PLANNING OF FOREST RESTORATION FOR EACH FOREST ZONE IN EACH PILOT SITE IN SIEM REAP AND KAMPONG THOM PROVINCES

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I INTRODUCTION

1.1 Background

Forest Administration (FA) reported in 2011 that deforestation rate from 2006 to 2010 was estimated at 0.5 % annually (FA, 2011). Forest degradation has reduced forest quality, diminished forest products, loss of native species diversity and threatened livelihoods of local communities. Furthermore, the impact of climate change has put more pressure to local livelihood.

Therefore, in order to contribute to the improvement of local livelihood, forest restoration has to be taken into account. Forest restoration refers to re-establish the presumed structure, productivity and species diversity of the forest originally present at a site. The ecological processes and functions of the restored forest will closely match those of the original forest (Gilmour, *et al.,* 2000).

The project "Multi-function forest restoration and management of degraded forest areas in Cambodia", launched in December 2011 aims at building capacity of local communities for restoration of community forests in Siem Reap and Kampong Thom provinces for production of timber and NTFPs as a means to improve livelihoods of local communities. In order to achieve the objective, a series of activities have been proposed, one of which is the assessment and zoning of the two pilot sites. At the completion of the project, project results and experience will be compiled, published and distributed to interested stakeholders.

1.2 Objective

The main objective of this assignment is to provide recommendation for restoration approach and option in each zone of Ou Some and Tbeng Lech community forests based on zoning and resources assessment in both communities.

II APPROACH AND METHODOLOGY

Rapid site assessment in Tbeng Lech and Ou Some community forestry were conducted in order to have some picture about physical characteristics of each site including vegetation cover, species diversity, as well as soil characteristics. Furthermore, community members have been consulted in order to better understand about some constrain on forest restoration as well as local knowledge on forest restoration.

III SITE CHARACTERISTICS

3.1 Ou Some community forestry

There are two main types of soil type in this site, namely: Plinthite podzols and Cultural hydromorphics which are mainly sandy soil and low quality. Furthermore, it was reported that some areas, especially deciduous forest with agricultural land and grass.

There are two main forest types have been observed during field visit. These two main forest types are deciduous and semi-evergreen forest. Both forest types have been disturbed by human activities through over harvesting, shifting cultivation, and forest fire. However, deciduous forest can be further classified into a small patch of abandon agricultural land with grass and land area dominated with Tbeng (*Dipterocarpus obtusifolius)*.

Semi-evergreen forest: This forest type presented in the Southeast of the community. In this forest, all big trees of the high-value timber (HVT) species were removed as results of illegal logging and land encroachment. Only a few big trees of lesser known species such as Khos (*Lithocarpus elegans*), Popel (*Shorea cochinchinensis*) , Pun svay, and kreng have been observed scattering in this forest type. However, the high natural regeneration of this area has been noted. Even there are natural regeneration, but these regeneration are mostly less commercial tree species such as Chromas (*Vatica odorata*), Kokos (*Sindora cochinchinensis*), Popel (*Shorea cochinchinensis*), Pring (*Eugenia sp.*), Trobtum (*Crypteronia paniculata*).

Abandoned agricultural lands inside deciduous forest: This area is dominated with invasive species, *Imperata cylindrica* (Sbove) mixing with pioneer tree species, such as *Pinus merkusii, Tramkang, Svay Prey (Mangifera indica).* There are also regeneration of less commercial tree species, especially Chromas (*Vatica odorata*), Krong (*Aporusa filicifolia)*, and some Kokos (*Sindora cochinchinensis)*. Since forest fire happens frequently, some seedlings have been disturbed. Furthermore, many seedlings were regenerated from sprout.

Deciduous forest dominated with Tbeng (*Dipterocarpus obtusifolius)***:** In this stand, *Dipterocarpus obtusifolius* in the second diameter class presented around 60% of tree species in the area. Even this species are the majority species in the second diameter class, Kreil was the main big tree species in the first diameter class (DBH≥30cm). It is noted that seedling density in this site is quite high. The majority seedlings species in this site are Plong, Tbeng (*Dipterocarpus obtusifolius*), Kreal, Kray *(Polyalthia cerasoides),* and most of them are low commercial tree species.

