



Mekong River Commission

# **Thematic Assessment Interim Report Agriculture and Land Use Change**

November 2016

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## 1. Background

Agriculture is a very important sector within the Lower Mekong Basin (LMB). Farming is the primary occupation of the rural areas within the LMB in each country. Between 2011 and 2014, the numbers engaged in farming have increased in Cambodia, Thailand and Viet Nam by on average 9% to 6.9 million, whereas the total number of farmers in Lao PDR has appeared to decline from 238,000 to a little over 15,000. The most important secondary occupation is farm labor, again reflected in all four countries, which had apparently increased by 485% between 2011 and 2014 to 18.6 million. Both primary and secondary important occupations confirm the importance of agricultural sector to generate household income.

Agriculture is the dominant water-related sector, particularly in Thailand and Vietnam whereas agriculture in Cambodia and Lao PDR is currently less intensively developed. In the whole LMB, the dry-season irrigated area of about 1.2 million hectares is less than 10% of total agriculture area. The expansion of irrigation is limited by the availability of dry season water flow and investment capacity.

During the past decade, agricultural land has been changed with some following trends: (i) expanding agricultural area: some areas have become cultivation land from bush forest after land clearing for agriculture and improving agriculture facilities especially irrigation development, (ii) crops and crop pattern have been changed: due to the improvement of irrigation, technology and market orientation, farmers have changed crops and crop pattern. In some rice areas, one annual rice crop is changed to two rice crops per year because of the irrigation development; (iii) in some area, agriculture land is degraded so that crop cultivation is not effective, therefore the farmers let these lands to be fallow; (iv) agricultural land has been changed into other use purpose depending on social-economic development. For example, these kinds of land would be for hydropower projects, industrial zone, resident's area and transportation etc.

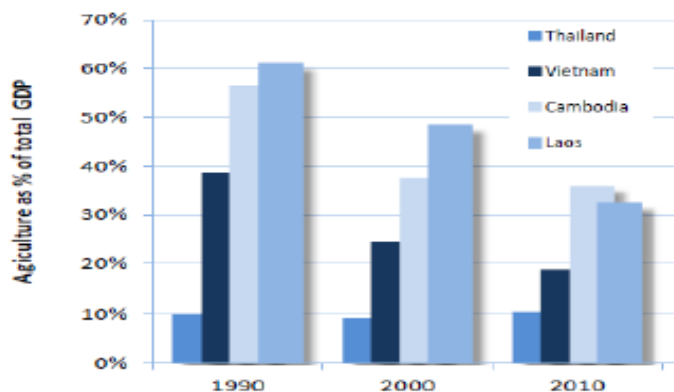
The change of agriculture land has transboundary impact; hence they need to be monitored. Firstly, these changes lead to change in water allocation for agriculture itself and for other purposes. Sustainable water allocation in the whole region and sub-basin needs the information on the agriculture development. Secondly, the ensuring food security depends on agriculture activities. Agricultural land use change needs to make sure to supply enough food at different scales. On the other hand, agriculture is main livelihood of the local farmers; therefore it needs to be monitored to identify opportunities and risks to local farmers to seek timely adaptive solutions. Furthermore, the land use change has transboundary impact on the hydrology process and sediment transportation. They affect directly to other important social-economic sectors such as fisheries, navigation etc.

In general, land use change may have positive or negative impacts at multi levels of the basin on environment and local people livelihood, land use change needs to be monitored to understand the change and its impacts to the basin.

The most recent available population figures (2008-2012) shows a total population of 64.8 million people living within the LMB. Compared to the previous estimate of 60.6 million, based on the 2005 Census (Lao PDR) and 2008 Census (other LMB countries), there has been an apparent population increase of 9%. Earlier population data showed a 14% population increase from 1995-2000 to 2—5-2008. The most populous provinces are found in Thailand, Viet Nam and on the floodplains in Cambodia.

The rural population in Cambodia is projected to remain stable around the current level of 10 million people, while population growth will occur in cities. In Lao PDR, the rural population is projected to decrease somewhat as cities grow and absorb the population growth. There has been a decrease in the total rural populations in Thailand and Viet Nam and this is projected to continue.

Between 1990 and 2010, the economies of Viet Nam, Cambodia and Lao PDR experienced rapid structural changes with a significant reduction in the proportion being contributed by agricultural sector to national GDP, and a notable rise in the proportions being contributed by the industrial and service sectors. In Viet Nam, the contribution of the agricultural sector fell from 39% in 1990 to 19% in 2010. Although the economies of Cambodia and Lao PDR are primary based on transformation occurred in the 1970s and 1980s so, by 1990.



## 2. Current Status of the Sector

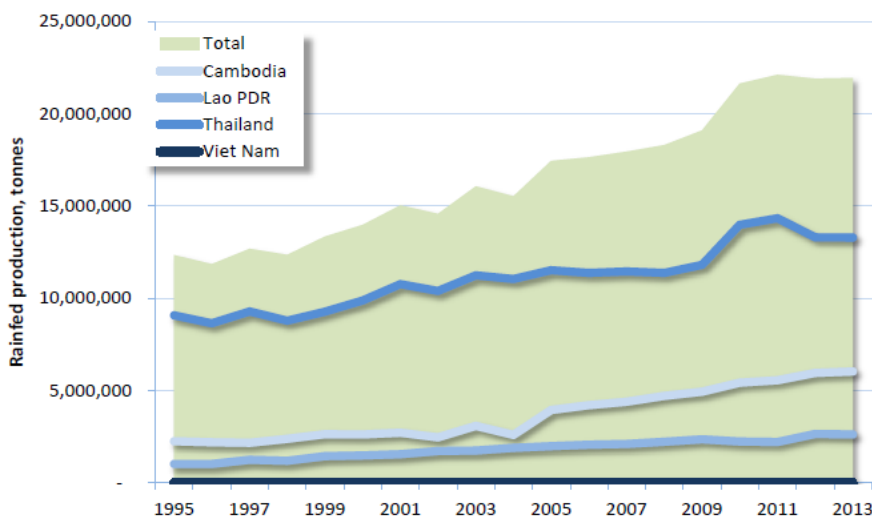
The data from Member Countries shows that the total rainfed harvest area for rice in the LMB is larger than the total irrigated harvest area for rice in 2013. Within the LMB, Mekong Delta in Viet Nam is the largest irrigated area for rice cultivation. Cambodia, Lao PDR, and Thailand have still large potential to be irrigated. Table 1 shows rice harvest area in 2013 in MCs.

Rice harvest area in 2013		
	Irrigated Harvest area (ha)	Rainfed Harvest area (ha)
Cambodia	483,446	2,485,521
Lao PDR	92,340	683,125
Thailand	598,805	6,312,846
Viet Nam	4,569,400	-
Total	5,743,991	9,481,492

Table 1: Rice harvest area in 2013 in MCs.

The production of rice under rainfed condition in the LMB is still very subsistent, especially in Thailand and Cambodia, and totaled 22 million tonnes in 2013, with Thailand and Cambodia accounting for 13 million tonnes and 6 million tonnes respectively.

**Figure 5-5 Past trends in rain fed rice production in LMB**



Source: Data from Member Countries, no data for Viet Nam

The area and production of rainfed maize have been increasing in Cambodia, Lao PDR and Viet Nam, but have been decreasing in Thailand. In 2003, the overall area of rainfed maize in the LMB was estimated at 0.92 million hectares with a total production of 4.4 million tonnes, of which 1.5 million tonnes was produced in Thailand.

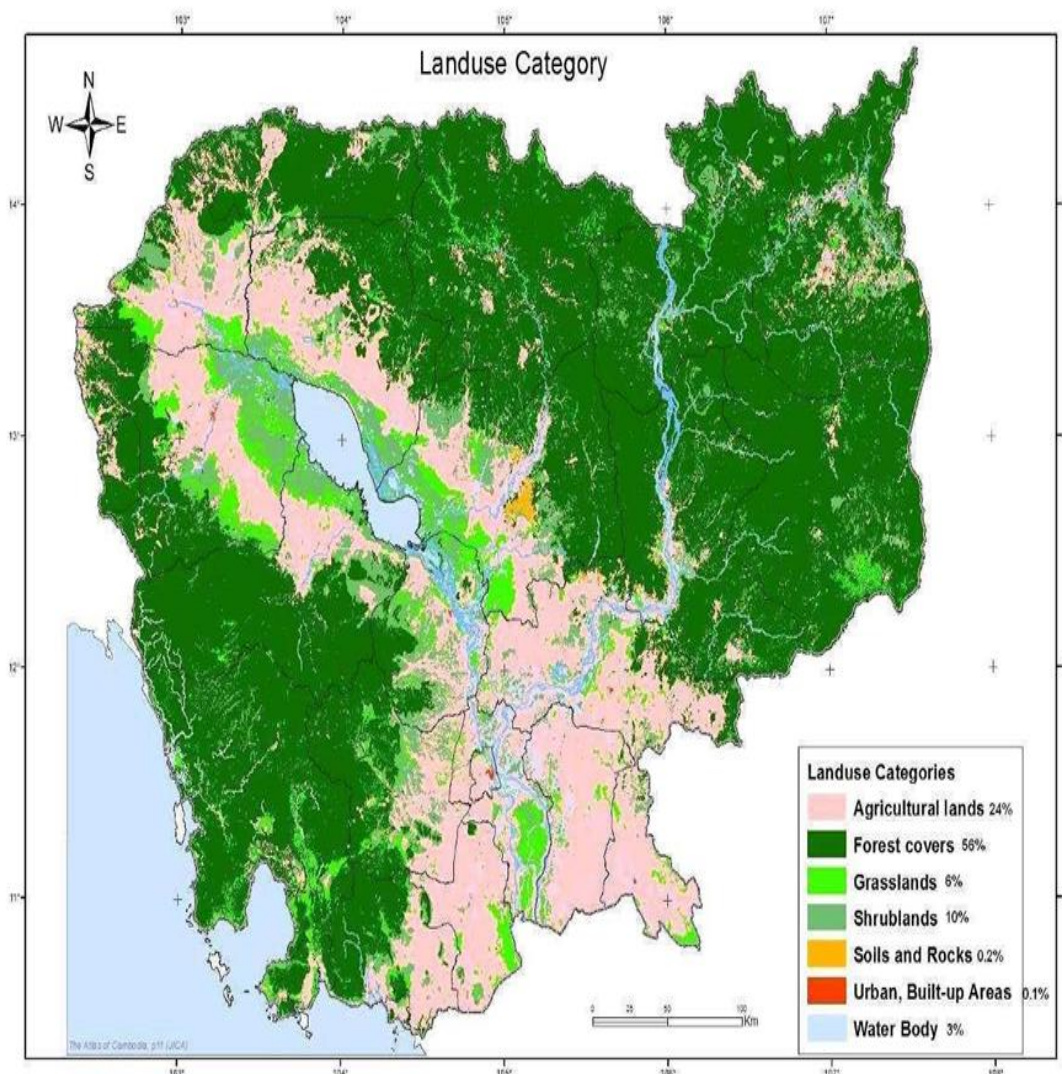
### 2.1 Land use, forestry and mining in Cambodia

Cambodia land use has been changed rapidly, especially during the last decade, in which resulted from development activities. In 2006, forest cover was estimated at 59.9% of the total land area of the country. However, this forest cover was decreased to 57.7% of the total land area of the country in 2020. While forest cover has decreasing from year to year, agricultural land has been increased. It was reported that rice production area was increased from 2.72 million hectare in 2009 to 3.05 million hectare in 2013. The same trend with rice production area, the production areas of other four main crops, namely: maize, cassava, mung bean and soya bean, were increased from 206,058 to 239,748 ha, 160,326 to 421,375 ha, 49,599 to 54,312 ha, and 96,388 to 80,680 ha from 2009 to 2013, respectively. Among four main crops, cassava seems to be a promising opportunity for case income to local community because the total land area has been increasing rapidly during the last three years.

Because of the boom of economic land concession, some forest area have been converted to industrial crop and also the forest plantation such as acacia, eucalyptus and teak plantations, as well as plantation. The area for rubber plantation has been increased from 129,920 ha in 2009 to 328,771 ha in 2013. According to MAFF, till 2012, the Royal Government of Cambodia has granted Economic Land Concession to 118 companies with the total land area of 1,204,750 ha. Among these companies, 39 companies was recorded to plant forest tree sepcies.

Total cultivated area of Cambodia is about 4.37million ha (24% of the land), while forests cover about 56%. Rice is the dominant crop, which covers approximately 3.57millionha, (80% of agricultural land) including the area of receding, floating rice and paddy rice interspersed with villages. Figure 4 shows land use and land cover in Cambodia.

The result of geological studies and mineral investigations, carried out since the latter half of 19<sup>th</sup> century by French and Chinese geologists, have indicated significant mineral potential in Cambodia, including gold, iron, bauxite, manganese, silica, kaolin, limestone, phosphate, rubies, coal, construction materials and other minerals. But, the reserves of those mineral resources have not been evaluated yet for development and mining.



**Figure 4: land use and land cover in Cambodia.**

In summary, the following table shows the current area of agriculture and land use in 2007.

Summary table of current agriculture and land use	
Cambodia	
2007	
Rainfed agriculture (ha)	82,059
Forest (ha)	462,769
Surface mining (ha)	47,977

### 2.1.1. Rainfed agriculture

In addition to forest tree plantation development by ELC, cassava is industrial and upland crop which is popular by local community, especially local people in the provinces neighboring to Vietnam and Thailand such as Kampong Cham, Battambang, Svay Rieng, Kratie, Pailin, Banteay Meanchey. The cultivated land for cassava production has increased from year to year.

