11.00	0.82	0.00		1.20	0.00

$$GHG_{soil} = CO_2 + DOC + CH_4^* + N_2O^* + Wildfire^{**}$$

* Global Warming Potential (GWP) 25 CO₂-eq. for CH₄ and 298 CO₂-eq. for N₂O emissions (IPCC 2007)

** Wildfire (drained peat) t d.m. ha⁻¹ * SOC (%) / 100 * 0.91 (% burned per year) / 100

Additional to soil GHG emissions there are emissions from above ground tree biomass due to

- Wildfire (tree) CO₂ emissions = tree AGB (t C ha⁻¹) * area * 0.91 (% burned per year) / 100 (this occurs currently and cannot be excluded for the project scenario)
- Clearance (tree) CO₂ emissions = tree AGB (t C ha⁻¹) * area of clearance (this is relevant for the baseline scenario when trees are removed for oil palm plantations)

Table 4: Baseline scenario (not including oil palm carbon sink)

Site	Area (ha)	GWP at area that remains in current IPCC land use category, cf. Table 1 (t CO ₂ -eq ha ⁻¹ yr ⁻¹)	GWP at area that meets IPCC land use category “Plantations, drained, oil palm” (t CO ₂ -eq ha ⁻¹ yr ⁻¹)	site GWP (t CO ₂ -eq site ⁻¹ 20 yr ⁻¹)
NHA Bor Lor	300	3.99	48.03	58612.17
Don Sai Forest	100	25.53	50.01	57491.92
Kuan Ngoen	90	25.81	51.20	52454.45
Suan Somdej Chao Fa	240	32.27	56.91	170419.23
Baan Sai Kanoon	1300	31.32	46.14	864926.38
additional KK sites	2270	31.18	47.72	1490455.32
Reforestation sites	300	30.49	43.90	195711.24

Total baseline emissions (not including oil palm carbon sink): 2.890 Mt CO₂-eq

Total oil palm carbon sink: 0.097 Mt CO₂-eq

Total baseline emissions: 2.793 Mt CO₂-eq

Table 5: Project scenario (not including reforestation carbon sink):

Site	Area (ha)	GWP at area that remains in current IPCC land use category, cf. Table 1 (t CO ₂ -eq ha ⁻¹ yr ⁻¹)	GWP at area that meets IPCC land use category “tropical rewetted organic soils” (t CO ₂ -eq ha ⁻¹ yr ⁻¹)	site GWP (t CO ₂ -eq site ⁻¹ 20 yr ⁻¹)
NHA Bor Lor	300	3.99	3.99	23928.61
Don Sai Forest	100	25.53	4.35	40474.80
Kuan Ngoen	90	25.81	4.56	36896.02
Suan Somdej Chao Fa	240	32.27	5.60	122895.52
Baan Sai Kanoon	1300	31.32	3.64	634453.04
additional KK sites	2270	31.18	3.98	1084981.75
Reforestation sites	300	30.49	3.24	143967.34

Total project emissions (not including reforestation carbon sink): 2.088 Mt CO₂-eq

Reforestation carbon sink: 0.129 Mt CO₂-eq

Total project emissions: 1.959 Mt CO₂-eq

Emissions avoided by the project: baseline emissions minus project emissions = 0.834 Mt CO₂-eq.

The PIF estimated that project activities on 4,300 ha peat swamp forest would avoid emissions of 953,095 Mt CO₂-eq from peat oxidization, 546,137 t CO₂-eq from peat fires, and would create a carbon sink of 59,558 t CO₂-eq by reforestation of 300 ha, resulting in a total emission avoided by the project of 1,558,790 t CO₂-eq. That is nearly twice the result of the more detailed study presented above.

The area assumed in the baseline to be drained and converted to oil palm plantations in the PPG is: 25% of 4,600 ha = 1,150 ha. But the PPG study has shown that, in contrast to PIF assumptions, the project sites are not pristine primary peat swamp forests of ZERO emissions, but significantly degraded sites with secondary forests that suffer during the dry season from water shortage and have significant CO₂ emissions from peat oxidation and wildfire. Only 300 ha have a water level year-round at or above the water level and can be classified as IPCC land-use category “Tropical Rewetted organic soils”, while the water level at the remaining 4300 ha are “Forest Land and cleared Forest Land (shrubland), drained”. The project will improve the situation by putting in place measures to rewet the 4,600 ha and prevent drainage of the 300 ha wet soils, but due to relief of the pilot area and lack of elevation model and spatial hydrological data it can only be said with certainty that at least 25% of the area will have a water level high enough (less than 20 cm below surface) to be able to classify it as IPCC land use category “tropical rewetted organic soils”. Therefore the project emissions will not be ZERO, but 2.088 Mt CO₂-eq (see above).

Because of the same reason the baseline emissions are much higher, as compared to the PIF; not only the 25% land converted to oil palms represent a large GHG source, but the other 75% that are assumed to remain in current situation have significant emissions too. Other, but less important reasons for differences between PIF and present study are:

1. Carbon sequestration by trees was accounted for by the PIF only for the 300 ha reforestation in the project scenario, while the present study additional accounts for carbon sequestration by oil palms in the baseline scenario.
2. Carbon sequestration by reforestation of 300 ha was calculated in the PIF using default values from IPCC 2007 while the present study used local tree growth data of the species selected during the PPG.
3. Wildfire in the PIF was assumed to burn the soil organic matter at 0.85% of the area per year in the baseline, while the present scenario assumed, based on local fire statistics, that 0.91% of dry sites (but not oil palm plantations) would burn, in baseline and project situation.
4. The PIF accounted only for CO₂ emissions from peat oxidation and peat fire, what indeed are the largest sources (see Fig. 1). The present study also included emissions of CH₄, N₂O, and DOC export as well as deforestation by fire and for land-use change.
5. The PIF assumed 25% of the land to be immediately converted to oil palm plantations while the PPG results suggest that conversion will be gradually, at a rate of 1.25% per year.

Significance of GHG sources and their changes according to management

The main GHG source is the mineralization of soil organic carbon (Fig.1). It accounts for one third of the current GHG emissions. CO₂ efflux from the soil will increase in the baseline scenario. In the project scenario, in contrast, CO₂ efflux from the soil will be significantly reduced. The second largest current CO₂ source is burning of SOC by wildfires, accounting for one fifth of the emissions. This will be slightly reduced in both scenarios, but the reduction is stronger in the project scenario. DOC is the next by importance, but much smaller source, being

equal in current situation and baseline, and slightly smaller in the project scenario. As trees are removed for oil palm plantations in the baseline scenario, CO₂ emissions from deforestation by tree cutting and wildfire are higher in the baseline as compared to the current situation and project scenario. Methane emissions are lowest in the baseline and highest in the project scenario, but their impact on the GHG balance of the project sites is very small. Carbon sequestration by trees is not accounted for in the current situation. It is a significantly larger CO₂ sink in the project as compared to the baseline scenario. All together GHG emissions in the project scenario are 9.4 t CO₂-eq. ha⁻¹ yr⁻¹ lower as compared to the baseline scenario.

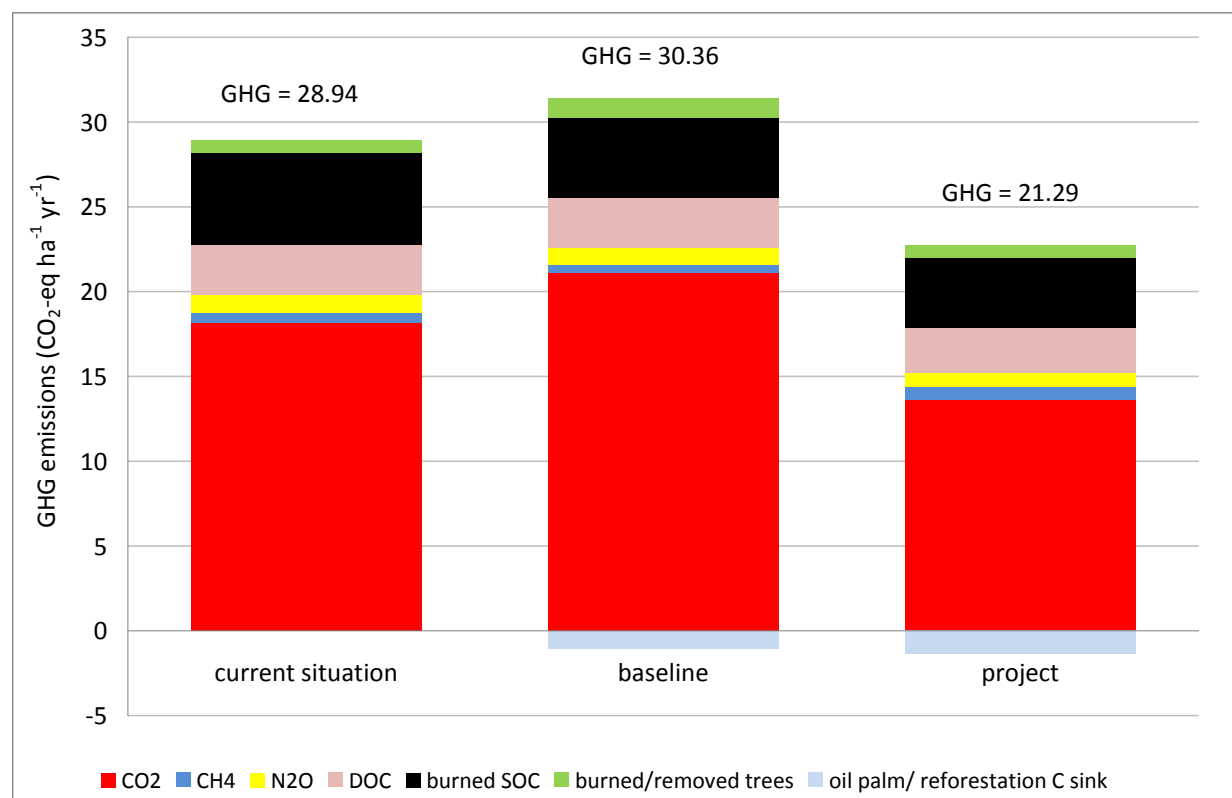


Figure 1: Average annual GHG exchange rates from relevant pools for current situation, baseline scenario, and project scenario per hectare and year (negative numbers indicate a sink, positive a source)

References

- Agus F, Henson IE, Sahardjo BH, Harris N, van Noordwijk M, and Killeen TJ. 2013. Review of emission factors for assessment of CO₂ emission from land use change to oil palm in Southeast Asia. Reports from the Technical Panels of the 2nd Greenhouse Gas Working Group of the Roundtable on Sustainable Palm Oil (RSPO).
- IPCC, 2007. Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.
- IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi, T., Krug, T., Tanabe, K., Srivastava, N., Baasansuren, J., Fukuda, M. and Troxler, T.G. (eds). Published: IPCC, Switzerland

Addendum to Annex 4: Are IPCC 2014 emission factors applicable to the soils of the pilot sites?

Soil conditions of the Kuan Kreng landscape and at Kanthulee differ in terms of content of soil organic carbon, nitrogen, and bulk density (Table 1). Emission factors given in IPCC 2014 are for organic soils, i.e. soils with soil organic carbon contents of more than 18 percent of dry weight (SOC > 18 wt%). Not all soils of the Kuan Kreng landscape meet this criteria. The SOC of the Community Forest Kuan Ngoen (90 ha) is about 3 wt% and the soils are per definition not organic (Table 1). The question therefore is: are IPCC 2014 emission factors applicable to the soils of the 4300 ha project area?

To answer this we divided in a first step the soil samples of Kuan Kreng and Kanthulee accordingly to the soil organic carbon content into three groups: SOC < 9 wt%, SOC 9 – 18 wt%, and SOC > 18 wt%. Dry bulk density differs between these groups (Fig. 1), ranging from an average of 0.99 g cm⁻³ for mineral (N=11) to 0.23 g cm⁻³ for organic (N=13) soils (Fig. 1). This is higher as compared to values reported from tropical peatlands of SE-Asia and the Amazonian floodplains (Lähteenoja et al., 2011; Hooijer et al., 2012; Nagano et al., 2014). The largest soil organic carbon density is found in the organic soils (0.1 g SOC cm⁻³, N=13), the lowest (0.04 g SOC cm⁻³, N=11) in the mineral soils. But the low values are still similar to the SOC density of 0.042 g SOC cm⁻³ reported for oil palm and *Acacia* plantations on Indonesian peatlands by Couwenberg and Hooijer (2013).

Table 1: Soil description, soil organic carbon (SOC), nitrogen (N), SOC/Ntot ratio, dry bulk density, and SOC density

Site	Soil description	Sample depth (cm)	SOC (wt%)	Ntot (wt%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
Kuan Ngoen 1	0-60 cm white fine sand						
	60-80 cm clay and silt with orange-brown patches	10	3.19	0.23	13.87	1.24	0.04
Kuan Ngoen 2	0-40 cm mineral. loamy	10	3.25	0.20	16.25	1.39	0.05
Suan Somdej Chao Fa Chulabhorn	0-20 cm peat with roots & leafs	10	41.13	1.76	23.37	0.22	0.09
	20-60 cm peat with charcoal	35	64.62	0.30	215.40	0.20	0.13
	60-140 cm peat with wood	60	45.75	0.57	80.26	0.24	0.11
Don Sai Forest	0-10 cm dark fine sand	5	5.15	0.40	12.88	1.03	0.05
	10-30 cm grey loamy soil	20	1.58	0.04	39.50	1.43	0.02
	40-80 cm brown loamy. organic	70	9.23	0.29	31.83	0.82	0.08
	80-150 cm grey clay	140	3.14	0.11	28.55	0.89	0.03
Grass Land	0-13 cm dark silt	5	5.16	0.22	23.45	0.82	0.04

Site	Soil description	Sample depth (cm)	SOC (wt%)	Ntot (wt%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
	13-26 cm dark silt with plant remains	20	4.82	0.16	30.13	0.78	0.04
	26-51 cm organic rich clay	35	14.82	0.40	37.05	0.49	0.07
NHA Bor Lor	0-15 cm organic with clay	5	35.05	1.32	26.55	0.25	0.09
	15-60 cm dark organic with wood	20	34.37	0.74	46.45	0.21	0.07
Baan Sai Kanoon	0-8 cm dark organic with living roots	5	54.07	0.65	83.18	0.27	0.14
	8-50 cm brown organic with wood	15	61.55	0.47	130.96	0.23	0.14
		30	49.57	0.86	57.64	0.21	0.10
	50-75 cm dark peat	60	46.14	0.83	55.59	0.16	0.07
	75-90 cm grey silt, fine sand, with plant remains						
	90-110 cm light grey/blue clay						
Kuan Ki Sian Ramsar 1	0-15 cm clay-rich organic	5	11.29	0.69	16.36	0.61	0.07
	15-70 cm organic, silty	30	11.61	0.74	15.69	0.57	0.07
	70-80 cm dark, mineral with silt & clay						
	80-100 cm peat with wood	90	35.26	0.70	50.37	0.20	0.07
	100-120 cm light grey, almost blue fine sand						
Kuan Ki Sian Ramsar 2	0-23 cm organic with sand, wood, charcoal	15	13.34	0.80	16.68	0.54	0.07
	23-30 cm grey fine sand						
	35-38 cm black, organic, burned wood?						
	>38 cm light grey, silt, clay, sand						
Peninsular Botanical Garden Phatthalung	0-20 cm dark grey organic with clay, silt, and plant remains	5	5.76	0.28	20.57	0.65	0.04
		10	4.80	0.25	19.20	0.69	0.03

Site	Soil description	Sample depth (cm)	SOC (wt%)	Ntot (wt%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
	20-40 cm dark, organic	30	16.49	0.61	27.03	0.51	0.08
	40-60 cm peat with wood						
	60-110 cm peat	65	37.86	0.90	42.07	0.16	0.06
	110-120 cm clay-rich organic						
Kanthulee I	0-15 cm decomposed, loose peat with roots	0-15	48.41	2.19	22.11		
	15-30 cm loose peat with roots	15-30	38.98	2.08	18.74		
	30-45 cm peat with few roots	30-45	38.06	1.69	22.52		
Kanthulee II	0-15 cm decomposed, loose peat with roots	0-15	37.95	2.23	17.02		
	15-30 cm loose peat with roots						
	30-40 cm wet peat with few roots	30-40	37.42	1.87	20.01		
Oil palm	0-20 cm dark, organic soil, wood	10	28.23	0.87	32.45	0.34	0.10
	20-140 cm grey clay	70	4.50	0.25	18.00	0.94	0.04
	150 cm organic						
ditch at Oil palm	0-10 cm organic	10	37.79	0.78	48.45	0.32	0.12

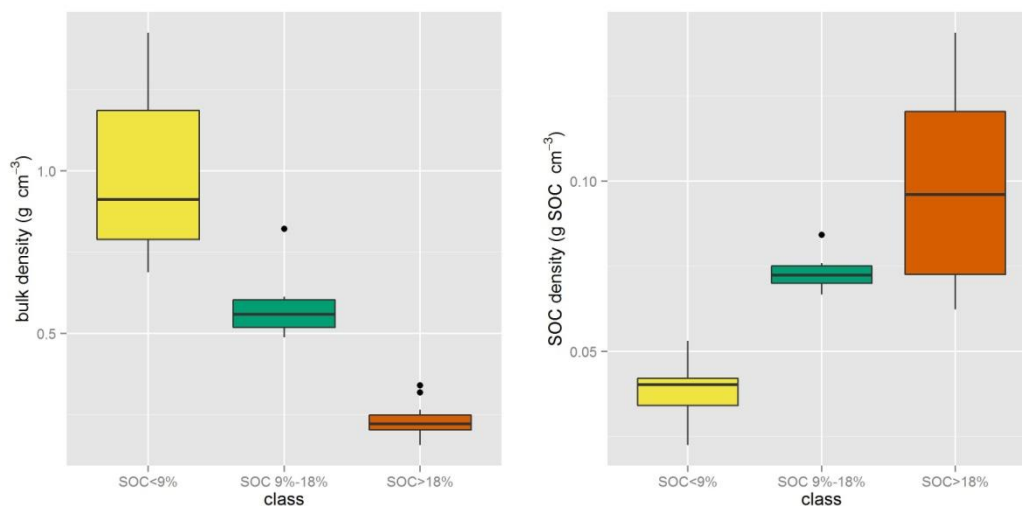


Figure 1: Bulk density (left) and SOC density (right) of soil samples (except Kanthulee) classified according to SOC content. N (SOC<9%) = 11; N (SOC 9%-18%) = 6; N (SOC>18%) = 13.

