

Assessment on Land Use of Phanom Dong Rak Mountain Range

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Abstract

The assessment on land use of Phanom Dong Rak Mountain Range was designed to evaluate the change of land use at the border area in the Phanom Dong Rak mountain range as affected by the border conflict between Thailand and Cambodia over Phra Viharn Temple. Methods of study included land use classification from satellite images in 2001, 2006, and 2011 by using visual interpretation from image software, and land use change analysis by using post classification comparison method. The study area had been divided into 3 zones: Zone I, Zone II and Zone III, for land use change comparison in each period.

Results of the study revealed that in Zone I of Thailand territory, the whole area was situated in Phanom Dong Rak Wildlife Sanctuary outside the disputed area. The dry evergreen forest had increased in 2011 due to Thailand's policies on forest conservation and restoration. However, there were some areas that could not be controlled by authorities, therefore, the mixed deciduous forest had been reduced in 2011 because of deforestation by villagers. In Zone I of Cambodia territory, the natural forests tended to decrease. More villages and military construction had been built in 2011. New roads had been built near the Thai-Cambodia border. The political factors affected land use of this area. In Zone II of Thailand territory, the natural forests in Phra Viharn National Park and Phanom Dong Rak Wildlife Sanctuary had increased in 2011 due to the government policies on forest conservation and restoration. The areas surrounding Phra Viharn Temple in Thailand were invaded by the road built to the temple by Cambodia in 2006 and 2011. The factors affecting land uses were political factors. There had been an expansion of villages since 2001 in the area in vicinity of the Phra Viharn National Park and Phanom Dong Rak Wildlife Sanctuary outside the disputed area. Villagers had adopted their land uses to economic plantations for higher income. Hence socio-economic factors affected land use of this area. In Zone II of Cambodia territory, the natural forests had decreased tremendously by being converted to villages and military construction. Roads had been built near the border connecting the road to Phra Viharn Temple. The changes were driven by political factors. In Zone III of Thailand territory, the natural forests in Phra Viharn National Park had increased in 2011 due to the government policies. Regarding the area outside the national park, villages and building have increased in 2006 and 2011. The villagers had adopted their land uses to economic plantations for higher income. The socio-economic factors affected land use of this area. In Zone III of Cambodia territory, the natural forests had decreased tremendously in 2006 and 2011. The villages and military construction have been increasing significantly since 2001. Roads were also built to run to the Thai-Cambodian border. The changes were driven by political factors. Land use change in the study area was mostly induced by Cambodian's international politics aiming at a sole occupation of the area at the Thai-Cambodian border surrounding the disputed area.

Keywords: land use, land use change, Phanom Dong Rak mountain, territory dispute

Introduction

Land is an essential natural resource, both for the survival and prosperity of human society, and for the maintenance of all terrestrial ecosystems. Over millennia, people have become progressively more expert in exploiting land resources for their own ends. The limits on these resources are finite while human demands on them are not (Kutter and Neely, 1999; Ziadat, 2007). Demand for land is driven by the need of certain land use types, which could be broadly categorized into residential use, commercial use, and government use. Within each of these there exists several subcategories (Clark, 2010). Political and socio-economic conditions are related to the change in land use (Mather, 1989; Sietchiping, 2010). In socio-economic condition in tropical countries, one of the prominent characteristics of land use change is the decline in forest and woodlands due to land conversion, particularly from agricultural expansion for cash crop production (Barbier, 2003). In addition, changes in land use are the result of politics. The government of most countries exerts direct or indirect influence on land use (Mather, 1989; Verheye, 1997; Lewis and Kuttler, 2005; Clark, 2010; Sietchiping, 2010). Different countries have different emphases on the goals of their policies. This almost universal influence reflects something of ambivalent attributes held by man towards land (Amler et al., 1999). The use of land, and government policy and action in controlling or directing this use, is fundamental to planning at national, regional, and local levels (FAO, 1995; Kutter and Neely, 1999). The state of knowledge about land use, and the degree of government control over it, differ greatly between developed and less developed countries (Young, 1998). Conflicts in land and resources often occur in the border area, between the neighboring countries that border each other. The conflict in the territory is classified as security issues. Often, the problems need be solved by political measures. The war is very often the deciding machine (Prunier, 1995; Young, 1998; Bamrungsuk, 2006a). This study is designed to assess the changing of land use of the border area in the Phanom Dong Rak mountain