Cassava is the upland crop that has gained greatest in popularity, reflecting a combination of a high demand for domestic use and for export, and relatively high prices. The total area of four main crops (maize, cassava, mung bean, and soya bean) was increased from 392,755 ha in 2007 to 796,123 ha in 2013, which is double. The greatest increase has been in Kampong Cham province in Northeast Cambodia.

Cassava is adaptable to diverse climates and can be grown in soil with low fertility. It is planted either as a single crop or intercropped with maize, legumes, vegetables, rubber or other plants. Cassava is normally planted during February-April and harvested in eight of 12 months depending on market price and the availability of labor for harvesting.

Cassava is annual crop. The cassava planting materials are kept by farmers from one planting season to another. However, the farmers have limited access to healthy/good quality planting materials. In the last few years, the planting materials were often infected with diseases/pests. The farmers do not know the names of cassava varieties that they are planting. However, they noticed that these varieties are imported from Vietnam, Thailand, Malaysia, etc. This indicates that the selection of good varieties is very limited, because different varieties are used for mixed planting.

The investment cost of cassava production involve with land rental, land operation, cost of inputs, labor, loan, and others. The total production cost of cassava per hectare was estimated at USD329. The largest share of cassava production cost is land which is accounted to 40% of the total cost or USD 132 per hectare. This followed by labor cost accounted to 34.5% of the total cost. Even the total cost is USD 329 per hectare, the input from family shared 62% while the purchasing input shared only 38% of the total production cost of cassava.

The average production of cassava per hectare in Momet in 2010-2011 was 20t/ha. The price of cassava fluctuates depending on market demand, especially demand from neighboring countries such as Vietnam. In 2003, the price of fresh cassava ranged from 290 to 310 riels/kg (about USD 0.075). The farmers prefer to sell fresh rather than dry cassava; furthermore, selling fresh cassava is easier for local community so that they can get money sooner for paying back the production cost. In addition, it is lower risk than selling dry cassava. To make dry cassava, the farmers need more labor and time, and the price is not really good enough to attract them.

It should be noted that the production cost of Cassava in Battambang province is higher than in Kampong Cham province. The discussion with farmer in December in 2015 on the production cost of cassava was reported USD440/ha while in Kampong Cham was only USD329/ha. However, the production and, thus, more family inputs than production in Battambang province. Furthermore, the average yield of cassava in Battambang was estimated at 30 t/ha while in Kampong Cham was only around 20 t/ha.

Cambodian farmers mostly export fresh cassava, while there are very limited processing plants inside the country. Fresh cassava is mainly exported to Vietnam and dry cassava chips are exported to both Thailand and Vietnam: cassava farmers along the Cambodia-Thai border make the dry chips. The price of cassava fluctuates depending on market demand in the neighboring countries.

Aside from cassava, maize is the second popular crop for local community and Investment Company. According to MAFF, the area for maize production was increased from 216,330 ha in 2012 to 239,748 ha in 2013. It was reported during the discussion that the average yield of maize in Ratanak Mondul district of Battambang province was at 4 t/ha. The current price of this product was KHR810,000/t (around USD203/t).

### **2.1.2. Forestry**

For contribution to economic development, the Royal Government of Cambodia has allocated some degraded forest areas for economic land concession (ELC). These ELC planted different crop and tree such as rubber plantation, forest plantation, and industrial crop. The major goal of this ELC is to provide free (non-use) land for agricultural and agro-industrial plantation, and processing for export, which is expected by the government to create the jobs and generate income for the people living in the rural area.

Some ELCs has planted forest tree species such as *Tectona grandis*, *Acacia* sp, *Eucalyptus* sp and pine.

Among 40 ELCs which is accounted to 46% of the total ELCs involve with forest tree plantation establishment, there are 26 companies reported planting acacia while 14 companies reported planting Teak (*Tectona grandis*).

The cost of acacia plantation consists of seed, land preparation, labor for planting, maintenance, post/pole, farm tools, chemical and fertilizer, and gasoline. It is reported that an average cost of acacia plantation was about USD 256 per ha for the period of 5 years with the maximum of USD 1078 per ha in the first year and minimum of USD 25 per ha in the fifth year.

It is reported the results of meeting with company in Kampong Thom that the price of 5 year old acacia plantation was ranging from USD 1,500 to 2,700 per ha. This result was confirmed with the discussion with key informant in Stoeung Treng province.

The cost of teak plantation consisted mainly of seeding, land preparation, planting, plantation maintenance, and staff salary. The cost of teak plantation is obtained from the key informant who works at the private company which has been awarded economic land concession of 5,000 ha by the government. Therefore, the cost of land rental which commonly included in the cost estimation of some other study is excluded in this study.

The harvesting cycle of teak plantation is 12 years which is two time longer than harvesting cycle of some forest tree species such as acacia and eucalyptus. An average cost of teak plantation is USD 1,102 per ha for the period of 12 years with the maximum of USD 2,557 in the first year, and the minimum of USD 800 per ha from the fourth year on ward. The largest share of teak plantation is personnel cost – representing 63% of total expenditure in the first year, followed by 92% in the second year, and 100% in the fourth year onward.

Teak has a very small proportion of world timber production and trade. The estimated market share of teak logs in total tropical round wood production is less than 2 % but in terms of value it is much larger since teak is part of the high-value hardwood market. Planted teak forests have globally attracted large investments from the private sector in many countries.

Between 2005 and 2014, the global annual trade of teak roundwood was more than 1 million m<sup>3</sup> on average; the imports were valued at US\$487 million a year, which is about 3 percent of the value of the global timber trade (US\$15.5 billion). In Cambodia, however, teak logs are extremely small compared with acacia and eucalyptus – registered only 20 Sdt in 2009 and 6 Sdt in 2011.

To date, the teak planters have never experience in selling teak products to the market due to plantation establishment is still in the initial stage. Therefore, the price of teak from teak plantation establishment seems to be unknown. However, it is reported that the price of teak round logs from plantations published by the World Trade Price in 2012 was 500 USD per m<sup>3</sup> and the production of 250 m<sup>3</sup> per hectare, the value of teak at year 12 in one hectare is estimated at 125,000 USD.

### **2.1.3. Mining**

The rest of geological studies and mineral investigations, carried out since the latter half of 19<sup>th</sup> century by French and Chinese geologists, have indicated significant mineral potential in Cambodia, including gold, iron, bauxite, manganese, silica sand, kaolin, limestone, phosphate, sapphires, rubies, coal, construction materials and other minerals.

By using the available mineral and geological data, so far there are around 91 companies (from Australia, China, Vietnam, Thailand, and domestic) licensed to conduct 139 exploration projects. Currently, they are being under their exploration phase. The exploration license includes metallic mineral, bauxite, antimony, chrome, coal, silica, sand, and white clay.

It is reported that there are currently 19 gold deposits in Cambodia, according to the Strategic Plan on



the Management of Mercury and Mercury Containing Waste in Artisanal Small Scale Gold Mining. Gold mining in Cambodia is currently shifting from small-scale community-level activity to become increasingly mechanized, industrial-scale activity undertaken by local, national and international stakeholders. The peak of the mining season (that is, during the dry season from November to May the following year), between 5,000 and 6,000 people worked as artisanal miners.

## 2.2 Land use, forestry and mining in Lao PDR

The land classification in Laos has divided in 3 main types such as: 1) forest (forest cover, forest defines for protect water resources, the area for forest restoration and the area for plantation forest), 2) agriculture (current paddy field, areas for paddy field expansion, area for crop long and short cycle, pasture and other agriculture land, and 3) other land.

In 2008 the forest area of Laos had 70.24% or 16,632,376 hectare and the country expects that in 2020 the forest area will be slightly increase 1.59% (71.83%) or 17,009,845 hectare by increasing the area of plantation forest and the restoration forest up to 12% while the forest cover will be slightly decrease from 40.92% to be 40.34%. This is based on the policy of the Lao government strategy that trying to increase the forest area to be 70% by 2020. On the other hand, the agriculture land in 2008 had 19% or 4,728,966 hectare with total current used area approximately 2 million hectare or around 9.5% of the country area and this agriculture will increase to 21% in 2020 by increase 1 million hectare for rice expansion and 831,138 hectare and 899,262 hectare for the crop long cycle and short cycle respectively. The area for rice expansion is to support the target of rice production to be 5 million to in 2020 for the food security as well as the export to other country. In addition, the other land which includes the residential area, water resources, wet land, stone area and etc will be decreased from 10% in 2008 to be 7% of the country area in 2020.

In summary, the following table shows the current area of agriculture and land use in 2007 in Lao PDR.

Summary table of current agriculture and land use	
Lao PDR	2007
Rainfed agriculture (ha)	861,920
Forest (ha)	9,552,425
Surface mining (ha)	323,114

Rural development in the uplands of Lao PDR has presented many challenges for farmers and their communities. GoL's policy is directed at reducing the production of upland rice and providing sustainable alternative livelihoods for upland farmers.

As we known that slash and burn agriculture in Lao PDR is practiced widely in upland, rural areas, and it is significant to the cultures of ethnic groups. It can be sustained with long fallow periods and when population densities are low. But productivity is extremely low, and it is vulnerable to both drought and excessive rain. When pressures on land and forest increase, fallow periods are shortened, resulting in increased degradation and deforestation. The clearance of forest for shifting cultivation is declining, but still amounts to an estimated 200,000 ha per year.

In general, reasons of impact agricultural productivity, particularly in valley and uplands areas, they are caused by:

- Small landholders, with about half of farm households owing less than 1 ha;
- In-secure land tenure;
- Heavy dependency on rainfall in the wet season, with little possibility of dry season cultivation;
- Natural disasters, including floods and landslides;
- High cost of quality inputs such as fertilizers, seed, tools and machinery;
- Poor agro-processing and storage to reduce post-harvest losses;
- Inadequate markets and transport infrastructure and services that make it difficult to shift

surplus food from have to have not provinces and district;

- Unexpected ordinance (UXOs), especially along the border with Vietnam, which it impact an agricultural land and reduce cultivation;
- Reduce available land for cultivation;
- Lack of technical agricultural training into farmers (insufficient farmer education) at provincial and district levels;
- Insufficient an infrastructure for agricultural system for example new roads assess to be a carry out agricultural land/product;
- Internal and external labor migration is high and it not enough lab for maintain the agricultural activities. Most external migrants work in Thailand, which was home to an estimated more than 150,000 of Lao workers which were registered and un-registered in 2014;
- Lack early warning system for agricultural when disasters is coming or standard operating procedures for who will do what during the immediate onset of disasters. And this is hampered by the lack of a legal framework Governing Emergency Relief operations. But later on Lao PDR had National Disaster committee and it could solve a flood prevention in 2008.

### **2.2.1. Rainfed Agriculture**

Rainfed agriculture refers to those agricultural systems that are not irrigated and rely solely on rainfall for their water supply. About 80% of the world's farmed lands are rainfed and this ratio rises up to 88% in mainland Southeast Asia so "Tropical uplands" of northern and central in Lao PDR were main crops grown on rainfed lands in Lao PDR include maize, sweet corn, soybean, sugarcane, tobacco, coffee, upland rice and a range of fruits and vegetables.

Vegetables are mostly grown in the dry season (October-May) while rice is mostly grown during the rainy season (June-September).

These systems are highly sensitive to climate variability, which limits agricultural production. Often, the total amount of rainfall is more than adequate for crop growth, but the variation between years and distribution within the wet season means that unpredictable droughts and water shortages reduce production. Inundation can reduce productivity or even completely destroy crops.

Irrigated rice is also grown during the dry season. Upland rice planted area is baseline 2007 and comparison with 2014.

In this year 2007 characteristics of southern Lao PDR for crop plantation such as for Saravane province was planted area of coffee 20,935 ha and Champasack province was 32,780 ha. But, northern Lao PDR like Luanprabang province was a plantation the area of Job's tear 7,350 and Sesam with 8,440 ha.

In the year 2014 characteristic of southern Lao PDR for crop plantation such as for Champasak province was the area for coffee plantation was increased 49,000 ha also Saravan province with 23,910 ha, Sekong with 11,425 ha and Savannakhet province wqas increased the area plantation of sugarcane with 14,565 ha.

About shifting agriculture, it is a negative trend highlighted in Lao PDR's Agriculture Development Strategy 2011-2020. Encroachment on forest areas as a result of land concessions and increasing exploitation of the agricultural and natural resource sector raises major social and environmental concerns. The government has requested FAO assistance to apply Participatory Negotiated Territorial Development (PNTD) to address these issues with a multi-stakeholder, gender sensitive and negotiated land use and resource development approach.

### **2.2.2. Forestry**

The Forestry Strategy 2020 recognizes that forests have an important role in local livelihood systems.

In the upland areas the strategy aims at, for example, linking rehabilitation, conservation and the expansion of forest cover with meeting the needs for food and commodity production. It also aims at decreasing the amount of land used for shifting cultivation. The implementation principles of the strategy include the development of village based natural resources management and the promotion of sustainable participatory Non-timber forest product (NTFP) management and processing. The strategy targets to complete the land-forest allocation programme by 2020.