In a second step we measured CO₂ emissions of the soils samples in the laboratory using the automated system for continuous soil respiration measurements described by Heinemeyer et al. (1989). For this experiment soil samples from the same locations and with similar bulk density and SOC were combined to larger samples. The experiment shows that the average emission rates related to SOC are slightly but not significant higher in mineral (6.5 $\mu\text{g CO}_2\text{-C g}^{-1}\text{ SOC h}^{-1}$, N=6) as compared to organic (4.8 $\mu\text{g CO}_2\text{-C g}^{-1}\text{ SOC h}^{-1}$, N=7) soils (Fig. 2A). The CO₂ emissions related to volume soil are 1.5 times lower for mineral (mean = 0.27 $\mu\text{g CO}_2\text{-C cm}^{-3}\text{ soil h}^{-1}$, N=6) as compared to organic (mean = 0.41 $\mu\text{g CO}_2\text{-C cm}^{-3}\text{ soil h}^{-1}$, N=7) soils, because the SOC density is much lower in mineral than in organic soils (Fig. 1B). CO₂ emissions from soils with SOC from 9-18 (N=2) are not different from organic soils.

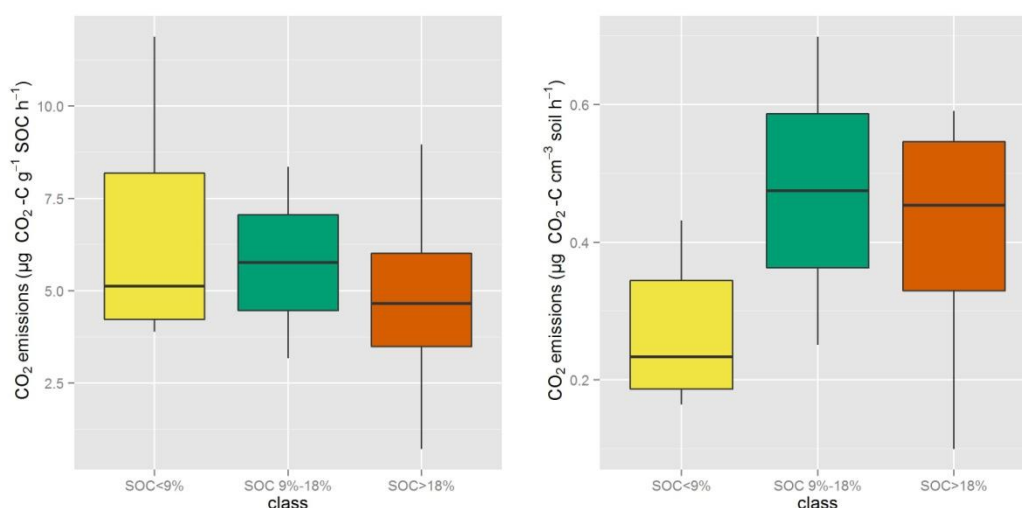


Figure 2: CO₂ emissions related to SOC (left) and soil volume (right) from soil samples (except Kanthulee) classified according to SOC content. N (SOC<9%) = 6; N (SOC 9%-18%) = 2; N (SOC>18%) = 7.

The emission factors of IPCC 2014 are likely to be applicable not only for the organic, but also for the mineral soils of Kuan Kreng, because the soil organic carbon density of the mineral soils

is 0.04 g SOC cm⁻³) that is the same as in peatlands with oil palm and *Acacia* plantations in Indonesia (Couwenberg and Hooijer, 2013) and CO₂ emissions were found to be on average only 1.5 times lower as compared to organic soils.

References

- Couwenberg J, Hooijer A. 2013. Towards robust subsidence-based soil carbon emission factors for peat soils in south-east Asia, with special reference to oil palm plantations. *Mires and Peat* 12 (01): 1–13.
- Heinemeyer O, Insam H, Kaiser EA, and Walenzik G. 1989. Soil microbial biomass and respiration measurements: An automated technique based on infra-red gas analysis. *Plant and Soil* 116: 191-195.
- Hooijer A, Page S, Jauhiainen J, Lee WA, Lu XX, Idris A, and Anshari G. 2012. Subsidence and carbon loss in drained tropical peatlands. *Biogeosciences* 9: 1053-1071.
- IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi T, Krug T, Tanabe K, Srivastava N, Baasansuren J, Fukuda M, and Troxler TG (eds). Published: IPCC, Switzerland
- Lähteenoja O, Reategui YR, Rasasen M, Torres DDC, Oinonen M, and Page S. 2011. The large Amazonian peatland carbon sink in the subsiding Pastaza-Marañon foreland basin, Peru. *Global Change Biology* doi: 10.1111/j.1365-2486.2011.02504.x
- Nagano T, Osawa K, Ishida T, Sakai K, Vijarnsorn P, Jongskul A, Phetsuk S, Waijaroen S, Yamanoshita T, Norisada M, and Kojima K. 2013. Subsidence and soil CO₂ efflux in tropical peatland in southern Thailand under various water table and mana

ANNEX 5: CARBON DIOXIDE SINK CREATED BY REFORESTATION OF 300 HA WITH NATIVE TREE SPECIES

300 ha of burned peat swamp forest will be reforested with native species: *Eugenia kunstleri*, *Eugenia oblata*, *Sterculia gilva*, *Baccaurea bracteata*, *Calophyllum sclerophyllum*, *Camptosperma coriaceum*, *Sandoricum beccarianum*, *Alstonia spathulata*, *Ixora grandifolia*. These species have been studied in a long term project on how to restore peat swamp forests (Nuyim 2005) in deforested peat swamps in Narathiwat. Annual growth rates (tree height, tree diameter at 10 cm above ground) and survival rates have been monitored there for 9 to 14 years. Optimal planting density was found to be 1250 individuals per hectare.

Planting trees on 300 ha will increase biodiversity and biomass carbon stocks. To calculate the net carbon sequestration over a time horizon of twenty years we assume similar growth rates of the tree species in Kuan Kreng as has been observed in the mentioned peat swamp forest restoration project. Tree diameter and tree height increased linear in time, at species specific rates. Rates were extrapolated over twenty years. Survival rates were also species specific, linearly extrapolated over 20 years.

The next step was to derive from the 10 cm height diameter the diameter at breast height (130 cm). This was done using the equation (1) for the calculation of DBH from diameter at 30 cm height of trees, lianas and palms (Gehring et al. 2008).

Equation (1)

$$\text{LN}(\text{DBH}) = a + \alpha * (\text{LN}(\text{diam30}))^2 + \beta * \text{LN}(\text{diam30}) \quad a = -0.778; \alpha = -0.028; \beta = 1.261$$

As we used diameter at 10 cm height instead of 30 cm height we may slightly overestimate DBH, and consequently tree biomass. However, our estimation does not include below ground biomass and therefore does still seriously underestimate the total carbon sequestration by the planted trees within 20 years, resulting in a conservative project scenario. Tree height, diameter at breast height of each tree species expected for 20 years after planting are given in Table 1.

Wood density values (Table 1) are from the Global wood density database (Zanne et al. 2009), which is more complete as that of IPCC 2006. The database provides values for nearly all above mentioned tree species for tropical South-East Asia, with the exception of *Eugenia oblata* and *Sterculia gilva*. As estimates for the two species we used the lowest density values of other species of the same genus and region, *Eugenia papillosa* and *Sterculia macrophylla*., again aiming at conservative project estimates.

Aboveground tree biomass (AGB) per tree was calculated using the equation (2) Chave et al. (2005) for moist tropical forest stands (Table 1).

Equation (2)

$$\text{AGB, dry matter [kg]} = 0.0509 * \text{wood density [g cm}^{-3}] * \text{DBH [cm]} * \text{DBH [cm]} * \text{height [m]}$$

The resulting average above ground tree biomass after 20 years is 207.56 t dry matter (d.m.) per hectare (Table 1), what is above the average AGB of tropical moist deciduous forests given by IPCC 2006 (IPCC Table 4.7: AGB 180 (10-560) tonnes d.m. ha⁻¹). It is also above the estimate given in the PIF, based on above-ground net biomass growth of 8 t d.m. ha⁻¹ yr⁻¹ (IPCC Table 4.10 for tropical moist deciduous forest plantations), and resulting for 20 years in 160 t d.m. ha⁻¹. The differences are because of *Alstonia spathulata*, a fast growing species that produces within

20 years AGB of 1391 d.m. ha⁻¹. Without *Alstonia spathulata* the average AGB of all species after 20 years would only be 54.64 t d.m. ha⁻¹.

To calculate total tree biomass we used, as the PIF, the ratio of below-ground biomass to above-ground biomass of 0.2 (IPCC Table 4.4). The total biomass is 207.56 t * 0.2 + 207.56 t = 249.07 t d.m. ha⁻¹. Also similar to the PIF, biomass was then converted to carbon assuming that the carbon fraction of tropical and subtropical above-ground forest biomass of 0.47 (IPCC Table 4.3) does also apply to below ground biomass. The resulting total tree biomass is 117.06 t C ha⁻¹. For 300 hectares the carbon dioxide sequestered by the planted native trees during 20 years will be **0.129 Mt CO₂**.

Here we give, for comparison, the equation used in the PIF:

$$8 \text{ t d.m.} * 0.47 + 8 * 0.2 * 0.47 = 4.512 \text{ t C ha}^{-1} \text{ yr}^{-1} = 4.512 * 44 / 12 = 16.54 \text{ t CO}_2\text{-eq ha}^{-1} \text{ yr}^{-1}.$$

This should for 300 ha and 20 years result in 0.099 Mt CO₂, but the PIF arrived, by mistake at 0.060 Mt CO₂.

Table 1: Tree size, above ground biomass, tree number per hectare (according to survival rate) and above ground biomass for the planted tree species after 20 years

species	H [m]	DB H [cm]	WD [g cm ⁻³]	AGB, d.m. [kg tree ⁻¹]	Survival [%]	Trees ha ⁻¹	AGB, d.m. [t ha ⁻¹]
<i>Macaranga pruinosa</i>	8.92	14.3 5	0.31	28.99	41	515	14.92
<i>Eugenia kunstleri</i>	10.5 4	15.3 6	0.73	92.35	67	836	77.22
<i>Eugenia oblata</i>	10.0 8	11.8 8	0.49	35.47	70	875	31.03
<i>Sterculia gilva</i>	7.66	14.5 4	0.20	16.48	83	1038	17.11
<i>Baccaurea bracteata</i>	8.88	10.6 1	0.63	32.08	83	1039	33.33
<i>Calophyllum sclerophyllum</i>	14.0 6	15.6 0	0.57	99.32	84	1047	104.72
<i>Campnosperma coriaceum</i>	10.2 8	29.5 8	0.35	160.13	86	1078	172.85
<i>Sandoricum beccarianum</i>	8.77	13.2 7	0.38	29.88	55	683	20.91
<i>Alstonia spathulata</i>	13.2 9	70.6 2	0.34	1147.36	97	1213	1391.18
<i>Ixora grandifolia</i>	7.25	11.7 0	0.69	34.84	42	528	9.65
average							207.56

H – tree height, *DBH* – diameter at breast height, *WD* – wood density, *AGB* – above ground biomass, *d.m.* – dry matter, *Survival* – percentage of planted trees still vital after 20 years

References

Chave J, Andalo C, Brown S, Cairns MA, Chambers JQ, Eamus D, Folster H, Fromard F, Higuchi N, Kira T, Lescure JP, Nelson BW, Ogawa H, Puig H, Riéra B, Yamakura T. 2005. Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia* 145, 87–99.

Gehring C, Park S, and Denich M. 2008. Close relationship between diameters at 30cm height and at breast height (DBH). *Acta Amazonica* 38: 71 – 76

Nuyim T. 2005: Manual on Peat Swamp Forests Rehabilitation and Planting in Thailand. (in English. Thai-version published in 2003)

IPCC 2006. Guidelines for National Greenhouse Gas Inventories, Prepared by the National

Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Zanne AE, Lopez-Gonzalez G, Coomes DA, Ilic J, Jansen S, Lewis SL, Miller RB, Swenson NG, Wiemann MC, and Chave J. 2009. Global wood density database. <http://datadryad.org/handle/10255/dryad.235>

ANNEX 6: ESTIMATION OF ECONOMIC BENEFITS FOR LOCAL PEOPLE FROM ALTERNATIVE LIVELIHOODS

The following table summarizes the findings of an assessment of the economic benefits that local communities can derive from the project's promotion of alternative, sustainable livelihoods that are based on “wet” use of peatlands.

What	Where	How	Partnerships	Pre-project	Post-project
Krajood (Sedge <i>Lepironia articulata</i>) harvesting	Kreng sub-district Cha-uat sub-district Baan Tul sub-district	Regulate - harvest of natural krajood - Promote cultivation to increase raw material - Develop community's agreement on sustainable use - Facilitate market opportunities - Develop community enterprise to link the different krajood networks together to work on pricing, marketing, and identifying value-added products	- At least 1,000 households - Local Government Organizations - Small and Medium Enterprise Promotion Office - One Tambon One Product Promotion Office, Ministry of Interior	- Lack of cooperation in price negotiation - Average incomes generated from: Harvesting: USD 47/ month Handicraft: USD 94/month	With the establishment of community enterprises, the average incomes generated from Krajood products will increase by 20%
Honey harvesting	Kreng sub-district	-Regulate water level in peat swamps to conserve the habitat, trees and flowers that bees feed on - Provide extension service to improve technical knowledge on bee keeping e.g. attracting bees to build their hives in natural habitats. - Support the development of community enterprises	- 50 households of honey harvesters/ bee keepers - Biodiversity-based Economic Development Office (BEDO), under MONRE - Lemon Farm Organic/ Natural Products Retailers	- Average incomes from honey harvesting = USD 1600/ year / household (each household produces on average 100 bottles of honey/ year; the market price is at USD 16 per bottle)	With improved packaging, labeling, branding, and marketing, the selling price could increase to USD 25/ bottle
Products from <i>Melaleuca</i>	Kreng Sub-district	-Provide technical support to develop essential oil from <i>Melaleuca</i> , which can be used to produce aromatherapy products, e.g., incense, room fresheners, etc. - Provide training/ capacity building on the production process	- At least 30 households - Agricultural Products Research and Development Institute, Kasetsart University - Community Forest Division, RFD - Royally-Initiated Pak Panang River Basin Development project	- There is no village group producing the <i>Melaleuca</i> essential oil yet. The market price of the essential oil is USD 60 per liter.	Once developed, this will be additional income for participating communities with potential replication to other sub-districts

What	Where	How	Partnerships	Pre-project	Post-project
Processed fish produce	Kreng sub-district Cha-uat sub-district Baan Tul sub-district	Regulate - water level in peat swamps to conserve/ increase numbers of catfish - Establish community agreement on sustainable fishing - Provide technical support on improved food preservation technique and product development especially for fermented fish -Strengthen community enterprises on their management and financial plans - Facilitating market channels	- At least 1500 households in 3 sub districts in KKL - Thaksin Fermented Fish Community Enterprise in Cha-uat District - Provincial and District Fishery Office - Royally-Initiated Pak Panang River Basin Development project	-Average income from fishing and fermented fish products is USD 1400/ year/ household (the high season for fishing is from Nov- Jan)	The value of fermented fish products from sustainable sourcing could be increased two fold. The current market price of fermented fish from farming is at USD 5-7 per kg; while the fermented fish produce from natural catch is at USD 10-14 per kg.

ANNEX 7: INFORMATION ON PILOT PEAT SWAMP SITES IN THE KUAN KRENG LANDSCAPE WHERE HYDROLOGICAL REGIME IS TO BE IMPROVED

The project aims to prevent peat swamp degradation due to drainage at 4,600 ha of tropical peat swamps in the Kuan Kreng landscape. In these sites specific measures will be implemented to rewet and maintain water levels, and avoid conversion to oil palm cultivation. This will generate practical know-how and experience in Thailand on how to reduce carbon emissions from drained peat swamps and increase carbon sequestration capacity.

Pilot sites are listed in the table below. Site selection is based on consultation with government officials in Bangkok and local agencies. Consultations were also held with NGOs, TAOs and villagers in the Kuan Kreng landscape. Criteria for selection included (1) presence of peat swamps, (2) potential for rehabilitation of forest, (3) active interest from NHAs, and communities, with existing actors such as community forest committee.

Table 1: Pilot sites where hydrological regime is to be improved

	Name	Area (ha)	Land ownership	Sub district	District	Province
# 1	Don Sai Forest (100 ha)	2,670	NHA Bor Lor and Reserve Forests	Kuan Pang	Ron Pi Bul	Nakhon Si Thammarat
	NHA Bor Lor (300 ha)			Suan Luang	Chaloem Phra Kiat	
	Peat swamps in National Reserved Forest (these are primarily pockets of land surrounding Bor Lor and some additional areas) (2,270 ha)					
# 2	Community Forest Kuan Ngoen	90	Public land	Baan Tul	Cha-uad	
# 3	Community Forest Suan Somdej Chao Fa Chulabhorn	240	Reserve forest	Cha-uad	Cha-uad	
# 4	Community Forest Baan Sai Kanoon	1,600	NHA Thale Noi	Kreng	Cha-uad	
Total area		4,600				
# 5	Kanthulee (control site)	65	Public land	Kanthulee	Tha Chana	Surat Thani

Of all the project sites, Kanthulee, a small peat swamp forest of 65 ha, is in the best condition. Located in Surat Thani Province, 200 km north of the Kuan Kreng landscape, it is covered by primary-like forest with ground cover, shrub layer and tree layer composed by many different species including medicinal, and is characterized by a peat layer of more than three meters and a groundwater table what is year round close to the soil surface. Kanthulee serves as an example of a peat swamp in good condition for comparison with the other project sites.