range according to the border conflict between Thailand and Cambodia over Phra Viharn Temple. In geopolitical view, the conflict between two countries is often from each neighboring country (Young, 1998). In Thailand, there is an attempt to peacefully solve border dispute by appointing the joint border committee. However, a problem for Thailand is the preparation of the information. The preparation for solving the border dispute is not only by military guarding and border's control but also by having complete information and fact in order to be ready for the negotiation and military discussion. Military readiness alone does not guarantee the accomplishment on solving border dispute. Finally, border dispute will need to be solved politically. Therefore, political advantage in term of treaty, history, topographic area information, and the change of land use and resources information are important to be ready for border dispute negotiation in the future (Bamrungsuk, 2006a, 2006b, 2006c, 2006d). Therefore, the objectives of this study were to study the land use types, to study the changes of each land use type and to study bio-physical, socio-economic, and political factors affecting land use changes at Phanom Dong Rak mountain range.

Materials and Methods

Study Area

The study area situated between 14° 19' 7" N – 14° 28' 19" N and 104° 32' 26" E – 104° 46' 55" E according to the Latitude/Longitude unit, whereas it ranges between 48P 1583000N – 1603000N to 450500E – 476500E basing on the UTM unit. The study area covers Phanom Dong Rak mountain range where Phra Viharn Temple is situated. It covers a total area of 44,200 hectares in Thailand and Cambodia. There are 20,656.84 hectares on the Thai side and 23,543.16 hectares on the Cambodian side. The study area includes sub-districts of Sao Thong Chai, Lalai, Rung, and Phu Pha Mok, Kantharalak district, Srisaket province in Thailand and sub-districts of Kantruat, Chomkrasan district, Preah Vihere province in Cambodia (Figure 1).