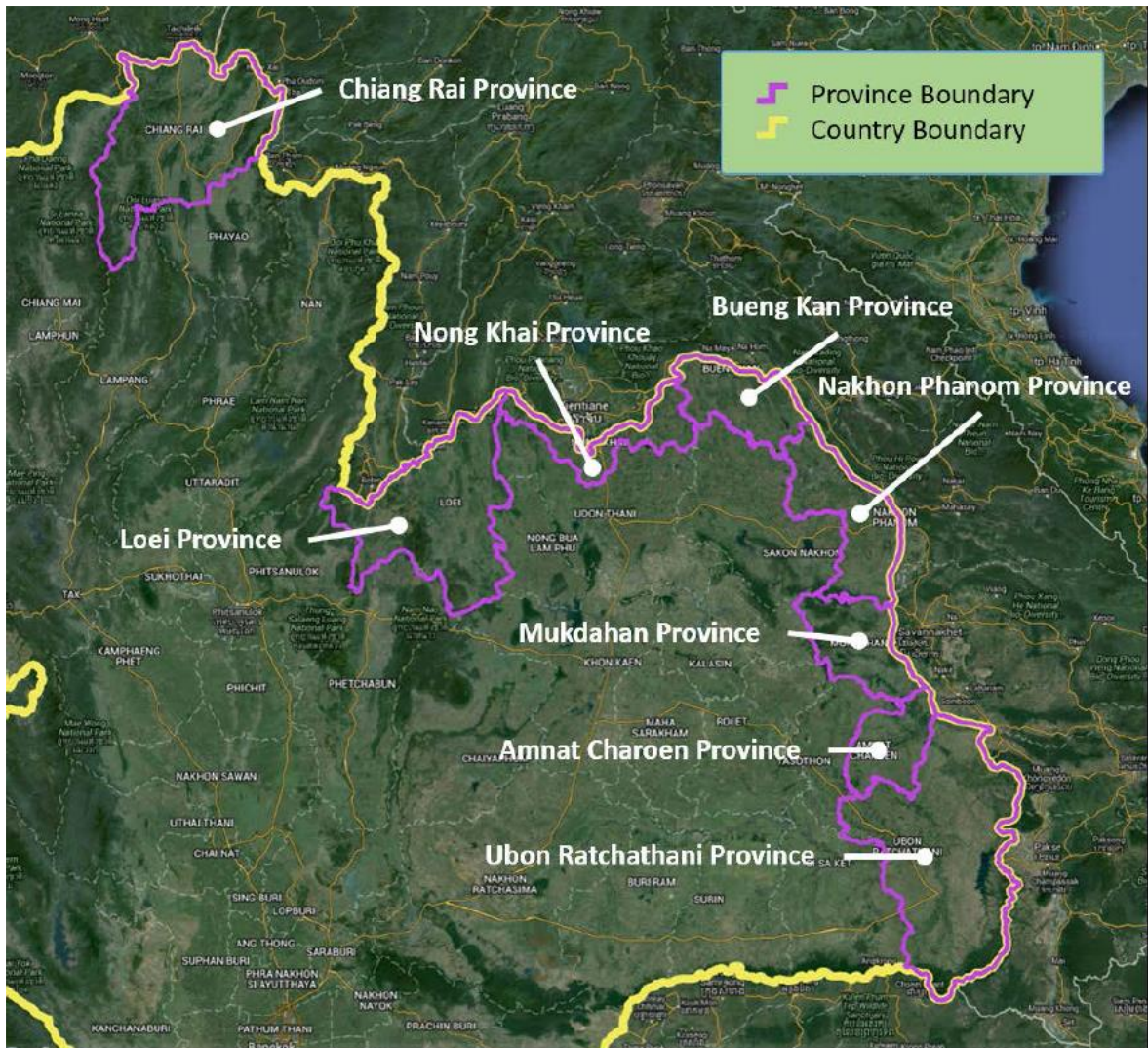
The GoL has set an ambitious goal of reaching 65% forest cover by 2015 and 70% by 2020. The Forestry Law defines and delineates three forest management categories: conservation, protection and production forest. These categories do not indicate the current land cover but are instead administrative categories determining management and land use regulations. By overlapping the inventory data with spatial data, almost one third of all concessions and leases granted were shown to occur on lands categorized as forest. While production forest could be expected to host the greatest number of investment projects considering limitations on development activities in protection and conservation forest areas, most investment occurs on lands categorized as protection forest.

The statistics is based on visual point sampling and maps are produces to visualize major changes areas. The production of forest cover is 40.25% in 2009. The potential forest and current forest categories are relatively difficult to separate from the imageries, thus, there are not very clear changes in national level. Country level standard error of sampling is 0.38, which means that with 95% confidence the results are between 39.5-41.0%. The region specific results indicate regional changes. Fairly rapid decrease in Southern (-1.1%/year) and Central (-0.4%/year) regions can be identified. Clear development in Southern region needs special attention. Proportion of potential forest has increased and part of forest areas has been converted into other land use category. Significant reduction of forest area can be identified in Bolikhamxay, Khammouane in central region. Similar minor trend can be found in Savannakhet. The largest reduction in forest area can be found in Salavan, Xekong, and Champassak provinces (13-16% in each).

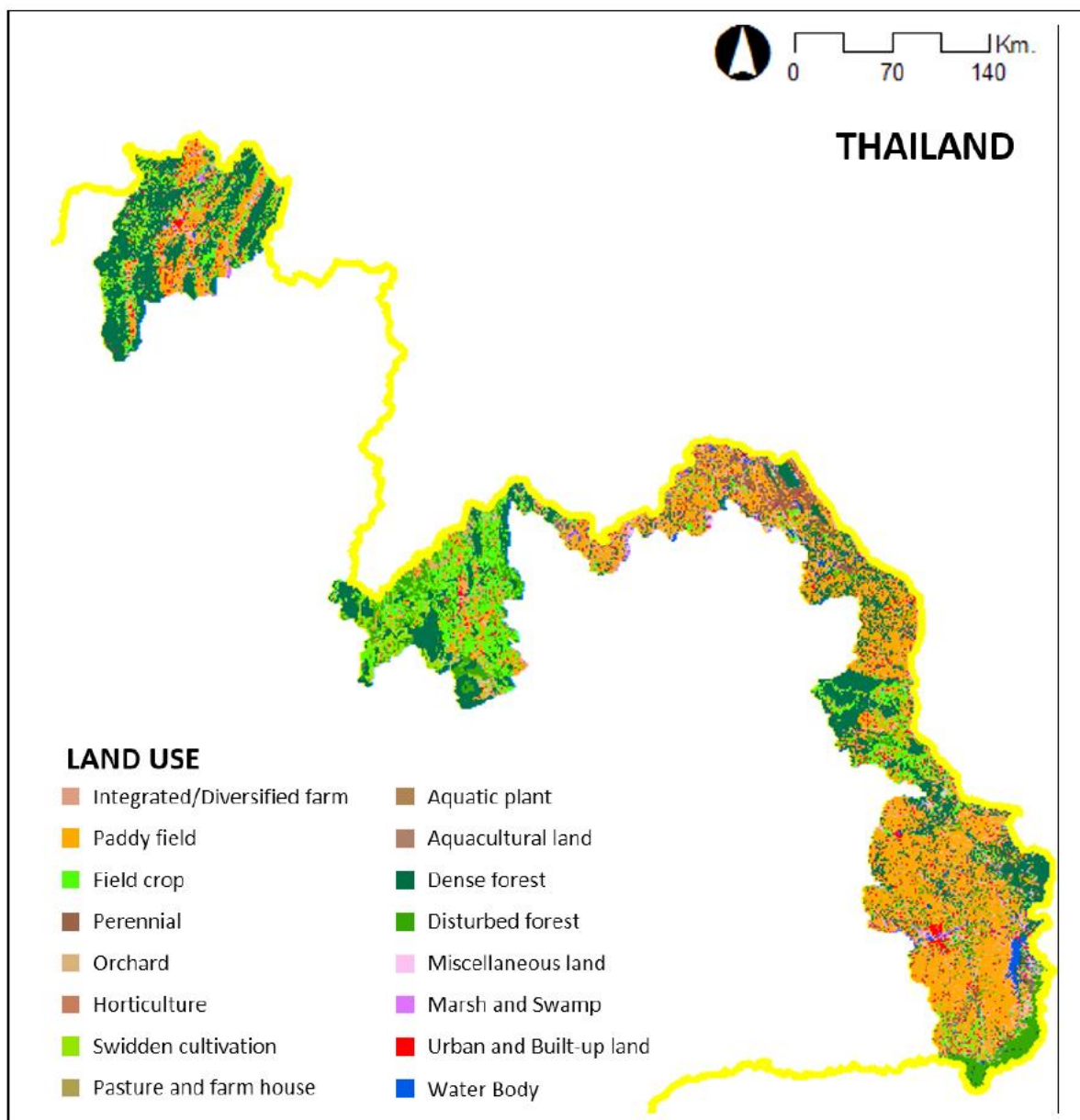
### **2.3 Land use, forestry and mining in Thailand**

The study area covered eight provinces including Chiang Rai, Loei Khai, Bueng Kan, Nakhon Phanom, Mukdahan, Amnat Charoen, and Ubon Ratchathanai provinces.

Total MRC province area in 2007 was approximately 5.82 million hectares. Agricultural area occupied 56.3 percent of total area where paddy field was approximately 2.01 million hectare. Field crop and perennial areas covered 0.69 and 0.27 million hectares respectively. Dense forest and disturbed forest areas covered 1.45 and 0.46 million hectares respectively. Other area (e.g., urban, built-up land and water body) occupies about 10.8 percent of total area.



Eight province boundaries on Google Map as a study area



Land use map of eight provinces

The areas for each type of land use is shown in below table:

Land use type	Area (ha)	Percent
Agriculture	3,279,182	56.3
Integrated farm /Diversified farm	1,286	0.0
Paddy field	2,015,302	61.5
Field crop	696,382	21.2
Perennial	278,217	8.5
Orchard	160,998	4.9
Horticulture	3,914	0.1
Swidden cultivation	110,557	3.4
Pasture and farm house	5,659	0.2
Aquatic plant	21	0.0
Aquacultural land	6,846	0.2

Forest	1,914,286	32.9
Dense forest	1,453,534	75.9
Disturbed forest	460,752	24.1
Other	628,339	10.8
Miscellaneous land	203,350	32.4
Marsh and Swamp	36,160	5.8
Urban and Built-up land	187,071	29.8
Water Body	147,062	23.4
Unclassified	54,696	8.7
<b>Total</b>	<b>5,821,807</b>	<b>100.0</b>

In summary, the following table shows the current area of agriculture and land use in 2007.

Summary table of current agriculture and land use	
Thailand	2007
Rainfed agriculture (ha)	3,279,182
Forest (ha)	1,914,286
Surface mining (ha)	1,214

### 2.3.1. Rainfed Agriculture

Crop suitability map is a key spatial feature that used to simulate a future land use in this study. Rice is a target crop of conversion. Unsuitable paddy field will be convert to other better choice of agricultural activity as in agricultural management zoning policy or forest area as in forest restoration policy.

A total area of Thailand MRC province is 5.82 million hectare approximately, there are around 0.94 million hectares classified by LDD as suitable paddy field where 2.76 million hectares are unsuitable. Chiang Rai (CR) province is only one province that has suitable paddy field more than fifty percent of provincial total area. Agricultural management zoning policy may impact to Loei (LO), Amnat Charoen (AM) and Ubon Rathcathani (UB) provinces the most. More than eighty percent of area will convert to other better choice. In total, 2.10 million hectare are un classified and carries uncertainty for this study.

Maize is one of alternative crops of paddy field conversion. However, the opportunity may be high only Mukdahan (MU) province where the suitable area is higher than forty percent Loei (LO) seems to be a second choice for maize that will be replace on unsuitable paddy field. Bueng Kan (BK), Amnat Charoen (AM) and Ubon Ratchathanai (UB) have the most less area of suitable area for maize compare to the other provinces. The chance of conversion depends on numbers of point that spatially meet the condition of conversion.

Sugarcane is the one of preferable crop for the Thai northern farmers because of the high market opportunity. Serval sugar mills can be found in this region, however there is no spatial data can be provided to this study. Conversion of unsuitable paddy field to sugarcane used to be a small pilot project of agricultural management zoning policy. If sugar industrial gets involve in the policy implementation, this might be a turning point for farmers in this region to convert their unsuitable paddy field to sugarcane field in the future. Mukdahan (MU) and Loei (LO) provinces have a high chance of conversion because of the high percentage of suitable area for growing sugarcane. Bueng Kan (BK), Nakorn Panom (NP) and Nong Khai (NK) have the lower chance of conversion.

Cassava is the one that Thai government tries to promote for farmers. Cassava can be both food crop and energy crop. However, price is a key factor that limits the expansion of cassava in Thailand. In addition, suitable area for growing is limited. Within the MRC provinces, Mukdahan (MU) and Loei (LO) have the highest opportunity to convert unsuitable paddy field to cassava, while Bueng Kan (BK) and Chiang Rai (CR) provinces have the lowest opportunity due to the less area of suitable land.

### **2.3.2. Forestry**

Thailand Land Development Department (LDD) provided land use maps of eight provinces of Thailand. The spatial information was collected during 2006 and 2007. GIS was used to be summarized land use areas for those maps.

Bueng Kan (BK), Nong Khai (NK) and Amnat Charoen (AM) provinces area occupied by agricultural area around 75.0, 67.6 and 63.2 percent of each province's total area where Mukdahan (MU) and Chiang Rai (CR) provinces have only 47.8 and 42.5 percent of agricultural area. Paddy field is a key land use type of almost all provinces except Loei (LO) province where field crop occupies 0.31 million hectares. Swidden cultivation can be found in Chiang Rai and Loei provinces.

Mukdahan and Chiang Rai provinces have 48.8 and 46.6 percent of area occupied by forest area. Forest areas of Bueng Kan and Nong Khai provinces are around 8.0 and 14.2 percent of provincial total area, respectively. Dense forest is the main forest type of all provinces except Ubon Rathctani.