The other 4,600 ha of the project sites are located in the Kuan Kreng landscape and are dominated by *Melaleuca cajuputi* secondary forests. The landscape is mainly flat, intersected by numerous rivers and ditches, and strongly influenced by the river dynamic. Water level for most of the area and for most of the time is more than 20 cm below surface; only during the rainy season (November – February) does it rise above ground surface.

Pilot Site 1. NHA Bor Lor and Reserve Forest

Peat swamp forest pilot site NHA Bor Lor and Reserve Forest is 2,670 ha.

Location of sample plots and related data

Site	Coordinates (°N, °E)	Vegetation	WL, dry (cm)	WL, wet (cm)	Litter (cm)
Don Sai Forest	8.2084, 99.9971	mixed forest dominated by <i>Antidesma velutinosa</i> , <i>Mitragyna javanica</i> with dense <i>Paspalum conjugatum</i>	90 below	150 above	2
Grassland	8.2073, 99.9917	<i>Hymenachne pseudointerrupta</i> grassland	83 below	150 above	3
NHA Bor Lor	8.0749, 100.0313	<i>Melaleuca cajuputi</i> forest without significant understory	5 below	150 above	5

site	Soil description	Sample depth (cm)	SOC (mass%)	Ntot (%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
Don Sai Forest	0-10cm dark fine sand	5	5.15	0.40	12.88	1.03	0.05
	10-30cm grey loamy soil	20	1.58	0.04	39.50	1.43	0.02
	40-80cm brown loamy. organic	70	9.23	0.29	31.83	0.82	0.08
	80-150cm grey clay	140	3.14	0.11	28.55	0.89	0.03
Grass Land	0-13cm dark silt	5	5.16	0.22	23.45	0.82	0.04
	13-26cm dark silt with plant remains	20	4.82	0.16	30.13	0.78	0.04
	26-51cm organic rich clay	35	14.82	0.40	37.05	0.49	0.07
NHA Bor Lor	0-15cm organic with clay	5	35.05	1.32	26.55	0.25	0.09
	15-60cm dark organic with wood	20	34.37	0.74	46.45	0.21	0.07

	TOC	DOC	POC
	mg/l		
Grassland, ditch	14.7	12.9	1.8
NHA Bor Lor, ditch	14.7	9.2	5.5
NHA Bor Lor, ditch 2	9.1	6.3	2.8
NHA Bor Lor, soil sample pit		24.8	

site	Canopy cover (%)	above ground tree biomass (t C ha ⁻¹)
Don Sai Forest	70-82	32.59
NHA Bor Lor	50-60	22.04

Land ownership status

This cluster of pilot sites are patches of peat swamp forests within NHA Bor Lor as well as patches surrounding the NHA that are classified as National Reserve Forests. The NHA Bor Lor

is committed to working with the project as it was recently established (2013) and the head of the NHA wants to develop a management plan, and also needs technical support for fire protection and control of water level.

Local communities

There are communities living in the National Reserve Forests in Kuan Pang and Suan Luang sub-districts.

Conservation and sustainable use measures to be put in place by the project at the pilot site

- Study of hydrology.
- Based on the study, identify and implement hydrological rehabilitation plans with the aim to maintain and establish permanently wet conditions.
- Monitoring of water levels: Water levels will need to be monitored not only in the canal, but in a grid all over the project areas. Water levels in relation to soil surface is the main control on GHG emissions. Because we do not understand the hydrology of the area, the surface relief, and the hydrological connectivity of the soils, it is not sufficient to only measure water levels in the canal (which is for demarcation and fire protection purposes).
- Monitoring GHG emissions and building associated capacities.
- Monitoring and control of forest fires.
- Monitoring encroachments.

Future land use model

The area has been declared a protected area (NHA) in 2013. The patches of peat swamp outside the NHA fall under the National Reserve Forest category. Both NHA and NRF designations place restrictions on economic activities. The project's efforts to (i) strengthen the management plan for NHA Bor Lor, and (ii) develop a management plan and zoning for the entire Kuan Kreng EPA will ensure that economic activities that could lead to drainage and GHG emissions in the future are restricted.

Biodiversity benefits and monitoring

The site harbors a number of threatened species (based on the IUCN Red List of Threatened Species) that will benefit from project interventions at the site. These are:

- Near threatened (NT) species are:
 - 1.1 Black-headed Ibis (*Threskiornis Melanocephalus*)
 - 1.2 Black-bellied Malkoha (*phaenicophaeus diardi*)
- Endangered (EN) species are:
 - 2.1 Yellow-headed Tortoise (*Indotestudo elongate*)
 - 2.2 Fishing Cat (*Prionailurus viverrinus*)
- Vulnerable (VN) species are:
 - 3.1 Painted Stork (*Mycteria Leucocephala*)
 - 3.2 Smooth-coated Otter (*Lutrogale perspicillata*)
 - 3.3 King cobra (*Ophiophagus Hannah*)
 - 3.4 Striped New Guinea Softshell Turtle (*Pelochelys bibroni*)
 - 3.5 Southeast Asian Box Turtle (*Cuora amboinensis*)
 - 3.6 *Malayemys subtrijuga*
 - 3.7 *Siebenrockiella crassicollis*

3.8 Giant Asian Pond Turtle (*Heosemys grandis*)

Other biodiversity benefits of the project: buffering the neighboring protected area, creating ecosystem connectivity, maintaining the supporting and regulating water services.

Monitoring of biodiversity will be conducted by the NHA Bor Lor Authority and local communities.

Benefits for local communities

Local people living around NHA Bor Lor are able to use this area for husbandry, grazing, medicinal plants, honey harvesting, and fishing. Conservation and sustainable use measures implemented by the project will help maintain these ecosystem services.

Pilot Site 2. Baan Tul sub district: Community Forest Kuan Ngoen

Peat swamp forest pilot site Community Forest Kuan Ngoen (90 ha) is located in Baan Tul sub-district that is bordered to the south by Cha-uat sub-district. The eastern part of the sub-district is connected to a national forest sanctuary and NHA Bor Lor. The total area of the sub-district is 8,115.84 hectares.

Location of sample plots and related data

Site	Coordinates (°N, °E)	Vegetation	WL, dry (cm)	WL, wet (cm)	Litter (cm)
Kuan Ngoen 1	8.0398, 99.9638	Melaleuca cajuputi forest with dense Scleria poaeformis	7 above	300 above	3
Kuan Ngoen 2	8.0403, 99.9636	Melaleuca cajuputi forest with dense Lepironia articulata and Scleria poaeformis	at surface	?	6

Site	Soil description	Sample depth (cm)	SOC (mass%)	Ntot (%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
Kuan Ngoen 1	0-60cm white. fine sand 60-80cm clay and silt with orange-brown patches	10	3.19	0.23	13.87	1.24	0.04
Kuan Ngoen 2	0-40cm mineral. loamy	10	3.25	0.20	16.25	1.39	0.05

	TOC	DOC	POC
	mg/l		
Kuan Ngoen 1, surface	54.6	39.4	15.2

Site	Canopy cover (%)	above ground tree biomass (t C ha-1)
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Kuan Ngoen 1	30	11.23
Kuan Ngoen 2	70-80	66.85

Land ownership status

This pilot site is government land that is under the authority of the Baan-Tul TAO, with management and use by local communities. The community has managed this forest for the last 20 years. Past efforts to rehabilitate the area by planting native species were unsuccessful because few seedlings survived.

Local communities

Most communities are located in the western part of the sub-district. Baan Tul sub-district has 5 villages including Moo 1 Bhantun, Moo 2 Baankuanngaeun, Moo 3 Bhangumpae, Moo 4 Baantungpran, and Moo 5 Baannongyao. It has a population of approximately 7,105 persons (3,562 males and 3,543 females).

90 percent of the population is engaged in agriculture. Agricultural activities rubber, palm oil, rice, crops, vegetables and fruit (such as mangosteen, longgong, lime, rambutan, durian), livestock (such as cattle, pigs). Additional sources of income are from seasonal labor and small businesses. Average income in 2010 was around 61,416 baht per household per year.

Based on meetings with the community forestry committee, the communities are willing to collaborate with the project. Some of the activities prioritized by them include: canal dredging to improve fishing and patrolling for forest fire control, building a tower to better survey peat swamp forests, nature trail for students and local people to learn about the peat swamp ecosystem. The communities are interested in learning from other experiences with peat swamp forest management.

Conservation and sustainable use measures to be put in place by the project at the pilot site

Pilot site activities will be led by the Baan Tul community forestry committee, village headman, and Baan Tul School, under the supervision of academic/ scientific experts from universities and experts from the Royal Irrigation Department. The following activities are envisaged:

- Community forestry management plan development and implementation
- Study of hydrology.
- Based on the study, identify and implement hydrological rehabilitation plans with the aim to maintain and establish permanently wet conditions.
- Monitoring of water levels: Water levels will need to be monitored not only in the canal, but in a grid all over the project areas. Water levels in relation to soil surface is the main control on GHG emissions. Because we do not understand the hydrology of the area, the surface relief, and the hydrological connectivity of the soils, it is not sufficient to only measure water levels in the canal (which is for demarcation and fire protection purposes).
- Monitoring GHG emissions and building associated capacities.
- Community based biomass monitoring
- Monitoring and control of forest fires.
- Monitoring encroachments.
- Nature trail

- Learning hub for education/ information dissemination on rewetting and sustainable use of peat swamp forests, working with schools and ecotourism operators

Future land use model

The community forest has a clearly demarcated boundary, so there is no encroachment. This area was public land, which was later occupied by local villagers and is currently being used by them. At present, following natural reforestation of the area, the peat swamps provide fish habitat, aquatic nursery, water for agriculture, and grazing area. The project's efforts to (i) strengthen the community forestry management plan, (ii) support sustainable community forestry use schemes, and (iii) develop a management plan and zoning for the entire Kuan Kreng EPA will ensure that the ecosystem services provided by the peat swamp forest are maintained in the future and economic activities that could lead to drainage and GHG emissions in the future are restricted.

Biodiversity benefits and monitoring

The site harbors a number of threatened species (based on the IUCN Red List of Threatened Species) that will benefit from project interventions at the site. These are:

- Near threatened (NT) species are:
 - 1.1 Black-headed Ibis (*Threskiornis Melanocephalus*)
 - 1.2 Black-bellied Malkoha (*phaenicophaeus diardi*)
- Endangered (EN) species are:
 - 2.1 Yellow-headed Tortoise (*Indotestudo elongate*)
 - 2.2 Fishing Cat (*Prionailurus viverrinus*)
- Vulnerable (VN) species are:
 - 3.1 Painted Stork (*Mycteria Leucocephala*)
 - 3.2 Smooth-coated Otter (*Lutrogale perspicillata*)
 - 3.3 King cobra (*Ophiophagus Hannah*)
 - 3.4 Striped New Guinea Softshell Turtle (*Pelochelys bibroni*)
 - 3.5 Southeast Asian Box Turtle (*Cuora amboinensis*)
 - 3.6 *Malayemys subtrijuga*
 - 3.7 *Siebenrockiella crassicollis*
 - 3.8 Giant Asian Pond Turtle (*Heosemys grandis*)

Monitoring of biodiversity will be conducted by the TAO and local communities.

Benefits for local communities

Local people rely on NHA Bor Lor for husbandry, grazing, medicinal plants, honey harvesting, and fishing. Conservation and sustainable use measures implemented by the project will help maintain these ecosystem services.

Pilot Site 3. Cha-uat sub district: Community Forest Suan Somdej Chao Fa Chulabhorn

Peat swamp forest site Community Forest Suan Somdej Chao Fa Chulabhorn (240 ha) is located in Cha-uat sub district. The southeastern boundary of Cha-uat sub-district adjoins Kreng sub-district and in the north it neighbors NHA Bor Lor. Total area of the sub-district is 4,392 hectares; peat swamp forest conserved by the community totals 240 hectares. Most of the land is alluvial plains called Pakpanang, Most of the land contains peat soils and acidic water due to which they cannot do much rice plantation and use the land for animal farming. Some parts have sandy soil that is suitable for growing crops. Cha-uat River runs through the southern part of the sub-district.

Location of sample plots, vegetation, water levels, litter

Site	Coordinates (°N, °E)	Vegetation	WL, dry (cm)	WL, wet (cm)	Litter (cm)
Suan Somdej Chao Fa Chulabhorn	7.9908, 100.0135	Melaleuca cajuputi forest with dense Phragmites karka and Fuirena umbellata	55 below	130 above	10

site	Soil description	Sample depth (cm)	SOC (mass%)	Ntot (%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
Suan Somdej Chao Fa Chulabhorn	0-20cm peat with roots & leafs	10	41.13	1.76	23.37	0.22	0.09
	20-60cm peat with charcoal	35	64.62	0.30	215.40	0.20	0.13
	60-140cm peat with wood	60	45.75	0.57	80.26	0.24	0.11

site	Canopy cover (%)	above ground tree biomass (t C ha ⁻¹)
Suan Somdej Chao Fa Chulabhorn	70-81	69.47

Land ownership status

This pilot site is government land that is under the authority of the Cha-uat TAO, with management and use by local communities. The community has been managing this forest.

Local communities

Cha-uat sub-district has 10 villages include Moo 1 Bankhokrak, Moo 2 Baanthasathon, Moo 3 Bhanneanin, Moo 4 Banpakbangklom, Moo 5 Bhanneanklang, Moo 6 Bhangicphnom, Moo 7 Banthakhen, Moo 8 Bhanthungcai, Moo 9 Bhanonnean, Moo 10 Bhanshompsonuch, with a population of approximately 9,475 persons (4,723 males and 4,752 females).

The most common occupation is farming, including rubber plantation, oil palm plantation, animal husbandry, seasonal labor, and the harvesting of krajood from the swamp forest for products processing (the latter is not to the same extent as in sub-district Kreng). The average income is around 45,000 baht per person per year. Income from honey from the swamp is

150,000 - 300,000 baht per year, income from krajoed is approximately 1 million baht per year, and from fishing is 10,000 - 20,000 baht/ year.

Occupational groups in the sub-district include the fish farming group, rice plantation group, chicken farm group, cow farm group, craft group, organic vegetables farming group and so on.

Cha-uat is a strong community as it is well organized with high levels of awareness. They also have a number of key local people who are keen to learn.

Conservation and sustainable use measures to be put in place by the project at the pilot site

- Community forestry management plan development and implementation
- Study of hydrology.
- Based on the study, identify and implement hydrological rehabilitation plans with the aim to maintain and establish permanently wet conditions.
- Monitoring of water levels: Water levels will need to be monitored not only in the canal, but in a grid all over the project areas. Water levels in relation to soil surface is the main control on GHG emissions. Because we do not understand the hydrology of the area, the surface relief, and the hydrological connectivity of the soils, it is not sufficient to only measure water levels in the canal (which is for demarcation and fire protection purposes).
- Monitoring GHG emissions and building associated capacities.
- Community based biomass monitoring
- Monitoring and control of forest fires.
- Monitoring encroachments.
- Support to handicraft centre for value-added processing
- Learning centre/ hub, working with schools

Future land use model

The community forest has a clearly demarcated boundary, so there is no encroachment. The project's efforts to (i) strengthen the community forestry management plan, and (ii) support sustainable community forestry use schemes, and (iii) develop a management plan and zoning for the entire Kuan Kreng EPA will ensure that the ecosystem services provided by the peat swamp forest are maintained in the future and economic activities that could lead to drainage and GHG emissions in the future are restricted.

Biodiversity benefits and monitoring

The site harbors a number of threatened species (based on the IUCN Red List of Threatened Species) that will benefit from project interventions at the site. These are:

- Near threatened (NT) species are:
 - 1.1 Black-headed Ibis (*Threskiornis Melanocephalus*)
 - 1.2 Black-bellied Malkoha (*phaenicophaeus diardi*)
- Endangered (EN) species are:
 - 2.1 Yellow-headed Tortoise (*Indotestudo elongate*)
 - 2.2 Fishing Cat (*Prionailurus viverrinus*)
- Vulnerable (VN) species are:
 - 3.1 Painted Stork (*Mycteria Leucocephala*)
 - 3.2 Smooth-coated Otter (*Lutrogale perspicillata*)
 - 3.3 King cobra (*Ophiophagus Hannah*)

- 3.4 Striped New Guinea Softshell Turtle (*Pelochelys bibroni*)
- 3.5 Southeast Asian Box Turtle (*Cuora amboinensis*)
- 3.6 *Malayemys subtrijuga*
- 3.7 *Siebenrockiella crassicollis*
- 3.8 Giant Asian Pond Turtle (*Heosemys grandis*)

Monitoring of biodiversity will be conducted by the TAO and local communities.

Benefits for local communities

Local people are able to rely on NHA Bor Lor to carry out husbandry, grazing, medicinal plants, honey harvesting, and fishing. Conservation and sustainable use measures implemented by the project will help maintain these ecosystem services.

Pilot Site 4. Kreng sub district: Community Forest Baan Sai Kanoon

Peat swamp forest project site Baan Sai Kanoon (1600 ha) is located in Kreng sub-district which is in the heart of the swamp Kuankhreng. The whole sub-district area is located in Thale Noi NHA. Total area of the sub-district is 17,602 hectares, swamp area is about 70 percent and the remaining are forested wetlands with water present throughout the year. The Cha-uat River runs through the north. Most of the houses in the hills are known as "Khuan".

