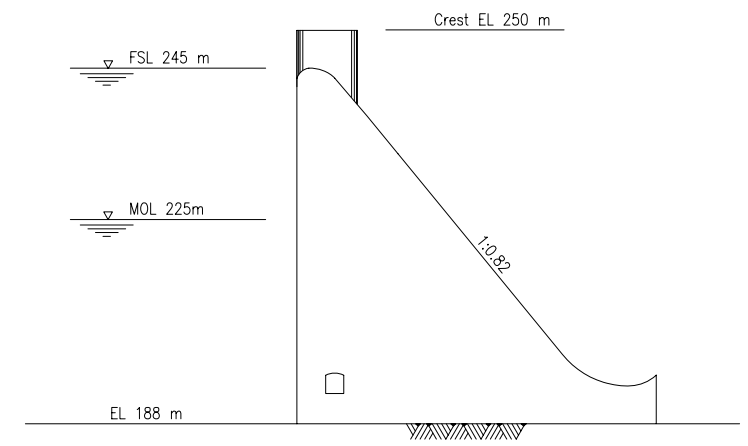
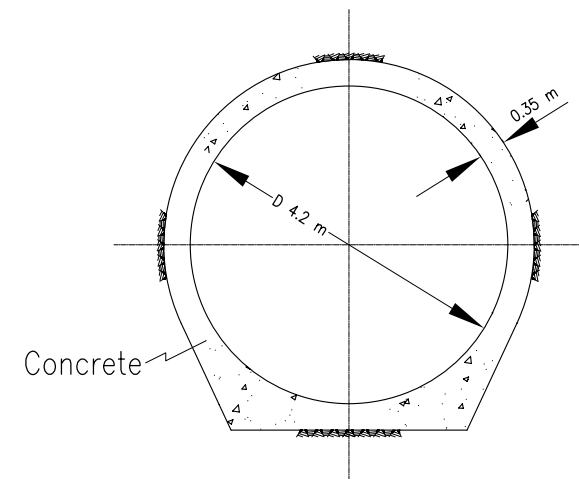
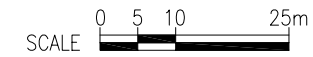


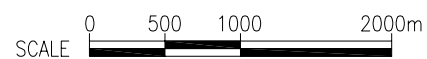
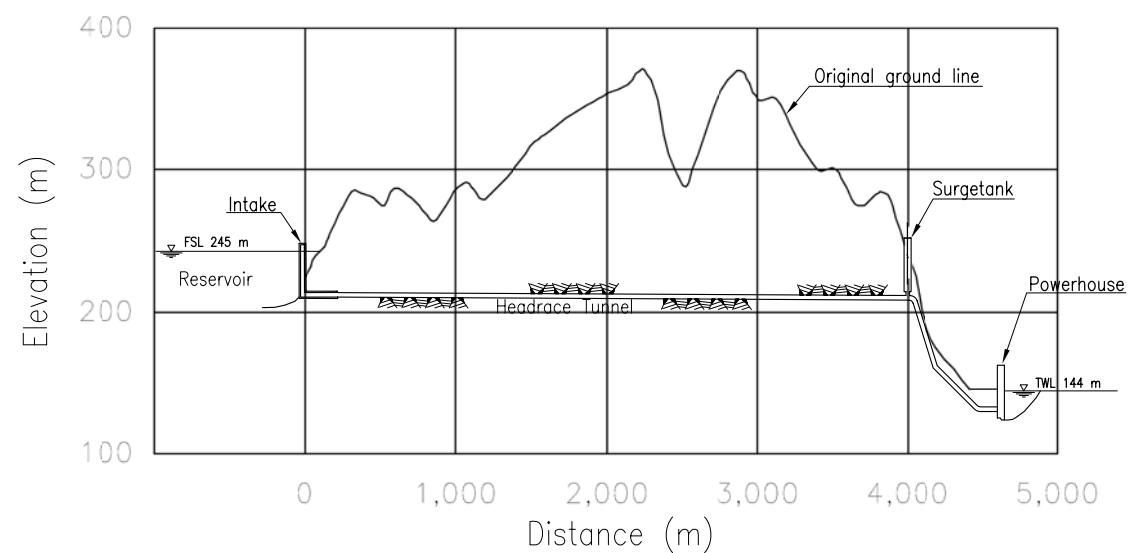
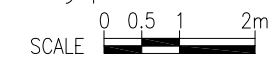
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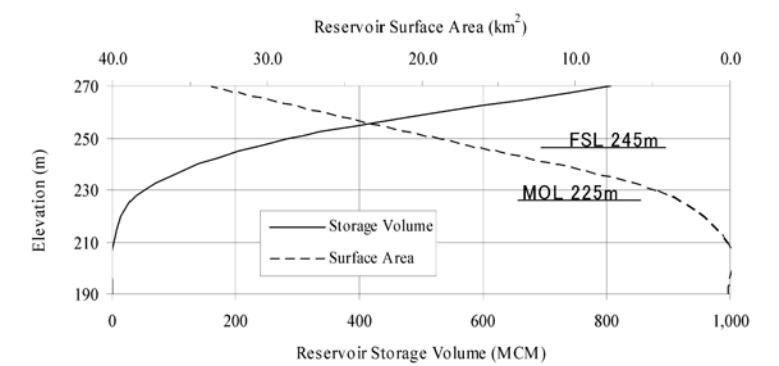
Typical Section of Dam



Typical Section of Headrace Tunnel



Profile

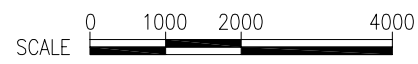
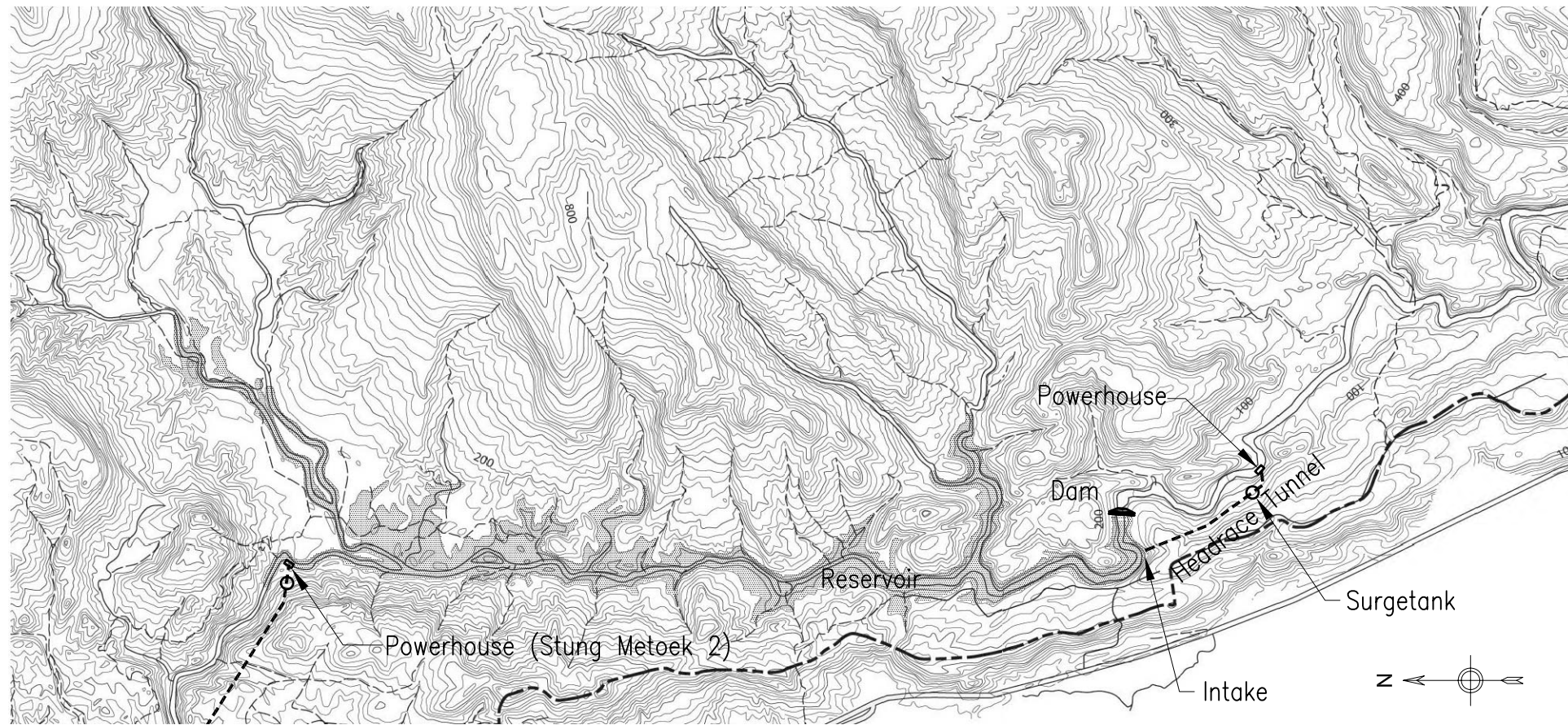


Reservoir Area-Storage Curve

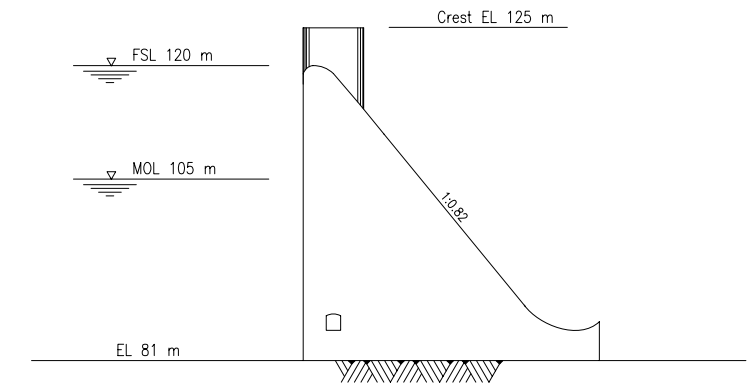
The Master Plan Study of
Hydropower Development in Cambodia

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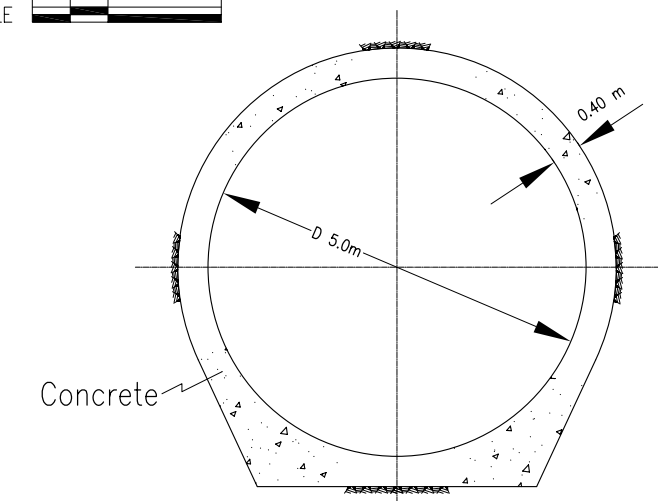
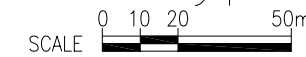
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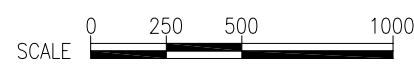
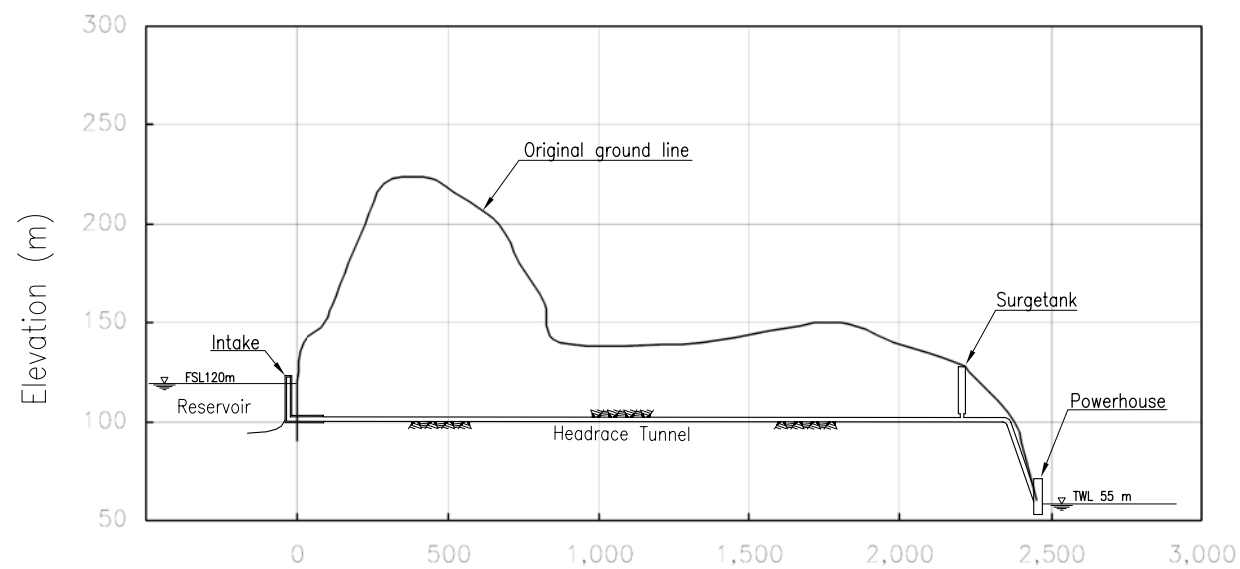
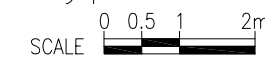
Plan



Typical Section of Dam

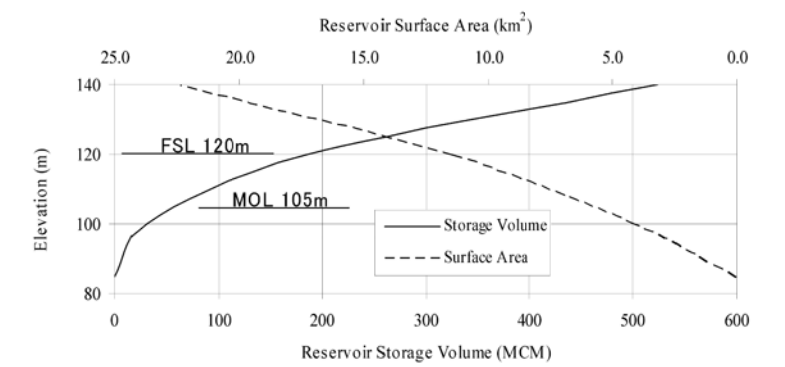


Typical Section of Headrace Tunnel



Distance (m)