Rubber is only one perennial crop that Thai government promotes for both economic and environment issues. Rubber product mainly is latex. Today, global latex price has dropped during few years, hence conversion from unsuitable paddy field to rubber is under considering of policy makers. However, rubber tree can be a source of wood product for furniture industry. Rubber also plays a role of perennial tree in forest even it has less biodiversity in rubber plantation area. For this reason, rubber may still be a good alternative crop for farmers. Chiang Rai (CR), Mukdahan (MU) and Loei (LO) provinces have a high opportunity to expand rubber plantation on unsuitable paddy field with the large area of suitable land compare to the other provinces of this study while the suitable lands of Amnat Charoen (AM), Ubon Rathcathani (UB), Nakorn Panom (NP) and Bueng Kan (BK) provinces are less than 10 percent of provincial area.

Protected forest area is a key limitation of agricultural expansion due to the forest restoration policy. Chiang Rai (CR), Loei (LO), Mukdahan (MU) and Bueng Kan (BK) provinces have protected forest area around 65.0, 64.9, 62.1 and 55.9 percent, respectively, while Nakorn Panom (NP) province has only 16.8 percent of protected forest area. This can be expected that the first four provinces might have less opportunity to expand agricultural production in the future.

### **2.3.3. Mining**

In the past, mining industry in Thailand was one of the key industries as it was important for producing and feeding raw materials for the industry sector, especially ore and subsequent products from mineral refinement and metal work. They were used as the raw materials for making products and goods in the subsequent industries, which were important for the country, for example, construction industry, iron industry, gem and accessory industry, glass and mirror industry, and ceramic industry, etc. Some minerals were also used in alternative-energy sector, for example, the coal was used, instead of other minerals, to produce electricity. This led to economic growth of the country.

## **2.4 Land use, forestry and mining in Viet Nam**

Vietnam is characterized by two typical systems according to the area.

In the Mekong Delta, intensive irrigation of rice crops is conducted. The natural and engineered network of canals feeds the paddy rice plots either by gravity or by pumping according to the tide water level. In the current situation, 1.9 million ha are fully developed. Three seasons of rice production are occurring in the delta area.

Irrigation systems in the Central Highlands (Upper Se San and Srepok Basins) of Viet Nam are typical

reservoir-gravity canal systems. The irrigation designed capacity is 165,086 ha but the actual irrigated area totals 124,191 ha or equal to 75.2% of the design capacity

Figure 6 and Figure 7 shows land use maps 2010 in Mekong Delta and Central Highlands.

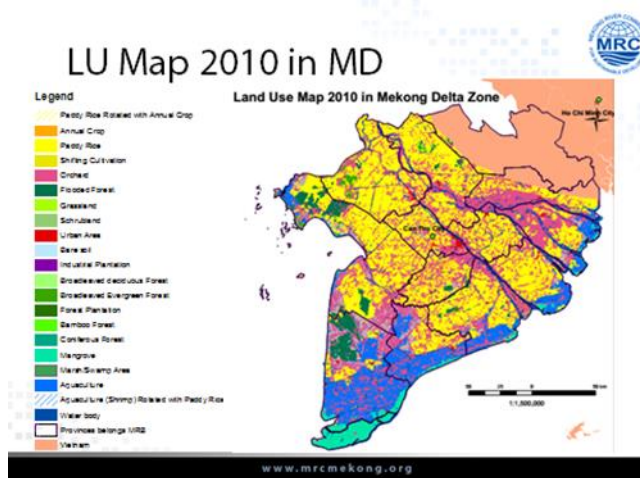


Figure 6: land use maps 2010 in Mekong Delta

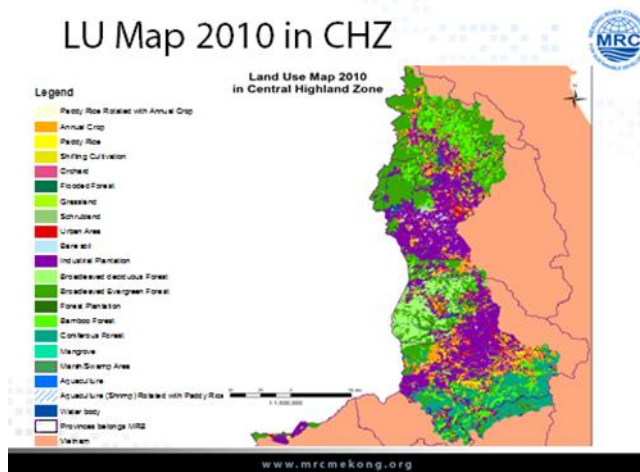


Figure 7: land use maps 2010 in Central Highlands.

Central Highlands consists of mountain ranges with height of about 2000m and the plateau with elevations ranging from 300-800 m sloping to the west, southwest and south. Mountainous area with an altitude of over 800 meters, with an area of about 1,536 hectare, accounts for 34.5% of the whole area. The total natural area of the Central Highlands in 2008 was 5,464 thousand hectares, including quite large area for agriculture. Agricultural land accounts for 29.8%, forest land area accounts for 57.1% of nature of the region.

Mekong Delta region of Vietnam displays a variety of physical landscapes, but is dominated by flat flood plains in the south, with a few hills in the north and west. This diversity of terrain was largely the product of tectonic uplift and folding brought about by the collision of the Indian and Eurasian tectonic plates about 50 million years ago. The soil of the lower Delta consists mainly of sediment from the Mekong and its tributaries, deposited over thousands of years as the river changed its course due to the flatness of the low-lying terrain.

Regarding mining, the mineral kind and capacity in Central Highlands and in Mekong Delta are as follows:



In Central Highlands: The mineral is mined primarily focused on non-metallic minerals (most common building materials such as building stones, sand, gravel, clay) and industrial minerals as kaolin, diatomite, bentonite, pozzolanic; With the exception of bauxite are in the pilot process, the mining area in Lam Dong, a several iron mines in Gia Lai and Dak Lak, two mines of lead – zinc; The active mines are on a small scale by local licensing and local businesses are the main operators. The mineral mine mainly uses simple technology, the mining activities are mainly self organized and focus on ore mining and crafts;

In Mekong Delta: Mekong delta has poor mineral resources both in capacity and mineral kinds; the most exploited mineral kind is sand, which causes a concern environmental impact. Other kinds of minerals are mainly ones for construction materials production.

In summary, the following table shows the current area of agriculture and land use in 2007.

Summary table of current agriculture and land use	
Viet Nam 2007	
Rainfed agriculture (ha)	322,556
Forest (ha)	2,868,708
Surface mining (ha)	132,080

### 3. Estimated current economic value of this sector

Based on the farm gate price of rice and maize in respective LMB countries, the total economic value (US\$/annum) of rainfed rice and maize in 2013 was estimated at US\$ 6,111 million with rice accounting for US\$ 5,5504 million and maize contributing a further US\$ 607 million.

Table 5-2 Economic value of rain fed rice and maize in 2013

	Rice				Maize				Total
	Rainfed harvest area (Ha)	Rainfed production (ton)	Farm gate price (US\$/ton)	Economic value (US\$/annum)	Rainfed harvest area (Ha)*	Rainfed production (ton)*	Farm gate price (US\$/ton)**	Economic value (US\$/annum)	Economic value (US\$/annum)
Cambodia	2,062,004	6,030,854	268	1,613,657,301	189,121	824,553	138	113,788,578	1,727,445,879
Lao PDR	657,488	2,616,504	248	648,912,422	174,167	1,008,044	138	139,110,252	788,022,673
Thailand	5,640,349	13,298,185	244	3,241,785,806	364,881	1,544,398	138	213,127,334	3,454,913,140
Viet Nam	-	-	-	-	191,234	1,020,834	138	140,875,284	140,875,284
<b>Total</b>	<b>8,359,841</b>	<b>21,945,543</b>		<b>5,504,355,529</b>	<b>919,404</b>	<b>4,397,829</b>		<b>606,901,447</b>	<b>6,111,256,976</b>

#### 3.1 Estimated current economic value of this sector in Cambodia

Given the cash flow of each crop production and forest tree species plantation that got from literature review, local community consultation, and the assumption of the discount rate; the Net Present Value for rainfed agriculture (cassava and maize) and forestry (acacia and teak) can be written as following:

$$NPV = \sum_{t=1}^n \frac{(Bt - Ct)}{(1+i)^t}$$

Where:

- Bt and Ct - benefit and cost during period t, respectively
- n - Number of time periods of the project
- i - Discount rate

Benefit cost ratio (B/C) is the discounted gross benefit divided by the discounted gross cost. The B/C measures the social equity and economic efficiency or resources utilization from the stand point of the society. A decision of B/C is to accept projects with a ratio above one. B/C has the following formula:

$$B/C = \frac{\sum_{t=1}^n \frac{B_t}{(1+i)^t}}{\sum_{t=1}^n \frac{C_t}{(1+i)^t}}$$

Bt, Ct, I, and t as defined for NPV

### (1) Rainfed agriculture

The NPV of cassava is the highest amongst compared with maize. It registered at USD 1,084 per ha if the discount rate was only 8% and USD 1,007 per half if the discount rate was 15%. With the discount rate of 10%, the NPV of cassava was 15 times higher than that of maize – indicating that cassava is the most profitable crop. Furthermore, the investment cost of cassava is even lower than maize.

Table. Net present value and benefit cost ratio of cassava and maize

Tree species	NPV			B/C		
	8%	10%	15%	8%	10%	15%
Cassava	1,084	1,064	1,007	4.6	4.6	4.4
Maize	208	204	195	1.4	1.4	1.4

### (2) Forestry

The NPV of acacia was negative with the minimum price (USD 1500/ha). However, the NPV of acacia turns to positive if the maximum price (USD 2700/ha) is applied. The benefit cost ratio ranges from 1.1 to 1.4. The NPV for teak is the highest amongst the selected species. It registered at USD 43,675 per ha if the discount rate was only 8% and USD 18,604 per ha if the discount rate was 15%. With the discount rate of 10%, the NPV for teak was 90times higher than that of acacia – indicating that teak is the most profitable tree species even though its initial investment seems to be the largest and its rotation year is twice longer than acacia. Its benefit and cost ration is in the range of 5.4 to 3.3.

Table. Net present value and benefit cost ratio per ha of acacia and teak plantation

Tree species	NPV			B/C		
	8%	10%	15%	8%	10%	15%
Acacia ( <i>Acacia</i> spp.)	526	377	84	1.4	1.3	1.1
Teak ( <i>Tectona grandis</i> )	43,675	34,436	18,604	5.4	4.7	3.3

This would suggest that investment in teak plantation may be an economic viable under some condition. However, it should be noted that the value of NPV shown above excluded rental of land value.

Even the NPV of acacia is much lower than teak, but some large-scale acacia plantations have now been established by private investors. This involves with many reasons such as the investors already have established markets outside Cambodia and they have facilities to generate the value-added products meaning that private companies can be benefit from the whole value chains while local farmers mainly get benefits from firewood and pole.

## 3.2 Estimated current economic value of this sector in Thailand

### Mining

- Production

In 2014, Thailand produced more than 40 kinds of mineral valuing at 63,005.2 million Thai Baht (1,750.1 million USD@36 Thai Baht per USD), an increase of 5.32% from 2013. The minerals with the highest production value was limestone at 18,471 million. Thai Baht followed by lignite at 17,272, gypsum at 7,205, gold at 5,845, and zinc at 3,312 million Thai baht. The Mining Production Index (MPI) was increased 2.07% from 2013 to 2014 as the number of operating mines was increased from 547 to 557.

Among the metal ores, the highest production amounts were silver at 30.98, and gold at 4.33 million grammes, iron at 0.35 and zinc at 0.23 million tones. While for the non-metallic minerals, limestone was produced the highest amount at 164.94 million tones, followed by basalt at 14.13 and gypsum at 12.45 million tones. The only mineral produced for energy was lignite at 17.99 million tones.

- Import

Even though Thailand could produce many minerals, there are some minerals that their supplies were inadequate and some that were below standards, therefore, those were needed to be imported. In 2014, the country imported minerals worth 63,383.2 million Thai Baht (1,760.6 million USD @36 Thai Baht per USD), which was an increase of 14.28% from 2013. The mineral with the highest amount imported was bituminous coal at 28,802 million Thai Baht, followed by other coals at 17,664, tin at 2,385, talc at 1,660, and niobium and vanadium at 1,085 million Thai Baht. The energy minerals (i.e., coals of bituminous and other kinds such as anthracite, coke and lignite) were among the high amount imported at a combination of 47,952 million Thai Baht, which was 75.59% of the amount of all the imported minerals.

- Export

Thailand exported some domesticly-produced minerals due to the domestic over supply. In 2014, the country exported the minerals worth of 8,803 million Thai Baht (244.5 million USD @36 Thai Baht per USD), which was an increase of 16.84% from 2013. Some of the key exported were gypsum at 5,104, feldspar at 771, anhydrite at 630, dolomite at 471, and iron at 313 million Thai Baht, which was a decrease of 21.49% from 2013. Some key exported metal minerals were tin at 9,223, gold at 5,967, silver at 618, zinc at 199, and copper at 56 million Thai Baht. The minerals were exports in 2 forms: 1) refined minerals from imported ores such as tin and zinc, and 2) unrefined ores exported as mixed metal minerals such as gold and silver.

#### 4. Development Trends

##### 4.1 Development trends in Cambodia

The national rice production and the yields of Irrigated rice crops have improved in the last years thanks to better water management, seeds quality and fertility management. The National Strategy lays particular emphasis on increasing the area of irrigated land, in order to make farmers less reliant on rainfall and allow them to cultivate more crops with more certainty and predictability, resulting in higher productivity and improved livelihoods. Priority is given to the rehabilitation of the thousand of existing schemes instead of the creation of new schemes. The government mobilized irrigation funds to invest in irrigation development and for the irrigation services centers to provide capacity and management support to the FWUC.