Location of sample plots, vegetation, water levels, litter

Site	Coordinates (°N, °E)	Vegetation	WL, dry (cm)	WL, wet (cm)	Litter (cm)
Baan Sai Kanoon	7.9223, 100.1174	Melaleuca cajuputi with dense Lepironia articulata	27 below	50 above	7

Site	Soil description	Sample depth (cm)	SOC (mass%)	Ntot (%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
Baan Sai Kanoon	0-8cm dark organic with living roots	5	54.07	0.65	83.18	0.27	0.14
	8-50cm brown organic with wood	15	61.55	0.47	130.96	0.23	0.14
		30	49.57	0.86	57.64	0.21	0.10
	50-75cm dark peat	60	46.14	0.83	55.59	0.16	0.07
	75-90cm grey silt. fine sand. with plant remains						
	90-110cm light grey/blue clay						

	TOC	DOC	POC
	mg/l		
Baan Sai Kanoon, ditch 1	0.5	0.4	0.1
Baan Sai Kanoon, ditch 2	17.6	14.2	3.4
Baan Sai Kanoon, soil sample pit		28.4	

Site	Canopy cover (%)	above ground tree biomass (t C ha-1)
Baan Sai Kanoon	25-30	11.95

Land ownership status

This site falls within the NHA Thale Noi. However, communities residing here have land rights and land use rights over a total of 16,900 hectares (full land rights over 11,084.80 hectares and land occupation without full rights over 5,812.20 hectares), accounting for nearly 37% of the total area in the Thale Noi NHA. When it was declared an NHA, communities were already residing here. Originally, there were few land disputes or conflicts, but later, after the amended 1992 Wildlife Conservation and Preservation Act came into effect, land disputes increased, due to the fact that this Act contains clauses restricting land occupation and use in NHAs. This situation of communities residing within and near the NHAs makes it particularly challenging to balance conservation needs with pressures for conversion of peatlands to oil palm production or small scale farming. Most villagers in the Thale Noi NHA seem in agreement with proposals to enhance protection; some are concerned that their access to the land would be restricted.

Local communities

Kreng sub-district has 11 villages includes Moo.1 Bankhuanpom, Moo. 2 Baansaihuama, Moo.3 Bankhuanyao, Moo.4 BanKuan Kreng, Moo. 5 Bhanthungkrai, Moo. 6 Bankhoklao, Moo.7 Bhanyandeng, Moo.8 Bhansametngam, Moo. 9Bhankhuanching, Moo. 10Bhandonteaw, Moo.11 Bansaikhanoon. Total population is **7,640** (3,743 males and 3,897 females).

74 percent of the population is farmers, followed by government officer / government employees (11.90 percent), and construction workers (4.30 percent). Annual household income is 244,548.37 baht, mostly from agriculture (138,911.03 baht per year). Of this crops are 108,019.07 baht per year, perennial plants 25,783.25 baht per year, livestock 5108.70 baht per year. Non-agricultural income is 101,485.65 baht per year, and income from gathering forest products is 4151.69 baht per year. Household expenditure is 151,055.07 baht per year, most of which is household expenses (127,938.70 baht per year) and the rest the cost of production agriculture (23,116.37 baht per year). So the net income of households is estimated at 93,493.30 baht per year, an average of about 30,000 baht per person per year.

There are many occupational groups in the district such as krajoed product group, off-season rice group, fish farming group, mushroom plantation group, tailors group, herdsman group, wet season rice group, rubber plantation group and so on.

Conservation and sustainable use measures to be put in place by the project at the pilot site

The Kreng TAO will take the lead role for community forest management and other pilot site activities as follows:

- Reforestation of 300 ha area that has been deforested due to past fires with native species. This will include building nursery for seedlings of native species.
- Community forestry management plan development and implementation
- Study of hydrology.
- Based on the study, identify and implement hydrological rehabilitation plans with the aim to maintain and establish permanently wet conditions.

- Monitoring of water levels: Water levels will need to be monitored not only in the canal, but in a grid all over the project areas. Water levels in relation to soil surface is the main control on GHG emissions. Because we do not understand the hydrology of the area, the surface relief, and the hydrological connectivity of the soils, it is not sufficient to only measure water levels in the canal (which is for demarcation and fire protection purposes).
- Monitoring GHG emissions and building associated capacities.
- Community based biomass monitoring
- Monitoring and control of forest fires.
- Monitoring encroachments.
- Support to handicraft centre for value-added processing
- Learning centre/ hub, working with schools

Future land use model

The area has been declared a protected area (NHA). The NHA designation places restrictions on economic activities. The project's efforts to (i) strengthen the management plan for NHA Thale Noi, and (ii) develop a management plan and zoning for the Kuan Kreng and Songkhla Lake EPAs will ensure that economic activities that could lead to drainage and GHG emissions in the future are restricted.

Biodiversity benefits and monitoring

The site harbors a number of threatened species (based on the IUCN Red List of Threatened Species) that will benefit from project interventions at the site. These are:

- Near threatened (NT) species are:
 - 1.1 Black-headed Ibis (*Threskiornis Melanocephalus*)
 - 1.2 Black-bellied Malkoha (*phaenicophaeus diardi*)
- Endangered (EN) species are:
 - 2.1 Yellow-headed Tortoise (*Indotestudo elongate*)
 - 2.2 Fishing Cat (*Prionailurus viverrinus*)
- Vulnerable (VN) species are:
 - 3.1 Painted Stork (*Mycteria Leucocephala*)
 - 3.2 Smooth-coated Otter (*Lutrogale perspicillata*)
 - 3.3 King cobra (*Ophiophagus Hannah*)
 - 3.4 Striped New Guinea Softshell Turtle (*Pelochelys bibroni*)
 - 3.5 Southeast Asian Box Turtle (*Cuora amboinensis*)
 - 3.6 *Malayemys subtrijuga*
 - 3.7 *Siebenrockiella crassicollis*
 - 3.8 Giant Asian Pond Turtle (*Heosemys grandis*)

Other biodiversity benefits of the project: buffering the neighboring protected area, creating ecosystem connectivity, maintaining the supporting and regulating water services. Monitoring of biodiversity will be conducted by the NHA Thale Noi, TAO and local communities.

Benefits for local communities

Local people living in NHA Thale Noi are able to use this area for husbandry, grazing, medicinal plants, honey harvesting, and fishing. Conservation and sustainable use measures implemented by the project will help maintain these ecosystem services.

Pilot Site 5. Kanthulee (control site)

Kanthulee peat swamp forest, a national wetland, is located in tambon Kanthulee, Thachana district, Surat Thani province. In 1982, there was a forest fire that destroyed 50 percent of the forest area and land was encroached for farming leading to deforestation. Some plantations were abandoned due to the soil being degraded and this was followed by natural succession. In 1998, 62.56 hectare of Kanthulee was demarcated as 'land state' title. In 2009, the cabinet reviewed and put forward a resolution that Kanthulee is a significant wetland at the international and national levels and that it is urgent to conduct an inventory and protect it.

Kanthulee is home for 40 species of fish, 50 species of birds, 16 species of mammals, 7 species of amphibians, 25 species of reptiles, 2 species of land snail and 36 species of plants.

Production system and land use in Kanthulee consists of agriculture for fruit orchard, coconut, coffee, mixed crop and rubber and oil palm plantation, fishing, wildlife hunting and harvest for wild fruit, Loom phi and mushroom. Fishing is important as cash income for local people. Threats in Kanthulee include intensive commercial plantation, destructive fishing gear, over hunting for wild birds, pig-tailed monkey (*Macaca nemestrina*), honey and wasp.

The Kanthulee conservation Group was established in 1987 by local people. This group has a significant role in conservation and management of the forest and gets support from local government, NGOs, university, and private sectors. For example, villagers share the forest area to protect and prevent outsiders from unsustainable use or misuse of peat swamp. In 1992, Kanthulee was protect from forest fire by digging a canal to lead water from irrigation canal in to the swamp area. All projects in Kanthulee must be approved /endorsed by local people. (Information from 2014, Apiradee Hanpongkittikul, Inland Fisheries Research and Development Bureau Department of Fisheries, Thailand).

Location of sample plots, vegetation, water levels, litter

Site	Coordinates (°N, °E)	Vegetation	WL, dry (cm)	WL, wet (cm)	Litter (cm)
Kanthulee 1	9.6796, 99.1143	Nearly primary swamp forest <30years,	5 below	at surface	10
Kanthulee 2	9.6781, 99.1148	Nearly primary swamp forest <50years	5 below	at surface	10

Site	Soil description	Sample depth (cm)	SOC (mass%)	Ntot (%)	SOC/Ntot	Dry Bulk density (g/cm ³)	SOC density (g/cm ³)
Kanthulee I	0-15 cm decomposed. loose peat with roots	0-15	48.41	2.19	22.11		
	15-30 cm loose peat with roots	15-30	38.98	2.08	18.74		
	30-45 cm peat with few roots	30-45	38.06	1.69	22.52		
Kanthulee II	0-15 cm decomposed. loose peat with roots	0-15	37.95	2.23	17.02		
	15-30 cm loose peat w/ roots						
	30-40 cm wet peat with few roots	30-40	37.42	1.87	20.01		

Land ownership status

The land in this pilot site is state land under the authority of the Kanthulee TAO Moo 5, 7.

Local communities

There are 2 communities residing in the area with a total population of 1,046 people.

Conservation and sustainable use measures to be put in place by the project at the pilot site

- Community forestry management plan development and implementation
- Study of hydrology.
- Based on the study, identify and implement hydrological rehabilitation plans with the aim to maintain and establish permanently wet conditions.
- Monitoring of water levels: Water levels will need to be monitored not only in the canal, but in a grid all over the project areas. Water levels in relation to soil surface is the main control on GHG emissions. Because we do not understand the hydrology of the area, the surface relief, and the hydrological connectivity of the soils, it is not sufficient to only measure water levels in the canal (which is for demarcation and fire protection purposes).
- Monitoring GHG emissions and building associated capacities.
- Community based biomass monitoring
- Monitoring and control of forest fires.
- Monitoring encroachments.
- Support to handicraft centre for value-added processing
- Learning centre/ hub, working with schools

Future land use model

Kanthulee has clear boundaries/ demarcation. The project's efforts to (i) strengthen the community forestry management plan, and (ii) support sustainable community forestry use schemes will ensure that the ecosystem services provided by the peat swamp forest are maintained in the future and economic activities that could lead to drainage and GHG emissions in the future are restricted.

Biodiversity benefits and monitoring

There are no IUCN Red List species, but the following fish species are present as listed in ONEP 2005:

- *Clarias macrocephalus* Vulnerable, Vu
- *Clarias nieuofii*
- *Rasbora paciperforata*

Benefits for local communities

The peat swamps at Kanthulee provide water. It is also well-known as a learning center for peat swamp forests. There is a walkway, bird watching tower, and recreation opportunities for local people and tourists.

ANNEX 8: DETAILS ON PEAT SWAMP CARBON FLUX MONITORING SYSTEM

In peatlands there is a strong link between carbon pools, water levels and GHG emissions. Water saturated conditions in undisturbed peatlands hamper decomposition of plant remains. As a result carbon dioxide is withdrawn from the atmosphere and carbon accumulates. A part of the accumulated carbon is released as methane, another part is leached as dissolved and particulate carbon by water, but net carbon uptake dominates. Drainage of peat swamp forests, however, causes aeration and mineralization of the organic soil and makes it prone to fire. Soil and biomass carbon stocks become carbon sources and export of dissolved organic carbon (DOC) increases.

The peat swamp carbon flux monitoring system needs to account for emissions from the main carbon pools, i.e. the soil, biomass, and litter.

3.1. Measuring GHG emissions from the soil

Direct measurement method: The most common way to measure GHG emission from soils is the closed chamber approach. Transparent chambers allow measuring CO₂ uptake (photosynthesis) and release (respiration) simultaneously, while opaque chambers exclude photosynthesis. However, the main uptake of CO₂ in tropical peat swamp forests is by trees, which cannot be placed into a chamber. Therefore most chamber studies on tropical peatlands focus on the CO₂ efflux from the soil, while carbon uptake by trees is monitored by measuring tree growth rates. Soil CO₂ emissions result from heterotrophic respiration (mainly microorganisms) and autotrophic respiration (plant respiration). To eliminate autotrophic respiration, roots need to be cut (trenching) about one year before the measurements start, and a fine grid should be introduced into the soil to avoid growth of new roots into the measurement plot. While CO₂ concentrations in the chamber are measured in situ with a portable infrared gas analyser, fluxes of N₂O and CH₄ are mostly not measured directly, but a series of air samples is taken from the chamber's head space with syringes or evacuated gas-tight flasks and their gas concentration is measured later in the laboratory using a gas chromatograph. Gas fluxes are derived from concentration changes in this series of samples. There are laser analysers capable for direct measurements of CH₄ and N₂O in the field, but they are quite expensive. Chamber deployment time depends on the expected concentration increase and is usually very short for CO₂ (3-5 minutes) and longer for CH₄ and N₂O (10-40 minutes).

Indirect measurement method based on water levels as proxy: However, GHG emissions and their changes cannot be measured directly all over the project area because it would be prohibitively expensive and time consuming. Water level is a suitable proxy for CO₂ and CH₄ emissions from tropical peatlands (Couwenberg et al., 2009), but need to be tested and calibrated before it can be applied for monitoring and upscaling. However, there is no clear relation between N₂O emissions and water levels with exception to the fact that significant N₂O emissions only occur at drained sites. Therefore, it is advisable to measure N₂O to get the complete GHG balance.

Indirect measurement method based on subsidence: Another indirect method is the monitoring of subsidence of the peat surface at drained sites, resulting from shrinkage, compaction and oxidation. It is monitored at poles, which are inserted through the peat and anchored to at least 0.5 m in the underlying mineral substrate. Contribution of compaction (including shrinkage) and

oxidation to subsidence are calculated by determining the net increase in bulk density of the peat above the water table caused by compaction, and the total amount of subsidence in that period. Therefore peat volume, bulk density and carbon content need to be measured down the vertical peat profile before the subsidence monitoring starts and after it has finished (Hooijer et al., 2012). Subsidence measurements are less work intensive as compared to measurements of heterotrophic soil respiration with chambers, but need to be corrected for CH₄ and DOC losses.

Indirect measurement method based on water level: Relations between water level, subsidence, and emissions of CO₂ and CH₄ for tropical peatlands (Couwenberg et al., 2009, Jauhiainen et al., 2012) allow for indirect emission assessments based on an extensive water level monitoring of the project areas. IPCC 2014 emission factors, as used to estimate emissions avoided by the project (see paragraph 2) factors only allow to divide between “dry” and “wet” conditions, i.e. dry means water level > 20 cm below surface and wet means higher water levels. Dry conditions are associated with high CO₂ and low CH₄ emissions, and wet conditions with low CO₂ and high CH₄ emissions. The overall GHG emissions are much higher for dry as compared to wet conditions. However, in tropical and temperate peatlands emissions of CO₂ and CH₄ as well as subsidence rates change more gradually over a wide range of water levels (Couwenberg et al., 2009, 2011, Jauhiainen et al., 2012) allowing to calibrate water level as an indicator for GHG emissions. For at least two years to develop the water level based GHG-emission indication for S-Thailand peatlands. Calibration should be done along elevation and vegetation transects. We suggest to conduct chamber measurements of GHG emissions and subsidence measurements together with automated water level monitoring for at least two years. Measurement sites are not restricted to project sites but should represent water level, soil, and vegetation conditions of project and baseline.

Monitoring GHG-emissions of the project sites will be indirect, by monitoring the water level in relation to ground surface. This can be done with automated devices installed in wells in a sufficient dense network on the project sites. Then, based on the water level data and the relation between water level and GHG emissions, the GHG balance of the project sites can be calculated.

3.1.1. Measuring DOC concentrations and losses through leaching from drained soil

Concentrations of dissolved organic carbon were not high in the water samples. However, this may be different during the rainy season when large amounts of carbon may be laterally lost (Moore et al. 2013). Reliable estimates of lateral carbon loss require a hydrological model of the area. This may be beyond the project capacities, because there are many other urgent tasks. Therefore, we suggest to just monitor DOC concentrations in different seasons of the year to assess the significance of this process.

3.2. Measuring biomass carbon pool

The forest at many project sites is rather young. Consequently the biomass carbon pool can be expected to grow. The main part is the above ground tree biomass, which needs to be monitored at selected permanent plots. Field measurements to be taken are number of trees in a plot, diameter at breast height, tree height, and canopy cover. Conversion functions and published wood density values can be used to calculate from this the biomass (Chave et al., 2005; Zanne et al., 2009). Details on allometric equations and ways to validate them are given by a VCS Module (VCS, VMD0001 vs1, 2011).

3.3. Measuring litter carbon pool

Above ground litter carbon can be estimated by spatial repeated measurements of the litter thickness and determination of bulk density and carbon content of litter samples from the complete litter layer.

3.4. Measuring fire-caused GHG emissions

Burning biomass or soil organic carbon produces large emissions of carbon dioxide. To account for these losses, it is necessary to monitor the area annually burned and, based on biomass carbon pool data, calculate the emissions by converting the lost above ground tree carbon to carbon dioxide. If peat fires occurred, emissions can be estimated by measuring area and depth of burning and the dry bulk density and organic carbon content of the soil. Areas burned per year may be monitored using remote sensing data, or, if available, data of the firefighting agencies.

3.5. Vegetation composition

Vegetation types are used as indicator for GHG emissions from temperate peatlands (Couwenberg et al. 2011). It is not yet clear, if vegetation will be a qualified indicator for GHG emissions from tropical peatlands, too. Vegetation reflects long-time water level conditions and other factors that control GHG emissions, like soil characteristics and land-use. Moreover vegetation influences GHG emissions by CO₂-fixation and autotrophic respiration, supplying organic matter for CH₄-formation and heterotrophic respiration, providing possible bypasses for CH₄-emission (aerenchyma, “shunt species”). So, monitoring of water levels and subsidence combined with soil- and vegetation characteristics may improve the accuracy of GHG emission estimations of the project sites.