3.2 Tbeng Lech community forestry:

Tbeng Lech community forest consisted of two main soil types, namely: Red-yellow podzols and Cultural hydromorphics. Crocker (1962) described Red-yellow podzols as a soil type that has a low natural fertility in deeply developed acid soil profile. The A horizon is usually friable loamy sand or sandy loam while B horizon was sandy loam to clay loam. There are three main zones in this community as following:

Waterlogged area: This waterlogged zone is located in Southwestern part of the community. Not so many tree species presented in this area since it is flooded in the whole year round. The main species in this area are Sroeng (some time it is called Kongkang which means mangrove) and Khloem Andoek. Only Sroeng can be used locally for cottage construction, warehouse for keeping pigs and cows.

Degraded evergreen forest: Before degraded, this area consisted of many main species including Chhoeu Teal (*Diperocarpus alatus)*, Pdeak (*Anisoptera costata*), Korki (*Hopea odorata*), Kokos (*Sindora cochinchinensis*), Kronhoung (*Dalbergia cochinchinensis*), Popel (*Shorea cochinchinensis)*, Chambak, and Thnung (*Pterocarpus macrocapus*). Practicing shifting cultivation and illegal logging, this area becomes degraded. Currently, the main species found in this area are Poplea, Langeang (*Cratoxylum formosum)*, Chambak, Semoin (*Nephelium hypoleucum*), Angkat Khmao, Kray (*Polyalthia cerasoides*), and Chromas (*Vatica odorata*). However, some commercial tree species including Koki (*Hopea odorata*), Kokos (*Sindora cochinchinensis*), Kranhoung (*Dalbergia cochinchinensis*), Pdeak (*Anisoptera costata*), and Thnung (*Pterocarpus macrocapus*) have been observed in this area with very

low density and they are still young and, thus, could not provide seed for the next generation at this moment.

Abandoned agricultural lands (Veal Trapeang Ropeak): This area used to be clear for rice cultivation and left abundant for 12 years already since the establishment of this community forestry. Currently different tree and other plant species have been observed in this area including Dipterocarpus alatus, Hopea odorata, Komphneang, and rattan. This area is flooded every year from September to November.

IV METHODS FOR FOREST RESTORATION

4.1 Ou Some Community Forest

This community is located in Sala Visay commune, Prasat Banlang district, Kampong Thom Province. The rainfall in this area ranged from 1,400mm to 1,600mm (FA & DANIDA, 2003).

Semi-evergreen forest: Since the forest canopy is largely open, the ground layer covered densely with light demanding species such as climbing plants, bamboos and rattans. Enrichment planting by lines with shade tolerant, high-value timber species is recommended. Shade demanding species, particularly those of the *Dipterocarp* family, *Dipterocarpus alatus, D. costatus, Anisoptera costata*, *Hopa odorata*, and *Heritiera javanica* (Table 1), are suitable for the current site conditions. Assisted natural regeneration can be applied, in combination with line planting of the above mentioned species, where there are not sufficient natural regenerations of commercial species (seedlings or saplings). Table 2 shows some characteristics of recommended tree species.

Abandoned agricultural lands inside deciduous forest: This area is dominated with invasive species, *Imperata cylindrica* (Sbove) mixing with pioneer tree species, such as *Peltophorum ferrugineum*. Rehabilitation of this site is a challenge since the site conditions, soil fertility and microclimate, are less favorable for introducing seedlings. Two methods of forest rehabilitation, mix species plantation of nitrogen-fixing trees in this area and enrichment planting of legume species are recommended. These legume species include *Albizia lebbek*, *Albizia lebbekoides*, *Dalbergia cochinchinensis*, *Pterocarpus macrocarpus*, *Sindora cochinchinensis* and *Xylia xylocarpa*. Furthermore, Pdeak (*Anisoptera costata)* and Kroel were also found in this area, which are also potential for introducing these species in this site.

Beside above mentioned method, natural assisted natural regeneration would also be an interesting method to integrate with the method mentioned above. Strict prevention the site from forest fire is a must activity for promoting regeneration that need to be taken into account. This is because it was reported that forest fire happen frequently in this area and, thus, spread to many other areas in this community.