Profile



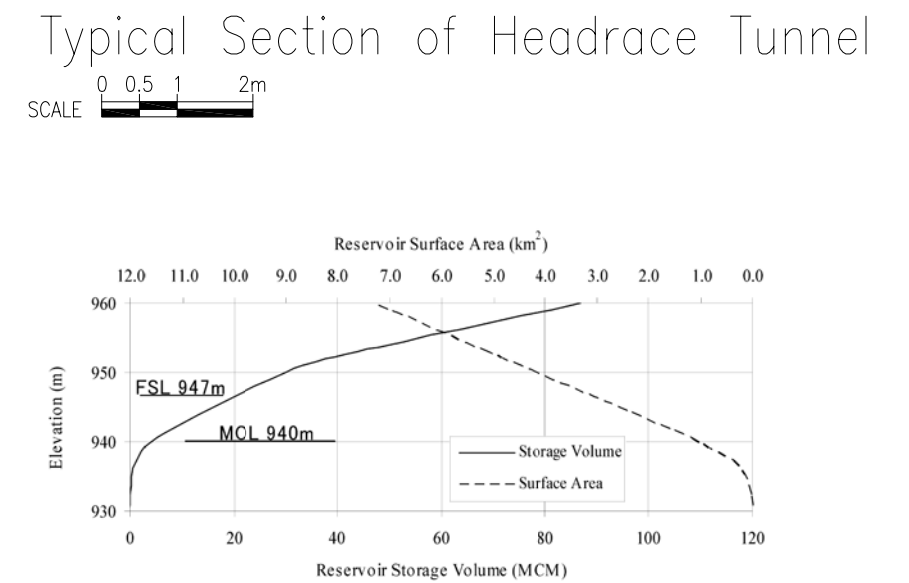
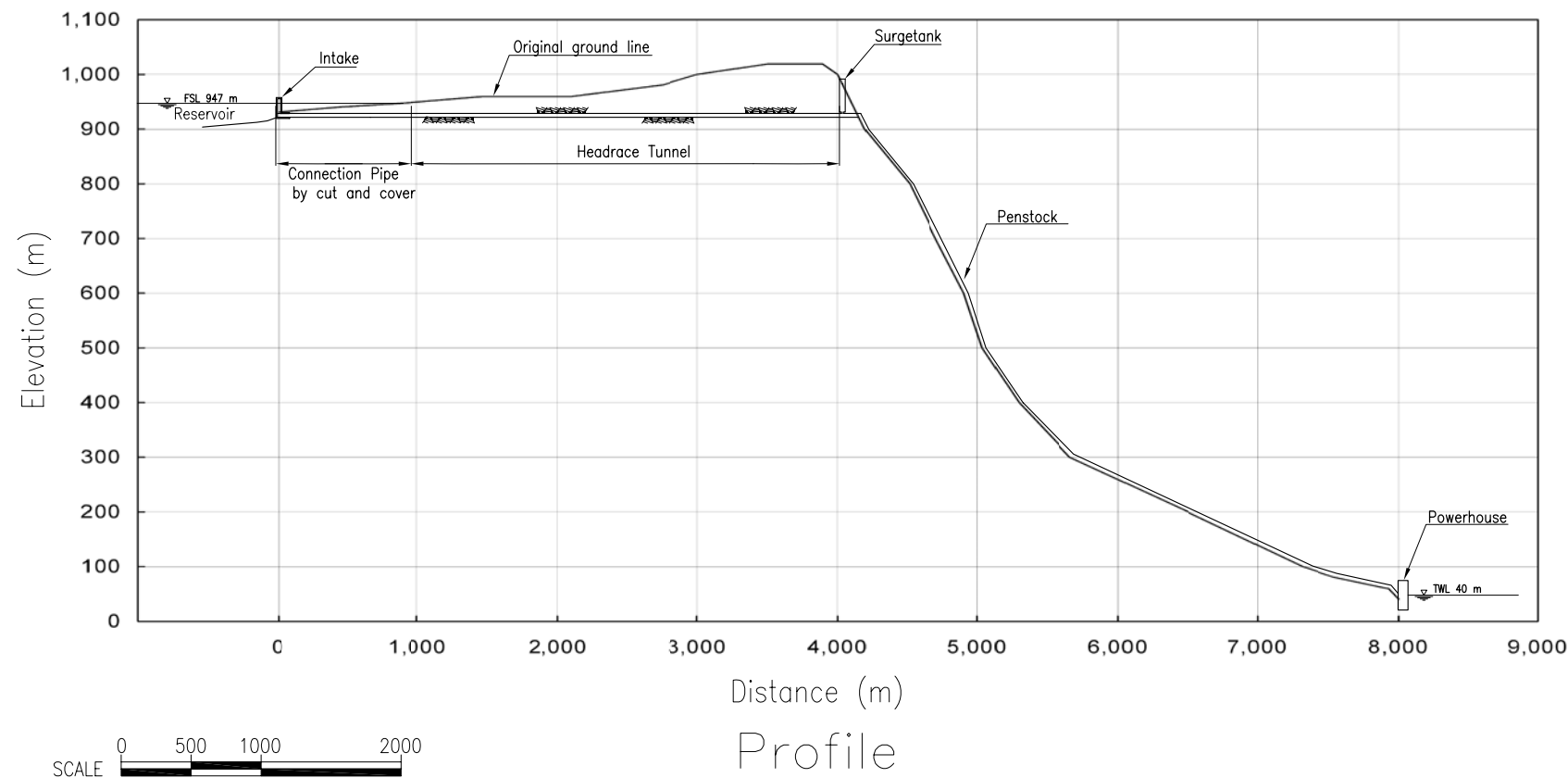
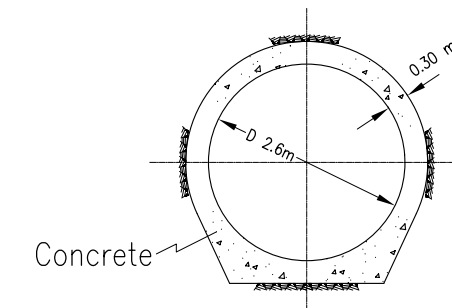
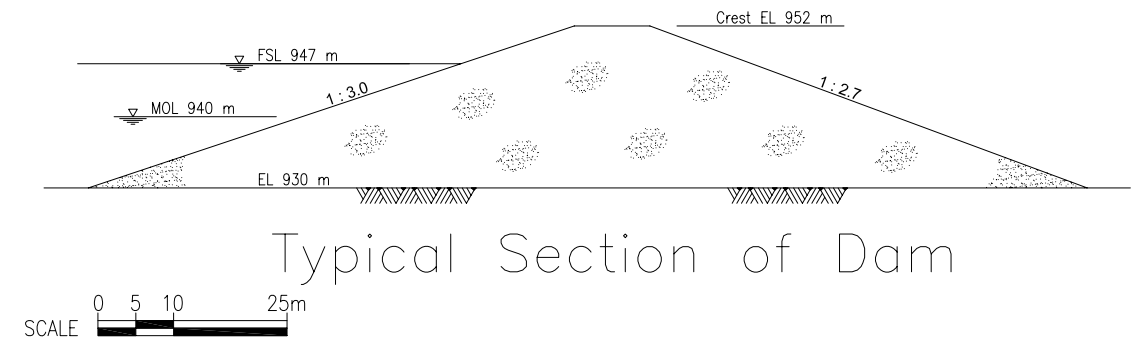
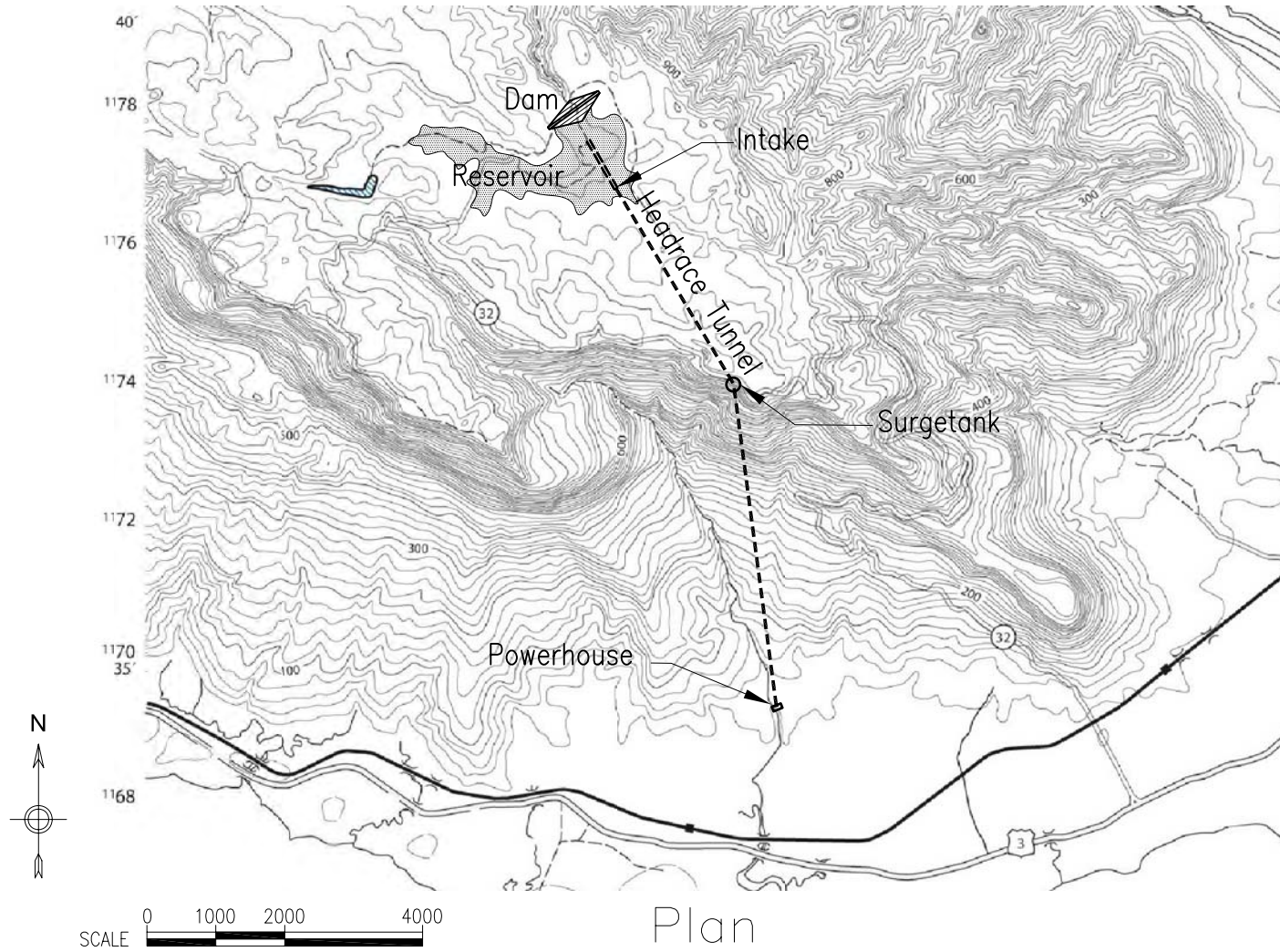
Reservoir Area-Storage Curve

The Master Plan Study of
Hydropower Development in Cambodia

NIPPON KOEI CO., LTD. DWG. NO. A-6

TITLE

Stung Metoek 3 Hydropower Project



The Master Plan Study of Hydropower Development in Cambodia			
NIPPON KOEI CO., LTD.		DWG. NO.	A-7
TITLE Bokor Plateau Hydropower Project			

付属資料-B 現地再委託調査による自然環境調査結果

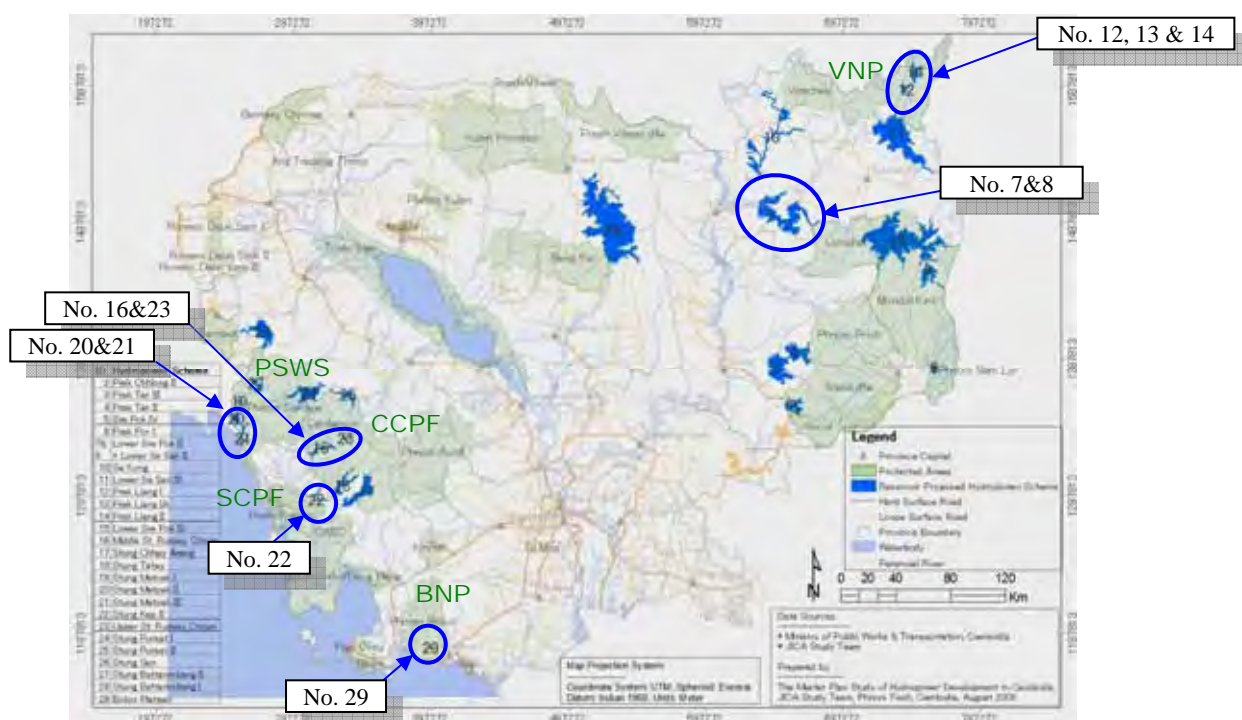
NATURAL ENVIRONMENT

The rapid economic growth of Cambodia in recent years drives a huge demand for electricity. A power sector strategy 1999–2016 was formulated by the government in order to promote the development of renewable resources and reduce the dependency on imported fossil fuel. The government requested technical assistance from Japan to formulate a Master Plan Study of Hydropower Development in Cambodia.

The objective of this paper is to survey the natural and social environment of 10 potential hydropower projects in Cambodia that can be grouped into six sites as listed below. This survey constitutes part of the Master Plan Study of Hydropower Development in Cambodia. The objective of the survey is to gather baseline information on the current conditions of the sites, which will be used as input for a review and prioritisation of the selected project sites.

This report indicate the natural environment of the following projects on 6 basins.

	Original Site No.	Name of Project	Provice	Protected Area (Abbreviation)
1	No. 12, 13 & 14	Prek Liang I, IA, II	Ratanak Kiri	Virachey National Park (VNP)
2	No. 7 & 8	Lower Se San II & Lower Sre PokII	Stung Treng	-
3	No. 29	Bokor Plateau	Kampot	Bokor National Park (BNP)
4	No. 22	Stung Kep II	Koh Kong	Southern Cardamom Protected Forest (SCPF)
5	No. 16 & 23	Middle and Upper Stung Russey Chrum	Koh Kong	Central Cardamom Protected Forest (CCPF)
6	No. 20 & 21	Stung Metoek II, III	Pursat & Koh Kong	Phnom Samkos Wildlife Sanctuary (PSWS)



LOCATIONS OF HYDROPOWER PROJECT AND PROTECTED AREA

1. PREK LIANG I, IA, II

1.1 VILLAGES CLOSE TO THE SITES

The hydropower projects Prek Liang I, IA and II are located on the Prek Liang river, which flows into the Ou Ta Bouk river. The latter is a main tributary of the Se San. The selected survey areas focus on one of the two communes of Ta Veng district of Ratanak Kiri province. Three villages of Ta Veng Leu commune were selected for field surveys: Bangket, Ta Bouk and Ta Veng. The majority of the population in these villages are ethnic hill tribes, Brao and Lun (3SPN 2007).

The three villages are located on the Se San River, and the livelihoods of the local people are related to the river. They have experienced the same changes in water flow patterns in the river as the villages in the Lower Se San-Lower Sre Pok area.

1.2 ACCESSIBILITY OF TARGET VILLAGES

There are no village observed in the Prek Liang I, II Sites. The closest communities in the district of Ta Veng is located 53 km north of the Ratanak Kiri provincial capital. Access is via a small clay road in fair condition during the dry months that can be used by cars and small trucks. Access to this district must be worse during the wet months. Ta Veng village is located within the Ta Veng district centre, while Bangket and Ta Bouk are located about 6 km and 12 km north of Ta Veng district, respectively. The 6 km section of road between Bangket and Ta Bouk village crosses the forest area. Motorbikes are used because cars can not drive from the district centre to the two target villages.



Photo 1-1: Road to Ta Veng District, Bangket and Ta Bouk village

1.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

In the three target villages, a water and sanitation programme has been offered to the people by German Agro-Action since 2005. It has included an awareness campaign on sanitation, the construction of hand wells and distribution of water filters. The most extensive projects were conducted by the River Coalition. Its work is similar to that it has done in the Lower Se San-Lower Sre Pok area.

Recently the government approved mineral exploration within Virachey National Park, upstream from the target villages. The three projects are planned to be located in this park. The mineral exploration zone overlaps with the project sites.

1.4 PROTECTED AREA : VIRACHEY NATIONAL PARK (VNP)

1.4.1 History and geography

It is hard to clarify the environmental conditions of the Prek Liang I and II's project sites. Since there is no specific information of the project sites, the general information of the Virachey National Park is stated as the references.

Virachey National Park was created under a royal decree on the creation and designation of protected areas, issued on 1 November 1993, and is managed by the Ministry of the Environment. The park is one of the top priority conservation areas in south-east Asia. Located in Ratanak Kiri and Stung Treng provinces, it covers an area of 3325 sq km and protects flora and fauna of international significance. The

streams from the mountains of the park contribute significantly to the flow of the Mekong. A high percentage of people living around the park are ethnic minorities.

Since 2000, the World Bank has financed a Biodiversity and Protected Area Management Project (BPAMP) within Virachey National Park. The project aims to improve the capabilities of the Ministry of Environment to plan, implement and monitor national protected areas. This includes developing and testing proactive measures to minimise unsustainable exploitation and degradation of biodiversity of national and global significance. There are four components: 1) national policy and capacity building, 2) park protection and management, 3) community development and 4) project management. The extension of this conservation project (2008–12) is expected to be approved soon by the World Bank.

The people living close to the National Park seem to live in harmony with nature. An ethnic minority, they rely on slash and burn agriculture and collection of non-timber forest products. Forest product trading is a minor problem.



Photo 1-2: Ou Chul river in Ta Veng villag (left), forest cover in Bangket (centre) and Ta Bouk villag (right)

Most of the forest is close to the villages. However, forest hunting and gathering occur further away. The main non-timber forest products harvested are rattan, bamboo and malva nuts. Hunting for food and for trade occurs in Virachey National Park, and although a consistent decline in wildlife populations has been observed, reports indicate that tigers, Himalayan black bears, Malayan sun bears, gaurs, sambar deer, muntjac and civet are still being hunted. Turtles, monitor lizards and pangolin are the most commonly traded animals. Rabbits, forest rats and other smaller animals are usually hunted for subsistence closer to the villages.

1.4.2 Flora

Dense semi-evergreen lowland and montane forest, upland savannah, bamboo thickets and occasional patches of mixed deciduous forest predominate in the vegetation of Virachey National Park. Hills and low mountains dominate the topography, with most areas lying higher than 400 m above sea level, and elevations reaching more than 1500 m along the border with Laos and Vietnam. Grassland and shrubland as well as marshes are found in isolated areas.

The literature describes two broad vegetation formations in the park as the following, found in seven landscapes, each with its own predominant vegetation (BPAMP 2005):

- Humid medium elevation formations (above 600 metres) with montane slopes and montane peneplain.
- Humid low elevation formations with middle valley reaches, valley floors, western lowland, isolated granite outcrops and wetlands.

Logging and timber collection are prohibited within the park, and there is no reported timber production. Non-timber products are widely collected by indigenous people to exchange for necessities such as rice, salt and medicine. These products include wild vegetables (more than 60 species), wild fruits (30 species), dry and oil resin (three kinds), honey, rattan and bamboo (BPAMP 2000).

Forest management within the protected area aims at conservation. Patrols are launched from the three ranger stations to prevent or record offences. A tree nursery has been created for future restoration of degraded areas within the park (BPAMP 2007).

1.4.3 Fauna

The first major survey of the forest and biodiversity within Virachey National Park was conducted in 1998 (Ashwell 1998). The latest survey was conducted by Conservation International in 2007, but the

report is not yet available. A previous survey by CI was conducted in June 2006, involving a rapid assessment of mammals, reptiles, amphibians and fish. The biological research focused on selected sites within Ta Veng district in the eastern part of the park, along the Ou Ta Bouk river downstream from the Prek Liang project site. Those areas are well known for biodiversity and are relatively unfragmented and large enough to accommodate viable populations of animals (Emmett 2006).

The surveys indicate that there may be as many as 156 vertebrate species in the park, of which 43 are of international significance. Of these, bovids, cats, small carnivores and primates are threatened. Globally threatened primate species occurring in the park include the slow loris, pygmy loris, pig-tailed macaque, long-tailed macaque, douc langur and yellow-cheeked crested gibbon. Species of particular concern include elephants, tigers, gaurs and bantengs (BPAMP 2007).

(1) MAMMAL

Emmett (2006) used the camera traps to confirm the presence of large and small mammals. Three camera traps were set in suitable places in an attempt to photograph medium-sized and large mammals. The traps were set for five days only. They were baited with fresh pork and “Hawbakkers Wildcat Lure no 2” to attract most animals species. The threat to wildlife comes from cross-border hunting and wildlife trade from Vietnam. Table 1-1 shows the list of species from camera trap results.

Table 1-1: List of species from Camera trap results

Common Name	Scientific Name	IUCN Redlist
Elephant	<i>Elephas maximus</i>	EN
Tiger	<i>Panthera tigris</i>	EN
Leopard	<i>Panthera pardus</i>	LR/nt
Clouded leopard	<i>Pardofelis nebulosa</i>	VU
Fishing cat	<i>Prionailurus viverrinus</i>	VU
Marbled cat	<i>Pardofelis marmorata</i>	VU
Leopard cat	<i>Prionailurus bengalensis</i>	LC
Sun bear	<i>Ursus malayanus</i>	DD
Gaur	<i>Bos gaurus</i>	VU
Pig-tailed macaque	<i>Macaca nemestrina</i>	VU
Long-tailed macaque	<i>Macaca fascicularis</i>	LR/nt
Stump-tailed macaque	<i>Macaca arctoides</i>	VU
Sambar deer	<i>Cervus unicolor</i>	LR/nt
Red muntjac	<i>Muntiacus muntjak</i>	LR/nt
Wild pig	<i>Sus scrofa</i>	
East Asian porcupine	<i>Hystrix brachyura</i>	VU
Large Indian civet	<i>Viverra zibetha</i>	LR/nt
Large-spotted civet	<i>Viverra megaspila</i>	VU
Small Indian civet	<i>Viverricula indica</i>	LR/tn
Owston's palm civet	<i>Hemigalus owstoni</i>	LR/nt

EN= Endangered, DD= Data Deficient, LC= Least Concern, LR/nt= Near Threatened VU= Vulnerable
Source: Emmett 2006.

(2) BIRDS

It is estimated that as many as 100 bird species of international significance are present in Virachey National Park. This is one of only two areas in Cambodia known to support Germain's peacock pheasant, a restricted-range species. In addition, the park supports a number of globally threatened and at-risk species, including Siamese sirebacks, red-collared woodpeckers and great hornbills (BPAMP 2005). A number of significant records have been made (Mlicovsky 1999), including three species recorded for the first time in Cambodia: the white-browed piculet (*Sasia ochracea*), Eurasian woodcock (*Scolopax rusticola*) and Japanese paradise-flycatcher (*Terpsiphone atrocaudata*). In the park's aquatic environment, fresh-water crocodiles, otters, fresh-water tortoises and some fish are of conservation significance.