Figure 8 shows agro-ecological zone in Cambodia.

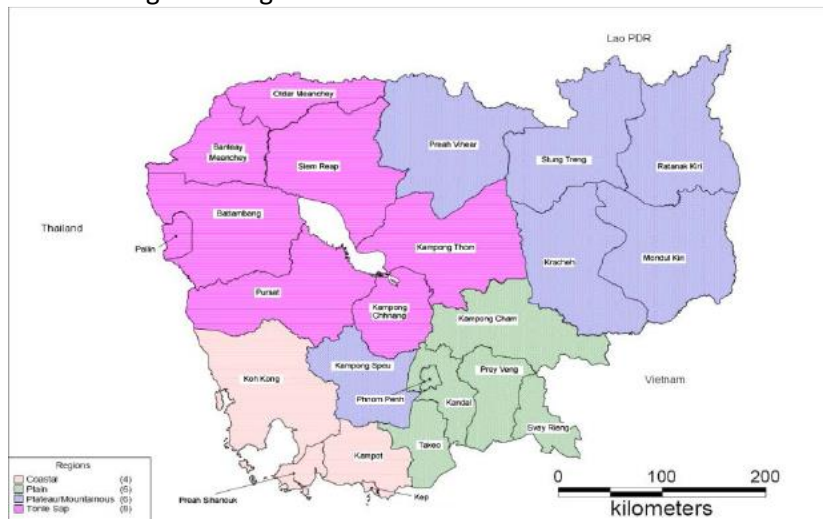
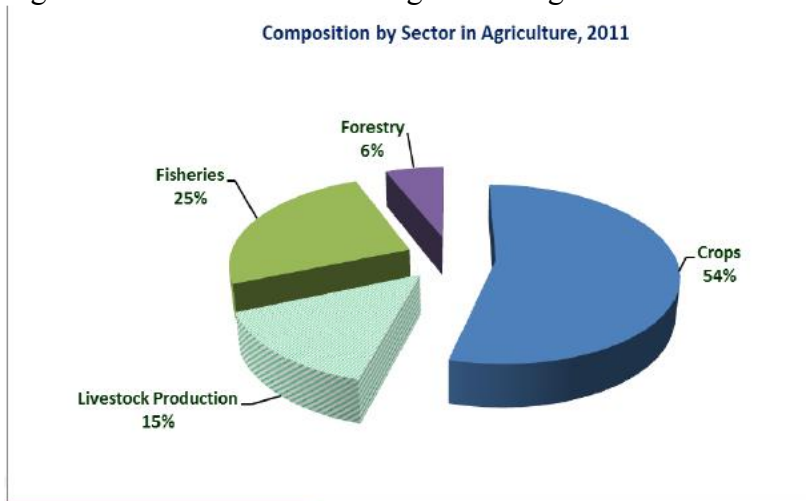


Figure 8: Agro-ecological zone in Cambodia.

Figure 9 shows sub-sectors to agricultural growth in Cambodia.



Source: MAFF, 2012

Figure 9: sub-sectors to agricultural growth in Cambodia.

Priority programmes of Agricultural Development of Cambodia are as follows:

1. Enhancing Agricultural Productivity and Diversification;
2. Increase Market Access for Agricultural Products;
3. Strengthening Institutional, Legislative Framework and Human Resource Development (HRD);
4. Sustainable Fisheries Resources Management and
5. Sustainable Forestry Resource Management

It was reported by MAFF (2014) that the total production area for annual crop was increased from 392,755 ha in 2007 to 796,123 ha in 2013. Among four main annual crops, only cassava shows promising crop which covered the areas more than 50% of the total area of main crops during the last three year.

In addition to these crop, many ELC granted by MAFF have contributed to forest tree planting programme. Those forest tree species include acacia, eucalyptus, pine, and teak. The projects that were selected for this study are rain-fed agriculture, forestry (tree plantation), and mining.

Rain-fed agriculture:

Among the four main annual crop production in Cambodia, cassava and maize cover an area of 71% of the total production area in 2009 and 2010. The area of these two crop was increased to 81% in 2011 and 2012 while in 2013 the area for these two crops continue to increase to 83% of the total land area of the four main crop production.

Forestry:

Forest tree species that were popular for tree planting by many companies are acacia and teak.

Mining:

Mining activities began during 2006-2007 when the Chinese company, Phou Yang Cambodia, obtained a license from the government to explore mines in a 4km<sup>2</sup> forested region in Phnom Proek from 2006-2007. However, Phou Yang obtained a license from the government for 2007-2011 to explore the area. In 2011, the company expanded to 20 hectares.

By using the available mineral and geological data, so far there are around 91 companies (from Australia, China, Vietnam, Thailand, and domestic) licensed to conduct 139 exploration. Currently, they are being under their exploration phase. However, the preliminary results showed that about 17 of

139 explorations were confirmed positive.

In summary, the following table shows area of agriculture and land use in scenario 2020 and 2040 in Cambodia.

Summary table of scenarios for agriculture and land use				
Cambodia	2020		2040	
	ha	% increase from 2007	ha	% increase from 2007
Rainfed agriculture	404,500	393%	462,754	464%
Forest	462,769	0%	462,769	0%
Surface mining	47,977	0%	47,977	0%

#### 4.2 Development trends in Lao PDR

The objective of the National Irrigation Development strategy is to create a more conducive environment for irrigated agriculture development. The strategy foresees a re-modeling and re-orienting of the mechanisms of the various areas of public management that relate to the Irrigation Agriculture Subsector. The implementation of those plans could see the new development of 101 700 Ha in the period 2015-2020 and 329 425 Ha in the period 2020-2040 reaching a total irrigated area of 446 125 Ha for the large projects. The target is to use the potential water resource by developing gravity irrigation systems in order to reduce the cost of irrigation service and production that will enhance the price competitiveness of agriculture products.

53 Large irrigation projects have been identified for development up to 2020 and 2040. According to an estimation based on designed and feasibility study, the command area the 53 projects will be able to supply irrigation water to 446,125.00 ha. The first 27 projects plan to be implemented over 101,700 Ha during 2010-2020. The remaining 26 projects will be implemented over 329,425 Ha during 2020 - 2040. Figure 10 shows large irrigation projects in Lao PDR.

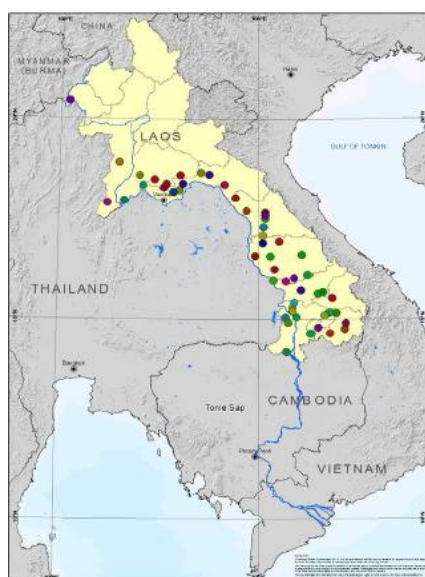


Figure 10: large irrigation projects in Lao PDR.

In 2008 the forest area of Laos had 70.24% or 16,632,376 hectare and the country expects that in 2020 the forest area will be slightly increase 1.59% (71.83%) or 17,009,845 hectare by increasing the area of plantation forest and the restoration forest up to 12% while the forest cover will be slightly decrease from 40.92% to be 40.34%. This is based on the policy of the Lao government strategy that trying to increase the forest area to be 70% by 2020.

On the other hand, the agriculture land in 2008 had 19% or 4,728,966 hectare with total current used

area approximately 2 million hectare or around 9.5% of the country area and this agriculture will increase to 21% in 2020 by increase 1 million hectare for rice expansion and 831,138 hectare and 899,262 hectare for the crop long cycle and short cycle respectively. The area for rice expansion is to support the target of rice production to be 5 million ton in 2020 for the food security as well as the export to other country. In addition, the other land which includes the residential area, water resources, wet land, stone area and etc will be decreased from 10% in 2008 to be 7% of the country area in 2020.

Based on the agriculture and forest strategy plan 2020 from Ministry of Agriculture and Forestry has classified the forest area in 4 main types: forest area, forest for protects water resources, te area for forest restoration and the area for plantation forest. The central part will have forest area more than the other part (18% of the country area) the northern part is 14% while the southern has lower than 10% of the country area. Furthermore, the northern part has more potential to increase forest cover than the other part because the forest restoration area, forest for protects water resources and area for plantation forest in the north is 33.71%, 26% is in central and 12% is in southern part. This also means that northern part had more activities causes to degraded land more than the other part.

In summary, the following table shows area of agriculture and land use in scenario 2020 and 2040 in Lao PDR.

Summary table of scenarios for agriculture and land use				
Lao PDR	2020		2040	
	ha	% increase from 2007	ha	% increase from 2007
Rainfed agriculture	1,322,724	53%	1,892,179	120%
Forest	9,552,425	0%	10,427,122	9%
Surface mining	70,629		3,279,749	

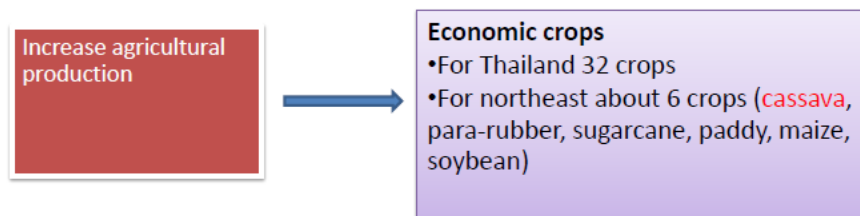
#### 4.3 Development trends in Thailand

RID's Strategic Plan was formulated in accordance with the State Administration Plan, The Eleventh National Economic and Social Development Plan (2012-2016), and The Agricultural Development Plan. The plan can be substantially performed by applying structural measures and non-structural measures. The structural measures mainly emphasize the use of water inside the basins especially in the areas suffering from both flood and drought. The water diversion between the basins will then be considered secondly. The non-structural measures are the applications of technologies, coordination with other sectors and participations in managements of storages and irrigation. Figure 11 shows strategy to action, agricultural planning.

**Strategy to Action  
Agricultural planning**

**Land use planning for Northeast Thailand, Mekong sub basin**

**Strategy 2: The Agricultural Development Goal**



**Figure 11: Strategy to action, agricultural planning.**

For Thailand, the production, import, and export of the minerals were increasing as a result of the growing economy. The domestic supplies of the minerals did not meet the demands, so the country relied on the enormous amount of the imported minerals, while at the same time, there was a decrease in the number of operating mines. The value ratio between the domestically-produced and the exported minerals was 1:2.7. only the minerals for construction that were domestically produced adequately while the other groups of the minerals having the greater import amount than domestically produced, which were for chemical and energy at the value ratios of between the domestically-produced and the exported minerals at 1:2.3 and 3.3, respectively. The demand of the minerals increased between 2010 to 2011. It was suspected to be the result of the country’s economic growth, especially the government in mega projects, which was expected to increase in the future.

This study investigates trends of land use change using two major scenarios including (1) land use in 2020 and (2) land use in 2040. The land use in 2020 scenario considers all plans that is under implementation or commitment to implement and will be completed on/before 2020. In the same way, the land use in 2040 scenario considers all plans that are expected to take place before 2040 plus continued tend to develop for this study. Agricultural management zoning policy and sustainable natural resource and forest management policy are key driving force of change. The alternative crops and will be end at 2032. The natural resource and forest management policy was implement in 2014 to reach the target of 40 percent increased forest area by 2024.

In summary, the following table shows area of agriculture and land use in scenario 2020 and 2040 in Thailand.

Summary table of scenarios for agriculture and land use				
Thailand	2020		2040	
	ha	% increase from 2007	ha	% increase from 2007
Rainfed agriculture	3,273,538	0%	3,259,941	-1%
Forest	1,922,993	0%	1,928,797	1%
Surface mining	864	-29%	ND	

**4.4 Development trends in Viet Nam**

The overall objective of the Agriculture sector is to develop a comprehensive and sustainable system and to optimally utilize the potential. Generate a greater production characterized by a high

productivity, quality, efficiency and competitiveness. The part of Agriculture within the *Agriculture, forest and fisheries sector* will decrease by 2020 in favor of the Aquaculture development. Irrigation development is foreseen in the Mekong Delta and Central highland areas to address the questions of the sustainable water management for land conservation

Development trends in Mekong Delta Area are:

Area subject to climate change effects and urbanization growth

The future plans only foresee a slight decrease of the irrigation development that would decrease to 2.384 million Ha in 2020 (DFS scenario) and would decrease to 2.323 million Ha in 2040 (PDS scenario) Farmers will switch to aquaculture (shrimp) to overcome the climate change effects and seek for higher income

Several major infrastructural projects are scheduled to meet the objectives of the water resources planning. It consists of canal works, dikes improvement, drainage water management, regulation structures and pumping stations development.

Figure 12 shows map of proposed land use to the year 2020 in Mekong Delta Area.