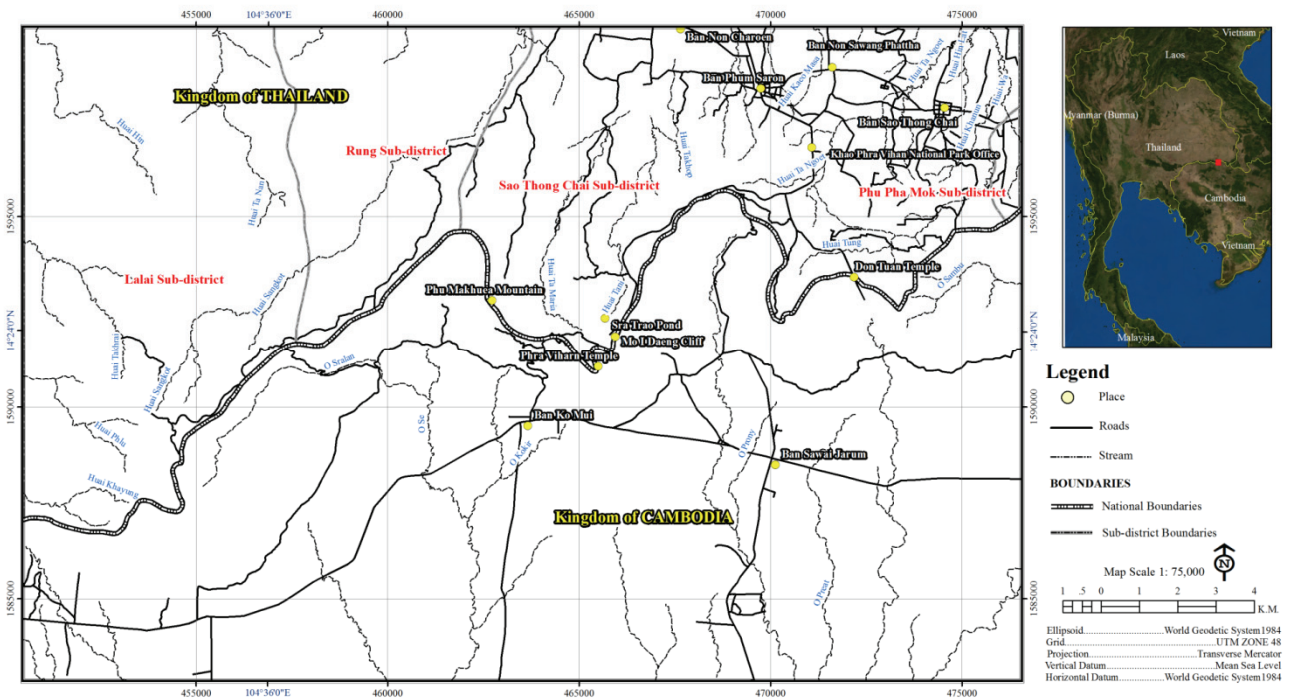


Figure 1 Study area

Data Collection

Bio-physical data used in this study included: topography, geology, landforms, soil, climate, water resources, and land cover and land use. Socio-economic data used in the study were both primary data and secondary data. The primary data were collected through the field surveys and in-depth interviews of the focus groups in the study area. The secondary were from the village's status database obtained from Community Development Department. Socio-economic data included: 1) sociological data such as transport, career, family structure, infrastructure, and education and 2) economic household such as household structure, land ownership, and incomes. Political and policy data were obtained from secondary data including: public policy, national security policy, and political conflict data.

Data Analyses

LANDSAT-5 TM satellite data taken in 2001, SPOT-5 satellite data taken in 2006, and THEOS satellite data taken in 2011 were used in this study. Imagine software for image processing and ArcGIS for GIS data based management and analysis were used in this study.

Geometric correction of LANDSAT-5 TM satellite image data taken in 2001 using image to map technique by employing 16 ground control points. The GCPs of the study area were collected from the topographic maps at the scale 1:50,000 UTM, WGS1984, Zone 48, of the area. Registration was then applied using second order polynomials with RMS error less than 1 pixel with resampling to 25 meters per pixel using nearest neighbor method. Geometric correction of SPOT-5 satellite data taken in 2006, and THEOS satellite data taken in 2011 using image to image technique. The GCPs were collected from the result of geocoded satellite image data of year 2001. Registration was then applied using second order polynomials with RMS error less than 1 pixel, followed by resampling to 25 meters per pixel using nearest neighbor method.

Land use and land cover classification and mapping of the study sites were carried out on performed geocoded satellite data using visual interpretation. Land use and land cover change detection were conducted by overlaying technique. After the 3 classified land use and land cover maps (for 2001, 2006, 2011) were obtained, the patterns of land use and land cover changes during these periods were identified using post-classification comparison

method which compare 2 classified land use and land cover maps (from different dates) and reports any changes found on a pixel by pixel basis.

Field investigation was conducted to acquire data on land use types and land cover change and to evaluate field sheet designed for the project, coordinates of observation points will be collected by using GPS digital camera.

Results and Discussion

Biophysical Resources of the Study Area

The climate in the study area is tropical savanna. The average rainfall in 2001 to 2011 is 1,495 millimeters per year. The highest temperature is 35 degree Celsius and the lowest is 19 degree Celsius. Most of the areas in Thailand are steep mountains and hills with different height ranging 200 to 600 meters above sea level. The area around Phanom Dong Rak mountain range in Thai territory are rolling, undulating, and plain but most of the areas in Cambodia are plain. The geological characteristics in Thailand composed sedimentary rocks of Sao Khua formation, Phu Phan formation, and Khok Kruat formation. Geomorphology of Phanom Dong Rak mountain range is sandstone cuesta of Khorat Group with riverine deposits. The escarpment of the area at Phra Viharn Temple has a slope of fifteen degrees in South to North direction. The watershed boundary of Phanom Dong Rak mountain range is bordered by fold rocks. In Thailand, the important natural water resources are Huai Tani, Huai Ta Maria, and Huai Ta Ngoet streams and the main reservoirs are Huai Takhop, and Wai Sib Song reservoirs. In Cambodia, the important natural water resources are O Se, O Kokir, and O Prony streams. There are 5 soil and land units in the study area in Thailand composing of Khorat series, Dong Takhian Series, Satuek series, Nam Phong series, and Slope Complex. Slope Complex is the most extensive land unit in this area. Most of the study area in Thailand are in Phanom Dong Rak Wildlife Sanctuary and Khao Phra Vihan National Park. The forest types are dry evergreen forest, mixed deciduous forest, and dry dipterocarp forest.