Virachey National Park is one of only two areas in Cambodia known to support Germain's peacock pheasant *Polyplectron germaini*, a restricted-range species. In addition, the park supports a number of globally threatened and near-threatened species, including the Siamese fireback *Lophura diardi*, red-collared woodpecker *Picus rabieri* and great hornbill *Buceros bicornis*. Virachey remains one of the most ornithologically unexplored parts of Cambodia. However, survey work in neighbouring areas of Laos and

Vietnam indicates that higher elevations are likely to be of particular importance for globally threatened species such as the black-hooded laughing thrush *Garrulax milleti* and black-crowned barwing *Actinodura sodangorum* (BirdLife 2007).

Other regionally significant bird species are: the little cormorant, Indian cormorant, grey heron, purple heron, woolly-necked stork, black-necked stork, cotton pygmy-goose, brahminy kite, white-bellied sea-eagle, great-thick knee, river tern, little tern, orange-breasted green pigeon, green imperial pigeon, alexandrine parakeet, pied kingfisher, streak-throated woodpecker, great slaty woodpecker, yellow crown woodpecker, broad-and-red broadbill and white-bellied woodpecker.

(3) REPTILES AND AMPHIBIANS

The Global Amphibian Assessment in 2004 found 43 species (three endemic) for Cambodia (Emmett 2006). Emmett’s 2006 survey use timed diurnal and nocturnal searches and pitfall trapping with straight-line drift fences to collect the sample. Based on preliminary identifications, Emmett recorded at least 23 reptile and 18 amphibian species. Up to three reptile species and four amphibians may be undescribed species, but they have not been included in the total numbers of species unless there is no doubt that they are distinct species. Each species is listed in Table 1-2 below.

Table 1-2: Reptiles and amphibians species found in the 2006 survey

Reptile Common name	Reptiles Scientific name	Amphibians Common name	Amphibians Scientific name
Reticulated python	<i>Python reticulatus</i>	Leaf-litter frog	<i>Leptolalax sp1</i>
Banded krait	<i>Bungarus fasciatus</i>	Leaf-litter frog	<i>Leptolalax sp 2</i>
Plumbeous water snake	<i>Enhydris plumbea</i>	Litter frog	<i>Leptobrachium sp</i>
Red-necked keelback	<i>Rhabdophis subminiatus</i>	Horned frog	<i>Megophrys sp</i>
Common mock viper	<i>Psammodynastes pulverulentus</i>	Toad	<i>Bufo galeatus</i>
Unknown snake	(possibly juvenile water snake)	Striped spadefoot toad	<i>Calluella guttulata</i>
Green cat snake	<i>Bioga cyanea</i>	Striped sticky frog	<i>Kalophrynus interlineatus</i>
Unknown slender-toed gecko	<i>Cyrtodactylus sp</i>	Dark-sided chorus frog	<i>Microhyla heymonsi</i>
Tockay gecko	<i>Gekko gekko</i>	Painted chorus frog	<i>Microhyla pulchra</i>
Horned tree lizard	<i>Acanthosaura nataliae</i>	Kuhl's frog	<i>Limnonectes kuhlii</i>
Unknown horned tree lizard	<i>Acanthosaura sp</i>	Unknown frog	<i>Limnonectes sp 1</i>
Forest crested lizard	<i>Calotes emma</i>	Unknown frog	<i>Limnonectes sp 2</i>
Barred gliding lizard	<i>Draco taeniopterus</i>	Marten's puddle frog	<i>Occidozyga martensii</i>
Indo-Chinese water dragon	<i>Physignathus cocincinus</i>	Chantaburi stream frog	<i>Rana montivaga</i>
Long-tailed lizard	<i>Tachydromus sexlineatus</i>	Dark-sided frog	<i>Rana nigrovittata</i>
Many-lined sun skink	<i>Mabuya multifasciata</i>	Taiwanese frog	<i>Rana taipehensis</i>
Streamside skink	<i>Sphenomorphus maculata</i>	Green-sided frog	<i>Odorrana morafki</i>
Rough-scaled skink	<i>Tropidophorus sp</i>	Common tree frog	<i>Polypedates leucomystax</i>
Bowring's supple skink	<i>Lygosoma bowringii</i>		
Leaf-litter skink	<i>Scincella sp</i>		
Impressed tortoise	<i>Mnouria impressa</i>		
Giant Asian pond turtle	<i>Heosemys grandis</i>		
Asiatic softshell turtle	<i>Amyda cartilaginea</i>		

Source: Emmett, 2006

(4) FISHES

For a fish survey, Emmett (2006) found at least 39 different species were caught in five different places.

Table 1-3: Fish Species Discovered during Emmett’s 2006 Survey

Scientific name	Common name	Scientific name	Common name
<i>Osphronemus exodon</i>	Elephant ear gourami	<i>Garra cambodgiensis</i>	
<i>Raiamas guttatus</i>		<i>Pristolepis fasciata</i>	
<i>Xenentodon cancila</i>		<i>Hampala macrolepidota</i>	
<i>Barbodes schwanefeldi</i>	Tinfoil barb	<i>Channa gachua</i>	
<i>Hypsibarbus sp. Cf. vernayi</i>		<i>Balitora cf. annamitica</i>	
<i>Parambassis apogonoides</i>	Iridescent glassy perchlet	<i>Poropuntius laoensis</i>	
<i>Annamia normani</i>		<i>Danio gibber</i>	
<i>Mystus albolineatus</i>		<i>Hypsibarbus vernayi</i>	
<i>Rabora pavi</i>		<i>Schistura obeini</i>	
<i>Poropuntius laoensis</i>		<i>Schistura personata</i>	
<i>Mystus atrifasciatus</i>		<i>Lobocheilos rhabdoura</i>	
<i>Pristolepis fasciata</i>	Catopra	<i>Sineleotris namxamensis</i>	
<i>Epalzeorhynchus frenatum</i>		<i>Pareuchiloglamis nebulifer</i>	
<i>Hampala macrolepidota</i>		<i>Pseudecheneis sympelvicus</i>	
<i>Rasbora urophthalmoides</i>	Least rasbora	<i>Garra cyrano</i>	
<i>Xenentodon cancila</i>		<i>Rasbora aurotaenia</i>	
<i>Mystacoleucus greenwayi</i>		<i>Hypsibarbus vernayi</i>	
<i>Rasbora myersi</i>	Silver rasbora	<i>Glossogobius giuris</i>	
<i>Rasbora paviei</i>		<i>Rasbora steineri</i>	
<i>Poropuntius normani</i>			

Source: Emmett, 2006.

2 LOWER SE SAN, LOWER SRE POK

2.1 VILLAGES ALONG THE SITE

The Lower Se San-Lower Sre Pok II project site is on the Se San River, immediately downstream from where it is joined by the Sre Pok River. The selected survey areas focused on one commune in Ratanak Kiri province (Hat Pak) and four communes in Stung Treng province (Kbal Romeas, Srae Kor, Ta Lat and Phluk). In total, 11 villages were selected for the field survey. Five upstream villages will be completely flooded once the hydropower station is operational: Kbal Romeas, Krabei Chrum, Srae Sranok, Srae Kor Phum 1 and Srae Kor Phum 2. Two villages upstream of the dam will not be flooded: Hat Pak and Veun Hay. Ta Lat and Rumpoat villages will also be flooded once the dams are built, according to the people. Two villages downstream of the dam were also selected: Phluk and Ban Bung. The majority of the population in these villages is ethnically Lao.

There are six target villages of the interview survey located on the Se San River whose populations' livelihoods are related to the river: Hat Pak, Veun Hay, Srae Kor Phum 1 and Srae Kor Phum 2, Rumpoat and Ta Lat. They have experienced changes in water flow patterns in the river during the past 10 years (since the Yali dam was built). There is reason to believe that the Yali dam has seriously impacted fish stocks and species diversity. It is estimated that fish yield has been reduced to 10–30 percent of what it was previously (SWACO 2006). The impact on incomes and other tangible losses could be about USD2.3 million from 1996 to 1999 (Oxfam America 2001). An earlier report stated that flooding on the Se San River in 1996 raised the water level in the Sre Pok River as far upstream as Kbal Romeas commune (Baird *et al.* 2002).

2.2 ACCESSIBILITY OF TARGET VILLAGES

The district of Veun Sai is located about 40 km north of the provincial capital of Ratanak Kiri. Access is via a clay road in fair condition. Hat Pak commune is located on the bank of the Se San River and could be reached only by boat from Veun Sai district.



Photo 2-1: Road to Hat Pak commune, Hat Pak and Veun Hay villages



Photo 2-2: Road to Kbal Romeas, Krabei Chrum and Srae Sranok villages

All the three target villages in Kbal Romeas commune are located on the Sre Pok riverbank. Newly built earth roads provide easy access to them. The extension of the built road from Stung Treng town to Se San district provides many difficulties for travellers to Phluk commune.



Photo 2-3: Road to Phluk commune, Phluk and Ban Bung villages

2.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

The most extensive projects were conducted by the River Coalition, which involves the NGO Forum, 3S Rivers Protection Network (3SPN), Culture and Environment Preservation Association and Oxfam America. Its work is focused on environmental and human rights issues related to hydropower projects. Many documents have been produced related to people’s livelihoods, fisheries and the impact of hydropower projects on the Se San and Sre Pok rivers.

Ta Lat commune: Recently the government approved coal exploration at three places in Ta Lat commune (Ou Chongkal, Srae Kambot and Srae Phachang). Two forest communities have been established. Three economic land concessions were also licensed by the government and timber cutting has operated since 2005.

Kbal Romeas and Srae Kor communes: Several newly established economic land concessions are in full operation. Trees are being cut. The forest concessions limit villagers’ activity. Twelve forest communities have been established in Srae Kor commune. Their forest areas overlap with the economic land concessions.

There is no protected area related to the potential project sites of Lower Se San and Lower Sre Pok II. All the forests in the target villages there have been awarded to private concessions. There are very few surveys of natural resources in Sesan district. There was an environmental impact assessment of the economic land concessions within Stung Treng province, but the author could not obtain them from the companies, which claimed the reports were confidential.

2.4 NATURAL ENVIRONMENT AND POPULATION

The Lower Se San II and Lower Srepok II are seldom cover the National Conservation Area so that there is no previous report of a natural environment survey in the area of the target villages of the interview survey. The people seem to live in harmony with nature. An ethnic minority, they rely on agriculture and collection of non-timber forest products. Forest product trading is a minor problem. A boat trip was made to the project site, where workers employed by the company that will build the hydropower project had been active for months exploring the area.

Most forest is relatively close to the villages, but forest gathering and hunting occur further from the villages because the nearby forests were given to the economic land concessions. The riparian vegetation is quite dense.

The main non-timber forest products harvested are two kinds of resin. In the past, logging provided a major part of household income for the population of the target villages. Nowadays, all forest areas surrounding the target villages of Stung Treng province were switched to economic land concession schemes. The owner of those concessions does not allow local people to collected timber and non-timber product in the forest area. In each economic land concession, a tree nursery was established. The reservoir will affect those concessions.



Photo 2-4: Project site work, demarcation milestone and camp

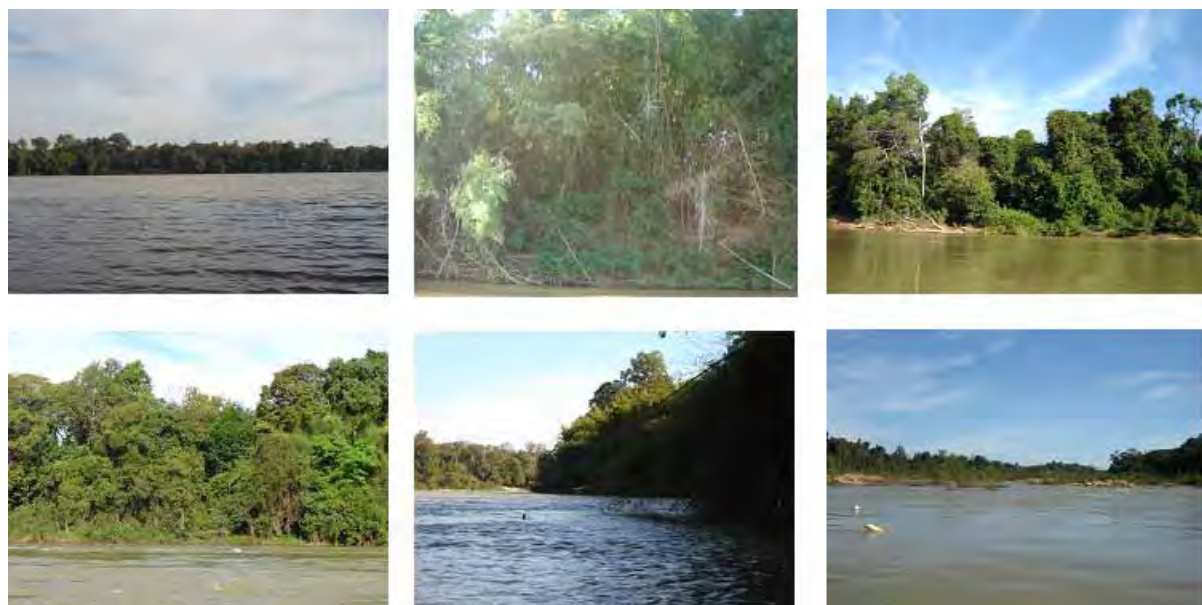


Photo 2-5: Riparian vegetation along Se San River from Phluk village to the project site



Photo 2-6: Forest area close to the project site (Project No. 7-8)



Photo 2-7: Forest cover around the Kbal Romeas commune

3. BOKOR PLATEAU

3.1 SURVEY AREA

The Bokor Plateau hydropower project site is located on a small river on Bokor mountain, about 2000 m downstream from the Popok Vil water fall. This river is one of several tributaries of the Prek Toek Chou river. The Kamchay hydropower project that is being built (193 MW) and it relies on water resource from the Prek Toek Chou river.

The selected survey areas focus on one of the 16 communes of Kampot district in Kampot province. Three of the four villages of Koh Touch commune were selected for field surveys: Kandal, Prek Ampil and Prek Chek. The majority of the people in these villages are ethnically Khmer. The three target villages are located along National Road No. 3 and are situated outside the catchments area of the Prek Toek Chou river. Local livelihoods come from wet season rice production and marine fishing.

3.2 ACCESSIBILITY OF TARGET VILLAGES

Koh Touch commune is located about 14 km south-west of the provincial capital. The access road is paved and in good condition. The roads to the three village centres are of clay and in fair condition during the dry months. These villages are located between National Road No. 3 and the sea.



Photo 3-1: Roads to Prek Ampil, Prek Chek and Kandal

3.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

The three villages of Kandal, Prek Ampil and Prek Chek in Koh Touch commune are involved in the Environmental Management of the Coastal Zone in Cambodia project.

The NGO Korphey Express has conducted awareness campaigns on natural resource conservation in the three villages. The Danish Red Cross offered sanitation facilities, wells and water storage facilities. The ASAC (Assistance on Curbing Small Arms) programme of the European Union built a school. The NGO Racha built a hospital and provided medical supplies.

3.4 NATURAL ENVIRONMENT AND POPULATION

There is no previously reported natural environment survey in the area of the three villages. In Kampot province, the forest area was reduced up to 12 percent in the period between 1993 and 2005. Protected forest represents up to 51 percent of total forest cover land (CZM 2007). The annual fish, squid and shrimp catch has continually decreased since 1995. This statement is corroborated by people's perceptions in the three villages. Most forest is now relatively far from the villages, mostly located within Bokor National Park (BNP).



Photo 3-2: Rice field in Prek Ampil village (left), Ou Koh Touch river (centre), overview of target villages from Bokor mountain (right)

3.5 PROTECTED AREA: BOKOR NATIONAL PARK (BNP)

3.5.1 History and geography

Bokor National Park (BNP) was created under a royal decree on the creation and designation of protected areas, issued on 1 November 1993, and is managed by the Ministry of Environment. BNP lies in the southern half of the Elephant Mountains, near the coast. It was first developed as a well-known resort during the French Protectorate.

It is one of the largest national parks of Cambodia, with a surface area of about 1400 sq km. Its elevation ranges from 30 to 1079 m. The park is undulating to hilly in the north-east, with a mountain plateau in the west and south-west. BNP is an important water catchments area for several rivers, in particular the Prek Toek Chou, which flows through the provincial capital (Sorensen 1998).

One of several tributaries of the Prek Toek Chou has its source in the highest level of BNP, and it is the water of this tributary that the Bokor Plateau hydropower project will rely on. BNP has suffered lots of pressure on resources. Illegal logging is a major threat. It is estimated by Global Witness that perhaps 80 percent of the park has been logged since 1997 (Sorensen 1998).

Six previous studies have been carried out in or about BNP. These were a study of vegetation (Dy 1970), a survey of tigers (Robinowitz 1999) park management requirements (Sorensen 1998), a primary bird survey (Goes *et al.* 1998), a localised but detailed study of forest vegetation (Ashwell *et al.* 1999) and a wildlife survey (WCS 2001).

In 1995, BNP was believed to have UNESCO World Heritage potential. But then, most species-rich forest areas were converted to species-poor shrubland. A newly approved project to create a large resort in the former town has ended the World Heritage attempt. The new resort, involving a USD2 billion investment, is under construction.

A delineation of the resort is being undertaken, but the BNP managers do not yet know the total area dedicated to the resort. At present, forest encroachment, illegal logging and charcoal production are considered the major threats to BNP. Numerous trails in the shrubland and forests have been made by collectors of non-timber forest products.



Photo 3-3: Damaged water intake (left), hill where this small river begins (centre), downstream flow to Bokor project site (right)



Photo 3-4: Damaged water intake (left), pump house (centre), water pipeline support pier (right)



Photo 3-5: Several pictures of the natural environment close to the Bokor Plateau project site

3.5.2 Flora

BNP is a biologically rich area. It contains several types of montane ecosystem and includes humid lowland evergreen forest in the south and semi-deciduous dipterocarp forests in the north. In middle of the Park are palm groves, hill and sub-montane forests, interspersed in the east with many gallery forests and humid sub-montane with drier sclerophyllic montane vegetation type, then interspersed in the west with fens and bogs in the highlands. On the upper slope are many Fagaceae and Lauraceae and on the plateau several formations of Myrtaceae and Vacciniaceae and also *Sphagnum* bogs (Sorensen 1998).

The southern part is lowland evergreen forest. In the north is deciduous and semi-evergreen forest (WCS 2001). Sorensen (1998) reported that the park harboured more endemic plant species per unit area than any other location that had been studied in Cambodia. Areas of high plant endemism within BNP can be found on the entire plateau along the west and south-west and in the gallery forest.

Few biological surveys have been conducted in the area, and these appear to have concentrated mainly on the lower elevations of the Elephant Mountains and the southern plateau. More complete plant survey information is found in Dy's (1970) analysis of the vegetation of south-west Cambodia. The southern gradient (1–1050 m) of the range of Dy's study is inhabited by a rather diverse and endemic biota of at least three major vegetation zones:

- Tropical evergreen forest is dominated by Dipterocarpaceae from sea level to 500 m.
- Tropical evergreen Oak—Tree Fern (*Cibotium*) forest from 500 to 800 m, and
- Short montane evergreen forest above 800 m that is dominated by gymnosperm (*Dacrydium* and *Podocarpus*), Myrtaceae and Ericaceae (*Vaccinium*) interspersed with occasional and often extensive sphagnum bogs or fens.