3.6. Measurement sites

Measurement needs to be representative of the expected project and baseline situation in terms of soil, water and vegetation for the project sites. Good access to measurement sites is important, especially for chamber measurements because they need to be repeated every three to four weeks and require transport of measuring instruments.

3.6.1. Baseline scenario

Without protection measures taken by the project the 4,600 ha will be subject to land-use changes, the most important being drainage, and land clearance for cultivation of oil palms. Between 2002 and 2013 the area of oil palm plantations increased from 2,200.48 to 9,622.82 hectares, i.e. by 10% of the Kuan Kreng landscape, while peat swamps decreased by about the same area (Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the Department of National Parks and Wildlife Conservation (DNP), 2014). This trend is increasing because of the growing demands in palm oil. At least 25% of the project area of 4300 ha is expected to become transformed to oil palms in the next 20 years. Reclamation of land for fruit orchards, integrated farming, and rubber plantation are also taking place, but on smaller levels. We did not include them, as well as drainage effects on adjacent areas and

increased susceptibility of the land to wildfires in the baseline assessment, because these processes are difficult to quantify. By not including these threads we underestimate baseline emissions, resulting in conservative estimates of emissions avoided by the project. The baseline scenario is as follows:

- 25% of 4300 ha are drained, cleared and cultivated by oil palms, gradually, by 1.25% of the area per year, attaining 1075 ha in year 20.
- Fires are not expected to occur on oil palm plantations.
- Oil palm plantation carbon stock for every year that palms are present is 44 t C ha^{-1} , what is the time-average above ground C stock of 36 t C ha^{-1} plus $1/4 (8 \text{ t C ha}^{-1})$ below ground C stock (Agus et al. 2013).
- The share of not reclaimed land decreases during 20 years by 1.25% per year and will be 75% (3,268 ha) after 20 years.
- The situation at the not reclaimed land will not change, but will remain as described above (present situation). We did not include biomass increase in the baseline, though most forests are quite young, because of limited data on tree growth rates. This again leads to conservative estimates because forest is removed in the baseline at 25% of the land, but not in the project scenario (see below) and consequently carbon uptake by the forest in the project scenario would have been larger as compared to the baseline scenario.

The measurement site has to be representative of this scenario. Oil palm plantations are found in many areas next to the project sites. The plantation visited during the PPG is near the office of the NHA Thale Noi and can be easily reached by car. However, a survey of other oil palm plantations needs to be conducted first to test for representativeness of the site.

3.6.2. Project scenario

The project will prevent land conversion to oil palm plantation at 100% of the area and improve the hydrological situation in a ways that at least 25% of the area will be effectively rewetted with year-round high water levels that do not drop more than 20 cm below the ground surface.

Melaleuca cajuputi is adapted to high water levels and will not die. Wildfires, however, cannot be excluded and are assumed to continue at pre-project rates, but they will only burn tree biomass, not the water saturated soil at the effectively rewetted 25% of the area. The situation on the remaining 75% is expected to be the same as presently. Increasing tree biomass is only accounted for at the 300 hectares reforestation area (see Annex: 5 Carbon dioxide sink created by reforestation of 300 ha with native tree species), while the increase of the currently present *Melaleuca cajuputi* carbon stock is not included because of limited data on tree growth rates.

The project scenario measurement site has to be representative of this scenario. The project sites differ in soil characteristics, water level dynamics, and vegetation. This will affect GHG emissions.

It is suggested to have GHG emission measurements at the following types of sites: those characterized by high water levels and high soil organic carbon (SOC) content, such as NHA Bor Lor; sites with low water levels and low SOC, such as Don Sai Forest; and intermediate sites, such as Kuan Ki Sian Ramsar 1, Baan Sai Kanoon or Peninsular Botanical Garden Phatthalung. Kuan Ki Sian Ramsar and Don Sai Forest are difficult to access, and Kanthulee is remote, located in another district. Bor Lor NHA, Baan Sai Kanoon, and the Peninsular Botanical Garden

Phatthalung are more suited from logistical perspective, because they are accessible by car, and the bases of authorities and initiatives working on their protection are nearby. They could support the measurements and possibly provide space to store equipment and to install weather stations. Weather stations are necessary to provide continuous records on parameters that are controlling GHG emissions and will be used for modelling annual GHG balance. Maybe sites with different conditions regarding soil and water level can be found in one of the mentioned project areas, which would allow to measure the GHG emissions along a gradient of those parameters to gather more data on the relation between water level and GHG emissions.

Subsidence can be studied at more sites, preferably along transects. And water level should be monitored at all project sites because they are necessary as proxy for GHG emissions.

Summary of peat swamp carbon flux monitoring system

Measurements at selected plots*	Measurements in a grid all over the project area
GHG-emissions (CO ₂ , CH ₄ , N ₂ O) with chambers	
DOC concentration	
Subsidence**	Subsidence***
	Carbon sequestration by tree growth
	Litter (thickness, organic carbon)
	Area burned by wildfire
	Water level dynamics
	Vegetation composition

* Representative plots for project and baseline conditions, preferably along water level gradients: Oil palm plantation, Secondary forest with high water level and organic soil (NHA Bor Lor), Secondary forest with periodical low water level and organic soil (Baan Sai Kanoon), Secondary forest with high water level and mineral soil (Kuan Ngoen?), Secondary forest with periodical low water level and mineral soil (Kuan Ngoen?), deforested site, reforestation site.

** Regular subsidence measurements, inclusive detailed profile analyses for volume, bulk density, and organic carbon before and after subsidence monitoring

*** Regular subsidence measurements, inclusive substrate description, and for 3-5 representative plots of each area with homogeneous substrate distribution plots, detailed profile analyses for volume, bulk density, and organic carbon before and after subsidence monitoring

ANNEX 9: RISK ANALYSIS

Risks/ Assumptions	Rating	Mitigation approach
Government does not support sound management of peatlands in line with the principles and criteria enshrined in the NSP	Low	The government has recognized the importance of peatlands conservation. Thailand's National Report on the Implementation of the Convention on Biological Diversity (2009) has noted the diversity of peatland ecosystems in Thailand, including those in the lowlands of Southern Thailand. Thailand has 14 declared Ramsar Sites that include wetland zones, while the National Biodiversity Strategy and Action Plan has a goal to have at least 35% of wetland areas "restored and conserved". The importance of peatlands as wetlands is also recognized in Thailand's Action Plan (2009-2014) for Wetland Conservation. Thailand is also participating in the Sustainable Management of Peatland Forests in Southeast Asia project (joined in January 2013). An <i>Action Plan of Peatland Management</i> is in draft form and under consideration by the National Committee on Wetlands and the National Environmental Board for endorsement. The government has also designated protected areas in KKL and other parts of the country to conserve peat swamp ecosystems. The issue is policy incoherence among government agencies in the management of peatlands ecosystem. While the environmental agencies are mandated to conserve its ecosystem services, agricultural agencies are mandated to provide lands for the poor and develop irrigation system for agricultural productivity. In addition, there is a lack of awareness and knowledge among policy makers about the full range of ecosystem services provided by peat swamps which leads to continuation of the view that peatlands are wasted or useless areas that need to be drained and developed in order to be more useful and productive for society. The project's efforts at the level of pilot sites will help build a pool of knowledge, capacity and experience on conservation and sustainable management of peatlands. In addition, at the policy level, it will engage the different government sectors in a dialog on a National Strategy for Peat swamps. Experience from the pilot sites will be used to inform the policy level discussions.
Stakeholder support is not secured for the creation and management of protected areas	Medium	This is an issue in Thailand and KKL in particular. Population density is high in the KKL. Local people depend on the natural resources of peat swamps. Local people would not support conservation efforts that would interfere with their livelihoods. However, it is important to note that conventional use by local communities does not damage the peat swamp ecosystem. They need technical and financial support so that they can increase their returns from these sustainable livelihoods. The government recognizes the importance of the participatory approach and requires this to be followed in any type of designation of a conservation zone. Any protected zone designation will therefore need the time to undertake these consultations. This has been the experience with Songkhla Lake EPA. The project will support the consultative process for Songkhla Lake EPA, for the Ramsar designation for KKL and eventual EPA designation. Undertaking pilot activities on community forestry support schemes based on sustainable "wet" use of peat swamps is another aspect that will help engage communities and secure their support.
National plan to declare the Songkhla EPA changes; ONEP does not have the mandate to process declaration of EPA	Low	Songkhla Lake EPA designation process is progressing. Scientific work is nearing completion but support is needed for the consultations with communities which is what the project will support. ONEP has mandated 7 EPAs already and 6 more (including Songkhla) are in the pipeline.
There is lack of cooperation between communities and relevant government agencies at sub-district level.	Low	Communities, provincial authorities, and sub-district organisations (TAOs) are supportive and participative to the project. However, the change of administration/ leadership at the community/ sub-district/ provincial level during the course of project implementation could result in a change in development priorities and conservation policies. The project management arrangements have been designed to address this inasmuch as a provincial working committee will be set up to work on the project. This mechanism will ensure a certain degree of institutionalization of the commitment and

Risks/ Assumptions	Rating	Mitigation approach
		continuity of engagement even if there were to be a change in administration. For the sub-district level, the project has ensured that the focal points in the three TAOs are the Permanent Secretaries of the TAO administration, not the politicians (TAO chairs and TAO deputies), to ensure continuity.
TAOs are not willing to support community forestry management	Low	Looking at the budgets under the three year development plans of the 3 TAOs where project pilots are to take place, support for community forestry is there. There are already community forestry committees in Ban Tul and Cha-uaat sub-districts. In discussions during the PPG phase, the TAOs have expressed the interest to collaborate with the project on community forestry. This risk will be further minimized by the project activity related to registering the community forests with the Royal Forest Department; for registered community forests, it is required that the TAO in the area provide financial contributions to support community forest management.
Government cofinancing for the project is not available in a timely manner for implementing the project strategy at pilot peatland sites where hydrological regime is to be improved	Low	The cofinancing for component 2 is coming from DNP in the area (Fire Protection Station and Non-Hunting Areas). They are receptive to the project idea and have been involved in the project formulation since the PIF stage. It is in line with their management plan in regulating water level to reduce fire incidence and technical support from the project will add value to the work they currently undertake with local universities. During the project preparation phase, discussions were held with DNP to ensure that project activities were designed to be in line with and add value to the management plans of the 2 NHAs, especially activities related to fire protection and water management. This will reduce the risk of cofinancing not materializing and will ensure engagement of key DNP staff at site level.
Restoration activities undertaken in pilot peatland sites are undermined by climate change such as more frequent drought, warmer hot seasons and cold seasons	Low	Higher rainfall, maximum temperature increase by 2 degrees Celsius and minimum temperature increase by 1 to 2 degrees Celsius, and shortening of the duration of the cold season are some of the likely manifestations of climate change in Thailand. However, climate change is locality-specific and can deviate substantially from the overall picture (Thailand's Second National Communication to the UNFCCC). The project will address the inter-relationships between peat swamp state and climate impacts and take into account potential changes associated with climate change. This will be undertaken at two levels: (a) at the policy level, potential climate change impacts will be taken into consideration under Outcome 3 of the project in developing the criteria for sustainable peatland use, the peatland inventory, and the NSP; (b) in designing restoration activities at the pilot sites as well, potential climate change impacts will be taken into consideration. The paradigm shift from site-based to landscape management is pivotal in enhancing the resilience of peat swamps to potential impacts of climate change. By taking a landscape approach that shifts the focus from peat swamp protected areas as islands to a larger Environmental Protection Area with connecting corridors/ areas between existing patches of peat swamp forests, the project will enhance the potential to adapt to climate change. It will enable better integration of the biodiversity harbored in peat swamp PAs with the wider landscape thereby enhancing resilience and potential to adapt.
Government cofinancing for the project is not available in a timely manner for development of the peatland inventory, and NSP	Low	Cofinancing for component 3 is coming from ONEP. The NSP will address the gap in the national policy regarding wetlands, which to date still excludes the management of peatlands. During the project preparation phase, the National Wetlands Technical Sub-committee has been involved in the design of Outcome 3. The project will maintain their engagement during the implementation phase by using the Sub-committee as the technical advisory group. This mechanism will ensure that co-financing from related policy bodies for development of the NSP will be provided in a timely manner.

ANNEX 10: RESPONSE TO COMMENTS FROM GEFSEC, STAP, AND COUNCIL

Comment	Response
GEFSEC comments	
<p>Is (are) the baseline project(s), including problem(s) that the baseline project(s) seek/s to address, sufficiently described and based on sound data and assumptions?</p> <p>Recommended Action by CEO Endorsement: Please provide details on the hydrotechnical scheme to be used. Information on infrastructure, and management measures that will be needed to make the scheme operational is requested.</p>	<p>At present there is no clear understanding of the processes controlling the water level at the project sites in the KKL. The hydrology at most, if not all, project sites is connected to rivers and the floodplain regime. Rivers and canals are maintained and regulated by the national Irrigation Department, but the regulation does not usually meet the requirements of peat swamp forests conservation. Low water levels in dry season in most of KKL are most likely not only because of intensive evapotranspiration but also due to artificial increased runoff due to deepening and straightening of rivers and digging canals. Closing canals may help decreasing runoff but the data on the hydrological system of KKL is not sufficient to draw conclusions. Furthermore, there is no cooperation between the Irrigation Department and the local stakeholders. A detailed study of the hydrological system at the project sites will be required before prescribing recommendations in terms of hydrotechnical works. During the PPG, it became evident that there is no national expertise on peatland hydrology and how to design hydrotechnical measures/ models to maintain the natural hydrology of Thailand's peat swamps. Therefore, the project will need to tap into international expertise to develop local capacities in this field. International expertise will be made available by the project to conduct this study and identify measures for effective rewetting to stop peat oxidization and avoid fires.</p> <p>At this stage, therefore, it is not possible to provide a full outline of the hydrotechnical scheme. The project development team can, however, give an indication of some of the infrastructure and management measures to be considered. These are: place embankments along smaller patches of natural and semi-natural peatlands, rather than a large scale embankment, or a combination of an embankment around the natural areas, while blocking of smaller drains and ditches in the central parts of the peat swamps, and consideration of a combination of hydrological restoration with subsequent assisted natural regeneration (in areas damaged by storms or fires). The above clarifications can also be found in the detailed description of Output 2.1 in the UNDP Project Document (pages 38-40).</p>
<p>Are the components, outcomes and outputs in the project framework (Table B) clear, sound and appropriately detailed?</p> <p>Recommended Action by CEO Endorsement: (1) In component I total area to be covered is 128,000 ha, which is larger than the total area peatlands in the country (64000-75000 ha). Please explain.</p>	<p>(1) The reviewer is questioning why the area of the EPAs to be established under the project (at the PIF stage the target was the 128,000 ha Songkhla Lake EPA; now the project targets an additional portion of the KKL bringing the total to 154,464 ha) is so much larger than the total estimated peatlands in the country. The reason is that the EPAs include land cover classes other than peatlands, such as water bodies. Sections 1.1 and 1.2 of the UNDP Project Document further explain the estimates of peatlands and peat swamp forests in Thailand and in the KKL. According to Nuyim (2005) the peat swamp forest area for Nakhon Si Thammarat Province is 18,946 ha and for Phatthalung 2,767.5 ha. From this the total peat swamp forest area in the KKL can be estimated to be a maximum of 21,713.5 ha. The area estimates for peatlands in the KKL, however, differs. According to Kyuma (1995, citing Vijarnsorn 1992) the peatland area for Nakhon Si Thammarat is 12,300 ha and for Phatthalung 446 ha. From this the total peatland area in the KKL can be estimated to be a maximum of 12,746 ha. There has never been a detailed survey on the peatland area of KKL. Additionally, 2014 data from the Fire Protection Station in Pak Panang Basin, Regional Office 5 (Nakhon Si Thammarat) of the DNP state that peat swamp forests in the KKL covered an area of about 42,573 ha in 2013. This shows that while the area of the target EPAs might be far more than the estimates of national peatland area,</p>

Comment	Response
<p>(2) Please include measures or leverage measures used in other related projects in the area to ensure that deterrents proposed and awareness raised through the project produces tangible results on the ground.</p> <p>(3) A more detailed tCO₂e estimates in line with IPCC Tier 2 level is requested, especially given that the project proposes to do in-ground sample measurements. Separate estimations for protection of peat swamps, rewetting, prevention of fires and reforestation and comparison with appropriate baseline scenarios will be expected. These detailed estimations are deemed necessary to fill the knowledge gaps that are the main obstacles in decision making process in the country and international policy design regarding peatlands</p>	<p>the range of estimates for peatland and peat swamp forest in the KKL are less than the estimates of national peatland area.</p> <p>(2) As regards leveraging measures in other related projects in the area to ensure that deterrents proposed and awareness raised through the project produces tangible results, the project will (1) ensure that the Integrated Provincial Committee (IPC) in Nakhon Si Thammarat and Songkhla Provinces (where the EPAs will be established), be engaged in the project from the start (as advisory body to the provincial working group). This is because the IPC, chaired by the Governor, is the main platform whereby the 4-year Provincial Development Plan is developed, on a rolling basis. The committee consists of representatives of all line agencies operating in the province, as well as local chamber of commerce, and local federation of industry. If the committee is aware and recognizes the importance of peatlands and the pilot activities the project is undertaking, it will be instrumental in incorporating the activities/ lessons learned from the project into the provincial development plan with allocated budget and cooperation among line agencies in the province (see Management Arrangements section of the UNDP Project Document – page 63); and (2) it will pilot incentive schemes on alternative livelihoods, especially on <i>melaleuca</i> products and sedge harvesting (see description of Output 1.5 in the UNDP Project Document – page 37).</p> <p>(3) More detailed emissions reduction estimates have been prepared during the PPG phase but these are at the Tier 1 level. The estimates as well as the methodology used is covered in detail in Annex 4 of the UNDP Project Document. The PIF had stated that “At the stage of CEO endorsement more detailed tCO₂e estimates in line with IPCC Tier 2 level will be presented, including separate estimations for protection of peat swamps, rewetting, prevention of fires and reforestation and comparison with appropriate baseline scenarios.” While there are published emission values for CO₂ and CH₄ for Bacho and To Daeng in Narathiwat Province of southern Thailand (see Annex 2: Greenhouse gas emissions from Kuan Kreng peatlands – knowledge and gaps), and these values were considered for calculating expected emission reductions by the project because the research sites are only about 260 km south of the KKL, the final decision was to not use them for the following reasons:</p> <p>CO₂ emissions</p> <p>CO₂ emission values from peat mineralization and peat fires for Bacho peatland are based on subsidence measurements at five sites (Nagano et al. 2013). Subsidence measurements are an accepted approach to calculate CO₂ emissions from mineralization (IPCC 2014). However, CO₂ emissions at Bacho are much higher as compared to the IPCC land-use category “Forest Land and cleared Forest Land (shrubland), drained”. This is most likely because Bacho had been used for agriculture for decades. Only one of the measurement sites had not been used for agriculture and the CO₂ emissions of that site are similar (5.04 ha⁻¹ yr⁻¹) to “Forest Land and cleared Forest Land (shrubland), drained” (5.3 ha⁻¹ yr⁻¹). But this is only one site and therefore we could not estimate how representative the value is for a wider range of soil conditions and water levels of secondary peat swamp forests. The IPCC 2014 emission factor for “Forest Land and cleared Forest Land (shrubland), drained”, in contrast, is based on 21 sites and can therefore be used with more confidence to estimate CO₂ emissions from secondary peat swamp forests in the KKL.</p>