Land Use of Phanom Dong Rak Mountain Range

Land use of Thailand in 2001 consisted of 11 categories. The extents of land use types in descending order were dry evergreen forest, paddy rice, secondary forest, rock outcrop, other field crops, mixed deciduous forest, disturbed forest, village and building, pond and reservoir, dry dipterocarp forest, and cassava, respectively (Table 1 and Figure 2). Land use of Thailand in 2006 consisted of 14 categories. The extents of land use types in descending order were dry evergreen forest, paddy rice, other field crops, secondary forest, rock outcrop, mixed deciduous forest, village and building, pond and reservoir, disturbed forest, dry dipterocarp forest, mixed orchards, para rubber, eucalyptus, and cassava, respectively (Table 1 and Figure 3). Land use of Thailand in 2011 consisted of 15 categories. The extents of land use types in descending order were dry evergreen forest, paddy rice, para rubber, rock outcrop, secondary forest, mixed deciduous forest, other field crops, village and building, pond and reservoir, dry dipterocarp forest, eucalyptus, oil palm, mixed orchards, disturbed forest, and cassava, respectively (Table 1 and Figure 4).

Land use of Cambodia in 2001 consisted of 8 categories. The extents of land use types in descending order were mixed deciduous forest, dry evergreen forest, disturbed forest, rock outcrop, village and building, secondary forest, dry dipterocarp forest, and paddy rice, respectively (Table 2 and Figure 2). Land use of Cambodia in 2006 consisted of 9 categories. The extents of land use types in descending order were dry evergreen forest, mixed deciduous forest, disturbed forest, rock outcrop, village and building, secondary forest, other field crops, dry dipterocarp forest, and paddy rice, respectively (Table 2 and Figure 3). Land use of Cambodia in 2011 consisted of 9 categories. The extents of land use types in descending order were disturbed forest, dry evergreen forest, mixed deciduous forest, rock outcrop, village and building, secondary forest, other field crops, dry dipterocarp forest, and pond and reservoir, respectively (Table 2 and Figure 4).

Table 1 Land use types of the study area in Thailand.

Type use type	Area (ha)		
Thailand	2001	2006	2011
1. Dry evergreen forest	14,036.19	14,004.09	14,679.57
2. Mixed deciduous forest	318.05	353.50	367.94
3. Dry dipterocarp forest	84.01	84.01	84.01
4. Paddy rice	2,890.31	1,614.24	1,419.55
5. Other field crops	420.42	1,599.73	360.62
6. Cassava	3.53	22.00	20.68
7. Para rubber	-	48.08	1,378.38
8. Oil palm	-	-	43.49
9. Eucalyptus	-	48.10	67.66
10. Mixed orchards	-	52.01	22.56
11. Village and building	167.21	278.26	281.16
12. Pond and reservoir	153.22	222.52	188.99
13. Rock outcrop	906.92	906.92	906.92
14. Secondary forest	1,403.08	1,294.13	814.15
15. Disturbed forest	273.90	129.26	21.16
Total		20,656.84	

Table 2 Land use types of the study area in Cambodia.

Land use type	Area (ha)		
Cambodia	2001	2006	2011
1. Dry evergreen forest	10,117.54	9,937.20	7,891.20
2. Mixed deciduous forest	10,395.91	9,245.59	6,649.44
3. Dry dipterocarp forest	3.08	3.08	3.08
4. Paddy rice	0.88	0.88	-
5. Other field crops	-	3.75	3.71
6. Village and building	100.10	186.47	266.91
7. Pond and reservoir	-	-	0.47
8. Rock outcrop	394.08	396.72	396.58
9. Secondary forest	70.15	94.25	39.49
10. Disturbed forest	2,461.43	3,675.22	8,292.27
Total		23,543.16	

Land Use Change in the Territory of Thailand

In Thai territory, a total of 32.10 hectares of dry evergreen forest in 2006 had been reduced from 2001 due to degradation by villagers in the Phanom Dong Rak Wildlife Sanctuary and Khao Phra Viharn National Park (Table 1). While a total of 643.38 hectares of the dry evergreen forest in 2011 had been increased from 2001, due to the Thai government's forest conservation and restoration policy i.e. measures, strategies, conservation plans and sustainable biodiversity in 2003-2007, the 9th national economic and social development plan

during 2002 to 2006, the 10th national economic and social development plan during 2007 to 2011 and the government policy on natural resources and environment in 2006. However, there were some areas that could not be controlled by authorities, therefore, they were converted to agricultural areas i.e. cassava, other field crops, para rubber, paddy rice, and eucalyptus (Figures 2-4). Mixed deciduous forest in Khao Phra Viharn National Park and Phanom Dong Rak Wildlife Sanctuary had increased in 2006 and 2011 due to the Thailand's policies on conservation and restoration.