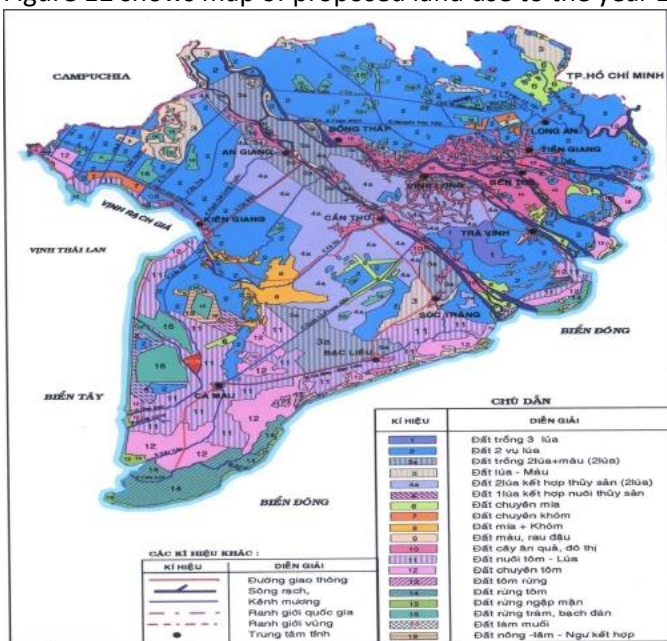


Figure 12: Map of proposed land use to the year 2020 in Mekong Delta Area

Development trends in Central Highland Area are:

The main objective for the development of the area is to minimize the transfer of agricultural land into unsustainable land cultivation systems.

It is foreseen to prioritize the expansion of rubber and coffee plantations and the development of land with annual crops in upland fields with irrigation.

The development of irrigation is targeted to improve rice cultivation areas and address the transfer of water service. Irrigation development will be prioritized to the precarious areas and turn them to cropland and other crops with a high economic efficiency.

Figure 13 shows land use planning map in Central Highland Area (at province level).



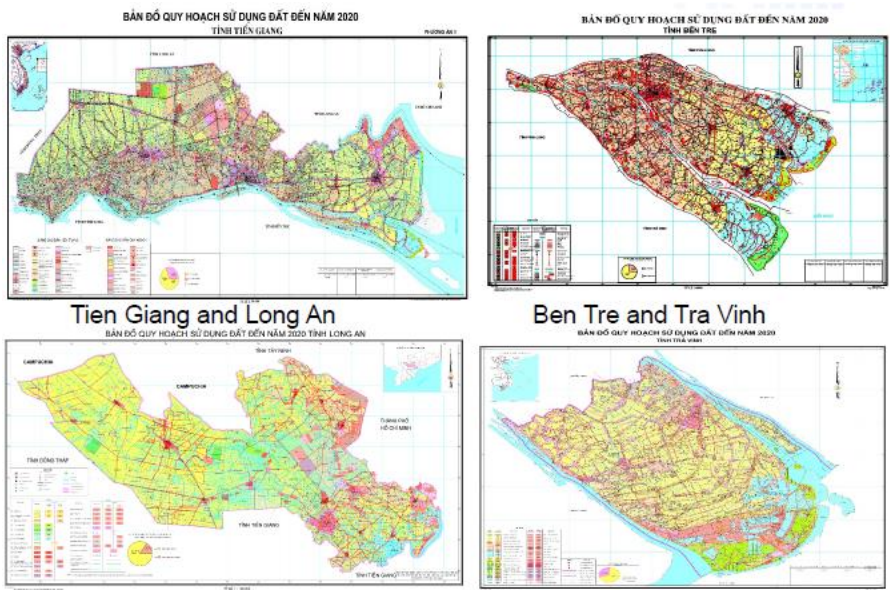


Figure 13: land use planning map in Central Highland Area (at province level)

In summary, the following table shows area of agriculture and land use in scenario 2020 and 2040 in Vietnam.

Summary table of scenarios for agriculture and land use				
Viet Nam	2020		2040	
	ha	% increase from 2007	ha	% increase from 2007
Rainfed agriculture	358,783	11%	ND	
Forest	2,733,780	-5%	2,760,271	-4%
Surface mining	175,080	33%	173,982	32%

**5. Direct Impacts**  
**Analysis of impact assessment of agriculture and land use change**

Four Member Countries implemented the direct impact assessment of agriculture and land use change with slight different ways by using literature review/desk study, and/or case studies. The assessment contains social, economic, and economic aspects. In general, rain-fed agriculture, forestry, and mining may contribute to create more employment opportunity and increase income for rural people. They might improve their livelihood. The environmental impacts may include negative aspects with soil erosion, loss of soil fertility, loss of biodiversity etc. However, due to the lack of collected dataset, this analysis of impact assessment is insufficient. Further data collection and impact analysis will be required.

**5.1 Direct impacts in Cambodia**

(1) Rain-fed agriculture

Cassava:  
 Traditionally cassava production in Cambodia was only a farmstead crop production that is given mainly on the farmer backyard. However, because of high market demand, production of this crop increase rapidly, especially in Kampong Cham where the production of cassava was ranked number one in 2011 with production of 1,318,109 metric tones accounted to 31% of cassava production in Cambodia.

Maize:

For the case of HLH agriculture, significant number of jobs were created when the project began operations in 2007, providing average daily wages of KHR10,000-12,000 (USD2.5-3). However, the number of workers employed has declined considerably as the company has replaced manual labour with imported machines, for example for sowing and harvesting. This has limited villagers' opportunity to access this new income source. It is quite similar with some other cases of ELC, the land conflict and utilize of natural asset have been reported. HLH agriculture has claimed around 40 percent of villagers' paddy rice fields and cleared forest land, severely affecting local people's main and traditional sources of income, namely rice growing and charcoal production.

## (2) Forestry

Acacia:

Conflict has been reported like some other companies. This conflict caused by weak communication between villagers, companies and authorities. In some cases, villagers were shocked to see the companies turn up to clear land close to their backyards. Furthermore, dispute has been occurred between the local community and company. This dispute caused by land grabbing and restriction of access to forest resources in which local community traditionally practiced for many years. The arrival of the company provides jobs opportunity to local community. However, it was reported that villagers no longer favor working for the company because its restriction and its land grabbing activities. In addition, the company built the access road to the company site. This road is not only for company transportation, but also for local community to some extent.

Teak:

In O Tanoeung village, most villagers are farmers who always consider paddy rice cultivation as a main activity followed by animal raising, NTFP collection, hunting and fishing for their living. Their rice fields were taken from the forest then passed through from one generation to another. The farmlands have traditionally been recognized by use. However, their rice field has been encroached by Global agricultural development company. The company also limited local community's access to natural resources that was claimed by the company. Therefore, like previous company, land dispute has been recorded. In O Tanoeung villagers ignore and reject participation in such a development process even though it has intended to include the local people through creating jobs for them.

## (3) Mining:

Mining generates some employment opportunities. However, the benefits will not be long term. Despite mining company helps local people earn for their living, this income is never sufficient enough to shun them from living from hand to mouth. Mining also has not resulted in infrastructure improvements. Besides hiring local people to work, no any infrastructure such as road, school or health center have been built.

## **5.2 Direct impacts in Lao PDR**

The assessment of direct impacts of development was implemented with a case study of a sugarcane development project.

The case study of the sugarcane development project shows as follows: (1) the most significant economic impact is that the plantation creates employment and income generation activities for local people. (2) the social impacts is that the project has had impacts on traditional livelihoods from independent farmers to dependent employees on an industrial plantation. (3) the environmental impact is that the plantation have had negative health effects for workers mainly attributed to contamination and use of chemical materials, especially pesticides.

According the socio-economic status, resources and livelihoods of the case study population, as well as background to the Mitr Lao Sugar Company has been reviewed, this sub-section will examine the economic, social and environmental impacts of the sugar cane plantation. About population and labor force, the total population of the whole case study area is about 2,065 people: about 62.3% of the population is of labor force age (15-60 years) and about 25% of the population is 14 or younger. Estimation that some people (workers) who live in rural area in Savannalhet province is still low

educational level and lack of experience with industrial production. It remains a constraint for investment in the province, especially for implementing contract farming, using modern techniques and technologies, following regulations/rules and orders related to work, as well as adaptation to the province's changing situation. According to focus group discussions, the occupational structure and livelihoods of people in the area is beginning to change. The industrial production mode and the lifestyle that accompanies it are replacing traditional livelihoods. About 2.3% of labor force in the case study area is now employed on the sugarcane plantations full-time.

### **5.2.1. Direct economic impacts**

The most significant economic impacts of the Mitr Lao Sugar investment in the case study are "The plantation creates employment and income generation activities for local people". According to focus group discussions, the plantation industry is an important source of additional income in the case study area. Though only 2.3% of labor force in the case study areas works fulltime on the plantations, most of the villagers in the case study area are employed in the plantation history, in some shape or form. Most are employed irregularly as day laborers. While the research team could not identify the exact percentage of the work force working part-time/irregularly on the plantations, it was clear that the majority of the labor force works on the plantations one or two weeks out of the year. As day laborers they earn about LAK 20,000 or about USD 2.4 per day. This is slightly lower than minimum wage fixed in the new regulation, i.e. LAK 569,000 per person per month, for full time work of 26 working days per month, 8 working hours a day, which equals LAK 21,885 per day. The villagers usually work in the plantation sector seasonally, after harvesting rice. According to information received in focus group discussions, full time local employees of Mitr Lao Factory earn about LAK 600,000 or about USD 35 per month. It is a little higher than the Lao minimum wage. The company also hire 103 foreign workers also the villagers use work on the plantation to supplement the income they receive through their traditional income, rather than to replace it. Most of the villagers do not want to risk leaving their traditional agricultural production to engage fully in the plantation industry. Many people in the focus groups mentioned that "the wage is too low and full employment in the plantation industry is too uncertain". According to findings from village surveys, only about 30 people, representing about 2.3 % of the labor force in the sampling villagers, work full-time in the plantation industry. However, it does not mean that these people are fully reliant on the plantation since other households, corresponding to about 13.5 % of the total households in the three villages, have joined the contract farming scheme with Mitr Lao Sugar. According to focus group discussions and village surveys, the income from the employment in the plantation industry contributes to about 8.5 % of total household income in the sampling villages.

On reason is "The investment has contributed to a reduction in livestock production". Livestock production used to be the second most important food and income source in the case study area, after rice production. According to findings from village surveys and focus group discussions, livestock production (cows, buffaloes, pigs, chickens, ducks, etc) used to account for around 20% of household income in the area. However, the growth of the plantation has caused villages to limit their livestock production, especially large livestock like cows and buffaloes.

The focus group in Dong Ohung, Kieng Head and Na Dieng villages mentioned that many cows in their villages had died due to weight loss and no longer have regular reproductive cycles, with the villagers suspecting that of the cause is feeding on grass contaminated by chemical materials used in the plantations.

### **5.2.2. Direct social impacts**

Based on findings from focus group discussions and village surveys in this case study area, the Mitr Lao investment project has had numerous social impacts in the three villages, including "The project has had impacts on traditional livelihoods" here it was a change of the livelihood traditional patterns of people are evident. These changes also demonstrate the strong link between environmental and social impacts in the case study area. Before the sugarcane plantations, villagers used to collect NTFPs for consumption and sale, as well as wood and straw for sale or for building after the rice harvest.

Collecting timber and NTFPs was a part of the people's traditional livelihood activities as well as a course of extra income. However, as discussed above, livelihood patterns have changed, with working in the plantations as laborers now constituting a major source of additional income. This change from independent farmers to dependent employees on an industrial plantation, in which people have to follow directions, represents a substantial change for local people in the area. Participants in the focus group discussions expect that their traditional way of living will be replaced by an industrialized and modernized livelihood, which is characterized by landlessness, dependent employment and increased individuality. Local people also feel that this kind of lifestyle is more dependent and uncertain than that of before, as they become more dependent on the external world and mechanisms that they are not able to control.

"The plantations have had negative health effects for workers and the local communities". The negative health effects noted during the participatory assessment were mainly attributed to contamination and use of chemical materials, especially pesticides, without sufficient knowledge, training and equipment. Many people in the focus group discussions mentioned that: "the factory does not provide adequate information on the dangers, nor protection training and equipment to workers who spray insecticide in the sugar cane plantation." More details are provided in the environmental impacts section below. In addition, the focus groups reported many cases of illnesses in their villages. Numerous people experienced headaches, dizziness, and pains after spraying pesticides or got itchy skin after washing in the river or ponds located near to plantations. In addition, two occupational injuries were reported to have occurred in 2009. Both cases involved children that were about 12 years old.

The occupational injuries as well as the complaints about the effects of chemicals suggest that workplace health and safety is not strongly regulated in the plantations and factory. "The investment project is associated with child labor and negative effects on education." Child labor appears to be widespread in the case study area (and it is recognized that it is not uncommon in rural areas of Lao PDR more broadly). According to focus group discussions, about half of the day laborers at the sugarcane plantation are children below the age of 14 year old. People's lack of understanding of the importance of education and the relatively low access to education contribute to this situation. Children often work to help earn extra income to support themselves and their families rather than attending school. The establishment of the Mitr Lao Sugar factory and the expansion of sugarcane plantations in the area provide school children with an opportunity to leave school to work.

### **5.2.3. Direct environmental impacts**

The findings from the focus group discussions and village surveys in the case study area also indicate that the Mitr Lao Sugar investment project has had a number of negative environmental impacts, as described below. Importantly, the project has been implemented without having conducted an environmental and social impact assessment (ESIA) or received an environmental compliance certificate (ECC), as required by Lao Law.

About the establishment of sugarcane plantations has affected forest cover and water resources, it need substantial impacts on forest and water resources from the Mitr Lao sugarcane plantations have been felt in the case study area. According to village authorities of all three villages, over 1,420 ha of production forest, representing about 46% of the total forest area managed by Dong Phung, Keng Head and Na Dieng villages was converted into sugarcane plantations. The pictures and table below provide more detail about the changes to forest cover in the village.