Dy (1970) enumerates 35 species of trees and shrubs and 20 species of lower stratum. Species groups occupying the upper stratum of the vegetation include Myrtaceae (two genera, seven species) Fagaceae (two genera, five species) and Lauraceae (three genera, four species). The prominent families of the lower stratum include Myrsinaceae (two genera, four species) and Rubiaceae (three genera, four species). The most species-rich groups of herbaceous families include the Cyperaceae and Rubiaceae.

Of the 35 species that Dy (1970) recognised as endemics of south-west Cambodia, 30 are known to occur solely in the Elephant Mountains). This justifies the view that the plant endemism is centred on Bokor hill and environs (Sorensen 1998). The 1998 survey found 38 timber species, of which the majority are rare, and 47 species of non-timber forest plants (Sorensen 1998).

Logging is prohibited within it, and there are no reports on timber production. However, forest clearance and encroachment have occurred since the early 1990s, exacerbated by migration from outside the province (Sorensen 1998). This view was supported by the household survey. Wood is collected for fuel and fence posts and also for selling.

Non-timber forests products are widely collected by poor households. They include bamboo, rattan, lianas, wild edible fruit (13 species), medicinal plants (19 species) and material for handicrafts (10 species) (Sorensen 1998).

Management of the protected area aims at conservation. No timber collection is allowed. Patrols have been launched regularly under the WildAid programme since 2000 to prevent and record violations of the ban. Community development is also brought under this programme.

3.5.3 Fauna

There was no survey of the mountain birds or mammals prior to 1998. The 1998 survey was done with support from the WWF. The bird survey provided some interesting results. The southern part of the BNP has 27 percent bird species recorded that are not found elsewhere in the other part of the Park. Approximately 300 bird species are expected here, although only 226 have been recorded (Sorensen 1998).

(1) MAMMALS

The 2000 survey by WCS identified 29 mammal species by direct observation, specimen or phototrap picture (WCS 2001). Nine of the them are globally threatened: the Sunda pangolin *Manis javanica*, pig-tailed macaque *Macaque nemestrina*, pileated gibbon *Hylobated pileatus*, Asian golden cat *Catapuma temminckii*, tiger *Panthera tigris*, Asian elephant *Elephas maximus*, gaur *Bos gaurus*, southern serow *Naemorhedus sumatraensis* and East Asian porcupine *Hystrix brachyuran*.

Evidence of Asian elephants was found in the south-west of BNP (Srae Muoy Roy) and both elephants and gaurs were found in the north-central area of the park (Boeng Thom and Ou Kaseap). Tiger tracks were found in the south-west (Srae Muoy Roy) and north-central (Ou Kaseap) areas.

Phototrap pictures of the Sunda Pangolin, sun bear *Ursus malayanus*, marbled cat *Pardofelis marmorata*, Asian golden cat, leopard cat *Prionailurus bengalensis* and East Asian porcupine were taken (see Appendix D for more detail).

The survey indicated that most abundant boreal species were (in descending order) red muntjac, lesser mouse deer, common palm civet, leopard cat, Asian brush-tailed porcupine, wild pig, Berdmore's squirrel, sun bear, East Asian porcupine and yellow-throated marten.

(2) BIRDS

Goes *et al.* (1998) reported that there are approximately 300 bird species in BNP, at least eight of them globally significant.

A 1998 survey in BNP found globally threatened species including the green peafowl, chestnut-headed partridge, rufous-winged buzzard and grey-headed fish-eagle. The first recordings for the country included the blue-cared kingfisher, crow-billed drongo and several warblers. BNP is the only place in the region where the great hornbill still thrives (Sorensen 1998).

A 2000 survey within the BNP was conducted by the Wildlife Conservation Society (WCS 2001). A total of 249 species were recorded. BNP is home to a number of globally threatened and near-threatened species, of which the green peafowl *Pavo muticus*, silver oriole *Oriolus mellianus*, spot-bellied eagle owl *Bubo nipalensis*, rufous-winged buzzard *Butastur liventer*, oriental darter *Anhinga melanogaster*, blue-rumped pitta *Pitta soror*, Swinhoe's minivet *Pericrocotus cantonesis* and chestnut-headed partridge *Arborophila cambodiana* are important records.

(3) REPTILES AND AMPHIBIANS

During the WCS survey, four main sites were visited to collect amphibians and reptiles. Most emphasis was on the southern plateau and the Prek Koh Touch, which flow past the three target villages. Eleven amphibian species of and nine reptile species were recorded (WCS 2001).

The poorly known Cardamom endemic gecko *Cytodactylus intermedius* was found to be abundant on the plateau. Two specimens of *Trimeresurus* tree-viper were collected that have brown tails instead of the typical red tail and were expected to be described as a new species or subspecies (WCS 2001). There may be a peninsular Thailand element at Bokor in that the *Acanthosora* lizards at Bokor were more like *A. armata* (a peninsular Thailand species) than the expected *A. capra* (a southern Annamite species) (WCS 2001).

(4) FISHES

There is no record or survey regarding the fish species within BNP.

4. STUNG KEP II

4.1 SURVEY AREA

One of the proposed Stung Kep II dam site (right site) is located on Stung Kep river in Russey Chrum commune, Thma Bang district of Koh Kong province. The other proposed dam site of Stung Kep II (left site) is located on the Stung Tatay river in Trapeang Rung commune, Koh Kong district of Koh Kong province. The nearest village is located about 18 km from the proposed dam site (left site), but only about 3 km from National Road No. 48. The Stung Kep flows into the Stung Tatay about 8 km downstream from the right site, before the Stung Tatay flows into the sea at Koh Kong Bay.

The selected survey areas focus on the two villages of Tatay Kraom commune in Koh Kong province (Anlong Vak and Koh Andaet). The majority of the population of these villages is ethnically Khmer. The two proposed dam sites are located within the southern Cardamom Protected Forest, managed by the Ministry of Agriculture, Forestry and Fisheries. The two target villages are located within the Peam Krasaob Wildlife Sanctuary (PKWS), which is managed by the Ministry of Environment.

There is no previously reported natural environment survey in the area of the two villages. Increased population and land speculation seemed to favour encroachment on the forest of the PKWS. Non-timber forest products were collected by the local population, especially rattan, resins, wild fruits and traditional medicinal plants. Charcoal is being produced at large in this area. The “buried kilns” are usually found behind houses or in farmland. Wooden materials such as poles and planks are collected for family use.



Photo 4-1: Natural environment of the target villages

4.2 ACCESSIBILITY OF TARGET VILLAGES

Tatay Kraom commune is located about 19 km south-east of the provincial capital of Koh Kong. The access road (National Road 48) is paved and in good condition. The two villages are located on the Stung Tatay riverbank.



Photo 4- 2: Stung Kep river and a road in Tatay Kroam commune

4.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

Two existing projects are being conduct within the study area that are the mangrove forest management project run out by the Ministry of Environment funded by International Development Research Centre and, the Environmental Management of the Coastal Zone in Cambodia with the fund from DANIDA.

4.4 PROTECTED AREA: PEAM KRASOAP WILDLIFE SANCTUARY (PKWS) AND RAMSAR SITES

The PKWS was created under a royal decree on the creation and designation of protected areas, issued on November 01, 1993. The sanctuary is situated in Mondol Seima, bordering Smach Meanchey and Koh Kong districts, and covers an area of 237 sq km. The PKWS boasts a unique mangrove ecosystem. Within the same area is Koh Kapi and associated islands which earned a nomination as Wetlands of International Importance under the Ramsar Convention. The PKWS and Koh Kapi Ramsar site have some of the best remaining examples of mangrove forests in the Gulf of Thailand, because many other areas have been cleared for intensive shrimp aquaculture and large-scale charcoal production (Marschke *et al.* 2001).

Although the coastline is relatively unpopulated, there has been a rapid increase in migration into the province, especially in the PKWS, due to improved security and short-term economic opportunities. Population pressures and access to markets place greater pressure on the mangroves and aquatic resources within and surrounding the PKWS.

The PKWS is a lush ecosystem replete with mangroves, aquatic species and wildlife. It spans parts of three districts and is home to around 10,000 people. Intertidal levels and water from highland areas both influence the PKWS. The estuarine areas are affected by the interaction between freshwater and saltwater, especially during the rainy season. The PKWS provides such favourable conditions for fishing and other resources that many people have settled there and depend upon its natural resources for their livelihood (Marschke *et al.* 2001).

The Stung Kep II dam site is located within the southern Cardamom Protected Forest. This important forest is proposed to be the south-west elephant corridor. It is located within the Phnom Samkos Wildlife Sanctuary, Central Cardamom Protected Forest and Peam Krasaob Wildlife Sanctuary. This forest has an essential role in the Cardamom biodiversity conservation corridor identified by the Asian Development Bank.

4.4.1 Flora

The 2003 dry season survey conducted by WildAid (Daltry *et al.* 2003) of the southern Cardamoms and the Botum Sakor Peninsula, where the proposed Stung Kep II project site is located, confirmed that in spite of heavy logging and hunting pressures in recent years, this area still contains nationally significant biodiversity, including important populations of endemic and endangered plants and animals. It should be a high priority for conservation.

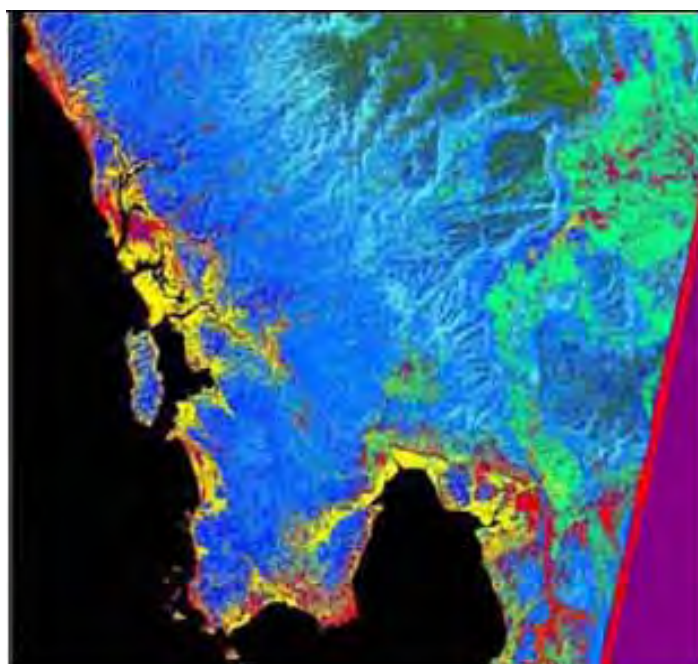
By April 2003, 251 species of epiphytes, vines and lianas were identified, and fertile specimens were taken from well more than 200 species of vascular plants. These inventories are undoubtedly far from complete, and future surveys are predicted to yield more species among all taxonomic groups. Many of the plants have yet to be positively identified, and it is likely that at least some are new to science (Daltry *et al.* 2003). The tall evergreen forest is of fairly high diversity on a global scale, and has the highest tree diversity of any forest in Cambodia.

The forest cover in the southern Cardamoms includes:

- Evergreen tall sandstone forest: Dipterocarp species, high densities of species from the Clusiaceae, Sapotaceae, Lauraceae and Myrtaceae families make these forests reminiscent of dipterocarp forest.
- Short evergreen sandstone forest: Dipterocarp trees are less abundant than in the evergreen tall forests, often being represented only by various *Hopea* species, and poor/acid soil groups become more abundant.
- Tall evergreen basalt forest: The canopy is dominated by giant *Ficus* trees, *Nageia wallichianus*, *Irvingia malayana*, *Heritiera javanica*, and various *Syzygium* spp., *Elaeocarpus* spp., *Garcinia* spp. and *Lauraceae* spp., including the valuable *Lauraceae* sp¹ at its densest in these forests.
- Upland forest and deciduous forest.

¹ *Lauraceae* sp in Khmer mreah prew” that is a wood that could be extracted for essential oils

- Freshwater swamp forest was dominated by just a few species, including *Polyalthia* sp., *Syzygium* sp., *Cinnamomum* sp., *Nephelium* sp., *Aglaia* sp., *Myristica* sp.,
- Open dipterocarp woodland, open *Melaleuca* woodland, open pine woodland, grassland, riparian forest, lowland river swamp, mangrove swamp, bamboo groves.



Classified Landsat image. Colour codes:

Black: water (25.0%);

Yellow: mangrove/swamp (6.1%);

Dark blue: tall evergreen forest (12.0%);

Mid-blue: medium and short evergreen forest (20%);

Pale blue: disturbed evergreen forest (8.4%);

Dark green: upland forest (6.3%);

Pale green: open woodland (9.7%);

Purple: grassland (8.5%);

Red: bare earth/ road (4.0%).

Source: Daltry & Traeholt 2003.

Figure 4-1: Classified landsat image of forest cover in the Southern Cardamom Region

Non-timber forest products known to be collected from the southern Cardamoms include: rattan (*Korthalsia* spp.) stems, for cane and wicker (common); aloewood (Chan Krisna, or gaharu; *Aquilaria crassna*) for essential oil; samraang (*Scaphium macropodum*) fruit, for whose boiled seeds there is large market; *vour romiet* (yellow vine, *Coscinium* sp.) stem, for chemical products; *tep porou* (*Cinnamomum tetragonum*) bark; *preah prew* (*Lauraceae* sp.) wood, for extraction of essential oils; *kuy* (*Willoughbeia edulis*) fruit; and antplant (*Myrmecodia* sp. or *Hydnophytum* sp.; epiphytes) roots, for medicine (Daltry *et al.* 2003).

4.4.2 Fauna

There are many previous biological surveys within the Cardamoms. This report takes into account the most recent survey by WildAid in 2003.

(1) MAMMALS

The 2003 survey by WildAid (Daltry *et al.* 2003) found that the southern Cardamoms contain 28 species of large mammals, but most of them in very small numbers. The list includes globally threatened species such as the clouded leopard *Neofelis nebulosa*, Asian elephant *Elephas maximus*, gaur *Bos frontalis* and Malayan sun bear *Helarctos malayanus*. There were no verifiable reports or observations of any of the large cats or Asiatic wild dogs. Signs of tigers *Panthera tigris*, were notably absent, in spite of alleged sightings by local people. These large predators are most likely present in very small numbers or possibly locally extinct. There were also no observations of hog deer *Axis porcinus* or Eld's deer *Cervus eldii*, despite several reports from villagers claiming that they used to be relatively common.

A total of 11 species of small and medium-sized mammals were documented in the southern Cardamoms Protected Forest (Daltry *et al.* 2003). One hundred and fifty-six small and medium-sized mammals

representing six species, from the orders Scandentia, Carnivora and Rodentia, were captured during 2192 trap nights. Five species of small mammals, from the orders Scandentia and Rodentia, were observed occasionally but not captured.

(2) BIRDS

The WildAid survey (Daltry *et al.* 2003) identified 137 species. Many of the birds were winter migrants, but most were residents. They included a number of species and subspecies that are endemic to the Cardamom Mountains eco-region, which encompasses the mountains of south-west Cambodia and south-east Thailand. It is anticipated that many more species will be found in future surveys.

Nineteen species were new records for the Cardamom Mountains. These were: white-winged duck, laced woodpecker, streak-throated woodpecker, Alexandrine parakeet, pompadour green pigeon, an unidentified crane, a greenshank (probably common), milky stork, woolly-necked stork, blackheaded stork, racket-tailed treepie, vinous-breasted starling, forest wagtail, Richard's pipit, blue-eared barbet, arctic warbler, Siberian blue robin, ruby-cheeked sunbird and thick-billed flowerpecker (Daltry *et al.* 2003).

(3) REPTILES AND AMPHIBIANS

The short survey by WildAid (Daltry *et al.* 2003) documented 59 species of reptiles, including 46 within non-protected parts of the southern Cardamoms. Most species were identified without difficulty or the need to sacrifice specimens, but one lizard (a skink) and one snake (a kukri *Oligodon* sp.) could not be positively identified in the field and were therefore collected for closer study. It is possible that these are species or subspecies new to science.

At least 23 species of amphibians were confirmed in the southern Cardamoms during the WildAid survey. Several have not yet been positively identified, however, and voucher specimens were collected for closer examination at the Muséum Nationale d'Histoire Naturelle in Paris. The confirmed checklist included frogs that are used locally for human consumption (e.g., *Hoplobatrachus chinensis*) as well as important prey for other animals (e.g., *Limnonectes limnocharis*). There is some evidence that the mangrove frog *Fejervarya cancrivora* inhabits mangroves and swamps on the coastal southern Cardamoms and Botum Sakor Peninsula.

The WildAid survey confirmed that the presence of Siamese crocodile is obvious in the Stung Ta Tai. The first indication that crocodiles were present came from a series of interviews with local hunters in 1999, but the species could not be identified from their descriptions alone. Between 25 February and 7 March 2000, several rivers in Koh Kong and Pursat Provinces were visited on foot (Daltry 2000). Three clear sightings of live crocodiles were made in the upper Stung Kep and Stung Krau rivers, confirming that the species was *Crocodylus siamensis*. There were also numerous observations of tracks, trails and dung: up to 23 crocodile scats were recorded.



Photo 4-3: Siamese crocodile prints (left) and its habitat (right) in Stung Kep

In 2003, the FFI conducted a survey of Siamese crocodiles along 357 km of waterways, or 25 percent of the watercourses draining the southern slopes of the central and southern Cardamom Mountains, including the Stung Tatay (Daltry *et al.* 2003). Much of this river is remote and difficult to reach. Seventy km of Stung Tatay stretches were surveyed, and three distinct sites confirmed to contain crocodiles, including a number of juveniles. One of these sites is located immediately upstream from the location of the proposed project site.

5. MIDDLE & UPPER STUNG RUSSEY CHRUM

5.1 SURVEY AREA

The hydropower project Middle and Upper Stung Russey Chrum (No. 16 & 23) is located on the Stung Russey Chrum river in Tatay Leu commune, Thma Bang district, Koh Kong province. The nearest village (Kien Chongruk) is about 13 km from the proposed project sites but is located in Veal Veng district of Pursat province. There are two project sites, both located within the Central Cardamom Protected Forest, which is managed by the Ministry of Agriculture, Forestry and Fisheries with technical assistance from Conservation International.

The selected survey areas focus on Koh Pao village in Bak Khlang commune of Mondol Seima district and two villages of Dang Tong commune of Smach Meanchey district (Phum Ti Buon and Phum Ti Pir) in Koh Kong. In two of the three villages, the population is urban and located about 70 km downstream from the project sites. Most of the population in these villages is ethnically Khmer.



Photo 5-1: Marine fishing in Koah Pao (left), Phum Pir (centre) and Phum Buon (right) villages

5.2 ACCESSIBILITY OF TARGET VILLAGES

Two of the three villages are located within the provincial capital of Koh Kong province. Koh Pao could be reached only by water.

5.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

With support from the International Development Research Centre, a group of researchers at the national level and in Koh Kong province are taking a new approach to managing mangrove resources—one that involves the leadership of local people. And the group is having success: people who were destroying the mangroves are now helping to protect them. Based in part on these results, the Cambodian government has also modified its policy on the environment.

In the three target villages, there is currently a project run by the Ministry of Environment with DANIDA funding called Environmental Management of the Coastal Zone in Cambodia. It aims to provide assistance for the protection, conservation and management of coastal and marine resources (CZM 2007).