Comment	Response
	<p>Net CO₂ exchange rates of a pristine peat swamp forest (To Daeng) and secondary peat swamp forest (Bacho) had also been measured continuously with the concentration gradient method, and periodically with the relaxed eddy accumulation method by Suzuki et al. (1999). Both sites were similar carbon sinks. The pristine, mature peat swamp forest sequestered 5.32 t CO₂-C ha⁻¹ yr⁻¹, and the young <i>Melaleuca cajuputi</i> secondary forest sequestered 5.22 t CO₂-C ha⁻¹ yr⁻¹. But the results strongly depend on the actual tree growth rates and can therefore not easily be transferred to the KKL. Separation of the annual balance between tree and soil CO₂ exchange is beyond the applied methods and require additional monitoring of biomass growth and heterotrophic respiration (cf. Lohila et al. 2007; Mäkiranta et al. 2007).</p> <p>CO₂ emission measurements with chambers (Vijarnsorn et al. 1995) at pristine peat swamp forest (To Daeng) and secondary peat swamp forest (Bacho) resulted in large emissions at both (6.7-17.9 t CO₂-C ha⁻¹ yr⁻¹ for pristine and 2.7-3.3 CO₂-C ha⁻¹ yr⁻¹ for secondary peat swamp forest). At least for the pristine peat swamp forest this is not plausible and probably caused by not excluding autotrophic respiration from tree roots.</p> <p>CH₄ emissions Vijarnsorn et al. (1995) studied 1993 and 1994 methane emissions from primary peat swamp forest (To Daeng), secondary peat swamp forest (Bacho), and a loamy paddy field (Pikurnthong) and arrived at very high values of 125 to 309 kg CH₄-C ha⁻¹ yr⁻¹, 118 to 177 kg CH₄-C ha⁻¹ yr⁻¹, and 72 to 99 kg CH₄-C ha⁻¹ yr⁻¹, respectively. This is much higher than the IPCC emission factor for rewetted tropical peatlands, which is 41 (7 – 134) kg CH₄-C ha⁻¹ yr⁻¹ (IPCC 2014). It is not clear where the differences come from. Therefore, the decision was to use the IPCC (2014) default values for the project and baseline emission scenarios with the recommendation to study methane emissions in KKL during the main project.</p> <p>1. N₂O emissions No local data</p> <p>2. DOC export No local data</p> <p>3. Carbon sequestration by oil palms No local data</p> <p>4. Carbon sequestration by reforestation Calculations were done using local data (Nuyim 2005). This allowed for Tier 2 level.</p> <p>5. Carbon in standing tree biomass Calculations were conducted using very few sample plots for tree height and diameter, and literature values for dry wood</p>

Comment	Response
	<p>density and carbon fraction. This gave very rough estimates, but in principle corresponds to Tier 2.</p> <p>6. CO₂ emissions from tree biomass due to wildfires</p> <p>We used site specific data on area burned per year and rough but site specific estimates of tree biomass (see point 7 above). Consequently the estimates are again, rough, but principally corresponding to Tier 2.</p> <p>7. CO₂ emissions from soil due to wildfires</p> <p>We used site specific data on area burned per year, but IPCC 2014 default values for dry soil matter burned per hectare and therefore meet only Tier 1.</p> <p>Thus, all emission data, besides that related to tree biomass, are of Tier 1 level, and therefore the estimated avoided emissions by the project are Tier 1. Real measurements are proposed for the project implementation phase and will allow for Tier 2 or even Tier 3 level estimates, and provide data to fill the knowledge gaps mentioned by the reviewer.</p>
<p>Is the role of public participation, including CSOs, and indigenous peoples where relevant, identified and explicit means for their engagement explained?</p> <p>By CEO endorsement please identify specific CSOs and local organizations that could be included in the project and elaborate on the benefits they would receive.</p>	<p>The following local organizations will be involved in the project:</p> <ul style="list-style-type: none"> (i) Community forestry committees: 4 committees (1 each in Baan Tul, Cha- uat, Kreng and Kanthulee sub-districts) will benefit from the project's technical and financial support to develop their capacities for designing and implementing community forestry management plans and associated community forestry support schemes (alternative sustainable livelihoods within the framework of the management plans) (ii) Occupational groups (related to alternative livelihoods) in all 4 sub-districts will benefit from technical support to add value to sustainably harvested resources through value-added processing and product design. (iii) Local universities will benefit from developing their capacities for carbon flux monitoring, and conservation and sustainable use of peatlands. (iv) The Love Homeland Association (Samakom Khom Rak Thin in Thai), located in ChianYai District, Nakhon Si Thammarat Province) supports community based natural resource management practices in Cha- uat and Baan Tul sub-districts (both in Cha-Uat District, Nakhon Si Thammarat Province). The Association will provide support for coordinating and facilitating local participation and implementation of the project and will develop a greater understanding of peatland conservation and sustainable use issues in the process. See section 2.8: Stakeholder Analysis in the UNDP Project Document.
<p>Is the project consistent and properly coordinated with other related initiatives in the country or in the region?</p> <p>Recommended Action by CEO Endorsement:</p> <p>(1) Please determine avenues of collaboration with the identified related projects and (2) provide details on how the project will build on the carbon accounting systems and protocols that the GMS is working on.</p>	<p>(1) Identified related projects are:</p> <ul style="list-style-type: none"> - GEF project "Integrated community-based forest and catchment management through an ecosystem service approach (CBFCM)". - GEF project "Catalyzing sustainability of Thailand's Protected Area System". <p>Both of the above projects are under implementation by MONRE, and the Ministry will ensure coordination and sharing of lessons as well as establish working level contacts between the implementation teams working on these projects.</p> <ul style="list-style-type: none"> - The Royally-Initiated Pak Panang River Basin Development project - IFAD-GEF regional project "Rehabilitation and Sustainable Use of Peat land Forests in South-East Asia": - GEF-ADB Greater Mekong Subregion Forests and Biodiversity Program

Comment	Response
	<p>The project will ensure coordination and sharing of lessons as well as establish working level contacts between the implementation teams working on these projects. Specifically, representatives from these projects will be invited to meetings of the Technical Advisory Group (see Management Arrangements section of the UNDP Project Document – page 62). Representatives of the Pak Panang project will be invited to meetings of the Working Committee at the Provincial Level (see Management Arrangements section of the UNDP Project Document – page 63).</p> <p>2) While Thailand is not yet a UN-REDD country, the project takes note of the carbon accounting systems and protocols developed under the UN-REDD in the carbon assessment and analysis process; and will benefit from experiences developed in the UN-REDD countries in the GMS. In addition, during the stakeholders' consultation process, the project has confirmed collaboration with the World Bank's supported Forest Carbon Partnership, which is also under DNP's leadership and will be rolled out in 2015 with several pilot sites, including one in Nakhon Si Thammarat Province (nearby to KKL). It has been discussed that the projects will compare note on carbon monitoring and carbon benefit analysis.</p>
STAP comments	
<p>On p7 please explain what is meant by "cameral measurements" (Is this static chambers?) and please provide details and/or reference for "vegetation proxy" method. N2O is not a carbon flux – describe the proposed measurements as GHG fluxes.</p>	<p>Yes, it is the closed chamber approach that is described in Annex 8 of the UNDP Project Document (Measuring GHG emissions from the soil). Vegetation proxy refers to the suitability of vegetation types to be used as indicator for CH₄ and CO₂ emissions because vegetation reflects long-time water level conditions and other factors that control GHG emissions (cf. Couwenberg et al. 2011). This is outlined in Annex 8, (Vegetation composition). Yes, measurement of N₂O emissions is also being proposed, and the relevant paragraph in Annex 8 is titled "Measuring GHG emissions from the soil". The tool, however, is still named "peat swamp carbon flux monitoring system". The reason is that there is still no appropriate N₂O emission monitoring system, because there is no clear correlation with parameters like water level or vegetation that could be monitored and serve as proxy for N₂O emissions. N₂O emissions should be measured at drained and wet sites anyhow to confirm at least for the measuring plots that N₂O emissions are reduced by rewetting.</p>
<p>On p8 please acknowledge that 40.33 tCO₂-e/ha/y is a rough, conservative estimate. Four significant figures gives an unwarranted impression of accuracy – it would be better to cite 11 t CO₂-C, with 40.33 in parentheses, in the main text. In the next sentence, should 40.33 have been used in this calculation instead of 44.33?</p>	<p>Page 18 (3rd paragraph from the top) of the UNDP Project Document acknowledges that 40.33 tCO₂-e/ha/y is a rough, conservative estimate. In addition, the PIF mistakenly used 44.33 instead of 40.33 in the calculation. For the Project Document, more detailed calculations have been undertaken. In Table 3 of Annex 4 (Baseline and project scenarios and calculation of emissions avoided by the project) the original IPCC emission factors are used, so for example for "Plantations, drained, oil palm", it is 11 t CO₂-C (instead of 40.33 tCO₂). In terms of the reviewer's comment that using decimals portrays "an unwarranted impression of accuracy", it should be noted that there are many places in the text of Annex 4 of the UNDP Project Document (and other places) where decimals are used, because they are part of the calculations and the reader could not arrive at similar results if figures are rounded too much.</p>
<p>It would be good to see more detail on how the baseline oxidation rates are estimated, as the IPCC draft document is not readily accessed.</p>	<p>The IPCC wetlands supplements is now published: IPCC 2014, 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands, Hiraishi T, Krug T, Tanabe K, Srivastava N, Baasansuren J, Fukuda M, and Troxler TG (eds). Published: IPCC, Switzerland. The baseline oxidation rates are based on the emission factors</p>

Comment	Response																					
	of IPCC 2014 and the calculation is given in Annex 4 of the UNDP Project Document.																					
STAP notes the intention to quantify the carbon sequestered through reforestation more accurately at PPG stage. The proponent may wish to utilize the Carbon Benefits Project carbon estimation tools for this purpose. The tool can be found here http://www.unep.org/climatechange/carbon-benefits/About/tabid/3539/Default.aspx	Thank you for the link to the Carbon Benefits Project carbon estimation tools. However, we did not use this tool because we could use growth data from a reforestation trial at Narathiwat peat swamps (Nuyim 2005). The trials have been conducted in peat swamps situated only about 260 km south of the KKL and the tree species proposed to be planted at reforestation sites are exactly the same as those of the mentioned reforestation trial, so, based on this growth statistics, we could calculate expected biomass growth for all species separately.																					
The “baseline projects” are very cursorily described “ it is difficult to measure what the “added value” of this project will be.	Further details have been added to the description of the baseline initiatives that the project builds on (see section 1.5 of the UNDP Project Document – page 25). In addition, Table 7 (Summary of global environmental benefits – page 29) has been added to the Strategy section of the UNDP Project Document to further clarify and summarize the added value of the project and the global environmental benefits it generates.																					
Component 1 targets the expansion of the PA system with a 13 000 ha core area, surrounded by zoned land uses which together embrace 128 000 ha. STAP would wish to have a description of the spatial land use planning approaches to be used, the land use classes, and the measures to be used (Such as the Management Effectiveness tracking Tool) to set baselines and monitor progress in achieving the goals of the PA component.	<p>During the project development phase, based on consultations with stakeholders, the target area where improved conservation status and improved management effectiveness is to be realized under Outcome 1 of the project has been modified (see detailed description of Outcome 1 in the UNDP Project Document – pages 32-37). The project now aims to improve the baseline situation of there being only 2 NHAs in the KKL to encompassing the entire KKL into an EPA such that the entire area will be managed as a unit using a landscape approach. In addition, the ongoing process of designating Songkhla Lake Basin EPA will also be supported. Thus the target area now is 154,363 ha comprising the following areas classified as EPAs (IUCN Category V):</p> <table><tr><td rowspan="3">EPA</td><td>Sathingpra Peninsula</td><td>80,000</td></tr><tr><td>Thale Noi NHA and buffer zone</td><td>48,000</td></tr><tr><td>Sub-total</td><td>128,000</td></tr><tr><td rowspan="5">EPA Kuan Kreng</td><td>Bor Lor NHA</td><td>10,016</td></tr><tr><td>Peat swamps in reserved forests around Bor Lor</td><td>4,357</td></tr><tr><td>Agricultural land reform zones, ALRO</td><td>9,085</td></tr><tr><td>Public land/ other land outside ALRO</td><td>2,905</td></tr><tr><td>Sub-total</td><td>26,363</td></tr><tr><td colspan="2">Total</td><td>154,363</td></tr></table> <p>The project will undertake designation of the Kuan Kreng EPA and Songkhla Lake EPA, developing management plans and zoning for the entire landscape of the EPAs, and undertaking targeted demonstrations (native forest reforestation, maintaining water levels, avoiding conversion to oil palm plantations, carbon flux monitoring) at some pilot sites. The land use planning and zoning approach is described in Output 1.2 and will consist of zoning the area into (1) core zone where only conventional uses that do not affect water levels will be allowed, (2) buffer zone where community forestry for local community use and management will be permitted, and (3) transition zone where residential and community areas will be permitted. In terms of monitoring the effectiveness of PA management, the METT has been used to set baselines and targets and monitor progress.</p>	EPA	Sathingpra Peninsula	80,000	Thale Noi NHA and buffer zone	48,000	Sub-total	128,000	EPA Kuan Kreng	Bor Lor NHA	10,016	Peat swamps in reserved forests around Bor Lor	4,357	Agricultural land reform zones, ALRO	9,085	Public land/ other land outside ALRO	2,905	Sub-total	26,363	Total		154,363
EPA	Sathingpra Peninsula		80,000																			
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	Sub-total	26,363																				
Total		154,363																				
Component 2 refers in the baseline scenario an intervention to re-wet 10,00 ha of peat	This is an error in the PIF. The correct area is 1,000 ha. Further, the budget of this baseline project of the RID, that is referred to in the PIF, has recently																					

Comment	Response
forest to avoid fires – the estimated cost cited is USD 1,5 M. Is this the correct figure, as it appears high?	been revised downwards to USD 200,000 and will be limited to a study of the hydrological profile of the KKL. See section 1.5.2 (page 27) of the UNDP Project Document.
<p>Component 3 addresses strategy and policy interventions. STAP would suggest that the specific legislative instruments to be developed and the relation to existing legislation be described in the revision. Further, reference is made to a national inventory and strategy for wetlands to be undertaken under this component, but no indication is given of the science and technological base and approaches to be used, the available information resources, and the institutions that will conduct the survey and develop the strategy.</p>	<p>In order to realize conservation and sustainable use of peat swamps in the KKL, the project relies on the framework provided by the existing NEQA law under which Environmental Protection Areas (EPAs) can be established in areas deemed to be “watershed area, or characterized by unique natural ecosystems which are different from other areas in general, or naturally composed of fragile ecosystems which are sensitive and vulnerable to destruction or impacts of human activities, or worthy of being conserved due to its natural or aesthetic value and ... is yet to be designated as a conservation area”³⁵. Through such designation, conservation and sustainable use requirements can be put in place including:</p> <ul style="list-style-type: none"> – Land use prescriptions for preserving the natural conditions – Prohibition of any acts or activities that may be harmful or adversely affect or change the pristine state of the ecosystems of such area. – Specifying types and sizes of projects or activities undertaken by government agencies, state enterprises or private entities, to be constructed or operated in such area, which shall have the legal duty to submit reports of environmental impact assessment. – Determination of management approach and method specific to the management of such area including the scope of functions and responsibilities of relevant government agencies for the purpose of co-operation and co-ordination that are conducive to efficient performance of work towards the preservation of natural conditions or ecosystems or aesthetic values and amenities in such area. – Prescriptions of any other protective measures, which are deemed proper and suitable to the conditions of such area³⁶ <p>The need for developing additional legislative instruments was not identified. Further to consultation with key policy-level stakeholders, the above outlined measures that come with EPA designation (under Outcome 1) were considered appropriate. In Component 3, the project will develop a National Strategy for Peat swamps (NSP) as the overarching policy on land use in peat swamps that will guide the application of other government policies and regulations in these areas.</p> <p>The scientific underpinnings of the inventory and NSP will be based on the body of knowledge and research of peatlands in Thailand, which will be coordinated under the project both at the national and local levels. Information resources will also come from the forthcoming national Action Plan of Peatland Management.</p> <p>The National Technical Wetlands Working Group will serve as the panel of experts to oversee the development of the NSP and Inventory and provide technical backstopping. Key national experts on peatlands including Tanit Nuyim, Pisoot Vijarnsorn, Jirasak Chukwamdee, who are already involved in the project preparation process will be invited to provide added expertise to the National Technical Wetlands Working.</p> <p>Thailand Institute of Scientific and Technological Research (TISTR), which did the survey on the status of peatlands in Thailand as commissioned by</p>

³⁵ Government of Thailand (1992) “The Enhancement and Conservation of National Environmental Quality Act, B.E. 2535”

³⁶ Ibid

Comment	Response
	ONEP in 2009, will conduct the inventory and develop the strategy, in collaboration with Prince of Songkhla University, and Land Development Department.
Global environmental benefits include the listing of a number of vertebrate species, but no plants. STAP would suggest that the description of the biodiversity values of the systems to be included in the project be strengthened by reference to IUCN categories of both plant and animal species that are of global importance and which occur in the project area.	This has been provided in section 1.2 of the project document for the project's target area i.e., the Kuan Kreng landscape.
Council Members	
No comments received	

ANNEX 11: UNDP ENVIRONMENTAL AND SOCIAL SCREENING

SUMMARY

Name of Proposed Project: Maximizing carbon sink capacity and conserving biodiversity through sustainable conservation, restoration, and management of peat swamp ecosystems

A. Environmental and Social Screening Outcome

☐Category 1. No further action is needed

☐Category 2. Further review and management is needed. There are possible environmental and social benefits, impacts, and/or risks associated with the project (or specific project component), but these are predominantly indirect or very long-term and so extremely difficult or impossible to directly identify and assess.