The forest of Keng Head Village, which is located near to the Mitr Lao Sugar Factory, has been especially affected. More than 1,103 ha of forest, representing about 99% total forest managed by the village, was converted into sugarcane plantations. However, even if the conversion was technically legal, i.e. the conversion of degraded forests land to plantations, it is important to recognize the role of secondary or regenerating forests in supporting the livelihoods of local people. As noted above, in addition to the loss of forest environmental services, such as carbon storage, soil protection and

biodiversity, decreased village forests also means the loss of forest products. It should be noted that it is unclear whether or not some of the forest that has been lost to the sugar cane plantations was provincial protection forest (meaning forest that is to be protected, such as in order to preserve a watershed area). The establishment of sugarcane plantations is also believed to have negatively affected water resources in the area. According to focus group discussion, many rivers, reservoirs and streams that used to have water during the whole year, no longer have water during the dry season.

These waterways include Hua Lhansy Chang and Tham Phung in Dong Phung Village. As noted in this project's main report for Savannakhet Province, the relationship between forests of plantations and water flow and quality is a complex one, dependent on numerous factors, such as the species involved, local rainfall, access to irrigation, soils, and so on. However, the implications of increased investments in the natural resource sector in Savannakhet Province on its water supply and quality will require careful considerations; in particular, the potential impacts of hydropower and irrigation development are interwoven with the impacts of plantations development and the negative effects of continued forest loss and degradation.

According to MAF and the Mitr Lao Sugar company itself, the use of any chemical insecticide can be dangerous; people must have adequate knowledge and protection, such as protective clothing and gear. The empty pesticide containers must also be buried safely. It has however exposed the area to environmental risks, such as soil depletion and water contamination due to poor soil management practices and improper chemical use, leading to environmental health issues. The costs of these environmental impacts are not fully factored within the households within their process as much of this information is not immediately known or well understood at the local level.

### **5.3 Direct impacts in Thailand**

#### **5.3.1. Direct socio-economic impacts**

##### **(1) Food security**

Land use change might not impact on food availability because Thailand can produce rice for food and export. In 2040, paddy fields in the Thailand MRC provinces will drop by eleven percent approximately. All of this areas are unsuitable paddy fields that can be produce rice gain at 20-40 percent of optimum yield.

There is no evidence about food accessibility. However, there are many rice mills in the Thailand MRC provinces. Farmers can sell their product to the local rice mills and then distribute to local population easily.

The policy is focusing on green and clean food. This implementation will improve quality of rice product and increase the utilization of food.

##### **(2) Farm income**

Rather than increasing land, policy is focusing on increasing land productivity and quality of agricultural products. Niche market will generate more farm income.

Sugarcane can gain more farm income. Sugarcane production normally is a contract farming. Growers can gain benefit from their product sugar and sell byproducts to food (e.g., alcohol) and energy (e.g., ethanol) industries.

#### **5.3.2. Environmental flow impacts**

##### **(1) Land resources**

Forest area will increase from the policy implementation. However, there is no evidence shows that biodiversity will be better. Normally quality of plantation forest in terms of biodiversity is lower than natural forest.

Soil quality requires maintenance. Good agricultural practices will help reserve soil quality and nutrient availability.

Methane emission will decrease from paddy field because of the reduction of unsuitable paddy field. On the one hand, nitrous oxide emission will increase from field crop production.

## (2) Water resources

Crop water requirement will be increase cause by the change of unsuitable paddy field to other field crop. Considering the Mekong river basin, rice requires around 4,156 m<sup>3</sup> per hectare while maize and sugarcane require 8,268 and 12,556 m<sup>3</sup> per hectare of water, respectively.

### 5.3.3. Impacts of mining

The mining and primary industries are ones of the ley industries of the country having their roles in mineral and metal explorations to feed the industry sector. The mine and primary industries are important and are links to the industry sector, leading to continuous industries that are economically high in value. Even though the number of the mining operations is not as high as other industrial operations, they are primary upstream industries. They have high impacts on the environment and the society, altering the landscape and natural resources, which are supposed to be co-owned by the general public. The mining operations also can affect environmental quality, including soil, water, and the air, that can be contaminated. The environmental pollutions can have adverse health effects. The affected land can be almost useless for agriculture.

#### (1) Environmental flow impacts

Basically, the mines are extracted from ores, which are compound substances. The refinement of the ores may result in the releases of some other minerals, for example, lead, zinc, manganese, and chromium, into soils and reservoirs, and be accumulated by plants. Those minerals then, in turn, are transferred to human beings directly or through food chains. For instance, the mining of the mercury may adversely affect miners and other organisms in the mine and surrounding areas.

All mines create environmental impacts from their operations. For example, the excavation results in soil leaching and erosion, turbid water resulted from the mining in the sea. Mining operations then are main obstacles in conservation of other resources as they affect soil resource, water and aquatic animal resources, forest resource, and air resource.

#### (2) Social impacts

Even though the industry sector, in general, is highly beneficial to the economy, it inevitably can create pollutions to surrounding areas. The mining and primary industries are one of the ley industries of the country having their roles in mineral and metal explorations to feed the industry sector. The mine and primary industries are important and are links to the industry sector, leading to continuous industries that are economically high in value. Even though the number of the mining operations is not as high as other industrial operations, they are primary upstream industries. They have high impacts on the environment and the society, altering the landscape and natural resources, which are supposed to be co-owned by the general public. They should gain the benefits resulted from mining operations. The mining operations can also cause impacts to the nearby communities, if the mining operations are not properly controlled. If they are not properly controlled, they can affect environmental quality, including soil, water, and the air, that can be contaminated. The environmental pollutions can have adverse health effects. The affected land can be almost useless for agriculture. This includes the land alteration resulting in grout and dust. The mining industry has been perceived mostly negatively by the society.

## 5.4 Direct impacts in Viet Nam

### (1) Rain-fed agriculture

- Providing products for domestic consumption and export: The project brings economic benefits for businesses and workers. It generates a large amount of goods for domestic consumers and for export, increases capital mobilization for the state budget.
- Improve the lives of people: The project contributes to improving people's lives in the area, especially the lives of ethnic minorities. On the other hand, it ensures security and social safety.
- Resolving labor, create jobs: The project attracts local labor force, especially ethnic minorities. It creates stable jobs for over 300 workers, contributes to reducing unemployment.

- Developing local infrastructure: The project contributes to building rural infrastructure such as electricity networks, roads, schools, clinics and social welfare facilities in the project area.

### (2) Forestry project

The positive impact of the project is described as follows:

- Contribute to the economic development in the district.
- Increasing the value of land in the project area, creating a new landscape.
- Improving life for people.
- Raise people's awareness of the importance of forests and mobilize people for forests conservation.

The negative impact of the project is described as follows:

- Some households have to change their livelihoods, their routine is disturbed. Reduced ability to collect forest products by local people.
- Environmental pollution causes adverse effects on health workers.
- Risk of occupational accidents due to transportation, weather, dangerous animals, weapons of war remnants.

### (3) Mining

The socio-economic benefits from mining activities can be included:

- Economic development of the province and locality
- Development of social and economic infrastructure, manufacturing and construction industries
- Commercial and public sector activities have improved significantly, as the generation of workers
- Creation of employment for local people

The socio-economic negative impacts from mining activities can be included:

- Resettlement of local people who live on the mining area
- Loss of forest, cover vegetation as consequence is loss of biodiversity
- Loss of fertile top soil
- Mining activities can cause air pollution, water pollution, and generation of excavated soil
- The presence of the mine has led to a rapid growth of the population through migration, which can cause social disorder, transmission of social diseases.

## **6. Coordination with the modeling teams**

Discussions were held with the modeling teams on the following topics:

- Models capabilities and models used according to the target zones
- Data exchange framework for the water quality, sediment transport, nutrient transport and water flow assessment
- General discussions on the data needed for the socio economic assessment

## **7. Summary of findings**

### **7.1 Summary of findings in Cambodia**

#### **(1) Rainfed agriculture and Forestry**

It seems that farmers are happy with practicing rainfed agriculture (the case of cassava and maize) because its production area has been increased every year. Farmer has changed from subsistent agriculture to commercialize agriculture. Like the case of cassava, farmer traditionally cultivate around their house. However, currently the practice has changed to larger scale. Large scale of cassava or maize production that invested by Economic Land Concession Company (ELC) provided job to local community and built up road network for company utilization in the area in which this road can be utilized by local community to some extends.

For forest plantation, most of forest plantations are invested by private company, especially ELC, built up some road and providing job opportunity for local community. However, local community has been limited access to natural resources that they have been practiced from generation to generation. It seems not so clear that the impacts of forest plantation is not directly from tree species that have been planted but the main impact is about unclear boundary which lead to conflict with local community. This means that private company claimed the land from local villager and local villager claimed the land from company. However, from other studies that have been conducted in other place showed that local community devoted their land for tree planting if the land is not suitable for other crop.

Among two crops that represented rainfed agriculture, cassava and maize, cassava provide higher benefit than maize. With the discount rate of 10%, the NPV of cassava was 5 times greater than that of maize. This indicates that investing with cassava is more profitable than maize. Furthermore, investment cost of cassava is even lower than maize.

The investment in teak plantation is much more benefit than acacia. With the discount rate of 10%, the NPV for teak was 90 times higher than that of acacia. This indicates that investing with teak is more profitable than acacia even though its initial investment seems to be the largest and its rotation year is twice longer than acacia. Even the NPV of acacia is much lower than teak, but some large-scale acacia plantations have been established by private investors. This involves with many reasons such as the investors already have established markets outside companies can benefit from the whole value chains while local farmers mainly get benefits from firewood and pole.

The practice of crops production by farmers is technically inappropriate, especially in the sloping land, which leads the land susceptible to soil erosion. Furthermore, practicing monoculture on the same land for many years also leads to low soil degradation. In large scale rainfed agriculture, the impact is about converting forest land to crop land which change ecosystem structure and function.

Quite similar with rainfed agriculture, the land for forest plantation establishment has been converted from degraded natural forest. The conversion from degraded natural forest to single tree species plantation establishment will lead to biodiversity degradation. Furthermore, by converting forest land to other land use, local community who has traditionally collected NTFPs will move to deeper into the forest and leads to forest degradation in some other areas, thus impact to the environment.

Mercury and cyanide are chemicals often used in ASGM which known to have severe long-term effects on humans and the ecological system. The impact along the stream have been recorded through the death of cow that drink contaminated water from in the stream.

Technical aspect in practicing rainfed agriculture is still limited, especially farmer who planted in the sloping area. This limitation ranges from land preparation to farming system which susceptible to soil erosion. Therefore, the improvement of technology and farming system for soil management would be essential for sustainable agriculture.

The price of some forest tree plantation such as acacia is very low. This is because this price is only for fire wood or pole. If the more value added products could be developed, more benefit could be generated from this plantation. Furthermore, if improved planting materials are used for plantation establishment, more benefit could be achieved.

In addition to the above mention challenges, farmer gas face with lower price of their product. Price is fluctuated every year, especially during harvest time. For improving this challenge, contract farming with private sector would be helpful to farmer. Beside price fluctuation, most of agriculture crop, especially rainfed agriculture faces with uncertainty of climate change. Therefore, improving climate focus would be beneficial to farmer.



## **(2) Mining**

In order to better improve the working conditions, minimize the environmental, social and cultural footprints left after the end-tenure of mining investment companies, and improve revenue transparency, it is recommended that mining companies operating in Cambodia, and the Government of Cambodia have to consider the following:

### Companies operating in Cambodia

- (1) Disclose to affected communities and the public information about company operations and all payment made to the government – revenue transparency can help combat corruption and ensure that mining revenue are used for the public good.
- (2) Respect community rights, in particular the right of indigenous peoples to Free Prior Informed Consent.
- (3) Establish community development programs for affected communities and seek community input into the design of these programs.
- (4) Abide by international best practice standards, including the OECD Guidelines for Multinational Enterprises, UN Framework on Business and Human Rights, the Extractive Industries Transparency Initiative and guidelines developed by the International Council on Mining and Minerals.
- (5) Companies with operational safeguard policies should ensure compliance at every stage of design, planning, operations and recovery – these guidelines should beyond the provisions of Cambodian legislation.

### Government of Cambodia

- (1) Complete the national legal framework guiding the extraction of mineral resources, prioritize the implementation and enforcement of national and international legislation (including re-instating that EIAs are required for exploration licenses) and revoke licenses in the case of non-compliance.
- (2) New application for concessions that overlap protected areas/forests must be reviewed by the technical agency responsible for managing. Concessionaires shall be compelled to reveal their revenue for public accessibility ensuring promotion of transparency and accountability in extractive industries.
- (3) Compile all mineral resource deposit data and develop a national mineral resource management strategy before offering extraction rights to ensure sustainable use and mitigation of negative social and environmental impacts by providing all companies with equivalent information.
- (4) Develop and implement a national policy for social and environmental responsibility in the mining sector which includes: 1) create Environmental Impact Assessment guidelines which employ multiple stakeholder participation and meaningfully fulfill their objectives; 2) ensure that all aspects of the award of rights, from pre-qualification to the implementation of contractual commitments by companies, are open to oversight by parliament and public; 3) establish an independent public agency with the mandate, resources and expertise to continuously oversee all aspects of the award of rights including the monitoring of health and socio-economic impacts; 4) develop provisions which will enable civil society groups and the wider public to have full access to information relating to the Extractive Industries Sector, according to international best practice standards including those set out by the Extractive Industries Transparency Initiative; and 5) ensure that people affected by the all activities of extractive industry sector have the opportunity for Free, Prior and Informed Consent.
- (5) Ensure that all mineral issues (licensing, contracts, revenues and impacts) are fully discussed with the inter-ministerial Technical Working Group for the Development of Action Plan and Monitoring of the Implementation of Mobilization and Management of Revenue from Oil, gas and other Mining Resources to coordinate this sector to

- ensure maximum benefit to country and people.
- (6) Issue an order requiring the cooperation and support from provincial authorities to implement and enforce the above recommendations.
  - (7) Urgently provide technical and financial support to relevant Cambodia government agencies to develop a national policy for social and environmental responsibility in the mineral sector.
  - (8) Encourage mining companies to adhere to principles of good governance, including the OECD Guidelines for Multinational Enterprises and UN Framework on Business and Human Rights, and to ensure that investments are done responsibly with minimal environmental and social harms.
  - (9) Provide funding support to Cambodia to help increase transparency in the minerals sector, including to promote the Extractive Industries Transparency Initiative.