The project's components include:

- Policy, legal and institutional framework: produce reports on the status of Cambodian coastal areas, coastal and marine environment issues, law and regulation in the coastal zone, etc.
- Cambodian shoreline management strategy: produce reports on the local area coastal resource management plan, the state of environment, the strategic environmental assessment, the state of the coastal environment and the socio-economy, etc.

The Fauna and Flora International (FFI) in cooperation with the Ministry of Environment and Forestry Administration, with undertakes three components of conservation: (1) community-based protection for the endangered Siamese crocodile and its habitat, (2) conserving the Cardamom Mountains by tackling human-induced threats and (3) building Cambodia's capacity for conservation by establishing education courses throughout the country.

The Cambodian Crocodile Conservation Programme has a special emphasis on the central and southern Cardamom Mountains, where most of the world's critically endangered Siamese crocodiles remain. Within this area, the project includes community-based initiatives that link livelihood assistance with crocodile protection and habitat preservation.

The Cardamoms Biodiversity Conservation Corridors in Cambodia, a pilot project financed by the Asian Development Bank, was prepared based on the following criteria: (1) located within the Greater Mekong Sub-region economic corridors or their zone of influence, (2) reducing ecosystem fragmentation by linking two or more protected areas, (3) areas of international biodiversity importance, (4) areas of high poverty incidence and population growth, (5) area of a transboundary protected nature and (6) area have institutional capacity that is currently active in implementing one or more projects.

The Forestry Administration's Wildlife Protection Office was selected to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) programme on monitoring the illegal killing of elephants (MIKE) in Cambodia. One of the two national MIKE sites covers the Cardamom Mountains, with the main emphasis on the southern Cardamoms Protected Forest.

5.4 PROTECTED AREA: CENTRAL CARDAMOM PROTECTED FOREST (CCPF)

5.4.1 History and geography

The both Upper and Middle Russey Chrum are inside of the CCPF.

The CCPF was gazetted and given a formally demarcated boundary in 2002. It is managed by the Cardamoms Conservation Programme, which is a partnership between Conservation International and the Forestry Administration. The area has now been designated a protected forest, and all logging concessions within its boundaries have been cancelled. The CCPF covers more than 4,000 sq km of evergreen forest, dry dipterocarp forest, pine forest, grasslands and wetland habitats, at elevations ranging from 50 to 1,500 m. The area contains a wide variety of lowland and mid-altitude habitats surrounding a core central plateau, of which about 60,000 ha have an elevation over 1,000 m (Emmett and Olson 2005). The CCPF been recognised as internationally important for biodiversity conservation. It forms part of the Indo-Burma Biodiversity Hotspot and represents one of the largest, most diverse and least developed forest regions in mainland south-east Asia.

Biological research in Cambodia has been extremely limited in scope, and there is a paucity of data for almost all taxa. A few conservation organisations have conducted biological surveys in south-west Cambodia. These include:

- A preliminary wildlife survey in the Cardamom region—FFI, 1999.
- Cardamom Mountains Biodiversity Survey—FFI, 2000.
- Social and Ecological Surveys of Phnom Oral Wildlife Sanctuary—FFI, 2002.
- Mini-RAP Assessment of the Silver Road Logging Concession, Cardamom Mountain area, Cambodia—CI, 2003.
- Biodiversity Assessment of the Southern Cardamoms and Botum-Sakor Peninsula—WildAid, 2003.

5.4.2 Major flora in the CCPF

The CCPF contains some of the most important hill river systems and swathes of contiguous evergreen forest in Cambodia. Habitat destruction within the CCPF is occurring at a comparatively low rate. Current levels of logging, land clearance for agriculture and charcoal production are low, and the evergreen forests appear to be in good condition. Collection of non-timber forest products is causing minimal damage except for activities that focus on globally threatened plant species such as the critically endangered agar tree *Aquilaria crassna*. Alteration to natural fire regimes is having an unknown but possibly detrimental impact on biodiversity in four grassland and pine forests (Emmett and Olson 2005).

The lowland wetlands on the eastern side of the Areng valley and the upland marshes to the east and north of Ou Saom represent the most significant still-water bodies in the CCPF, in terms of both size and biological importance. Of particular critically endangered species, the largest populations are in these wetlands. Wetlands within the Areng Valley are threatened by over-fishing or conversion to agriculture, but the upland marshes around Ou Som show fewer signs of disturbance (Emmett and Olson 2005).

5.4.2 Fauna

CI's 2004 survey found a very high diversity and abundance of threatened species. Twelve mammal species, two birds, seven reptiles, one amphibian and one fish recorded during this survey are classified as globally threatened, and many others are classified as near threatened or data deficient. Potentially undescribed species were discovered, including a rodent (*Rattus* sp.), at least one species of shrew (*Crocidura* sp.), a snake (*Oligodon* sp.), several frogs (e.g., *Philautus* sp. and *Polypedates* sp.), a skink (*Scincella* sp.) and a caecilian (*Ichthyophis* sp.) (Emmett and Olson 2005).

There are few previous biological surveys within the Cardamom Mountains region. This report takes into account the most recent survey by the Conservation International in 2004. Additional description of fauna and flora of previous surveys was documented in the report on hydropower projects Chapter 4: Stung Metoek II & III (No. 20-21) and Chapter 5: Stung Kep II (No. 22).

(1) MAMMALS

In total, 57 mammal species were recorded for the CCPF, for which there were voucher specimens, camera-trap photographs or confirmed observations. Of these, twelve are classified as globally threatened. This takes the total number of mammal species recorded for the Cardamom Mountains to approximately 79 (Emmett and Olson 2005). CI's 2004 survey failed to record the presence of fishing cats. Fishing cats and otters are dependent on wetland habitats where their main food source, fish, is plentiful. Previous camera trapping has not focused on the periphery of wetlands (Emmett and Olson 2005).

The statuses of the dhole *Cuon alpinus* and otter have recently been revised from vulnerable to endangered on the IUCN red list. Otter tracks were found on sandbanks along the Russey Chrum River and the Areng River. Photographs and casts were taken. Up to four species of otter could occur in the Cardamom Mountains: the Eurasian otter *Lutra lutra*, smooth-coated otter *Lutrogale perspicillata*, Asian small-clawed otter *Aonyx cinerea* and the hairy-nosed otter *Lutra sumatrana*. *L. lutra* has been tentatively confirmed in the CCPF by previous surveys (Daltry and Traeholt 2003), whereas *Aonyx cinerea* and *Lutrogale perspicillata* were only predicted to occur.

Lutrogale perspicillata is IUCN-listed as vulnerable due to hunting for skins, over-fishing and habitat alteration. *Aonyx cinerea* and *Lutra lutra* are classified as near threatened and *L. sumatrana* as data deficient, indicating trends similar to *L. lutra* and *Lutrogale perspicillata* (Emmett and Olson 2005).

Wild cattle tracks were frequently observed on the upland plateau in pine forest, montane evergreen forest and grassland. The gaur is vulnerable, and these observations and records are important and positive signs for the conservation of this species. Elephant dung was found in and around a large cave in the Knorgl Strol mountain area. Two species of bear inhabit this region: the Malayan sun bear *Helarctos malayanus* and the Asiatic black bear *Ursus thibethanus*. Both species are widespread in Asia, but are threatened by hunting and habitat loss throughout their range (Emmett and Olson 2005).

Large cat droppings were found in the Russey Chrum Valley. Their size and consistency indicate either a leopard or a tiger. The survival of these species in the region is dependent on high levels of direct protection and improved enforcement of Cambodia's wildlife law. Camera trap photographs recorded Asian golden cats and clouded leopards (vulnerable species), although only in fairly low numbers. Camera traps have recorded only two pangolins in four years, and the research team made no observations. Pileated gibbons were recorded at all surveyed sites. This species is classified as vulnerable and appears to be very abundant in the region (Emmett and Olson 2005).

The CI survey recorded two species of tree shrew and at least eight rodent and two insectivore species. Of these, 10 species are new records for the Cardamom Mountains, and six are new records for Cambodia. Several voucher specimens from the rodent genera *Maxomys* and *Niviventer* are externally different to previously recorded species for the country and may be new records for Cambodia, or even new to science (Emmett and Olson 2005).

Eleven species of bat were recorded during the survey. Two species, *Myotis horsfieldi* and *Rhinolophus lepidus*, are new records for Cambodia. Both are found throughout the CCPF. Another species, *Rhinolophus shameli*, is listed as near threatened by the IUCN. Very few individuals of *R. shameli* have been found in Cambodia (Emmett and Olson 2005).

(2) BIRDS

Long & Swan (in Daltry & Momberg, 2000) reported 82 species from the Central Cardamoms, including the endemic Cambodian Laughingthrush, *Garrulax ferrarius*. Long et al. (2002) recorded 91 species at Veal Veng, of which the most significant were the globally threatened (Vulnerable) Lesser Adjutant, *Leptoptilos javanicus*, and the near-threatened Grey-headed Fish Eagle, *Ichthyophaga ichthyaetus* and Great Hornbill, *Buceros bicornis*. Pierce & Pilgrim (2003) observed 107 bird species including 18 new records for the Cardamoms and two species of conservation concern: the Silver Oriole (*Oriolus mellianus*, Vulnerable) and Great Hornbill (Near Threatened). Daltry & Kuy (2003) reported 39 species from the upper Areng Valley, including White-winged Duck (*Cairina scutulata*, Endangered), Green Peafowl (*Pavo muticus*, Vulnerable) and Black-necked Stork (*Ephippiorhynchus asiaticus*, Near Threatened).

A total of 93 bird species were recorded in and around the CCPF during these surveys (eight of those could be identified only as to genus). Two additional but unconfirmed sightings are worth mentioning because of their potential significance: one of a duck consistent with the white-winged duck was made in the Russey Chrum Valley and an observation of a hornbill consistent with the White-crowned Hornbill was made near O'Som village (Emmett and Olson 2005).

Fifteen of the species represented new records for the CCPF, three also being new for the Cardamom Mountains. The new species for the Cardamom Mountains were the black-browed reed warbler, Chinese sparrowhawk and common moorhen. The additional new species for the CCPF are the lesser fish eagle, oriental bay owl, black-headed bulbul, changeable hawk eagle, common tailorbird, oriental darter, long-tailed broadbill, osprey, rackettailed treepie, cattle egret, oriental reed warbler and green imperial pigeon. Perhaps the most significant of these is the oriental darter, a globally near-threatened species for which the only record from the Cardamoms dates back to the 1930s (Emmett and Olson 2005). If confirmed, the potential record of the white-crowned hornbill would represent an expansion of the known distribution of this globally near-threatened species. Two globally threatened and five near-threatened bird species were documented during this study.

(3) REPTILES AND AMPHIBIANS

CI's 2004 survey recorded at least 55 reptile and 29 amphibian species. Up to four reptiles and five amphibian species may be undescribed, but were not included in the total numbers unless there was no doubt that they are distinct species (Emmett and Olson 2005).

A large number of the reptile species found in the CCPF have been classified as globally threatened. The Siamese crocodile *Crocodylus siamensis* is critically endangered and the elongated tortoise *Indotestudo elongata* is endangered. The Asiatic soft-shell turtle *Amyda cartilaginea*, Asian giant pond turtle *Heosemys grandis*, black marsh turtle *Siebenrockiella crassicollis*, impressed tortoise *Manouria impressa* and Asian box turtle *Cuora alboinensis* are classified as vulnerable. The Asian leaf turtle *Cyclemys atripons* is near threatened. One of the amphibian species, the spiny-breasted giant frog *Paa fasciculispina*, is classified as vulnerable, and Mortensen's frog *Rana mortenseni* is near threatened (Emmett and Olson 2005). The survey confirmed the presence of at least nine reptile and seven amphibian species that had not been previously recorded in the Cardamoms. Of these, at least three reptiles and three amphibians (over seven percent of the total species found) are also new records for Cambodia (Emmett and Olson 2005).

(4) FISHES

Forty-three species of fish in 14 families (five orders) were found by the CI survey, 33 of which were new records for the Cardamom Mountains. These results bring to 54 the total number of fish species recorded from drainages originating in the Cardamom Mountains. The family Cyprinidae (carps, minnows and barbs) dominated the collections with 20 species, more than three times as many as the next most abundant group, Balitoridae (hill stream loaches). Three or fewer species were observed in the other 12 families, with six families being represented by only one species (Anabantidae, Cobitidae, Gobiidae, Osteoglossidae, Pristolepididae and Sisoridae).

The highest priority for fresh-water fish conservation in the CCPF, and indeed in south-west Cambodia, is the endangered Asian arowana or dragon fish *Scleropages formosus* and blackfish *Tor* sp. At least one species from the genus *Tor* was found in the Cardamom Mountains. Over-collection of the dragonfish is seriously threatening the survival of remaining populations.



Photo 5-2: Asian arowana or dragonfish *Scleropages formosus* and unknown species of 'blackfish' *Tor* sp

6. STUNG METOEK II, III

6.1 SURVEY AREA

The hydropower project Stung Metoek II (No. 20) is located on the Metoek River in Thma Da commune, Veal Veng district, Pursat. The nearest village is located about five kilometres from the proposed project site. Stung Metoek III (No. 21) is located on the Metoek River in Bak Khlang commune, Mondol Seima district, Koh Kong province.

The selected survey areas initially given to the team focus on four villages of Thma Da commune (Aekpheap, Kandal, Sangkom Thmei and Thma Da). In reality, Thma Da village does not exist and only three villages were taken into account. All the villages are located upstream of the dam site and will be completely flooded once the dams are operational. The majority of the people in these villages are ethnically Khmer. The two proposed dam sites and target villages are located within the Phnom Samkos Wildlife Sanctuary, which is managed by the Ministry of Environment. The population experienced catastrophic flood during 1988 and most recently in 2006. Many household assets, livestock and crops were destroyed.

6.2 ACCESSIBILITY OF TARGET VILLAGES

The district of Veal Veng is located about 195 km south-west of the provincial capital of Pursat. The access road (National Road No. 56) is a clay road in fair condition during the dry months. This road is built as far as Thma Da commune and will be extended to the Thai border.



Photo 6-1: Road to Thma Da commune and Veal Veng district.

6.3 EXISTING PROJECTS WITHIN THE SURVEY AREA

Four existing projects are being conducted within the study area that are the Ministry of Environment project funded by Fauna and Flora International (FFI), the Cardamoms Biodiversity Conservation Corridors in Cambodia project funded by the Asian Development Bank, Cambodian Crocodile Conservation Program is now implemented by FFI and the Forestry Administration and the (MIKE) program of the Forest Administration's Wildlife Protection Office. The detail of these projects was described in the Chapter 3.

6.4 NATURAL ENVIRONMENT AND POPULATION

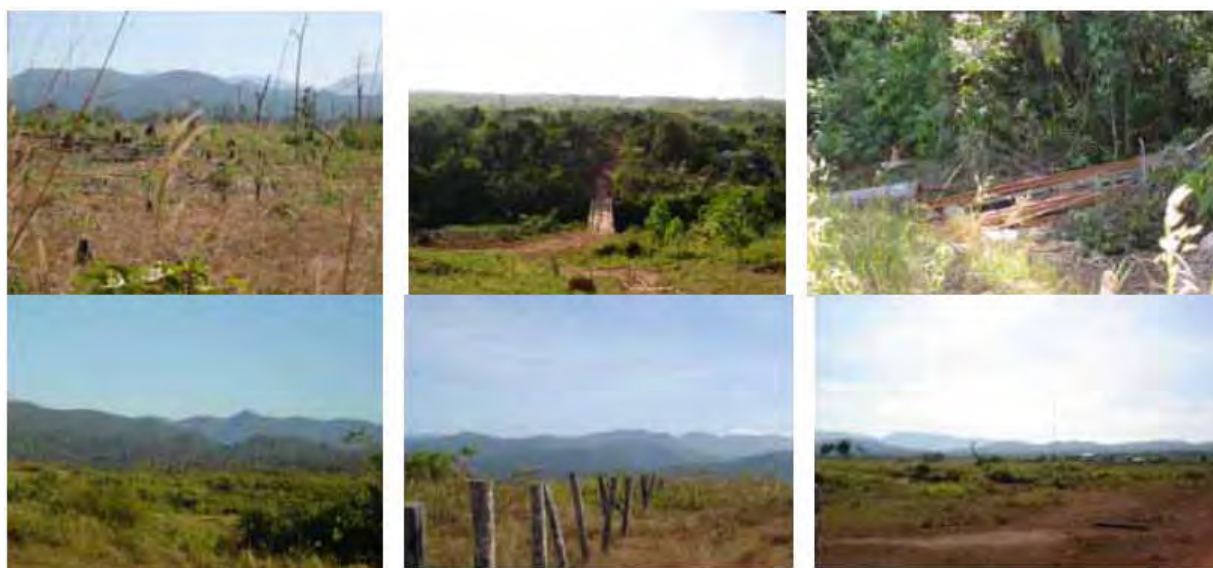


Photo 6-2: Natural environment of Kandal village (top centre, bottom left), Sangkom Thmei village (top left, bottom centre), Aekakpheap village (top right, bottom right)



Photo 6-3: Subsidiary activities include making thatch and brooms and growing vegetables in the dry season

There are no reports of earlier natural environment surveys in the area of the three target villages. Increased population, expectation of a new border crossing and land speculation seem to favour encroachment on the Phnom Samkos Wildlife Sanctuary (PSWS).

Observations during the field investigation in December 2007 indicated that the forest around the target area of Thma Da commune is typically characterised by semi-dense and dense evergreen mountain forest. The Ministry of Environment has handed over about 5,000 ha of forest land to Thma Da commune. Within the 5,000 ha, there are no remaining patches of forest except for sparse bamboo stands on the banks of streams and the Stung Metoek river bank.

The people in the village perceive that the forest and wildlife is abundant in the sanctuary. Landmines are also a major problem in the target villages. Firewood and charcoal are significant energy sources for cooking. Most people still depend on natural resources for subsistence. However, better off households may convert farmland into rubber plantations.

Fauna and Flora International have been supporting the management of PSWS in order to strengthen law enforcement. Nevertheless, it is expected that the new law on protected areas² may lead to some changes in levels of conservation. Discussions with representative of the PSWS and rangers revealed some key concerns:

- Cooperation levels with local authorities,
- Awareness among local communities

² The new law on protected areas was enacted by the National Assembly on 27 December 2007.

- Consideration of the PSWS management plans and the basic needs of livelihoods to meet conservation targets,
- Limited financial support.

These villages are similar in geographical features and are located on gentle slopes at an elevation of 240–250 m. They are not built on the banks of the Metoek River.



Figure 6-1: Thma Da commune map

6.5 PROTECTED AREA: PHNOM SAMKOS WILDLIFE SANCTUARY (PSWS)

6.5.1 History and geography

There are also sizeable areas of natural marshes and grassland. Human density is very low, and settlements are almost wholly confined to lowland areas near rivers (Momberg and Weiler 1999). The PSWS is located in Pursat and Koh Kong provinces and covers an area of 3,338 sq km, protecting flora and fauna of international conservation priority. The Metoek River and its catchments area are one of the most important rivers of the Cardamom Mountains. Its water contributes significantly to the survival of mangrove forest in its delta region (Koh Kong Bay).

FFI currently finances the Cardamom Mountain Wildlife Sanctuaries Project, which aims to ensure the long-term conservation of a landscape of global importance and its biodiversity while reducing poverty and ensuring essential national development. The focus is on establishing and maintaining management systems in two protected areas: Phnom Samkos Wildlife Sanctuary and Phnom Oral Wildlife Sanctuary. The Phnom Samkos Wildlife Sanctuary (PSWS) was created under a royal decree on the creation and designation of protected areas, issued on 1 November 1993, and is managed by the Ministry of Environment with financial and technical support from the Fauna and Flora International.