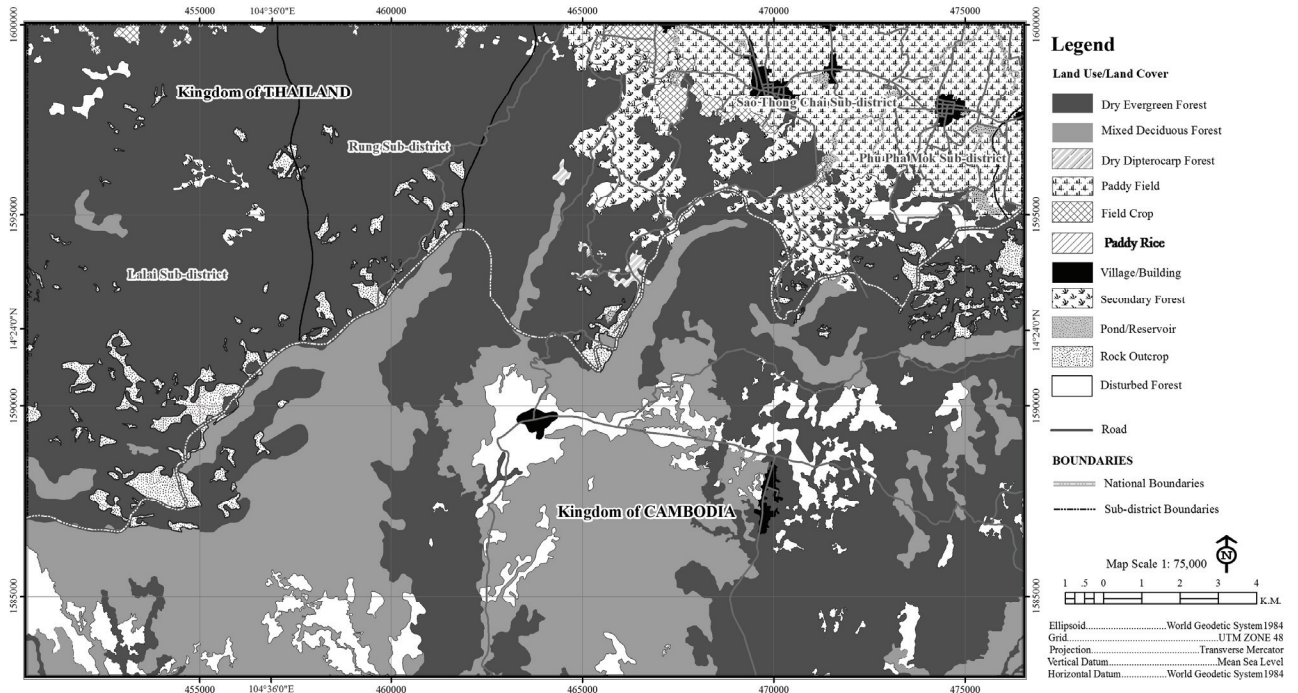


Figure 2 Land use types of Thailand and Cambodia in the study area in 2001.