Deciduous forest dominated with Tbeng (*Dipterocarpus obtusifolius)***:** In this stand, *Dipterocarpus obtusifolius* in the second diameter class presented around 60% of tree species in the area. Even this species are the majority species in the second diameter class, Kreil was the main big tree species in the first diameter class (DBH≥30cm). It is noted that seedling density in this site is quite high. The majority seedlings species in this site are Plong, Tbeng (*Dipterocarpus obtusifolius*), Kreal, Kray *(Polyalthia cerasoides),* and most of them are low commercial tree species.

A few species were found in association with this stand, such as *Pinus merkusii* and Pdeak (*Anisoptera costata)* while most of other species are non-commercial tree species. At this stage of development, mixed forest tree species dominated by Tbeng should be left to natural regeneration; no thinning or pruning are needed as canopy closure is needed to eliminate grass and keep the soil moisture.

4.2 Tbeng Lech Community Forest

This community is located in Tbeng commune, Banteay Srey district, Siem Reap Province. The rainfall in this area ranged from 1200mm to 1400mm (FA & DANIDA, 2003).

Waterlogged area: This waterlogged zone covers a small portion in the Southwestern part of the community. Many species were presented in this area. However, those species were not commercial species while only Throeng species (some time called Kaung Kang which means mangrove tree) have been used locally for household need. Currently, this area becomes degraded. Therefore, enrichment planting in line or in group of Throeng species is recommended for restoring this site.

Degraded evergreen forest: Before degraded, this area consisted of many main species including Chhoeu Teal (*Diperocarpus alatus)*, Pdeak (*Anisoptera costata*), Korki (*Hopea odorata*), Kokos (*Sindora cochinchinensis*), Kronhoung (*Dalbergia cochinchinensis*), Popel (*Shorea cochinchinensis)*, Chambak, and Thnung (*Pterocarpus macrocapus*). Currently, the main species found in this area are Poplea, Langeang (*Cratoxylum formosum)*, Chambak, Semoin (*Nephelium hypoleucum*), Angkat Khmao, Kray (*Polyalthia cerasoides*), and Chromas (*Vatica odorata*). However, some commercial tree species including Kokri (*Hopea odorata*), Kokoh (*Sindora cochinchinensis*), Kronhoung (*Dalbergia cochinchinensis*), Pdeak (*Anisoptera costata*), and Thnung (*Pterocarpus macrocapus*) have been observed in this area with very low density and they are still young and, thus, could not provide seed for the next generation at this moment.

Enrichment planting by lines with shade tolerant, high-value timber species is recommended. Shade demanding species, particularly those of the *Dipterocarp* family, *Dipterocarpus alatus, D. costatus, Anisoptera costata*, *Hopa odorata*, and *Heritiera javanica* (Table 1), are suitable for the current site conditions. Assisted natural regeneration can be applied, in combination with line planting of the above mentioned species, where there are some natural regeneration of commercial species (seedlings or saplings).

Abandoned agricultural lands (Veal Trapeang Ropeak): This area used to be clear for rice cultivation and left abundant for 12 years already since the establishment of this community forestry. Currently, few trees of commercial tree species (*Dipterocarpus alatus* and *Hopea odorata*) have been encountered while the density of these species in the previous time was much higher than current situation. Beside the two commercial species, other species such as Komphneang and rattan were also observed in this area.

Enrichment planting of mixed species in line or group in the area where there is no flooded would be recommended. This include the planting of mix species of legume family, such as *Albizia lebbek*, *Albizia lebbekoides*, *Dalbergia cochinchinensis*, *Pterocarpus macrocarpus*,

Sindora cochinchinensis and *Xylia xylocarpa*, with *Dipterocarpus alatus, D. costatus, Anisoptera costata*, *Hopa odorata* and *Heritiera javanica*.