☒Category 3. Further review and management is needed, and it is possible to identify these with a reasonable degree of certainty. If Category 3, select one or more of the following sub-categories:

☒Category 3a: Impacts and risks are limited in scale and can be identified with a reasonable degree of certainty and can often be handled through application of standard best practice, but require some minimal or targeted further review and assessment to identify and evaluate whether there is a need for a full environmental and social assessment (in which case the project would move to Category 3b). See Section 3 of the Review and Management Guidance.

☐Category 3b: Impacts and risks may well be significant, and so full environmental and social assessment is required. In these cases, a scoping exercise will need to be conducted to identify the level and approach of assessment that is most appropriate. See Section 3 of Review and Management Guidance.

B. Environmental and Social Issues (for projects requiring further environmental and social review and management)

Upstream activities that could have potential social and environmental impacts: Output 1.1: Designation of Songkhla Lake Basin EPA and Kuan Kreng EPA (IUCN Category V); Output 1.3: Kreng sub-district land use plan adjusted to reflect the new zones of the EPAs; Output 3.4: National strategy for peat swamp areas (NSP) drafted for government approval.

Social Impacts: The designation of the two EPAs, modifications to the Kreng sub-district land use plan, and approval of the NSP may result in recommendations for additional peat swamp areas to not be used for economic activities, and rewetting of peat swamp areas that have previously been drained for agricultural and livelihood purposes. Such areas are likely to be mostly forested with no settlements inside. For the most part, the recommendations will relate to promoting sustainable “wet” uses of peat swamps which are the conventional uses of the peat swamps by local communities that do no harm the peat layer. Potential negative impacts, such as loss of access to natural resources due to protected area prescriptions, loss of income due to restrictions on conversion of some peat swamp areas to agricultural land (including oil palm), are likely to be minimized by the fact that the project will work with the local communities to promote sustainable “wet” use of peat swamp areas, and will consult with communities in zoning the EPAs for different uses. The conservation of the peat swamp will create positive economic and

social impacts, through the establishment of community forests, where the harvesting of krajood and other non-timber forest products could increase the income levels of local communities and strengthen the subsistence livelihoods in these communities.

Environmental Impacts: These impacts are considered positive. The implementation of the EPAs, NSP and Kreng sub-district Land Use Plan will prevent further degradation of KKL's peat swamp forests resulting in maintenance of the many ecosystem services provided, ranging from livelihoods for local communities, acting as a rainwater and runoff reservoir, buffering from the impact of rains and floods, acting as a natural sediment filter before waters drain into Songkhla Lake, being a major store of carbon, and harboring important biodiversity including a number of globally threatened species.

Site-level implementation activities that could have social or environmental impacts: Output 2.1: Hydrotechnical measures implemented in pilot sites to prevent drainage and fires; Output 2.2: Native tree reforestation of areas damaged by storms and fires in Kreng sub-district

Social Impacts: As the areas earmarked for rewetting are natural secondary peat swamp forests and do not have any settlements in them, there will be no to very limited negative social impacts. The limited negative impact could be a slight loss of grazing areas for livestock. 300 hectares of land destroyed by fire will be targeted for reforestation. Again, this land is not currently being used for agricultural purposes and therefore there will be no negative social impacts.

Environmental Impacts: These are positive: The rewetting of peat swamps through the construction of hydrotechnical facilities will help to stop peat oxidation and fires, resulting in the reduction in carbon emissions. This will also maintain the unique habitat for peat swamps-associated wildlife. The reforestation of 300 ha will use native species enlarging the area under natural forests as well as the habitat of forest animals and plants.

C. Next Steps (for projects requiring further environmental and social review and management):

Environmental and social impact of upstream activities will only be known in the long term. These upstream actions, along with the next steps for environmental and social review/ management of these upstream outputs are listed below.

Output 1.1. Designation of Songkhla Lake Basin EPA and Kuan Kreng EPA (IUCN Category V): Based on the NEQA law, ensure that all requirements in terms of thorough consultations at the level of the community, sub-district, district, and province are to be followed in the process of designating the EPAs.

Output 1.3. Kreng sub-district land use plan adjusted to reflect the new zones of the EPAs: Ensure that a series of public consultation meetings will be organized to obtain consensus agreement among all stakeholders on the Land Use Plan. Based on the agreed and approved Land Use Plan, local rules and regulations will be established for the use of land, water, and other natural resources from peat swamp forests. Ensure that inputs will be obtained not only from a scientific expert but also from communities on the rules and regulations.

Output 3.4. National strategy for peat swamp areas (NSP) drafted for government approval. The impact of the implementation of the National Strategy for Peat swamps (NSP) will only be known in the long term. However, in supporting the development of the NSP, the project should ensure that environmental and social considerations are taken into account in NSP development. In terms of next steps for ensuring environmental factors are considered in NSP development, it needs to be ensured that the NSP focus

remains on consideration of ecologically optimal options for conservation and sustainable use of peat swamps. The NSP must take a landscape approach to management of peat swamp areas, wherein threats and associated management responses are considered at the landscape level and land use is not driven solely by short-term economic needs but also by needs of biodiversity conservation, soil conservation, and minimization of carbon emissions. Given that peat swamp areas are used by many stakeholders for agriculture, forestry, recreation, nature conservation, scientific research, and meeting the needs of local communities, multiple stakeholders need to be involved in developing this landscape approach. It should be ensured that a platform for cross-sectoral dialogue is created, that associated awareness and capacities are developed within the different entities responsible for peat swamp area management, and that the tools to support ecologically optimal decision-making on the use of peat swamp areas are developed. In terms of next steps for ensuring social factors are considered in NSP development, it should be ensured that the experience of the communities in the pilot sites of the project in terms of balancing livelihood needs with conservation needs should be used to inform the development of the NSP.

Environmental and social impact of site-level activities are expected to be mainly positive. These site-level actions, along with the next steps for environmental and social review/ management of these outputs are listed below.

Output 2.1. Hydrotechnical measures implemented in pilot sites to prevent drainage and fires: In developing the measures, cooperation between the Irrigation Department and communities should be ensured. Community representatives (e.g., representatives from Community Forestry Committees) should participate in field work and discussions on potential options for improving water levels, and their local knowledge and concerns should be taken into account.

Output 2.2. Native tree reforestation of areas damaged by storms and fires in Kreng sub-district: Community representatives (e.g., representatives from Community Forestry Committees) should participate in field work and discussions on potential options for improving water levels, and their local knowledge and concerns should be taken into account.

D. Sign Off



Sutharin Koonphol, Ms.

Programme Analyst, UNDP Thailand

Signed Date:

ENVIRONMENTAL AND SOCIAL SCREENING CHECKLIST

Name of Proposed Project: Maximizing carbon sink capacity and conserving biodiversity through sustainable conservation, restoration, and management of peat swamp ecosystems

QUESTION 1

Has a combined environmental and social assessment/review that covers the proposed project already been completed by implementing partners or donor(s)?

Answer to Question 1:No

QUESTION 2

Do ALL outputs and activities described ONLY fall in the Project Document fall within the following categories?

1. Procurement (in which case UNDP's Procurement Ethics and Environmental Procurement Guide need to be complied with)
2. Report preparation
3. Training
4. Event/workshop/meeting/conference (refer to Green Meeting Guide)
5. Communication and dissemination of results

Answer to Question 2:No

QUESTION 3

Does the proposed project include activities and outputs that support upstream planning processes that potentially pose environmental and social impacts or are vulnerable to environmental and social change (refer to Table 3.1 for examples)? (Note that upstream planning processes can occur at global, regional, national, local and sectoral levels)

Evaluation Result of Checklist Table 3.1:Yes

TABLE 3.1 EXAMPLES OF UPSTREAM PLANNING PROCESSES WITH POTENTIAL DOWNSTREAM ENVIRONMENTAL AND SOCIAL IMPACTS

1. Support for the elaboration or revision of global- level strategies, policies, plans, and programmes. For example, capacity development and support related to international negotiations and agreements. Other examples might include a global water governance project or a global MDG project.	No
2. Support for the elaboration or revision of regional-level strategies, policies and plans, and programmes. For example, capacity development and support related to transboundary programmes and planning (river basin management, migration, international waters, energy development and access, climate change adaptation etc.).	No
3. Support for the elaboration or revision of national-level strategies, policies, plans and programmes. For example, capacity development and support related to national development policies, plans, strategies and budgets, MDG-based plans and strategies (e.g. PRS/PRSPs, NAMAs), sector plans.	Yes
4. Support for the elaboration or revision of sub-national/local-level strategies, policies, plans and programmes. For example, capacity development and support for district and local level development plans and regulatory frameworks, urban plans, land use development plans, sector plans, provincial development plans, provision of services, investment funds, technical guidelines and methods, stakeholder engagement.	Yes

QUESTION 4

Does the proposed project include the implementation of downstream activities that potentially pose environmental and social impacts or are vulnerable to environmental and social change?

Evaluation Result of Checklist Table 4.1: Yes

TABLE 4.1 ADDITIONAL SCREENING QUESTIONS TO DETERMINE THE NEED AND POSSIBLE EXTENT OF FURTHER ENVIRONMENTAL AND SOCIAL REVIEW AND MANAGEMENT

1. Biodiversity and Natural Resources	
1.1 Would the proposed project result in the conversion or degradation of modified habitat, natural habitat or critical habitat?	No
1.2 Are any development activities proposed within a legally protected area (e.g. natural reserve, national park) for the protection or conservation of biodiversity?	No
1.3 Would the proposed project pose a risk of introducing invasive alien species?	No
1.4 Would the proposed project pose a risk of introducing invasive alien species?	No
1.5 Does the project involve the production and harvesting of fish populations or other aquatic species without an accepted system of independent certification to ensure sustainability (e.g. the Marine Stewardship Council certification system, or certifications, standards, or processes established or accepted by the relevant National Environmental Authority)?	Yes
1.6 Does the project involve significant extraction, diversion or containment of surface or ground water? For example, construction of dams, reservoirs, river basin developments, groundwater extraction.	No
1.7 Does the project pose a risk of degrading soils?	No
2. Pollution	
2.1 Would the proposed project result in the release of pollutants to the environment due to routine or non-routine circumstances with the potential for adverse local, regional, and transboundary impacts?	No

2.2 Would the proposed project result in the generation of waste that cannot be recovered, reused, or disposed of in an environmentally and socially sound manner?	No
2.3 Will the propose project involve the manufacture, trade, release, and/or use of chemicals and hazardous materials subject to international action bans or phase-outs? For example, DDT, PCBs and other chemicals listed in international conventions such as the Stockholm Convention on Persistent Organic Pollutants, or the Montreal Protocol.	No
2.4 Is there a potential for the release, in the environment, of hazardous materials resulting from their production, transportation, handling, storage and use for project activities?	No
2.5 Will the proposed project involve the application of pesticides that have a known negative effect on the environment or human health?	No
3. Climate Change	
3.1 Will the proposed project result in significant greenhouse gas emissions? The Environment and Social Screening Procedure Guidance provides additional guidance for answering this question.	No
3.2 Is the proposed project likely to directly or indirectly increase environmental and social vulnerability to climate change now or in the future (also known as maladaptive practices)? You can refer to the Environment and Social Screening Procedure Guidance to help you answer this question. For example, a project that would involve indirectly removing mangroves from coastal zones or encouraging land use plans that would suggest building houses on floodplains could increase the surrounding population's vulnerability to climate change, specifically flooding.	No
4. Social Equity and Equality	
4.1 Would the proposed project have environmental and social impacts that could negatively affect indigenous people or other vulnerable groups?	No

4.2 Is the project likely to significantly impact gender equality and women's empowerment?	No
4.3 Is the proposed project likely to directly or indirectly increase social inequalities now or in the future?	No
4.4 Will the proposed project have variable impacts on women and men, different ethnic groups, social classes?	No
4.5 Have there been challenges in engaging women and other certain key groups of stakeholders in the project design process?	No
4.6 Will the project have specific human rights implications for vulnerable groups?	No
5. Demographics	
5.1 Is the project likely to result in a substantial influx of people into the affected community(ies)?	No
5.2 Would the proposed project result in substantial voluntary or involuntary resettlement of populations? For example, projects with environmental and social benefits (e.g. protected areas, climate change adaptation) that impact human settlements, and certain disadvantaged groups within these settlements in particular.	No
5.3 Would the proposed project lead to significant population density increase which could affect the environmental and social sustainability of the project? For example, a project aiming at financing tourism infrastructure in a specific area (e.g. coastal zone, mountain) could lead to significant population density increase which could have serious environmental and social impacts (e.g. destruction of the area's ecology, noise pollution, waste management problems, greater work burden on women).	No
6. Culture	
6.1 Is the project likely to significantly affect the cultural traditions of affected communities, including gender-based roles?	No

6.2 Will the proposed project result in physical interventions (during construction or implementation) that would affect areas that have known physical or cultural significance to indigenous groups and other communities with settled recognized cultural claims?	No
6.3 Would the proposed project produce a physical “splintering” of a community? For example, through the construction of a road, power line, or dam that divides a community.	No
7. Health and Safety	
7.1 Would the proposed project be susceptible to or lead to increased vulnerability to earthquakes, subsidence, landslides, erosion, flooding or extreme climatic conditions? For example, development projects located within a floodplain or landslide prone area.	No
7.2 Will the project result in increased health risks as a result of a change in living and working conditions? In particular, will it have the potential to lead to an increase in HIV/AIDS infection?	No
7.3 Will the proposed project require additional health services including testing?	No
8. Socio-Economics	
8.1 Is the proposed project likely to have impacts that could affect women’s and men’s ability to use, develop and protect natural resources and other natural capital assets? For example, activities that could lead to natural resources degradation or depletion in communities who depend on these resources for their development, livelihoods, and well-being?	Yes
8.2 Is the proposed project likely to significantly affect land tenure arrangements and/or traditional cultural ownership patterns?	No
8.3 Is the proposed project likely to negatively affect the income levels or employment opportunities of vulnerable groups?	No

9. Cumulative and/or Secondary Impacts	
9.1 Is the proposed project location subject to currently approved land use plans (e.g. roads, settlements) which could affect the environmental and social sustainability of the project? For example, future plans for urban growth, industrial development, transportation infrastructure, etc.	No
9.2 Would the proposed project result in secondary or consequential development which could lead to environmental and social effects, or would it have potential to generate cumulative impacts with other known existing or planned activities in the area? For example, a new road through forested land will generate direct environmental and social impacts through the cutting of forest and earthworks associated with construction and potential relocation of inhabitants. These are direct impacts. In addition, however, the new road would likely also bring new commercial and domestic development (houses, shops, businesses). In turn, these will generate indirect impacts. (Sometimes these are termed “secondary” or “consequential” impacts). Or if there are similar developments planned in the same forested area then cumulative impacts need to be considered.	No

ANNEX 12: TERMS OF REFERENCE

Items	Relevant Output and tasks to be performed
Outcome 1	
Protected Areas Policy Expert	<p>The consultant will be the technical lead on all work under Output 1.1 and Outcome 3 and will work closely with the Land Use Planning Expert. The Protected Areas Policy expert will also work closely with the Field Coordination Office and Provincial Working Group for development of the relevant protected areas policy framework at site level.</p> <p>Key responsibilities: Conduct feasibility study and prepare relevant document for designation of Songkhla Lake Basin as EPA Assist in the preparation of the Information Sheet for Kuan Kreng peat swap to be declared as Ramsar Site by Year 2 of the project. Conduct feasibility study and prepare relevant document for designation of KKL as EPA Coordinate engagement with site level activities to test and verify different policy approaches Coordinate protected area policy formulation with development of land use planning framework (especially for Kreng sub-district). Facilitate and conduct series of consultation workshop on peat-swamp ecosystem as EPA at all levels.</p> <p>The expert will have at least 7 years' experience of working on environmental or other relevant policy within Thailand. S/he will be an excellent coordinator and facilitator able to bring together senior government officials, technical experts and civil society members and have experience of leading both technical policy work and advocacy work.</p>
Land Use Planning Expert	<p>The Land Use Planning Expert will lead the development of participatory management plans for the two EPAs (together with the PA Policy Expert) and alignment of sub-district land use planning framework with these management plans (Output 1.2 and 1.3). S/he will work closely with the Protected Areas Policy and support the Field Coordination Office and Provincial Working Group for ensuring the land use planning framework is in place.</p> <p>Key responsibilities: Identify existing gaps and opportunities within existing land use planning mechanisms with regard to KKL peat swamp management Conduct series of participatory meetings and workshops with relevant stakeholders at site level Present findings to key stakeholder groups Assist in building capacity of the TAO for land use monitoring and enforcement purposes.</p> <p>The consultant will have at least 7 years' experience of working on land use planning and management in Thailand and will have an excellent understanding of the operational linkages between national, provincial and local planning processes.</p>
Forest Conservation Curriculum Development and Training Expert	<p>The consultant will work closely with the Field Coordination Office and targeted NHAs and TAOs for developing the training curriculum and assist in series of training on patrolling, water controlling, fire protection and enforcement (Output 1.4). The consultant will identify gaps through a training needs assessment and propose training curriculum and conduct series of training workshops.</p> <p>Key responsibilities: Conduct Training Needs Assessment to identify the needs for training. Develop the training curriculum for different purposes Assist in identifying and coordinating with training institutes/organizations for delivery of training Conduct training and lead the workshop</p>