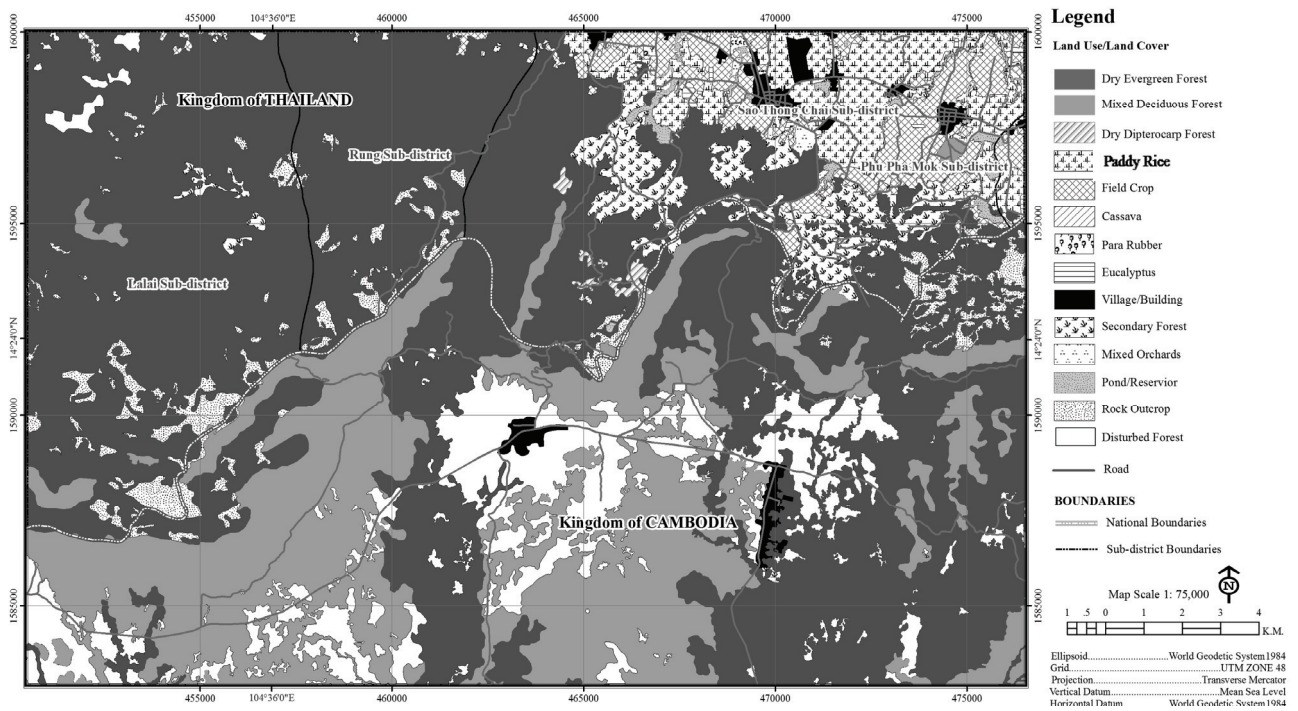


Figure 3 Land use types of Thailand and Cambodia in the study area in 2006.

Regarding other changes in 2011, two roads had been built near the border since there were the natural tourist attractions nearby: Plan Hin Paet Kon and Plan Hin San. Transportation routes were, therefore, built in the mentioned area (Figure 4).

The changes of the areas surrounding Phra Viharn Temple, in 2001, a road being built by Cambodia had invaded the Thai territory. This road is from Komui village of Cambodia and runs to Phra Viharn Temple (Figure 2). It was built in

1999. Apart from the road, Cambodia has also invaded Thai territory surrounding the temple by building temple, markets and military family accommodations. In 2006, another road had been built connecting to the road that invades the Thai territory and runs to Phra Viharn Temple (Figure 3). Such actions have violated Thailand's sovereignty. There had been protests by local officials and government level by Ministry of Foreign Affairs, during 2002-2011. However, Cambodia has not responded to that up until now since Cambodia considers the mentioned area under Cambodia sovereignty as well. The change is likely to be a result of the political factors on the the politics. Cambodia demands to seek for the sovereignty over the area surrounding the temple that lies on the Thai side. Thai and Cambodian governments cannot settle the territorial issue since they adhere to the different demarcation. The Phra Viharn conflict has always been the major problem of their relations of every Thai government and Hun Sen's government. Moreover, Hun Sen's policies are active by attempting to occupy the area surrounding the temple i.e. a policy to list the temple as World Heritage by UNESCO in 2003. In 2006 Cambodia submitted the application to UNESCO requesting the temple to be designated as World Heritage site without consulting Thailand, whom they used to consult as joint commission tasked to develop the temple as per the resolution of Thai – Cambodian Council Minister. Cambodia's political method had been proactive by constructing roads, temple, markets, military family accommodations and other activities in Thailand without obligating as per the borderline agreement between the two countries. Moreover, Cambodia issued the royal decree of the demarcation of temple reservation that overlapped the Thai border in 2006. They claim that it is the area under Cambodia's sovereignty. Cambodia also develops the infrastructure near the border in order to reduce dependence from Thailand when accessing the temple by connecting the routes within Cambodia itself. The roads were built to run to the temple and surrounding the temple complex area.