Table 1: Summary of methods of forest rehabilitation by forest type in each community forest

Forest type	Area (ha)	Suggested methods of forest rehabilitation
Ou Some Community Forest		
Degraded semi-evergreen forest		• Enrichment planting (line or group/gap) planting of commercial species. • Assisted natural regeneration.
Abandoned agriculture lands inside deciduous forest		• Mixed species plantation in line or group of nitrogen-fixing trees • Assisted natural regeneration, especially strict forest fire prevention.
Deciduous forest dominated by Tbeng		• Assisted natural regeneration, especially strict forest fire prevention. • Let it grows naturally
Tbeng Lech Community Forest		
Degraded evergreen forest		• Enrichment planting (line or group/gap) of commercial species in combination with assisted natural regeneration where adequate seedling is observed.
Waterlogged area		• Enrichment planting in line or in group of Throeng species
Abundant agricultural land		• Enrichment planting of mixed species in line or group in the area where is not flooded.

Table 2: Tree species suitable for rehabilitation of degraded forests

No.	Tree species	Local name	Family	Category	Habitat	Use
1	*Albizia lebbek*	Chres	Leguminosae	0	D	HVT, Fw
2	*Albizia lebbekoides*	Chamreak	Leguminosae	n	D	T, Fw
3	*Anisoptera costata*	Phdeak	Dipterocarpacea	2	E	HVT, P
4	*Cassia fistula*	Loeung Reach	Leguminosae	n	D	Fw
5	*Cassia garretiana*	Haisarn/Chansar	Leguminosae	0	D	Fw
6	*Cassia grandis*	Auy Mauy	Leguminosae	n	D	Fw, M
7	*Cassia siamea*	Angkanh	Leguminosae	0	D	Fw
8	*Dalbergia cochinchinensis*	Kranhoung	Leguminosae	0	MD	HVT, Fw
9	*Dalbergia cultrata*	Kranhoung Sva	Leguminosae	n	MD	HVT, Fw
10	*Dalbergia oliveri*	Neang Nuon	Leguminosae	0	MD	HVT, Fw
11	*Dipterocarpus alatus*	Choeuteal Toeuk	Dipterocarpacea e	2	E	HVT, R
12	*Dipterocarpus costatus*	Choeuteal Bankuoy	Dipterocarpacea e	2	E	HVT, R

13	*Erythrophleum succirubrum*	Treas	Leguminosae	1	D	T, Fw
14	*Heritiera javanica*	Daunchem	Sterculiaceae	2	E	HVT, P
15	*Hopa odorata*	Korki Masao	Dipterocarpacea	2	E	HVT, P
16	*Notaphoebe umbelliflora*	Bampong Prahok	Leguminosae	n	D	Fw, M
17	*Peltophorum ferrugineum*	Trasek	Leguminosae	1	D	T, Fw, P
18	*Pithecellobium*	Ampil Toeuk	Leguminosae	n	D	Fr, Fw
19	*Pterocarpus macrocarpus*	Thnong	Leguminosae	0	E, D	HVT, Fw
20	*Sindora cochinchiensis/ siamensis*	Krakoh	Leguminosae	1	E, D	HVT, Fw
21	*Xylia xylocarpa*	Sokram	Leguminosae	1	D	HVT, Fw

Timber category:

0 Luxury category (high-priced timbers, mainly used for high-quality furniture, interior decorations and musical instrument)
1 1st category (timbers are mainly used for construction material and furniture)
2 2nd category (timbers are mainly used for construction material)
3 3rd category (timbers can be used for construction materials)
n no classification

Habitat:

E Evergreen forest
D Deciduous forest
MD Mixed deciduous forest

Main uses:

HVT High-value timber
Fr Fruit
Fw Fuel wood
P Pole
R Resin
T Timber

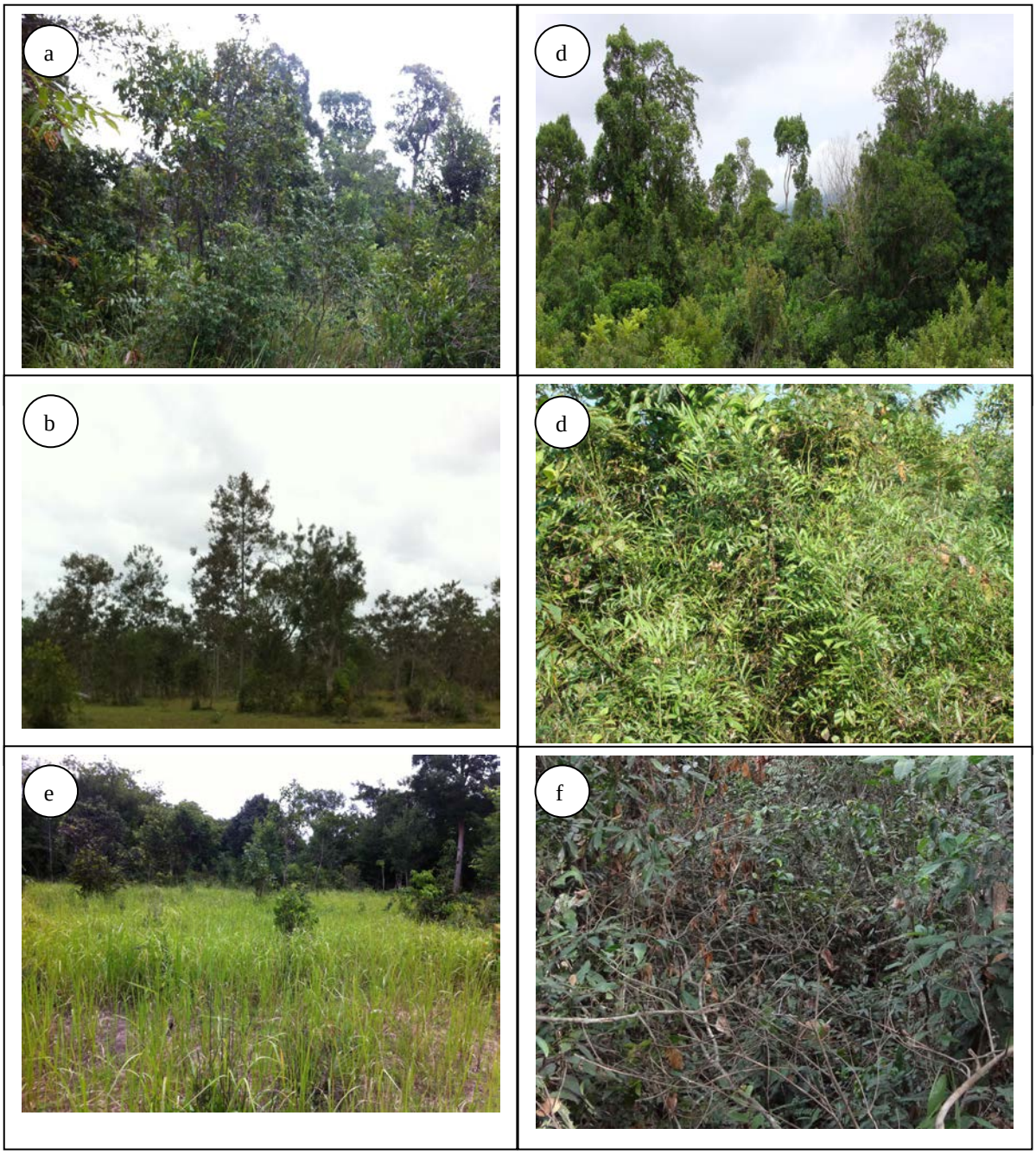

Figure 1. Forest condition of the project site. (a), Semi-evergreen forest; (b), Deciduous forest dominated with *Dipterocarpus tuberculatus*; (c) Abandoned agricultural land in Ou Some; (D), Evergreen forest (e), Abandoned agricultural land in Tbeng Lech, and (f), Waterlogged area

V CONCLUSION

There are three zones in Ou Some community forest. These zones are degraded semi-evergreen forest, abandoned agricultural lands inside deciduous forest, and deciduous forest dominated by Tbeng. There are also three zones in Tbeng Lech community forest. These zones are degraded evergreen forest, waterlogged area, and abandoned agricultural land.

Two main methods are recommended for forest restoration, namely: enrichment planting in line or group and assisted natural regeneration. Enrichment planting is recommended for the area where the required species are not sufficient for future uses while assisted natural regeneration is applicable for the area where the required species are adequate. Even,

different areas are recommended with the same method for forest rehabilitation, the tree species used in each area might be different.

In addition to above mentioned, strict fire prevention in Ou Some Community forestry should be taken into account since this area is mainly covered by deciduous forest and many patches of abandoned agricultural land covered with grass was observed in this area.

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