The PSWS is one of the three parts of the Cardamom Mountains region,³ which covers 1.87 million hectares. Ranging up to 1,771 metres (Mount Oral), the mountains are cloaked with a variety of natural forest types according to altitude, aspect, geology and hydrology: dry deciduous forest, semi-deciduous forest, lowland evergreen forest, hill evergreen forest, bamboo thickets and pine forest.

6.5.2 Flora

This is a very high diversity of habitats, some of which occur nowhere else in Cambodia, such as large expanses of fire-regulated ferns, upper montane forest, high elevation marshes and blackwater rivers (FFI 2007). The Cardamoms host more than half of Cambodia's known 2300 species of plants. Of about 230 species that are endemic to Cambodia, more than 100 are from the Cardamom forests (ADB 2005).

The Cardamom Mountains, with their 1.87 million hectares of dense forest cover, intricate network of rivers, coastal wetlands and mangrove forests, are also the key watershed for western Cambodia, providing water supply, climate regulation and abundant fisheries for hundreds of thousands of people (ADB 2005). The coastal Cardamoms are the only source of fresh water to the Bay of Koh Kong, where the mangrove forest is widespread.

The FFI survey in 2000 (Daltry & Momberg 2000) indicated that the Phnom Samkos Wildlife Sanctuary harbours high plant diversity and many endemic species. The specimens collected include species that are new to science or to the national record. The vegetation can be broadly separated into zones: the lower slopes are covered by mixed deciduous forests that grade into dry evergreen forest at an elevation of about 400 m above sea level. At around 1000 m, the evergreen forest becomes conspicuously wetter, with many palms, tree ferns and a greater diversity of trees, including *Pinus merkusi*. Above about 1300 m, the forest undergoes another transformation into a moist montane/cloud type. Here the trees become stunted (about 15 m maximum canopy height), encrusted with mosses, lichens and epiphytes. *Quercus* species (oaks) appears in this zone. The forest on the high plateaus is punctuated by clearings of bare rock and grasses, with Zingiberaceae (wild gingers) and *Rhododendron* spp. at the margins (Daltry & Momberg 2000).

The plant survey team's parataxonomist was able to identify only about 40 percent of the trees at the highest elevations, so dozens of unidentified specimens were collected and preserved. Many commercially important plants were recorded, such as *Calamus* spp. (rattan, widely used as a building material) above 300 m, and kresna wood (*Aquilaria* sp., exported for perfume production).

The FFI survey in 2000 (Daltry & Momberg 2000) was primarily intended to produce baseline biodiversity data in order to identify priority species and habitats for protection. Plants were also surveyed and their conservation needs assessed. The survey team believed that some of the vegetation communities are unique to the Cardamom Mountains. Recent botanical surveys have recorded seven genera of conifer from Cambodia: *Amentotaxus*; *Calocedrus*; *Cephalotaxus*; *Dacrydium*; *Nageia*; *Pinus*; *Podocarpus* (Tomas *et al.* 2007).

There have been many biological surveys within the Cardamom Mountains region. This report takes into account the FFI survey in 2000. Additional descriptions of fauna and flora by previous surveys are documented in Chapters 3 and 5.

6.5.3 Fauna

The Cardamom Mountains are now known to contain almost all the country's known mammals, birds, reptiles and amphibians. They are part of the most significant Indochina habitat of the tiger (*Panthera tigris*) and Asian elephant (*Elephas maximus*) and most significant global habitat for the Siamese crocodile (*Crocodylus siamensis*). They are one of the very few sites in Asia with white-winged ducks, black-necked storks and Asian arowana (ADB 2005).

The Cardamom Mountains and adjoining corridors contain significant populations of at least 59 globally threatened species and are crucial to the conservation of these species. The elephant population appears to remain highest in the Cardamom Mountains regions and is thought to be one of the largest in Indochina. The forests have been recognised the Ministry of Agriculture and Forestry and Fishery as a level I tiger

³ The Cardamom Mountains region constitutes three main massifs: Mount Samkos, the Central Cardamom Mountains and Mount Oral.

conservation unit. Other important species include the Asiatic wild dog, gaur, pileated gibbon, Eld's deer, elongated tortoise, spiny mountain frog, chestnut-headed partridge, Cambodian laughing thrush, silver oriole, great hornbill, lesser adjutant stork, Asian arowana, green peafowl, eaglewood and Siamese cycad (ADB 2005).

The FFI survey was primarily focus on larger mammals and their habitats, a wide range of other taxa, including plants, bats, other small mammals, reptiles, amphibians and insects, were also surveyed and their conservation needs assessed.

Although the FFI survey is the most extensive and detailed to have been conducted in the Cardamom Mountains, the species checklists are still far from complete. The fact that so many plants and animals were discovered in a short period in a relatively small area is testimony to the extraordinary biodiversity and pristine condition of the Cardamom Mountains. Further work is bound to yield more species and surprises.

(1) MAMMALS

The FFI survey found at least 34 species of large mammal, confirmed from tracks, droppings, visual searches, bushmeat remains and camera trap photographs (Daltry & Momberg 2000). Sixteen of them are classified as threatened or near threatened and 23 are listed by CITES. The project rated the Cardamoms as outstanding in density and diversity of large mammals. Confirmed species included globally threatened mammals such as gaur (*Bos frontalis* or *Bos gaurus*), Asian elephant (*Elephas maximus*), Asiatic wild dog (*Cuon alpinis*), smooth-coated otter (*Lutra perspicillata*), Asiatic black bear (*Ursus thibetanus*), pileated gibbon (*Hylobates pileatus*) and the rare Indochinese subspecies of tiger (*Panthera tigris*).

Carnivore specialists concluded that the Phnom Samkos Wildlife Sanctuary constituted “model habitat” for tigers. While certain large mammals, notably serow (*Naemorhedus sumatraensis* or *Capricornis sumatraensis*), were recorded only at high elevations, lowland habitats appeared to be especially important for elephants, tigers, sambars (*Cervus unicolor*) and wild dogs. Local people reported that there had been little or no decrease in large mammal populations during their lifetimes; elephant numbers were said to be on the increase (Daltry & Momberg 2000).

The FFI survey found 15 species of rodents had been captured by the middle of the survey, but the final total would not be known until voucher specimens had been fully examined in specialist museums. The mammalogists predict that some of these will be new to science. Fourteen bat species were captured using harp traps and mist nets on Phnom Samkos. Eight were new records for Cambodia, including the globally threatened *Harpiocephalus mordax*.

(2) BIRDS

The FFI survey recorded well more than 100 species of forest birds in the PSWS alone, with 15 new national records confirmed. As well as hosting many resident species, the Cardamom Mountains provide an important staging post for migrants. No new bird species were captured, but new subspecies may be described. While the mountain peaks were found to support fewer montane specialists than other, higher, parts of Indochina, the Cardamom foothills are notable for their exceptionally high bird diversity and biomass.

Certain IUCN red list and CITES-listed species such as the green peafowl (*Pavo muticus*) and wreathed hornbill (*Rhytoceros undulatus*) which have become rare in other parts of their range, appeared to be fairly common in the Cardamoms. Two known endemic birds, the Cambodian laughing thrush and chestnut-headed partridge (*Arborophila cambodiana*), were found to be abundant in the higher evergreen forests. A number of resident bird species are taken as bush meat for personal consumption, notably silver pheasants (*Lophura nycthemera*), partridges and hornbills (Daltry & Momberg 2000).

Eames *et al.* (2002) surveyed two hitherto unexplored mountains in the PSWS. A total of 166 bird species were recorded by either trapping or direct observation, including two threatened species (chestnut-headed partridge *Arborophila cambodiana* and green peafowl) and 15 species new for Cambodia. In total, 52 skins, one wing, 28 complete and 35 incomplete alcohol specimens and 35 tissue samples were collected. The collection included two specimens of the chestnut-headed partridge intermediate between the two known subspecies *A. c. cambodiana* and *A. c. diversa* and therefore distinctive enough to be described as a new subspecies. The occurrence of two restricted-range species (chestnut-headed partridge and

Cambodian laughing thrush (*Garrulax ferrarius*) means that the area should be considered to be of elevated conservation concern (Daltry & Momberg 2000).

(3) REPTILES AND AMPHIBIANS

The confirmed checklist includes a large number of endangered reptiles, such as the giant soft-shell turtle (*Pelochelys cantori*) and the Burmese python (*Python molurus*), as well as other species of economic, ecological, cultural and medical importance. Many of the reptiles were morphologically distinct from populations across the border in Thailand and could be described as new subspecies (Daltry & Momberg 2000).

Perhaps the most significant finding of the survey was the discovery of apparently intact populations of Siamese crocodiles (*Crocodylus siamensis*) in many of the larger rivers and marshes in the Central Cardamom Mountains. This critically endangered species was believed to be virtually extinct in the wild and has disappeared from most other parts of its range. This species was common and widespread in the wetlands and waterways of south-east Asia less than a century ago, but hunting and habitat loss have reduced its distribution to barely 1 percent of its former range. Based on surveys since 2000, it is estimated that fewer than 250 adults survive in the wild in the Cardamom Mountains (Daltry & Momberg 2000).

Grismer *et al.* (2007) described a new species of rhacophorid frog of the genus *Chiromantis* from Phnom Samkos. This new species is the eighth potential endemic from the Cardamom Mountains and underscores the need for continued field work there.

Thirty species of amphibians were found in the Cardamoms within the first month of the survey by Grismer *et al.* (2007). At least eight were new national records for Cambodia. A further 11 species, chiefly from high elevations, have not yet been identified and probably include several species new to science. The confirmed checklist includes frogs that are locally used for human consumption (e.g., *Rana raja*) as well as important prey for other animals (*Rana limnocharis* or *Limnonectes limnocharis*). From work elsewhere in Cambodia and neighbouring countries, there are probably well over 50 species of amphibians in the wider Cardamom Mountains.

The survey conducted by Daltry and Wüster (2002) found a new species of wolf snake of the genus *Lycodon* in the Cardamoms. Visually, the new species is most similar to *Lycodon subcinctus* from eastern Thailand and elsewhere in Cambodia.

(4) INSECTS

The FFI survey selected a single super-family of Lepidoptera, the Pyraloidea, to provide a measure of insect diversity and endemic species within different types of forest. Preliminary analyses suggest that the Cardamom Mountains harbour exceptional species richness: 1973 pyraloid moths were collected using light traps within just three weeks, of which one-fourth to one-third were estimated to be species new to science. Probably most are new national records for Cambodia. In addition, 100 flies, 15 dragonflies, 200 caddis flies, 20 wasps and 200 beetles were collected for identification by specialists (Daltry & Momberg 2000).

(5) FISHES

The FFI survey recorded 11 species of fish. Many are still awaiting identification. It is possible that more species could be found in this area. The species of special conservation concern, especially bonytongue *Scleropages formosus* of the dragon fish family Osteoglossidae, is reportedly found in the Cardamoms (Daltry & Momberg 2000).

付属資料-C ワークショップ対応

本調査では、合計 2 回のワークショップを開催し、マスタープラン調査の内容を関連機関へ公開し、意見・情報交換を行っている。また、インテリムレポートについての MIME の関心が高く、電力セクターの内部会議を計 3 回開催した。NGO への調査中間報告等も含め、会議の内容を以下に示す。

1. 第 1 回ワークショップ（非公開）

- (1) 開催日：2007 年 11 月 13 日（火）
- (2) 開催場所：鉱工業エネルギー省（MIME）1 階会議室（Phnom Penh）
- (3) 概要：

当初、公開ワークショップを予定していたがカウンターパート機関（MIME）の強い要望を踏まえて調整・協議の結果、内部ワークショップとして開催した。
 鉱工業エネルギー大臣名代で MIME Ith Praing 次官が議長を担当された。
 調査団が選定した優先 10 計画についての説明を行い、10 計画が承認された。

- (4) 出席者：別添出席者リストの通り。
- (5) プログラム：

Time	Program	Presented by
08:30-08:45	Keynote address	H.E. Secretary of State, Dr. Ith Praing
08:45-09:00	Introduction of study team members	JICA-MIME C/P Team
09:00-09:45	Section 1 Introduction	JICA team
09:45-10:50	Section 2 Project screening	JICA team
10:50-11:10	Tea break	
11:10-11:50	Discussion	
11:50-12:00	Concluding remarks	H.E. Secretary of State, Dr. Ith Praing

(6) 主なコメントと調査団対応

No.	コメント	調査団回答 / 意見等
1.	<p>H.E. Dr. Ith Praing (Secretary of State, MIME)</p> <p>水力マスタープランにおける公開ワークショップ必要性の理由は何か。</p> <p>情報公開 (dissemination) を行うことはよいが、マスタープランについて議論を行うことは難しい。マスタープランはまだ準備されていない。</p> <p>マスタープランは政策問題であり、公開ワークショップで議論することは適切でなく、困難であるが、宣伝 (disseminate) することは可能であろう。一般の人たちは水力マスタープランの技術的諸問題については興味を示さないであろう。</p>	<p>JICA カンボジア事務所</p> <p>本水力マスタープランは国民の注目を集めており、政府の政策を説明することが求められている。水力開発は政府のみ問題でなく、カンボジア国民の問題でもある。NGO などの無用な摩擦を避けるためにも説明が必要である。情報を公開しないと後々、大きな問題となるであろう。</p> <p>片山総括</p> <p>MIME にとってマスタープラン調査の進捗を説明し、電力セクターの政策 (Power Policy) を啓蒙することが必要であり重要である。</p>

No.	コメント	調査団回答 / 意見等
		最終結果のみ説明するのではなく、途中経過を公表することが大切と調査団は考える。
2.	<p>Mr. Tun Lean (Director General, MIME)</p> <p>通常マスタープラン調査では、関連省庁間のみの議論がなされ、情報公開等はプロジェクトの実施段階で行われる。</p> <p>住民移転は大きな問題であり、情報が公開されるとプロジェクト地域へ不法に移住するものが出てくる。</p> <p>マスタープラン調査の段階で NGO の議論への参加は不要と考える。</p>	<p>片山総括</p> <p>調査の進捗説明と情報公開を実施し、関係者の関心やニーズを把握し、調査に反映させることが重要と考えている。</p>
3.	<p>H.E. Dr. Ith Praing (Secretary of State, MIME)</p> <p>MIME は調査団の要請を聞いた後、大臣へ報告し公開ワークショップでの情報公開 (dissemination) について決定を待つ。</p>	<p>JICA カンボジア事務所</p> <p>NGO らはすでに水力開発マスタープランのことをよく知っており、JICA カンボジア事務所宛に調査に関する多数の問い合わせが来ている。</p> <p>片山総括</p> <p>選定されたプロジェクトに関する現地調査を開始する時期に来ており、現地で調査の背景等を説明する必要がある。優先 10 計画の承認の MIME による承認が必要である。</p>
4.	<p>Mr. Keo Rottanak, Director of Minister's Cabinet</p> <p>MIME は本日のプレゼン結果 (優先 10 計画を含む) を基本的に承認する。</p> <p>#7&8 LL2 計画についてはベトナムによる FS が進行中であるが、MP 調査団のベトナムによる FS に対する貢献は何になるか。</p> <p>マスタープランでは進行中 (コミットされた) 計画についての記述が無いが含めるべき。</p>	<p>片山総括</p> <p>調査は MIME と JICA 間で締結された Scope of Works に基づいて実施されている。調査団による現地調査はベトナムによる FS を手伝うものではなく、マスタープランにおける制度面の提言を行うために実施するものである。</p> <p>本マスタープラン調査は電源拡充計画における投入計画を策定するものであり、その時点でコミットされた計画も取り扱う。水力のみならず、火力も考慮して策定する。</p>
5.	<p>H.E. Dr. Ith Praing (Secretary of State, MIME)</p> <p>優先 10 計画の現地調査を許可する。すでに他社による調査が実施されているサイトもあり、調整が必要であろう。#7&8 LL2 計画はベトナムが FS を実施しており踏査は不要であろう。</p>	<p>片山総括</p> <p>調査団は制度面での提言を行うため、現地でのサンプル調査を行う必要がある。LL2 計画は環境面で顕著な影響を有するため慎重な EIA 実施が必要である。かかる提言は MIME がプロジェクトを審査する際の一助となる。</p>
6.	<p>Dr. Bun Narith (Deputy Director General, MIME)</p> <p>選定された優先計画はほとんどが貯水池タイプの開発であり、流れ込み式の開発がない。選定基準を聞きたい。</p> <p>堆砂の問題は、例えば排砂設備など技術的に解決策があるはずである。そのようなプロジェクトは検討対象から外すべきでないと考えます。</p> <p>水力密度の 500 kW/km² はどのように決められたのか。</p>	<p>片山総括</p> <p>2007 年 7 月のインセプションステージで議論されたとおり、北東部のポテンシャル地域では平坦な地形のためダムにより落差を得ることが必要である。一方で、南西部のポテンシャル地域では落差は確保できるものの乾季における流量低下が著しく、その流量を補うための貯水池が必要となる。流れ込み式の計画も検討したが、上記の理由により一般的には流れ込み式は採用できない。</p> <p>堆砂の問題については、中国の三峡ダムや、日本の美和ダムのように排砂を実施している例が</p>

No.	コメント	調査団回答 / 意見等
		<p>ある。メコン本流計画は排砂に必要な落差 (head) が不足していること、さらに広大な河道 / 貯水域を持つことから河道の一部分しか排砂されない恐れがあるなど、不利な条件を有している。排砂の技術的可能性が解決するための詳細な調査が必要である。</p> <p>水力密のしきい値である 500 kW/km² は、水力資源と環境保全のバランスを考慮して決めた。この基準を用いるとメコン本流計画をのぞいた技術的ポテンシャルの半分を開発できる。</p>
7.	<p>Mr. Tun Lean (Director General, MIME)</p> <p>Lower Se San III 計画や、Lower Sre Pok III 計画を流れ込み式の開発にできないか確認したい。</p>	<p>片山総括</p> <p>貯水池形式の開発を流れ込み式の開発に変更した場合、10 MW 以上の出力が期待できるか否か、調査団として甚だ疑問である。</p> <p>(項目 6. 参照)</p>
8.	<p>H.E. Dr. Ith Praing (Secretary of State, MIME)</p> <p>調査団選定の優先 10 計画を承認する。</p> <p>現地調査の開始を許可する。</p> <p>調査団は必要に応じて住民や NGO とコンタクトできる。</p> <p>調査団は本日配布の資料を用いて NGO の窓口へ本内部ワークショップでの説明と議論について説明してもよい。</p>	<p>調査団は優先 10 計画に基づき、現地踏査を実施。マスタープラン策定のための詳細検討作業を実施した。</p> <p>現地調査では、必要に応じて住民、NGO とコンタクトし、調査に必要な情報収集を行った。</p> <p>11 月 19 日に NGO の窓口である NGO フォーラムへ調査内容の説明を実施した。</p>

(7) コメントのマスタープラン報告書への反映

情報公開と NGO の参加問題： MIME から、第 1 回ワークショップで、「MP は政策課題であり、公開ワークショップに住民や NGO が参加して協議・検討するような対象ではない。MP 段階で NGO が議論に参加することは不要。しかし、政策の広報は必要だ」との意見がだされた。調査団は、MP 調査の位置づけでは MIME の見解を支持した。しかし、NGO にも情報公開が必要と考え、MIME の了承の下に、NGO へ説明する機会を持った。すなわち、計画の作成段階で、NGO に対して説明し、その意見を聴取するプロセスを持った。