In 2011, Cambodia requested the International Court of Justice to interpret the 1962 verdict regarding the area surrounding the temple. Cambodian claims that Thailand has not obligated

as per the verdict withdrawing their forces from the temple and the surrounding area and request the ICJ to issue the provisional measures – an immediate and unconditional withdrawal of all Thai forces from areas around the temple - prior to judgement interpretation. Regarding those requests, Cambodia has followed the demarcation in the 1:200,000 scale map. Thailand has followed the obligation in accordance with the 1962 verdict. However, the court did not rule on the matter of using that map as the borderline. Thailand has lodged formal protests and negotiations, but Cambodia does not respond up until now. Thailand has also protested the royal decree defining the scope of the Temple area and the map attached to the inscription of the temple as World Heritage encroaching into the Thai territory in order to protect the right of Thailand. These protests are rightful and international political process in order to protect territorial integrity (Ministry of Foreign Affairs, 2008, 2010, 2011).

Regarding the area in vicinity of the Khao Phra Viharn National Park and Phnom Dong Rak Wildlife Sanctuary outside the disputed area. There are 4 Thai villages composing of Ban Non Charoen, Ban Phum Saron, Ban Non Sawang Phatthana, and Ban Sao Thong Chai villages. There had been an expansion of villages since 2001 (Table 1). Land use of villagers has been agricultural. Villagers had adopted their land use to economic plantations for higher income. In 2011 they had adopted their land use from paddy rice and other field crops to para rubber (Table 1 and Figures 3-4). The para rubber growing area had been expanding due to the government policy in 2003 on developing one-million-rai para rubber project to improve income and livelihood of farmers in the northeast region. In addition, the para rubber price had increased continuously between 2001 to 2011 and that urged villagers to expand the planting area for higher incomes.

Land Use Change in the Territory of Cambodia

In Cambodia territory, the dry evergreen forest and mixed deciduous forest had decreased in 2006 and they decreased more tremendously in 2011 (Table 2 and Figures 2-4). An area of 180.34 hectares of dry evergreen forest had decreased in 2006. An area of 2,226.34 hectares of the dry evergreen forest has decreased in 2011 when