## **7.2 Summary of findings in Lao PDR**

About Mitr Lao Sugarcane plantation company, significant amount of investment have flowed into Savannakhet Province during the last decade, likely attracted by the province's strategic location and rich natural resources. The investment flows have helped to stimulate economic growth and poverty reduction.

Savannakhet province now has a relatively high economic development status and relatively low poverty rate compared to other parts of Lao PDR. However, based on the findings from this case study on Mitr Lao Sugar's investment in Xayburi district, their investments have also contributed to negative social and environmental impacts, especially damage to forest, watersheds, biodiversity, health, education, and so on. Most importantly, the investment flowing into Savannakhet province is changing traditional livelihoods into industrial livelihoods yet without necessarily improving the people's quality of life. Consequently, this study cannot say that the benefits from investments are sufficient to cover the costs.

The results from this case study also supports the argument that the investment management system in Savannakhet province needs to be improved in order to mitigate negative impacts and ensure that local communities benefit from investments. Positive satiation, it is changing lifestyle for a Lao household. For example, a head of a household, Mr. Kham, in the Xayburi district in this case study, it told us about the changes experienced by his household caused by expansion expansion of the sugarcane plantation and establishment of the sugar factory. For example, Mr. Kham's household includes six members: himself, his wife, one son, two daughters and their grandmother. Before the expansion of sugarcane plantations and the establishment of the sugar factory, the household engaged mainly in subsistence agriculture and collected NTFPs. After rice harvesting, Mr. Kham and his son would saw wood; his wife and daughters would go collecting vegetables, bamboo and mushrooms, or would cut straw for their own use and to sell. The grandmother used to stay at home and take care of livestock and cook for the rest of the family. The household had a middle socio-economic standing in the village; they were not poor and had sufficient food, an adequate house and clothes. They are still able to meet their basic needs; their livelihoods have changed but not their quality of life.

Event challenges of Rubber plantation are similar general challenges of sustainable agriculture. In Lao PDR, rubber expansion is therefore emblematic of the fundamental changes in agriculture and rural development patterns that the country is undergoing. It can be used as an entry-point to understand the larger societal process of the agrarian transition in Lao PDR and to provide cross-sectoral solutions to problems that are not specific to rubber, e.g. concessions, farmers' associations, promoting of conservation agriculture and agro forestry systems, monitoring mechanism for land use planning, environmental impact assessment and mitigation measures. As a consequences, the policy measures that will have a major influence on the rubber industry are not necessarily related to rubber but to more general mechanisms of regulation of foreign investment and patterns of development.

About the Daklak rubber plantation company, this report is possible to propose that future support for

the development of commercial agriculture in Lao PDR and it should change a direction. The emphasis should be placed on the generation of direct benefits for agricultural communities rather than the allocation of large areas of land to the private sector. This study has indicated the many problems which have arisen in the case of the major land concessions studied. The projects have not begun to create the kind of economic changes that might benefit local people. As a pathway for resolving the problems arising from the loss of land to the concession companies and as a means of adjusting the direction of land management in Lao PDR, the ecological scientist and social-livelihood ethnic group balancing will propose and recommendations short, middle and long term measurements as following:

- For the short term measures

It is possible to provide immediate relief for those suffering from the loss of land

- (1) A rice fund could be established in each community that has already lost a significant area of land to the companies and have consequently experienced hunger and extreme poverty.
- (2) The compensation payments must be reviewed, so that the people already affected can be compensated in as fair a manner as possible to respect as the Decree GoL-No192/PM Compensation and Resettlement of the Development Project, 7 July 2005.
- (3) Land must be found for all those who have lost their land, with a minimum of 1 ha per family for subsistence production.
- (4) Wage rates for the laborers in the rubber estates must be revised and monitored to ensure that they are sufficient by which to live. Written contracts must be completed for each laborer.

- Medium term measure

- (1) Set up an official committee to monitor and investigate the implementation of all land concessions. This committee should have the following powers and responsibilities:
- (2) To monitor the companies' operations in relation to land and land use, making sure land areas are as agreed.
- (3) To ensure that local land management authorities coordinate with the labor authorities to control, regulate the labor employment fairly, so that the villages can gain regular work, fair wages and welfare at work.
- (4) To coordinate with other institutions to find alternative occupations, provide assistance and provide some relief for the families who have suffered from the loss of their land and whose wages are too low to live on.
- (5) There needs to be a land survey and land zoning plan in each province. All areas of land that are genuinely used by the communities and individuals who have been issued with certificates under the Land and Forest Allocation policy should be kept free from land concessions.
- (6) The mechanisms for the authorization of land concession should reformed to reduce the problems associated with a very complex process.

- For the long term measures

- (1) Large-scale land concession should no longer be granted to foreign investors for commercial cropping over the long term.
- (2) Land management policy should emphasize building the capacity of people to develop their land use to increase its economic value, whereby right to use the land still belong to the people.
- (3) There should be a plan for land management which considers the balance between the benefits to the national economy, the local economy, a fair distribution of income, ecological benefits and biodiversity.
- (4) If there are to more land concessions, they should be small in scale, in land that is not subject to community use. Evaluations should be carried out of the potential impacts on the environment and society before a project is authorized.

In general to enable workers for working in the fields of agricultural sectors and land use system management to take advantage of these opportunities, priority must be placed on ensuring basic literacy skills. Greater priority should be placed on cultivating a work force that possesses the basic fundamental skills needed to be productive. Resources need to be focused more effectively on the critical windows of opportunities when skills are built by:

- Expanding and strengthening early childhood development and education to help develop school readiness skills and basic cognitive and behavioral skills related agricultural sectors, which also includes efforts to reduce chronic malnutrition which threatens cognitive development.
- Ensuring that all children can read by the end of grade 2, making reading a national obsession so Lao PDR can build a skilled and productive workforce; and
- Building job-relevant technical skills of crop plantations, with the Government taking on a more strategic role in vocational skills development by developing policies, information about the training system, and carrying out training evaluations.

One priority for Lao PDR is to help improve the livelihoods of its large agricultural workforce by increasing productivity in the agricultural sector. With 70 percent of its work force engaged in agriculture, Lao PDR remains primarily an agrarian economy. As discussed, for economies that are categorized as “agrarian”. In the shorter term, higher agricultural productivity will help generate better livelihoods for the 4.5 million Lao people living on farms. Over the longer term, increased productivity on the farms would eventually lower the need as publication of all fee schedules, permits, and licensing requirements; and establish a more predictable playing field for the private sector, with consistent implementation of publicly available legislation, rules, and regulation.

### **7.3 Summary of findings in Thailand**

#### **(1) Agriculture and Forestry**

This study investigates two key policies involved in agricultural land and forest change of Thailand. Base case in 2007 and two scenarios of 2020 and 2040 were formulated. Agricultural management zoning policy aims to convert unsuitable farmland especially paddy field to other alternative crops that benefits more land productivity and farm income. Approximately 22 and 75 percent of unsuitable land will be changed by 2020 and 2040 respectively. The role of natural resources and forest management policy is to enforce the law relevant to the natural resource and forest. Around 40 percent of plantation forest will be increase by 2040.

Suitability class maps of rice, maize, sugarcane, cassava and rubber, received from Thailand Land Development Department were used to analyze spatially. ALRO map was overlaid in GIS as a preserving agricultural land. Unsuitable paddy fields were selected and suitable lands of the alternative crops were selected for change. As a result, the paddy fields will decrease from 2,015,302 hectares in 2007 to 1,966,618 hectares in 2020 and 1,849,333 hectares in 2040. Sugarcane is the most extended crop. The area of sugarcane will increase 15,444 and 52,651 hectares in 2020 and 2040 respectively. Cassava also increases to 14,881 and 50,491 hectares in 2020 and 2040 respectively. Maize will increase 9,858 hectares in 2020 and 33,607 hectares in 2040. Unsuitable paddy fields will change to rubber with the area of 7,917 and 26,990 hectares by 2020 and 2040 respectively.

Protected forest, non-hunting area, wildlife sanctuary, and national park map were used to border forest areas and maintain natural resource. As a result, plantation forest will increase 8,707 and 14,511 hectares in 2020 and 2040 respectively. Suitable lands for rubber are found and can be grown 176 hectares in 2020 and increase to 293 hectares in 2040.

Other impacts of agricultural land use and forest change are expected. Food security will not be impacted by the two policies. The MRC provinces can produce enough rice for consuming and trading even though the paddy field will decrease in the future. Farm income is also expected to increase by change unsuitable paddy field to other alternative crops especially sugarcane. Forest areas definitely increase but no evidence shows that biodiversity will improve. Soil quality and GHG emission will change. Crop water requirement will increase due to the change of crops.

## (2) Mining

From the study of the mining operations in 8 provinces of Thailand Mekong Basin in the 3 scenarios: 1) Early Development Scenario/Situation (2007), 2) Definite Future Scenario (2020), and 3) Planned Development Scenario (2040), there are some key findings as the followings:

- In 2007, there were 39 operated mines and 40 concessions. One mine can have more than one concession as a concession has a limited area. In 2020, there were 20 operated mines and 20 concessions. There was no information for 2040.
- In 2007, the most mined mineral was limestone (8,902,848 tons in 373.28 ha), followed by basalt (4,279,960 tons in 207.90 ha).
- In 2020, the most mined mineral was basalt (5,796,692 tons in 265.70 ha), followed by limestone (1,926,900 tons in 117.83 ha).
- All mining operations were open pit that did not use water. The water was only used for mine dressing and for spraying to contain the dust, except in the minings of the heavy metals that used water. The used water was normally recycled.
- There were 3 provinces, Amnat Charoen, Mukdahan, and Nong Khai, with no mining operation since 2007.
- It was not possible to find mining details for 2040 as the longest time for a concession was 25 years. It meant that a mine that was supposed to be operated in 2040 should have been granted in 2015 (last year), but from the search, there was no mining operation granted until 2040. However, according to the opinions of the mining experts, there should be some minerals that could still be mined in 2040, for example, some industrial rocks (such as limestone, basalt, granite, and sandstone) and iron. At present, the price of the iron was decreasing rapidly. Some iron mined were stopped operating. If its price increases again in the future, the iron mines may be operated again.
- According the GIS file of Department of Primary Industries and Mines, Ministry of Industry, the number of the mines has been decreasing. In 2007, there were 56 mining concessions in the 8 provinces, but it was 46 in 2015. In 2020, there have been 26 granted mining concessions. There were several factors resulting in the decreasing of the operate mines. There were 1) the declining of the minerals, 2) govern policies, 3) raising awareness of the communities about the environment, 4) global and national economic situations. Also, some mines could not be operated, despite granted, due to a number of reasons, for example, price, market demand, economic situations of the mining operators, and community resistance.
- According to the Mineral Statistics of Thailand (2003-2014), the mining production, consumption, and import, had been increasing, but the export has been decreasing.
- Department of Mineral Resources had a project to survey the country's mineral reserves in 2016.
- Thailand would change to be an investor in mining operations in neighboring countries, especially ASEAN countries.
- In the future, the Thailand's national plans/strategies would be emphasized on effective utilization of the minerals and environmental-friendly production.

## 7.4 Summary of findings in Viet Nam

### (1) Rainfed agriculture

From an economic perspective, the rubber plantation project in Ia Blu commune, Chu Se district, Gia Lai province is clearly financially very attractive considering the high price of rubber on the international market. The 847 ha of plantations established between 2008 and 2014 are a technical success. The NPV was estimated at USD 14,581,025 (USD 17,215 per ha) over a 33-year period (2008-2040) with a discount rate of 10%. Considering social perspective, it is undeniable that the project has the potential to contribute significantly to the socio-economic development of the project area such as improving the lives of people, resolving labor, creating jobs for over 300 workers, developing local infrastructures. Besides, the project also has environmental impacts (both positive and negative) in three phases of the project: (1) reclamation, site preparation, (2) planting care of rubber trees and

latex extraction, (3) rubber trees liquidating.

### (2) Forestry

From an economic perspective, the results of the study indicate that there are significant potential net benefits from the forest conservation project of Cu Jut Forest Enterprise, Ea Po commune and Dak Win commune, Cu Jut district, Dak Nong province (with a NPV of USD 27,245 per ha over a 30-year period with a 10% discount rate). Considering social perspective, the project contributes to improve life for people as well as promote the economic development of Cu Jut district. It also raises people's awareness of the importance of forests and mobilize people for forests conservation. However, environmental pollution and risk of occupational accidents could causes adverse effects on health workers. For the environment, excluding the negative impact of carbon storage, the project has the potential negative impacts such as excessive soil erosion, loss of soil fertility, risk of pest infestation and disease, loss of biodiversity, fire risk.

### (3) Mining

From an economic perspective, the financial analysis of the sand mining project in An Binh commune and Dong Phu Commune, Long Ho district, Vinh Long province shows that the private profit from sand mining is large. The 0.175 km<sup>2</sup> project can earn as much as USD 65,170 per year. However, based on the findings from this case study, the project has also contributed to negative social and environmental impacts, especially damage to public health, water traffic, ecosystems quality, etc.