次の制度には、2007 年 7 月の Oxfam America との意見交換の結果が反映されている。

- **社会環境基金と SPC 株の交付：** アメリカの NGO である Oxfam America は、カ国北東部の 3S 地域で過去 10 年にわたり貧困削減に努力してきたが、思うようには成果があがらなかった。そこで、地場資源である水力開発をコアとして水源地域の振興を検討していた。SPC の資本金の一部を地域振興と環境保全に充当することも検討していた。
- これは、調査団がプロポーザルで提案していた構想に合致するものであり、DFR のページ 9-24 ~ 9-25、ページ 9-30 ~ 9-32 に紹介する「水源地域振興制度」の提言として、計画に反映された。

水力密度： 第 1 回ワークショップでは水力密度の提案が承認されたが、その後第 2 回ワークショップで撤廃要請があった。DFR では、ページ 1-13 から 1-15 および 9-26 と 9-27 に記述を追加し、基準の提案を維持した。追加説明の要点は次の 4 点。

- 水力密度基準により除外した 3 計画 (ページ 1-14 の表 1.2.6) は、ページ 1-15 の図 1.2.3 に示すように世界のダムと比べても影響が顕著なこと
- 同 3 計画の内 2 つは社会影響もあること (表 1.2.6、図 1.2.3)

- サトウキビ栽培によるバイオエタノール生産でも同程度の発電密度を達成できる可能性があること
- この水力密度基準は水力発電の単目的計画を対象とすること(多目的計画には適用しない)

出席者リスト(第1回ワークショップ 2007年11月13日)

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	K. Suzuki	Director of Electric Power and Energy Team	JICA Headquarter
2	S. Kobayashi	Program Officer	JICA Headquarter
3	Shigeki Miyake	ARR	JICA Cambodia Office
4	Nozomi Saito	Intern Trainee	JICA Cambodia Office
5	Akihisa Haraguchi	Project Formulation Advisor	JICA Cambodia Office
6	Takahashi Washizawa	JICA Expert to MIME	JICA Cambodia Office
7	Hitoshi Kanetsuki	Member of JICA Mission	Chugoku Electric Power
8	Hideki Narumi	Member of JICA Study Team	JEPIC-ICC
9	Atau Kishinami	Member of JICA Study Team	IDEA
10	Akio Katayama	Leader of JICA Team	NK
11	Yuichi Ueda	Hydrologist of JICA Team	NK
12	Mika Matsumura	Social Env./JICA Study Team	KRI
13	Takeshi Okamura	Hydropower Engineer	NK
14	H.E. Dr. Ith Praing	Secretary of State	MIME
15	H.E. Mr. Tun Lean	General Director	MIME
16	Dr. Bun Narith	Deputy General Director	MIME
17	Hul Kunnak Vuth	Executive Director	EAC
18	Victor Jona	Deputy General Director	MIME
19	Much Chhun Horn	Director	MIME
20	Praing Chulsa	Deputy Director	EDC
21	Chea Narin	Chief Office	MIME
22	Mak Thorn	Deputy Chief Office	EDC
23	Cheap Sour	Director	MIME
24	Heav Chanvisal	Chief of Construction	EDC
25	Nong Sareth	Deputy Director_HED	MIME
26	He Sam Ol	Deputy Chief Office	MIME
27	Hean Veasna	Staff_HED	MIME
28	Sok Sophorn	Staff of mapping	MIME
29	Pan Narith	Deputy chief, Hydro Dept	MIME
30	Horn Naren	Staff of HED	MIME
31	Oung Vuthy	Chief Office	MoE
32	On Vuthy	Deputy Director, HED	MIME
33	Heang Bora	Chief Office, DET	MIME
34	Pen Sameth	Staff, HED	MIME
35	San Vibol	Chief Office	MIME
36	H.E. Keo Rottanak	Director of Minister's Cabinet	MIME

2. 第2回ワークショップ（公開）

- (1) 開催日：2008年9月15日（月）
- (2) 開催場所：Cambodiana Hotel (Phnom Penh)
- (3) 概要：

第2次現地調査までの調査内容を取りまとめたインテリムレポートの内容に関するワークショップ。
 MIME Ith Praing 次官が議長を、MIME 水力発電部の Nong Sareth 次長が進行役をつとめ、調査内容の報告、質疑応答が行われた。

- (4) 出席者：別添出席者リストの通り。
- (5) プログラム：

Time	Program	Presented by
08:00-08:30	Registration	
08:30-08:35	Welcome Remarks	Katayama
08:35-08:45	Opening address	H.E. Dr. Ith Praing
08:45-09:00	Introduction of Hydropower Master Plan Study	Okamura/Much Chhun Horn
09:00-09:30	Section 1 Master Plan Projects Q&A, Discussion	Katayama/Dr. Bun Narith
09:30-10:10	Section 2 Hydropower Planning Q&A, Discussion	Okamura/ Much Chhun Horn
10:10-10:30	Tea break	
10:30-11:10	Section 3 Social and Environmental Considerations Q&A, Discussion	Yamashita/Heng Kunlearnng
11:10-11:40	Section 4 Economic Assessments Q&A, Discussion	Yamashita/Heng Kunlearnng
11:40-12:10	Section 5 Institutional Arrangements Q&A, Discussion	Katayama/Dr. Bun Narith
12:10-12:20	Concluding remarks	H.E. Dr. Ith Praing

(6) 主なコメントと調査団対応

No.	コメント	調査団回答 / 意見等
1.	Mr. Veasna Bun (World Bank) 調査団はプラントファクター40%を採用しているが、引き上げを図るべきだ。	標準的なプラントファクターとして 40%を採用した。これは、日 9.6 時間運転に相当する。選定された7つの MP 対象計画は高い Capacity-Inflow Ratio (CIR)を持ち、北東部流域では 20%、南西部流域では 30%である。したがって、CIF が 5%で流量調節の機能上は流れ込み式の LL2 計画以外は、年間を通じて安定したピーク電力を供給できる。発電設備容量とほぼ同水準のピーク出力が乾季でも毎日 9.6 時間発電可能である。そのピーク出力は流れ込み式のように乾季に低下することはない。
2.	H.E. Dr. Ith Praing (Secretary of State, MIME) 調査団の水力密度は注意深く検討すべき。水没する土地の内あるものは森林だが、あるものはそうでないだろう。ある土地は竹林かもしれない。 我々が評価しなければならないのは水没する森林面積だろう。水力密度は、貯水池全体を対象とするのではなく、森林面積だけを対象とすべきだろう。	片山総括 調査団は水力密度 0.5 MW/km ² という厳しい基準を導入した。選定されたプロジェクトはいずれもこの基準を満たしている。(注：この厳しい基準は発電の単目的計画に適用するもの。あるダム計画が多目的であり、治水、およびかんがいや都市用水供給のための水資源開発を含むような場合には、本基準は適用されない。)

No.	コメント	調査団回答 / 意見等
3.	<p>Mr. Someny, Forestry department</p> <p>5 項目総合評価で、魚に関する検討が少ない。魚の回遊ルートが影響を受ける。漁業について懸念を抱く。</p>	<p>片山総括</p> <p>北東部地域の河川については、Tonle Sap 湖から 3S 川の間魚の回遊ルートが存在するとの報告がある。魚道の設置がひとつのオプションである。湖面を用いた魚養殖も検討が必要である。(注: 漁獲量に対する影響を定量的に評価することは困難な作業である。WWF は、メコン川のリスク要因は過剰漁獲にあると報告している。古代の狩猟のような漁業は 21 世紀では継続困難であり、中国で実施されているように魚養殖の振興が必要である。)</p>
4.	<p>Mr. Hong Sinara (Deputy General Director, Ministry of Public Works and Transport)</p> <p>LL2 計画は Ou Pou Mon と Banlung 間の道路を水没させる。内務省と公共事業運輸省の間で、この道路について協議がもたれた。EVN から付け替え道路のレイアウト案を受け取った。しかし、貯水池の規模が定かでない。貯水池の確定計画を知りたい。</p>	<p>片山総括</p> <p>調査団は現地調査を含む MP 調査を実施している。EVN がより詳細なフィージビリティ調査を実施している。貯水池面積については、EVN がより正確な数値を提供できるだろう。付け替え道路の詳細計画はフィージビリティ調査で検討されるものであり、本調査の検討対象外である。(注: プレゼンのスライドにあった付け替え道路のレイアウト図は、EVN のレイアウト図を調査団は入手していないため、費用の概略推定のために調査団が仮定したものである。)</p>
5.	<p>Dr. Ty Norin (Chairman-Secretary of State, EAC)</p> <p>1) 環境社会配慮では、建設から O&M 段階までを対象とすることが必要。調査団は、環境費用と補償費用として、いくらを考慮したか？</p> <p>2) 公共投資と民間投資の 2 つの主要投資方法がある。民間投資は一般により高い料金を必要とするが、政府にとっては多大な税収が見込める。民間投資の場合でも、政府は、補償や環境影響軽減策などの面でも投資家の行動を制御できる。最速で実施するためのベストの方法を選定するために、公共投資と民間投資を比較検討することが必要である。経済財務評価はこの投資方法にも影響されるだろう。分析において、そのような投資形態について考慮が払われているか。</p>	<p>山下団員 (経済・財務担当)</p> <p>補償費用として、1 件当たり 3,500 ドル、農地 1 ha 当たり 11,000 ドルを計上。</p> <p>環境費用として土木工事費用総額の 3% を、全計画に計上。</p> <p>本 MP 調査の財務分析では、投資形態による政府の税収や支出の相違は検討していない。各計画を同一条件下で評価することを目指した。</p>
6.	<p>Mr. Veasna Bun (The World Bank)</p> <p>Stung Metoek 計画の発電原価は 10 cent/kWh となっている。そのような高い電力をどうやって輸出できるか？</p>	<p>片山総括</p> <p>本 MP 調査では、Stung Metoek 2 と Stung Metoek 3 計画は、それぞれの発電所をカンボジア領内に位置させるように、レイアウト計画を変更した。電力はカンボジア国内への供給を計画している。地形上、発電に利用できる落差は小さくなり、その結果発電原価が 10 cent/kWh を越えた。しかし、発電後に放流される流水は、長年にわたって厳しい水不足を経験している地域にあって、高い経済価値を持つ。Stung Metoek 2 and 3 計画を多目的計画として開発するならば、10 cent/kWh 超の発電原価はコストシェアリングにより低下できるだろう。</p>
7.	<p>Dr. Ty Norin (Chairman-Secretary of State, EAC)</p> <p>ダムと発電所はカンボジア領内に置いたまま、発電後の水をタイ国に供給することは</p>	

No.	コメント	調査団回答 / 意見等
	<p>可能だ。毎年約 500 mcm の水が標高 50m の地点で得られる。全量を Koh Kong 市に給水することもできるし、適量をタイ国に輸出することも可能。水輸出による収入以外にも、カンボジアのマクロ経済にとって大きな便益をもたらすだろう。</p>	
8.	<p>Mr. Hong Sinara (Deputy General Director, Ministry of Public Works and Transport)</p> <p>水力ダムの建設により、魚の回遊だけでなく、人々のボートによる通行も影響を受ける。MOPWT は人々の運搬手段の変化を検討することが必要。MOPWT は JICA 調査団に舟運を検討するよう要請する。</p>	<p>片山総括</p> <p>閘門は、マスタープランの提言の一部として含まれる。</p>
9.	<p>Dr. Ty Norin (Chairman-Secretary of State, EAC)</p> <p>プレゼンのスライド 7 で、約 0.4 cent/kWh の料金上乗せが示されていた。ある計画は経済性が高く、あるものは低い。このサーチャージの概念はどのようなものか？全てのプロジェクトに適用するのか、それとも発電原価の低いものに適用するのか？</p> <p>スライド 8 では、道路、電化のようなインフラ事業が、“4. Village development with Surcharge/SEF”の小項目として掲載されている。このようなインフラ事業には多くの省庁が関係する。日本における経験から、そのようなサーチャージや SEF はプロジェクトに還元可能なものか、それとも MEF の管理下にはいるものか、知りたい。</p>	<p>片山総括</p> <p>サーチャージは全ての系統需要家に課金されるだろう。一方、IPP からの SEF (Social and Environmental Fund)への醸金はプロジェクトの経済性に影響されるかもしれない。ある計画では、SEF への醸金が困難かもしれない。</p> <p>しかしながら、そのようなプロジェクトへの課金の論拠は、IPP にたいして、森林水没のような外部不経済費用を負担し、それをプロジェクトの費用に含めることを求めるものである。この環境費用を含むプロジェクト費用を評価対象とすべき。もし環境費用が高すぎる場合には、そのようなプロジェクトは経済性を持たない。</p> <p>鷲沢 JICA 専門家(MIME)</p> <p>EAC に対する技術協力のために 11 月から新調査団がやってくる。この調査団に日本でのサーチャージ料金制度について質問できる。</p>

(7) コメントのマスタープラン報告書への反映

水源地域振興制度： 第 2 回ワークショップで、電気料金への上乗せ(サーチャージ)を環境社会配慮活動の原資とするアイデアを紹介したところ、日本での事例の紹介、経済性の低いプロジェクトではどうするか、複数セクターにまたがるコミュニティ開発事業のために SEF からプロジェクトに交付して使用できるか、などの質問があった。また、8 月 29 日の電力セクター内部会議でも、「社会影響軽減の戦略と具体策」の提案が求められた。

これに対応して、DFR では、ページ 9-30 から 9-32 で、日本の電源三法による水源地域振興制度を紹介し、以下を提案した。

- 系統ユーザーによる相互補助を原資とする社会環境基金(SEF)から水源地域振興事業に対して資金支援
- IPP 事業者による 4 つの移転補償(家屋、農地、生計、コミュニティ施設)
- 非自発的移転の受け入れに対する感謝として SPC 株を交付(都市・地方間格差是正のため生活水準を継続的に向上させるための活動原資とする)
- 自然環境影響を軽減するための資金的貢献(アクセス道路を利用した立入チェックなど)

出席者リスト (第2回ワークショップ 2008年9月15日)

LIST OF ATTENDANTS

No.	Institution	Name	Organization	Post/Title
1	MIME	H.E. Dr. Ith Praing	MIME	Secretary
2		H.E. Mr. Khlaut Randy	MIME	Secretary
3		Dr. Bun Narith	MIME	Deputy Director General
4		Much Chhun Horn	MIME	Director of HED
5		Heng Kunleang	MIME	Director of EDD
6		Nong Sareth	MIME	Deputy Director of HED
7		Chiv Hour	MIME	Deputy Director of HED
8		On Vuthy	MIME	Deputy Director of HED
9		So Veasna	MIME	Deputy Director of ETD
10		Chea Narin	MIME	Chief of Office, HED
11		San Vibol	MIME	Chief of Office, HED
12		Kimnhan Chan Amrin	MIME	Deputy Chief
13		Pan Narith	MIME	Vice chief of Office, HED
14		He Samol	MIME	Vice chief of Planning Office
15		Pen Sameth	MIME	HED staff
16		Horn Naren	MIME	HED staff
17		Hean Veasna	MIME	HED staff
18		Bun Vichet	MIME	HED staff
19		Chea Piseth	MIME	HED staff
20		Sun Davin	MIME	HED staff
21		Chi Chanraksmeay	MIME	HED staff
22		Sok Sophorn	MIME	Staff of Geology Dept
23	DIME	Chhun Hin	DIME Kampot	Director of DIME Kampot
24		Say Hay	DIME Koh Kong	Chief of Energy Office
25		Seng Bunthol	DIME Pursat	
26		Hem Vanthorn	DIME Ratanakiri	Director of DIME Ratanakiri
27	Pheng Chea	DIME Stung Treng	Director of DIME Stung Treng	
28	Provincial Authorities	Sales Sen	Kampot Provincial Office	Vice Governor Kampot
29		Ean Savan	Koh Kong Provincial Office	Vice Governor Koh Kong
30		Keo Thy	Pursat Provincial Office	Vice Governor Pursat
31		Kong Sipa	Stung Treng Provincial Office	Vice Governor Stung Treng
32	Government Institutions	H.E. Dr. Ty Norin	EAC	Chairman
33		Mak Thorn	EdC	Vice chief of Office
34		Heav Chanvisal	EdC	Vice chief of Section
35		Kang Chanthan	MOWRAM	
36		Oum Borith	MLMUPC	Deputy Director Department
37		Chea Nareth	Forestry Administration	Staff of Forestry Administration
38		So Sophort	CNMC	Director of Department
39		Hong Sinara	Ministry of Public Works and Transport	Deputy Director General
40	Prum Somany	Ministry of Agriculture, Forestry and Fisheries	Fishery Department	
41	International Donor Agencies	Shigeki Miyake	JICA Cambodia Office	
42		Meng Chanvibol	JICA Cambodia Office	
43		T. Washizawa	JICA in MIME	JICA Expert
44		Veasna Bun	WB	Operations Officer
45		Nida Ouk	ADB	Senior Project Officer
46		Toch Sovanna	UNIDO	Representative
47	JICA Study Team	A. Katayama	JICA Study Team	
48		T. Okamura	JICA Study Team	Hydropower Engineer
49		T. Yamashita	JICA Study Team	
50		Ung Chanpisey	JICA Study Team	Secretary
51		Ches Sophy	JICA Study Team	Assistant
52	Kao Vannak	Raffle Hotel Le Royal		
53	Media	Ken Son	TVK	
54		Mak Renita	TV Bayon	
55		Nov Kunthea	Reaksmeay Kampuchea Newspaper	
56		Ty Uysong	Koh Santepheap Newspaper	
57	Interpreter	Sok Leang	Go Translation Service	Interpreter

3. その他の内部会議、NGO への説明等

2つのワークショップの他に、インテリムレポートに関する電力セクターの内部会議が下記の通り 3

度開催された。また、MIME の許可を得て第 2 回ワークショップの内容を NGO へブリーフィングし、意見交換を行った。以下に各会議、説明会の概要、主要コメント、調査団の意見 / 対応等を記す。

(1) インタリムレポートに関する第 1 回電力セクター内部会議

- 1) 日時：2008 年 8 月 21 日（木）8:40～12:00
- 2) 場所：鉦工業エネルギー省（MIME）会議室
- 3) プログラム

Time	Program	Presented by
08:30-08:40	Opening address	H.E. Mr. Tun Lean
08:40-09:00	Section 1 Master Plan Projects	Katayama
09:00-09:45	Section 2 Hydropower Planning	Okamura
09:45-10:15	Section 3 Social Impacts	Matsumura
10:15-10:30	Tea break	
10:30-11:00	Section 4 Environmental Impacts	Sah
11:00-11:30	Section 5 Economic Assessments	Katayama /Okamura
11:30-11:45	Section 6 Institutional Arrangement	Katayama
11:45-12:00	Concluding remarks	H.E. Mr. Tun Lean

4) 出席者：

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	H.E. Mr. Tun Lean	Director General	MIME
2	Dr. Bun Narith	Deputy Director General	MIME
3	Much Chhun Horn	Director of HED	MIME
4	Heng Kunleang	Director of EDD	MIME
5	Nong Sareth	Deputy Director of HED	MIME
6	Chea Narin	Chief Office	MIME
7	San Vibol	Chief Office	MIME
8	Kimnhan Chan Amrin	Deputy Director of HED	MIME
9	Pan Narith	Deputy Director of HED	MIME
10	Mok Phoumy	Deputy Chief	EdC
11	Heav Chanvisal	Chief of Construction	EdC
12	Nong Chhavyvann	Staff	MIME
13	Sok Sophorn	Staff of Geology Dept	MIME
14	Miyake Shigeki	ARR	JICA Cambodia
15	Meng Chan Vibol	Program Officer	JICA Cambodia
16	Takeshi Washizawa	JICA Expert to MIME	JICA
17	A. Katayama	JICA Study Team Leader	Nippon Koei
18	Y. Miyagawa	JICA Study Team	Nippon Koei
19	B. P. Sah	JICA Study Team	PASCO Corporation
20	T. Okamura	JICA Study Team	Nippon Koei
21	M. Matsumura	JICA Study Team	Koei Research Institute
22	Ung Chanpisey	Secretary	JICA Study Team