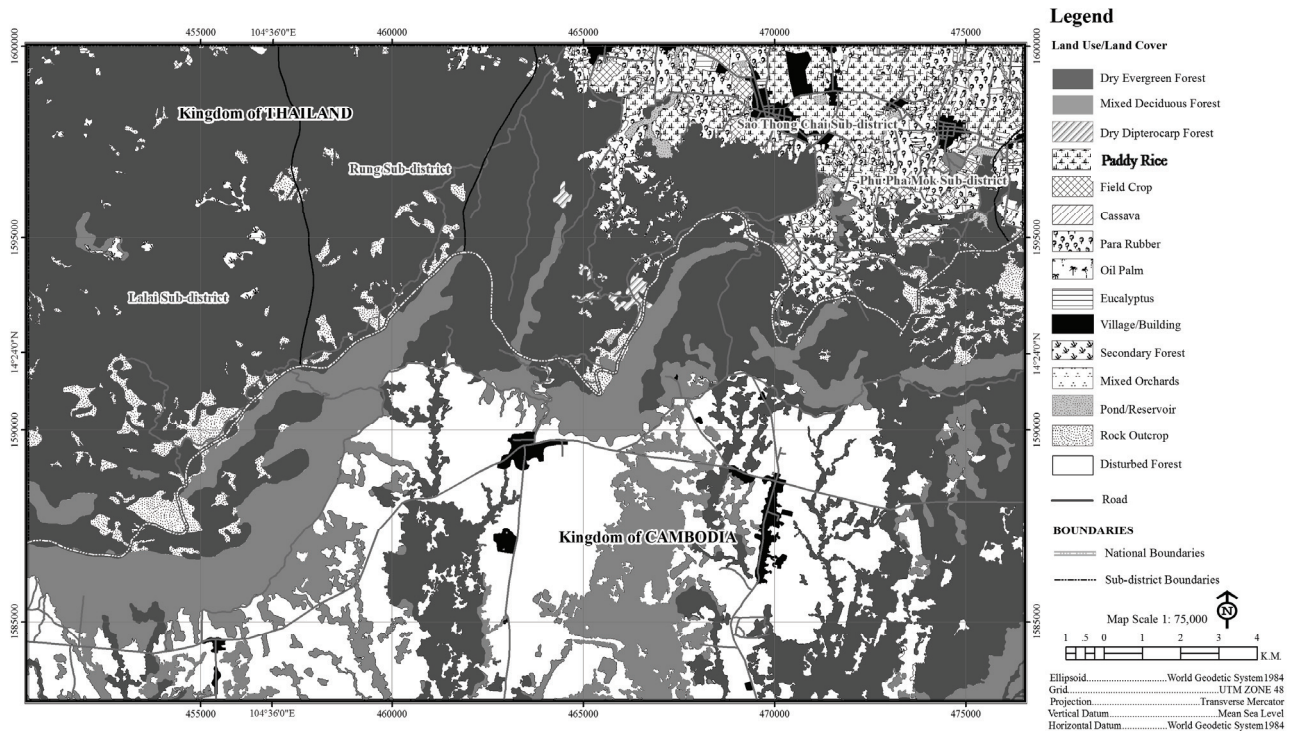


Figure 4 Land use types of Thailand and Cambodia in the study area in 2011.

compared to 2001. An area of 1,150.32 hectares of mixed deciduous forest had decreased in 2006. An area of 3,746.47 hectares of mixed deciduous forest had decreased in 2011 when compared to 2001. Most of the forests areas have been changed into disturbed forest, and villages and building including military constructions (Table 2 and Figures 2-4). Regarding other changes in 2006, New roads had also been built near the Thai-Cambodian. Some roads were built to connect with the road to Phra Viharn Temple. A field survey revealed that dirt roads had been converted to asphalt and concrete roads with wider lanes in 2011. The land use changes in this area were the result of the demand on sovereignty over the territory, the government, state policy, and politics. Hun Sen's government policies and political method had been proactive in order to occupy the area surrounding the temple i.e. submitting the application to UNESCO requesting that the temple be designated as World Heritage site and did not consult Thailand, whom they used to consult as joint commission tasked to develop the temple as per the resolution of the Thai – Cambodian Council Minister. In 2006, Cambodia issued the royal decree of the demarcation of temple reservation that overlapped the Thai border.

Moreover, in 2010, Prime Minister Hun Sen announced the Rectangular Strategy for Growth, Employment, Equity and Efficiency to tackle invasion from other countries particularly Thailand causing the border area to be developed quickly such as transportation development, community development along the border line, defense development and building of a strong army (Ministry of Foreign Affairs, 2008, 2010, 2011).

Conclusions

The natural forest in the conservation area of Thailand had been increased because the government has developed policy on forest conservation and restoration. The changed areas affecting national security were the area around the Phra Viharn Temple complex. Roads, temple, markets, and military family accommodations built from 2001 to 2011 had invaded territory Thailand territory. Furthermore, roads constructed from 2006 to 2011 by Cambodia have also invaded the Thai territory surrounding the temple. Therefore, the factors affecting land uses in this area were political factors on sovereignty, government, state policy, and politics. The major factor had been

their demand for sovereignty over the area surrounding the Phra Viharn Temple. Regarding the areas outside the wildlife sanctuary and the national park adjacent to the disputed area, more villages and buildings have been built. Villagers have adopted their land use to economic plantations for higher income. Hence socio-economic factors affected land use of this area.

Land use in Cambodia has been controlled by the government and the army of Cambodia. The natural forests had decreased by being converted to villages and military construction and road tremendously. Roads had been built near the border connecting the road to Phra Viharn Temple. The changes were driven by political factors on sovereignty, government, policies, and politics. The main factor was demand for sovereignty over the area surrounding the temple complex.

Land use change in this area was mostly induced by the international politics aiming at solely occupying the area and military security at the Thai – Cambodian border surrounding disputed area. The main reason of the dispute concerning land occupation and use along the Thai - Cambodian border around Phnom Dong Rak mountain range, is their demand to maintain benefit of their country, unclearness of the borderline in the past which cannot be amended or corrected simply. Also attitude between the two countries have caused paranoia. The government of Thailand should find a solution as an important foundation in order to resolve the conflict permanently, protect, and keep the benefit for their countries as much as possible. The government of Thailand should make straight forward negotiation with Cambodia on the demarcation line at the conflict area in order that Cambodia will withdraw its case from the International Court of Justice, reveal the fact to Thai people and make the people understand the advantage and disadvantage from the decision to get well-prepared for thing that might happen in the future, and make the referendum and public hearing for Thai people and listen to the people as well to solve the problem for reducing the current conflict in Thai society.

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