Items	Relevant Output and tasks to be performed
	<p>The consultant will have at least 7 years' experience on training curriculum development for specific purpose. Excellent understanding on environment issues and protected areas management in Thailand is an asset.</p>
Outcome 2.	
International Carbon Measurement and Monitoring Expert (Institution)	<p>The International Expert on Carbon Measurement and Monitoring will be recruited as a contractual service to provide technical inputs on the setting up and monitoring of the carbon flux system (Output 2.3). The expert institution will work closely with identified International Institute and Local academic institute to establish an effective carbon flux monitoring and measurement system.</p> <p>Key responsibilities: Engage in knowledge and technology transfer on carbon flux monitoring system Supporting the land use planning and zoning with other technical experts to develop / improve management plans of NHAs and EPAs, with carbon pool dimension as an integral part of the plans Working with extension workers to guide the training on local carbon monitoring for communities and local government organizations</p> <p>The institution will have at least 10 years' experience on carbon measurement and monitoring at International Level; strong track record of developing and implementing the carbon flux monitoring system with ability to transfer the knowledge.</p>
Hydrologist or Hydro-technical Expert	<p>The Hydrologist or Hydro-technical expert will lead the study of the hydrology of the KKL and development of hydrotechnical measures to be piloted in the KKL (Output 2.1). S/he will work closely with Local Academic Institute.</p> <p>Key responsibilities: Conduct research and study on hydrology of KKL Develop hydro-technical measures Test the developed hydro-technical models at each pilot sites Compile and collect the best practices and present findings to key stakeholder groups.</p> <p>The consultant will have at least 7 years' experience of working on hydrology in Thailand and will have an excellent understanding of hydrotechnical measures suitable for maintaining ideal water conditions in peat-swamps.</p>
Outcome 3.	
Natural Resource Economics Expert	<p>The Natural Resource Economics Expert will conduct the study and research on economic value of ecosystem services of peat-swamps in KKL. S/he will work closely with the Technical Advisory Group for ensuring that the outcomes will be applied for the setting of criteria and methodologies for assessment of peat-swamp ecosystem services as well as the development of National Strategy for Peat-swamps management in Thailand.</p> <p>Key responsibilities: Conduct economic valuation of ecosystem services of peat-swamps in KKL Conduct series of participatory meetings and workshops with relevant stakeholders at national level Present findings to key stakeholder groups.</p> <p>The consultant will have at least 7 years' experience of working on research methodology focusing on economic value of protected areas management in Thailand.</p>

ANNEX 13: ECOSYSTEM HEALTH INDEX

Brief Summary of the Ecosystem Health Index (EHI) Methodology

Definition: Ecosystem Health is taken to be the suitability of a site to continue to provide secure conditions for survival of component species and delivery of key ecological services, including resilience to climate and other changes.

Objective: EHI is not an evaluation. It is a dynamic, constantly varying index that reflects biodiversity health, just as a financial index reflects economic performance.

- EHI provides a baseline against which targets for maintaining or achieving a given level of health can be set
- EHI can be used as a results based indicator of project achievement and impacts
- EHI can indicate where the project is succeeding or failing and allow revision of activity efforts throughout the project
- EHI is complementary to the Management Effectiveness Tracking Tool (METT) in project monitoring and evaluation.

Introduction: Ecosystem health is reflected in the ability of a site to maintain its biodiversity values and ecological functions. These will vary significantly from site to site. The index developed to assess this health has three components: 1) score of habitat suitability for maintaining important biodiversity; 2) status of that biodiversity and 3) the broader environmental context. The score does not necessarily indicate stability. Many wetland sites are very dynamic but what we are interested in is the ability of the biota to adapt to or even thrive with the changes. This will become increasingly important as climate and water flow patterns change. A simple scoring system is recommended to give the results transparency and robustness. Each site using this index should undertake a baseline survey which also selects indicators and target species for subsequent surveys. Indicators should include key wetland birds, important aquatic fauna – fish, molluscs; selected indicator insects; endangered mammals; major components of vegetation; incidence of invasive species.

The index establishes a snapshot value at the time of surveying; can relate present scores against baselines established at an earlier date, identifying trends in the different indicators; and can establish reasonable targets for improvement for each different indicator, and compare current state against identified targets.

Just as a human body may appear healthy in not yet showing much physical deterioration, we can identify several indicators of lifestyle that certainly constitute health threats (excessive drinking and smoking habits, lack of sleep, lack of inoculation, living in region of known diseases, poor hygienic habits, lack of medical facilities etc.). In the same way we can recognize several threats to ecosystem health in the external context that may not be immediately reflected in condition of habitat or status of species. Such indicators include the levels of external development threats, the level of secure legal protection enjoyed, and the level of human use pressures being applied or expected in the future.

Use of the EHI score sheet

1. Forming the monitoring team

Should include manager, ecologist, consultant, local experts and if possible local community member/members)

2. Classifying and mapping main habitat types

The scoring of habitat sub-index requires assessing whether the extent, diversity, connectivity and condition of key habitats is maintained. For this it is necessary to classify, map, measure extent and status of specific habitats. For ease of work and subsequent analysis it is recommended to use a simple hierarchical habitat classification. An example for Poyang Lake is given below but it is not important to follow any formal classification system and use of whatever classification is already used by management or researchers in the area is usually adequate. If no suitable classification is already in use, it is recommended to follow the classification system of wetlands international (see Asian Wetlands Inventory Handbook) for wetland types. For terrestrial vegetation, use classifications in current use at local level. Google maps can be downloaded from internet and provide basis for mapping different recognizable vegetation formations. These can then be compared with later imagery to monitor changes in distribution. Use of GIS is useful but not essential. Once mapped, the area of habitat types can be calculated by counting dots on transparent sheets. Retain maps and results for future comparisons.

Example of habitat classification and hierarchy for Poyang Lake

1 st Order	2 nd Order	3 rd Order	4 th Order
Water bodies	Natural Fresh water	Lakes	Open Lake
			Shallows
			Small Lake
		Rivers	Large River
			Small River
	Artificial	Ponds	Reservoir
Terrestrial	Barren	Sparse vegetation	Beach
			Mudflats
		No natural vegetation	Bare Land
			Urban area
	Arbour	Woodlands	Willows
			Poplar plantation
			Mixed plantations
			Natural mixed forest
		Scrub	Scrub
	Herbaceous	Marshes	Reed-beds
			Lotus-beds
		Grasslands	Miscanthus meadow
			Phalaris meadow
			Carex meadow
			Artemisia meadow

3. Identify main threats to be monitored

- Key threats have already been identified for the project area at the PPG stage.
- Additional threats can be tagged for attention when local teams are assembled or if unpredicted changes occur during the project cycle. There should be a good match between indicator species selected and the specific threats they indicate.

4. Identifying suitable indicator species to be monitored

- Conservation target species (note: rarely seen species give little data)
- Commoner species that are sensitive to habitat quality – amphibia, dragonflies, birds

- Easily identified – large mammals
- Easily quantified (harvest levels of fish, crabs etc. or plants)
- Alien species of concern

5. Undertake baseline measurements

This will involve checking in the field, examining plans, maps and other documents, interviewing managers and local community members and undertaking status assessments of selected indicator species (this latter task should be incorporated into routine monitoring activities but baselines need to be established).

6. Calculate baseline indices

Pick the score for each indicator that best meets your observations. Of most importance is the need to complete the notes explaining the basis for score selection and listing the requirements that should be targeted by the project for improving this score. Identification of areas where improvement can be expected is the key to calculating the target index score that the project can realistically hope to achieve.

7. Periodically repeat measurements (minimum would be mid-term and end of project). Routine monitoring of indicator species should be more often than this and at least twice per year.

8. Analyze observed changes in relation to established targets

Note changes in relation to baseline or previous evaluations

9. Report results and feed into project planning revisions

Append full notes, maps, tables of scored species, or any data on human uses and activities on which the answers were based. This is important as the next team to evaluate may be different and need to see the basis for determining if conditions change or get worse.

It is recommended that the first 6 steps have expert assistance, but local teams can undertake subsequent monitoring and scoring.

The EHI scorecard

The EHI scorecard is designed for simplicity and robustness.

Different teams should reach similar scores. Team members do not require high levels of literacy, biological knowledge or statistical skills. The EHI scorecard is designed to match and augment the Management Effectiveness Tracking Tool (METT) being used in GEF Biodiversity projects and can be filled out at the same time.

TEMPLATE OF THE ECOSYSTEM HEALTH INDEX

Name of Site:		Wetland Ecosystem Health Index (EHI) Score Sheet		Scored by (names):	Date completed:
Issue	Criteria	Score: tick only one box per question		Comment/explanation	Target to improve?
Component 1. Habitat Health Assessment					
Habitat connectivity	Habitats severely fragmented by inhospitable barriers	0			
	Habitats fragmented but some connections or corridors remain	1			
	Habitats partly fragmented	2			
	Habitats enjoy good connectivity	3			
Habitat heterogeneity	Site composed of only one major habitat	0			
	Site contains only a small proportion of full range of regional wetland habitats	1			
	Site contains most of regional representative habitats	2			
	Site contains mosaic of all representative habitats of regional wetland type	3			
Original habitat diversity retained	Range of original habitats severely reduced by habitat losses and changes	0			
	50-80% of original habitats still well represented	1			
	>80% of original habitats still well represented	2			
	Full range of original habitats all well represented	3			
Habitats degraded	Most habitats severely degraded in structure, composition or productivity	0			
	Some habitats severely degraded	1			
	Minor habitat degradation	2			
	All habitats in healthy natural condition	3			
Water pollution	Water toxic causing death of fish, molluscs and other biota, presence of toxic algae or plankton	0			
	Water visibly dirty or smelly, surface scum visible	1			
	Slight discoloration, smell or cloudiness apparent	2			
	Water remains clear and potable	3			
Sediment load	Water seriously loaded with erosion sediments	0			

	Water opaque, cannot see bottom of ponds, streams	1			
	Water fairly clear but contains significant sediment	2			
	Sediment levels entirely normal	3			
Oxygen levels	Severe hypoxia kills fish and molluscs	0			
	Some signs of hypoxia, fish gulping at surface	1			
	Oxygen levels close to natural original figures	2			
	Oxygen levels remain at natural healthy levels	3			
Water supply	Water supply and water table seriously modified and damaging ecological functions	0			
	Water supply modified by major diversions, drainage or extractions	1			
	Water supply peaks (droughts and floods) exaggerated by regional changes in flow	2			
	Water supply remains in original seasonal pattern	3			
Physical disturbance (construction, fish traps, barrages, noisy activity)	Site is transformed by artificial developments, structures or disturbances	0			
	Site faces much disturbance from construction and disturbance	1			
	Minor structures or disturbances only	2			
	Original physical state preserved	3			
Disaster damage	Ecology irreversibly modified by natural or artificial disaster	0			
	Serious disasters frequent and ecological recovery period long	1			
	Severity and frequency of disasters increased through human activities but ecology shows high recovery rate	2			
	Frequency of disasters remains natural, capacity to recover remains high	3			
Design resilience (size, altitude, NS axis, lithology, dynamics, multiple catchments)	Site is too small, isolated and homogeneous to offer ecological resilience	0			
	Site is naturally vulnerable to change	1			
	Site enjoys moderate resilience design	2			
	Site enjoys natural high resilience	3			
Sub-total of habitat health risks		Sum score		% of total maximum	Index (HI) =
Component 2. Species Health Assessment					

Health of target species	All target species show declines	0			
	Most target species show declines	1			
	Some target species show declines	2			
	All target species stable or increasing	3			
Health of vertebrate indicator species	All indicator species show declines	0			
	Most indicator species show declines	1			
	Some indicator species show declines	2			
	All indicator species stable or increasing	3			
Health of plant indicator species	All indicator species show declines	0			
	Most indicator species show declines	1			
	Some indicator species show declines	2			
	All indicator species stable or increasing	3			
Health of invertebrate indicator species	All indicator species show declines	0			
	Most indicator species show declines	1			
	Some indicator species show declines	2			
	All indicator species stable or increasing	3			
Species diversity retained	Richness of faunal/floral communities irreversibly depleted	0			
	Significant gaps appearing in reporting of local species	1			
	Minor reductions in species richness noticed	2			
	Site retains full original species diversity with high proportion of locally potential species	3			
Highest trophic carnivores still present	No high trophic carnivores remain at site	0			
	Few carnivores remain at site	1			
	Some high trophic carnivores lost from local fauna	2			
	All high trophic carnivores or original fauna still present	3			
Aquatic Invasive Species (AIS) resilience	AIS out of control and permanently replacing some local species	0			
	AIS degrading ecosystem functions or displacing local species	1			
	Some AIS noticed at site but not seriously damaging ecosystem or local species	2			
	No AIS established in site	3			
Breeding/wintering success of target species	High mortality on wintering/breeding areas of site	0			
	Survival of some species a concern	1			
	Moderate survival	2			
	Key species all surviving well at site	3			
Key new species using site	Total species no. dropping over time	0			

	No new species recorded but species richness stable	1			
	Some new species (other than AIS) noted	2			
	No. of new colonizing species exceed local extinctions	3			
Economic harvest species (legal and illegal)	Uncontrolled overharvesting eliminating some species	0			
	Harvesting results in serious declines in several species	1			
	Harvesting results in minor declines of some species	2			
	No harvesting, or harvesting appears entirely sustainable	3			
Mortality/disaster of key species (fires, droughts, floods, diseases)	Disasters have caused irreversible or long term declines to important species	0			
	Disasters have caused serious damage to important species	1			
	Disasters cause minor damage to some species	2			
	No diseases, disasters in recent years or species recovery fast and complete	3			
Sub-total of species health risks		Sum score		% of total maximum	Index (SI) =
Component 3. Environmental Context Health Assessment					
Site boundaries and zones	Adequate boundaries not clearly marked or respected	0			
	Boundaries inadequate or not respected	1			
	Some boundaries marked, partially respected	2			
	Effective boundaries, zones in place and marked	3			
Legal framework	No legal protection for site	0			
	Weak legal protection or protection for only part of site	1			
	Legal status assured but some weaknesses remaining	2			
	Strong legal security and law enforcement procedures in place	3			
Tourism impacts	Tourism uncontrolled and causing serious damage and disturbance to site	0			
	Some controls in place but tourism exceeds safe carrying capacity	1			
	Tourism controlled but causing some negative impacts	2			

	Tourism absent or well controlled and within safe limits	3			
Human resource use pressures	Pressure on natural resources of site out of control	0			
	High levels of collection or use of renewable resources	1			
	Low levels of pressure for resources or land-use (e.g. grazing)	2			
	No human pressure on resources, or pressures now contained by alternative livelihood program	3			
Additional threats or stresses from external developments (existing or planned)	Water diversion plans, dams, drainage would completely change nature of the site	0			
	External developments negatively affect the ecosystem of site	1			
	Low risk or low impacts can be absorbed by ecosystem	2			
	No threats from external developments	3			
Local community relations	Local community alienated and oppose establishment of protected area on site	0			
	Local community accept existence of protected area but neutral and mostly not involved	1			
	Local community enjoy some benefits through employment or alternative livelihoods	2			
	Local communities strongly supportive; respect protected area and collaborate in protection, reporting work	3			
Sub-total of environmental context health risks		Sum score		% of total maximum	Index (CI) =
Overall EHI score (HI+SI+CI)/3 =				Target identified for project	Index (CI) =

ANNEX 14: CO-FINANCING LETTERS

- *See separated file* -

ANNEX 15: TRACKING TOOLS

- *See separated file* –

ANNEX 16: LETTER OF AGREEMENT FOR UNDP SUPPORT SERVICES

- *Drafted LOA will be prepared and submitted at DOA stage –*

SIGNATURE PAGE

Country: Thailand

UNPAF Outcome (s)/Indicator (s): Effective Responses to Climate Change

CPAP Outcome (s)/Indicator (s): Thailand is better prepared to coherently address climate change and environmental security issues through the enhancement of national capacity and policy readiness.

CPAP Output (s)/Indicator (s):

- 1: Improving protection of high conservation peat swamp forests and demonstrating their sustainable use within the broader landscape
- 2: Avoided degradation of high nature value peat-swamp forests
- 3: Effective national policy framework for management of peat-swamps address degradation threats and stipulating ecologically optimal management regimes for all peatlands in Thailand

Executing Entity/Implementing Partner: Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment (MONRE)

Implementing Entity/ Responsible Partner: ONEP, MONRE, and UNDP

Programme Period:	2015-2019	Total resources required	16,607,111
Atlas Award ID:	00084475	Total allocated resources:	16,607,111
Project ID:	00092458	○ GEF	3,224,400
PIMS #	4951	○ Other	13,382,711
Start date:	July 2016		
End Date	June 2020		
Management Arrangements	NIM		
PAC Meeting Date	18 Feb 2015		

Agreed by:

Date/Month/Year

Ms. Raweewan Bhuridej, Ph D

Secretary-General

Office of Natural Resources and Environmental Policy and Planning (ONEP)

Agreed by:

Date/Month/Year

Mr. Luc Stevens,

UN Resident Coordinator, and UNDP Resident Representative