5) 主なコメントと調査団回答

No.	コメント	調査団回答 / 意見等
1.	<p>Mr. Tun Lean (Director General)</p> <p>優先計画が当初 10 だったが、最終的に 7 つに減少した。当初どおり 10 にできないか？</p>	<p>当初 10 ヶ所を選定したが、下記理由により最終的に 7 つに減少した。</p> <p>PL1 と PL1 計画は、計画上合体させたものであり、出力は減少していない。</p> <p>USRC 計画は、最終的に経済性が低く、MP 事業としては推奨できないと判定された。</p> <p>New Tatay 計画は、調査団が中間報告書を仕上げ中の 2008 年 6 月に、カ政府が実施契約を交わしたものの、水力 MP には Committed Project として採択される。</p> <p>TOR は 10 ヶ所を選んでから、調査検討して優先順位付けをし水力 MP を作成することを求めている。10 ヶ所という数字を最終的に維持することを要求するものではない。</p>
2.	<p>Dr. Bun Narith</p> <p>メコン本流計画について調査団の結論は？</p>	<p>広く平坦な貯水池内に堆積した土砂を排砂 (Sand Flushing) する作業の技術的フィージビリティを確認できない限り、カンボジア国内のメコン本流計画 (Sambor) は実施すべきでない。技術的フィージビリティを確認するためには、流送土砂の粒度分布、濃度、鉱物組成 (特に粘土) を調査分析し、排砂に必要な掃流力を貯水池の主要範囲で確保できるかどうか、模型実験とシミュレーションにより確認することが必要だろう。</p> <p>広く平坦な Sambor 貯水池で必要な掃流力を確保するのは容易ではないだろう。</p> <p>MIME 次官は流れ込み式でもよいから開発を希望。分流河川を利用した流れ込み式による可能性は残る。</p>

(2) インテリムレポートに関する第2回電力セクター内部会議

- 1) 日時：2008年8月29日(金) 8:45～12:20
- 2) 場所：鉱工業エネルギー省(MIME) 会議室
- 3) プログラム：8月21日の会議と同様
- 4) 出席者：

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	H.E. Dr. Ith Praing	Secretary	MIME
2	H.E. Mr. Khlaut Randy	Secretary	MIME
3	H.E. Dr. Ty Norin	Chairman	EAC
4	H.E. Mr. Tun Lean	Director General	MIME
5	H.E. Mr. Keo Ratanak	Managing Director	EdC
6	Dr. Bun Narith	Deputy Director General	MIME
7	Cheap Sour	Director of Minister's Cabinet	MIME
8	Much Chhun Horn	Director of HED	MIME
9	Heng Kunleang	Director	MIME
10	Theng Marith	Director of Regulation	EAC
11	Nong Sareth	Deputy Director of HED	MIME
12	So Veasna	Energy Technique	MIME
13	Chea Narin		MIME
14	San Vibol		MIME
15	Oung Vuthy		MoE
16	Kimnhan Chan Amrin	Deputy Chief	MIME
17	Pan Narith		MIME
18	Mok Phoumy	EdC staff	EdC
19	Mak Thorn	EdC staff	EdC
20	Heav Chanvisal	EdC staff	EdC
21	Sok Sophorn	Staff of Geology Dept	MIME
22	Y. Miyagawa		JICA Study Team
23	B. P. Sah		JICA Study Team
24	T. Okamura	Hydropower Engineer	JICA Study Team
25	M. Matsumura		JICA Study Team
26	T. Yamashita		JICA Study Team
27	Ung Chanpisey	Secretary	JICA Study Team

5) 主なコメントと調査団回答

No.	コメント	調査団回答 / 意見等
1.	Mr. Keo Rotanak 社会影響軽減の戦略と具体策は？	これから詰めるが、調査団の構想は次のとおり。 電力系統ユーザーの相互補助による地方電化と電源地域開発支援=電気料金への上乗せ(サーチャージ) IPP 事業者に社会環境基金(SEF)の設立を求める 水力資源開発と環境保全のバランスに対する国民合意を形成 移転計画の慎重な作成、生計手段の配慮、コミュニティとしての移転、土地には土地を、家屋には家屋を補償
2.	Dr. Ty Norin (EAC) 人材育成・技術移転を主目的として政府直営方式の提案は、カ政府の民活方針と矛盾する	EDC を実施機関とし、MDB や JBIC 資金などを得て実施することにより、カ国政府職員の人材育

No.	コメント	調査団回答 / 意見等
	のではないか？	成が期待される。カ政府の民活方針は、EDC による電源開発を排除するものではないと理解。政府が有力案件を全て取り上げて実施するのでは民活政策に抵触する。しかし、水力開発推進のモデルとして、そして公的資金が得られるならば、ひとつの事業を政府が実施することは、国益に適うと考える。
3.	Dr. Ty Norin (EAC) IPP 事業者の選定に入札を提案しているが、具体的検討がなされていない	調査団は、全て入札制度にせよと主張しているのではない。例えば、Prek Liang 計画は、本調査によって初めて現地踏査と地形図を作製し、水力計画を具体的に提案した。その結果、カンボジアにとって貴重な水力資源であることが判明した。すなわち、JICA 調査によって付加価値が創出された。 このように公的調査によって特定・提案された優良案件は政府が実施するか、あるいは民活とする場合には実施業者を入札によって選定することが通常の方法である。 DFR では記述を追加予定だが、入札などの具体案は以前に世銀が調査報告書を出しており、本調査の TOR を越える。
4.	Dr. Ty Norin (EAC) 調査団は水力に限定して検討しているが、火力を含めて総合的に検討すべき	理解するが、調査は TOR に沿って実施している。
5.	Dr. Ty Norin (EAC) ボコール水力は、カムチャイ水力の発電量を減少させるのに、なお 4 位にランクされている理由は？	ボコール水力の有効落差は 912 m、一方カムチャイ水力は 122m に留まる。最上流に位置するボコール水力による転流の結果、カムチャイ貯水池の流入量が減少し、発生電力量が約 13GWh 減少する。しかし、その減少分を電力の現物で補償したと仮定しても、高落差計画のためなお 4 位にランクされる優良計画である。
6.	Dr. Ty Norin (EAC) Prek Liang 水力は国立公園内に位置することから、地下発電所を推奨しているが、カンボジアの財務体力を考えた場合それが妥当か疑問	発電所の形式は、一般的には、地下式、地上式、半地下式などを比較検討して、選定する。 1 点指摘しておきたいことは、地下発電所は一般に想定されるほど高価ではないことである。地上式の場合には、水車の所要押込水頭と基礎の岩着を図るために発電所の基礎標高を一般的に深く設定することが必要となる。その結果、発電所背面の斜面掘削が膨大な量となり、またその保護工事が必要となることが多い。地下式ではそのような長大斜面の掘削や保護工事は不要なので、工事費用には想像するほどの差は生じないことが多い。 さらに、PL1 計画の場合には、地下式発電所が唯一現実的なレイアウトである。また、地形が明かり発電所を可能とすると仮定しても、地下式では低単価の無圧放水路トンネルを採用できるので、明かりの場合には長大な圧力トンネル

No.	コメント	調査団回答 / 意見等
		と大きなサージタンクが必要となり、より高価となることが考えられる。
7.	<p>Mr. Keo Rotanak</p> <p>調査団は Prek Liang 計画を MDB の財務支援を得て政府直営方式で実施することを提案している。しかし、WB や ADB のローン申請には 4-5 年を要するだろう。そのような実施方式が現実的か疑問。それでも、調査団が直営方式を推奨するならば、直営方式と政府の電源開発自由化政策を調和させる出口 (wayout) が提案されるべき。</p>	<p>政府の人材育成と国立公園内の水力事業のモデルとするために、政府直営を提案するもの。これは、政府の電源開発自由化政策と対立するものではなく、水力開発推進のために政府の人材育成も平行して実施することを推奨したもの。</p> <p>Wayout とは、公的資金の提供を指すと思われる。調査団は資金提供を約束することはできない。資金の調達努力では政府が先頭にたつことが必要。</p> <p>2 項参照。</p>

(3) インテリムレポートに関する第3回電力セクター内部会議

1) 日時：2008年9月5日(金) 8:45～11:30

2) 場所：鉦工業エネルギー省(MIME)会議室

3) プログラム：

水力マスタープランの全体像(フレームワーク)についての説明
質疑応答

4) 出席者：

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	H.E. Dr. Ith Praing	Secretary	MIME
2	H.E. Mr. Khlaut Randy	Secretary	MIME
3	H.E. Mr. Tan Kim Vin	Secretary	MIME
4	H.E. Dr. Ty Norin	Chairman	EAC
5	H.E. Mr. Tun Lean	Director General	MIME
6	Dr. Bun Narith	Deputy Director General	MIME
7	Victor Jona	Deputy Director General	MIME
8	Cheap Sour	Director of Minister's Cabinet	MIME
9	Much Chhun Horn	Director of HED	MIME
10	Heng Kunleang	Director of Energy Development	MIME
11	Theng Marith	Director of Regulation	EAC
12	Nou Sokhon	Director of Transmission Dept	EdC
13	Nong Sareth	Deputy Director of HED	MIME
14	On Vuthy	Deputy Director of HED	MIME
15	Chiv Huor	Deputy Director of HED	MIME
16	So Veasna	Energy Technique	MIME
17	Chea Narin	Chief of Hydro Planning Office	MIME
18	San Vibol		MIME
19	Oung Vuthy		MoE
20	Kimnhan Chan Amrin	Deputy Chief	MIME
21	Houng Chantha	Technical Manager	EdC
22	Mok Phoumy	EdC staff	EdC
23	Mak Thorn	EdC staff	EdC
24	Heav Chanvisal	EdC staff	EdC
25	He Samol	Deputy Officer HED	MIME
26	Pen Sameth	Staff of HED	MIME
27	Horn Naren	HED	MIME
28	Hean Veasna	HED	MIME
29	Chy Chanrasmey		MIME
30	Seng Kimrithy	Planning Office	MIME
31	Bun Vichet		MIME
32	Chea Piseth	HED	MIME
33	Son Davin		MIME
34	Takeshi Washizawa	JICA Expert to MIME	JICA
35	T. Okamura	JICA Study Team	Nippon Koei
36	T. Yamashita	JICA Study Team	Nippon Koei

5) 主なコメントと調査団回答

No.	コメント	調査団回答/意見等
1.	Dr. Ith Praing MIMEは、2008年1月に首相承認された電力需要予測と電源投入計画を持っている。調査団は、この最新の計画に基づいて水力MPを作成して貰いたい。	問題点1 MIME-電力開発計画(PDP)の需要予測および電源拡充計画をレビューした結果、PDPでは電源投入計画が需要を満たしていないことが判明した。その結果、必要な Reserve

No.	コメント	調査団回答 / 意見等
		<p>Margin (予備率) である 15% を満たすことができないばかりか、2024 年までの 20 年間のうち、2009 年 (Reserve Margin: 11.6%)、2013 年 (12.2%)、2020 年 (1.9%) の 3 ヶ年以外では、設備容量が常に需要を下回る結果となっている。</p> <p>MIME-PDP をベースとすると、全ての水力発電を投入しても、なお需要を満たすことができない。このため、JICA 調査団側で火力発電所を更に追加して計画を策定する必要が生じる。しかし、JICA 調査の TOR は、KEPCO が 2006 年に策定した需要予測、電源拡充・送電系統拡張を含む既存電力 MP における水力発電の部分を見直すことである。火力発電を含む電源計画の策定はスコープ外である。</p> <p>2007 年 1 月の JICA・MIME の S/W 協議時にも、KEPCO の電源開発計画をベースに水力 MP を策定することが確認されている。</p> <p>問題点 2 別の場で MIME-EAC が主張するように、本水力 MP は電源拡充・送電系統拡張を含む電力系統 MP の一部を構成するものである。本コメントに沿い、MIME の需要想定及び電源開発計画 (MIME-PDF) に基いて作成した水力 MP では、その電力 MP との整合性を保てない。</p> <p>問題点 3 MIME から 8 月 28 日に提示された電源開発計画 (MIME-PDF) は、一般的な電源拡充計画策定の方法からかけ離れている。すなわち、水力の可能発生電力量の推定値があいまいであり、調査団でチェックした結果、一般的な方法を適用した結果と大幅な差異がある。MIME より提示された数値・計画をベースとすると、電源拡充計画の大幅な修正が必要となる。</p>
2.	<p>Dr. Ith Praing 調査団から SEF 構想を提案して貰って構わない。</p>	<p>EAC も MIME 大臣から類似構想の検討を指示されているとのこと。DFR で提案する。</p>
3.	<p>Dr. Bun Narith 水力密度による制約を撤廃して貰いたい。</p>	<p>水力密度による閾値 (0.5 MW/km²) 設定案は、2007 年 11 月 13 日に開催した第 1 回ワークショップにて説明・協議し、MIME もいったん承認したものである。しかし、この基準は調査団の推奨値であり、最終的に採用するかどうかはカンボジア政府の裁量である。</p> <p>最終ページに世界の事例を示す。世界でこの基準を下回る水力が 6 計画報告されている。本 MP 調査の第 1 ステージで、LSS3 計画と LSP3 計画はこの水力密度および移転世帯数</p>

No.	コメント	調査団回答 / 意見等
		と水没農地面積の観点から除外した。同図上では、これら2つの計画は右上に位置している。世界に前例がない訳ではないが、水没面積でも移転人口でも世界でも屈指の、環境影響が特に大きい水力計画であることがわかる。 参考までに、CDM 理事会が貯水池からのCO ₂ 発生原単位として簡易数値の適用を認めているのは、水力密度が 4.0 MW/km ² 以上の水力事業である。 (9.4.2 節 (1) 3) 参照)
4.	Dr. Bun Narith メコン本流計画を今後どのように推進していったらよいのか、示して貰いたい	8月21日会議の調査団対応、2項参照。 Sand flushing が不可能と判断された場合でも、分流水路の一部を利用した流れ込み式の開発の可能性は残る。
5.	Dr. Ith Praing 調査団が NGO に説明する場合それは調査団の責任であり、MIME は特に反対はしない。	9月15日午後に調査団から NGO に、調査の進捗と中間結果を説明した。

(4) NGO に対するインテリムレポートまでの調査内容報告

- 1) 日時：2008年9月15日(月) 15:00～16:30
- 2) 場所：NGO フォーラム会議室
- 3) プログラム：

調査概要説明

Section 1 Electricity and Hydropower

Section 2 Master Plan Study

Section 3 Way Forward

質疑応答

4) 出席者：

LIST OF ATTENDANTS

No.	Name	Post/Title	Organization
1	So Socheat	SCFO	WWF Greater Mekong
2	Mann Vuthy	Coordinator	Community Legal Educational Center
3	Tonn Kunthel	Project Officer	NGO Forum
4	WASHIZAWA Takeshi	JICA Expert	JICA in MIME
5	Meng Chanvibol	Program Officer	JICA Cambodia Office
6	Yamashita Akira	Project Formulation Advisor	JICA
7	MIYAKE Shigeki	A.R.R	JICA Cambodia Office
8	Ame Trandem	Advisor, Mekong Project	NGO Forum
9	Brian Lond		Oxfam
10	Seng Bunra		Conservation International
11	Bun Chantrea	Program Coordinator	NGO Forum
12	Akio KATAYAMA	JICA Study Team	JICA in MIME
13	Takeshi OKAMURA	JICA Study Team	JICA in MIME
14	Takeshi YAMASHITA	JICA Study Team	JICA in MIME
15	Ches Sophy	JICA Study Team	JICA in MIME

5) 主なコメントと調査団回答

No.	コメント	調査団回答 / 意見等
1.	<p>Conservation International</p> <p>JICA 調査団が作った MP は、中国の業者および MIME の事業実施計画にどのような影響を及ぼすのか？例えば、JICA 調査団が作った計画に含まれていないプロジェクトをカンボジアおよび中国業者が実施することができるのか？</p>	<p>調査団が作成している MP 案は、カンボジア政府の協力依頼を受けて作成しているものではあるが、公式な MP はこれを参照してカンボジア政府が作成する。カンボジア側が調査団作成 MP 案に沿って作成するか否かはカンボジア政府が決定することであり、調査団の計画には強制力はない。</p>
2.	<p>Conservation International</p> <p>Stung Chhay Areng は、マスタープランにおけるプライオリティー・プロジェクトに含まれていないが、中国業者およびカンボジア政府は実施をあきらめていないようだ。同地域の住民は、500 年以上前から居住しており伝統的な生活様式を持った民族である。Stung Tatay, Metoek などのプロジェクトは、貯水池面積が小さく、影響が限定的であるが、Stung Chhay Areng は、比較的平坦な地形であるため大規模な貯水池が必要となることから、動植物に与える環境面でのインパクトも大きく懸念している。</p>	<p>調査団が行った 5 つの観点から見た総合評価では、Stung Chhay Areng は、11 位にランクされている。この地域では稀な山間の広い平地を貯水池にするため、貯水池が大きくなり、村落もあるので住民移転が必要となる。</p>
3.	<p>NGO Forum</p> <p>Lower Sre Pok II + Lower Se San II は、貯水池面積も広く、コストも高い上に、社会調査ではダム建設および移転に反対する住民が多いことが明らかになっているにもかかわらず、調査団のランキングでは 2 位となっているが、理由を教えて欲しい。</p>	<p>LL2 は、優先順位を決める際のスコアリングにおいて、社会面、環境面でのスコアが低かったものの、技術面、経済性が高く、総合評価点が非常に高かったことから優先順位が高くなっている。</p>
4.	<p>Oxfam America</p> <p>貯水池面積が広い場合は、プロジェクト実施によって二酸化炭素が逆に増加する事例もあると考えられる。二酸化炭素削減効果の算定方法について教えて欲しい。</p>	<p>二酸化炭素削減効果については、1) ディーゼル発電からの代替による二酸化炭素削減効果、2) 二酸化炭素の吸収源である森林が貯水池に水没することによる二酸化炭素の吸収源(シンク)の減少、3) 貯水池から排出される二酸化炭素の増分、の 3 点を考慮に入れたうえで算定している。29 ヶ所のサイトのうち、スクリーニングの際に除外されたサイトでは、貯水池面積、森林水没面積が広がったために、逆に二酸化炭素が増加すると試算されたサイトが 2~3 ヶ所あった。</p>
5.	<p>Oxfam America</p> <p>経済評価において、環境的・社会的な側面の評価はどのように行っているか？例えば、北東部のサイトでは内水漁業によって生計を立てている住民が多いが、ダムの建設によって漁業が行えなくなることをどのように評価しているか？</p>	<p>環境的・社会的な観点では、住民移転のコストおよび社会環境基金への拠出金をコストとして含めてはいるものの、指摘があったような影響を金銭的価値に置き換えて評価することは行っていない。実際に評価を行うには、現段階における漁獲量、魚の販売価格のデータに加え、ダム建設によってどの程度漁獲量が減少するかを分析する必要があるが、MP レベルの調査でそれらを行うことは困難である。</p> <p>本調査では、そうした影響について定量化はしていないが、予測される影響項目とその一般的な軽減策を提示している。詳細な検討については、FS の段階で行うこととなる。</p>