



The Agricultural Land Use Situation on the Periphery of the Tonle Sap Lake

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Abstract The Tonle Sap Lake and its periphery exhibit many diversified land use patterns, including fishing areas, grass fields, agricultural land and forest land. Since there have been dramatic changes in these patterns, this research was conducted to identify the dynamics of agricultural land use from 2005-2010 and to investigate the farmers' socio-economic status in the Baray and Kampong Leaeng districts of Kampong Thom and Kampong Chhnang provinces, respectively. To achieve the objectives, Spatial Analysis on Aerial Photos in 2005 and 2010, Direct Observation, Semi-structured Interviews and Structured Interviews were used. The results showed that the total agricultural land use in Zone 2 of Baray district increased from 23% in 2005 to 30% in 2010, while agricultural land in Zone 2 of Kampong Leaeng district increased from 46% in 2005 to 67% in 2010. 82.39% of total households in Baray district are farmers, while 86.19% of total households in Kampong Leaeng district are farmers, with an average of 5 members per household who rely on rice, subsidiary and industrial crops cultivations. Farming households owned an average of 2.11 ha of rice land and 0.26 ha of cropland in Baray, while in Kampong Leaeng they owned an average of 1.41 ha of rice land and 0.67 ha of cropland. On average, a household in Baray earned \$1,452/year from farming and spent on \$1,690/year daily living and agricultural production, while in Kampong Leaeng a household earned \$1,568/year and spent \$1,840/year. In conclusion, the dynamics of agricultural land use in Baray and Kampong Leaeng districts have reduced the flooded forest areas on the Tonle Sap Lake's periphery. Although farmers have tried to increase their income by extending their productive areas, their income was still found to be lower than expenses. These farmers need to access more job opportunities to support themselves and their families.

Keywords agricultural land use, Tonle Sap lake's periphery, aerial photos, spatial analysis, farmers' socio-economic status

INTRODUCTION

As the main occupation of the majority of the population in Cambodia, more than 75% of rural households rely on agriculture and its related sub-sectors (SAW, 2009). In 2009, agriculture contributed 33.5% of GDP (MAFF, 2010) and the main employment of the majority of the workforce was subsistence farming (SAW, 2009). Agriculture in Cambodia has contributed to the economic growth, poverty alleviation and job employment. Over 70% of Cambodian households are working in agricultural sectors and sub-sectors, leading to a reduction in the poverty rate from

47% in 1994 to 35% in 2004 and recently estimated at 30% in 2007. The poverty rate has been declined by 1% a year, on average (MAFF, 2010).

In 2009, there was drastic growth in the agricultural production and agriculture contributed a high share of GDP. The cultivated area for rice covered about 2.71 million ha, providing an average yield of 2.83 ton/ha, with a total production of over 7.58 million tons. Moreover, the cultivated areas for subsidiary and industrial crops covered on about 0.49 and 0.18 million ha, with total production of over 4.86 and 0.56 million tons, respectively (MAFF, 2010). The consistent growth of agricultural sector in 2009 was due to the decline of the construction industry sector and the services sector since 2008 from the world economic crisis (MAFF, 2010).

The combination of Cambodian population growth from 13.7 million in 2005 (NIS, 2005) to over 14.8 million in 2009 (UNDESA, 2009) together with economic growth and globalization, have resulted in high strains on natural resource, especially critical changes of land use patterns.

The periphery of the Tonle Sap Lake, the main flooded plain area for agricultural production in Cambodia, covers over 1.4 million ha in total and extends to the six provinces between the National Road 5 and 6, included Kampong Chhnang, Pursat, Battambang, Banteay Meanchey, Siem Reap and Kampong Thom. The area is characterized into 3 main Zones: Zone 1, non-flooded areas which are the residential areas and the productive areas of rice and subsidiary crops; Zone 2, flooded areas which exhibit the residential areas, grass fields, forests, rice field, subsidiary and industrial crops; Zone 3, the flooded forest areas and protected areas. From 2005-2009, encroachments on the flooded forest for farming especially in Kampong Thom and Kampong Chhnang provinces led to an increase in the land used for agriculture by 34% and 40%, respectively (TSA, 2010).

The purpose of this research is to identify the dynamics of agricultural land from 2005-2010 and investigate farmer households' socio-economic status in Baray and Kampong Leang districts of Kampong Thom and Kampong Chhnang provinces located on the Tonle Sap Lake's periphery.

METHODOLOGY

Due to the limited time and the accessibility of the Aerial Photos, the research was conducted only in Zone 2 of Baray and Kampong Leang districts from May to November 2010. The Interpretation of the Aerial Photos in 2005 and 2010 was done using ArcGIS 9.3 to map the agricultural land use in 2005 and 2010 and the changes between the years. Then, Direct Observation was done to verify between the real situation of agricultural land use and the digitized maps, including GPS marking for any unclear interpretation. Moreover, Semi-structured Interviews were conducted with 21 key informants using a checklist to obtain some basic information about the dynamics of agricultural land use and general information about the farmer households' socio-economic situation in the studied areas. Lastly, the Structured Interviews were done randomly with 25 farmer households from Baray district and another 25 households from Kampong Leang district. The interviews used a questionnaire to obtain more information on the real situation of the farmer households' livelihood, agricultural activities, agricultural income and expense, housing condition, financial resource, the access to infrastructure development, education and health care, and some problem affect to their livelihood. All the data from the surveys, both qualitative and quantitative data, were stored and analyzed using simple descriptive statistics in Microsoft Office Excel 2007.

RESULTS AND DISCUSSION

Agricultural land use in Baray district

The result of the Aerial Photos Interpretation in Zone 2 of Baray district showed that the total land area in the Zone 2 is 35,380.67 ha and their land use patterns in 2005 included burned forests, forest, free land, grass field, industrial crops, rice fields, subsidiary crops, settlement areas and water. The land use patterns categorized into agricultural land use are rice fields, industrial crops and subsidiary crops. These totaled 8,075.52 ha in 2005. Among these uses, rice fields covered the most at 22.01%, while subsidiary and industrial crops covered 0.51% and 0.30%, respectively. In

2010, the agricultural land increased to 10,560.10 ha with land from burned forests and grass fields. Rice field increased by 30.36% and subsidiary crops and industrial crops by 25.12% and 70.09%, respectively, compared to the areas in 2005 (Table 1). Furthermore, among the increased areas, all of the burned forest was converted to rice fields and the grass fields were mostly changed to rice fields and partially to subsidiary and industrial crops (Table 2).

Table 1 Agricultural land use in Zone 2 of Baray district in 2005 and 2010

Land use patterns	2005		2010		Changed area (ha)	Growth's percent (%)
	Area (ha)	Percent (%)	Area (ha)	Percent (%)		
Rice Field	7,788.48	22.01	10,152.78	28.69	2,364.30	30.36
Subsidiary Crops	179.90	0.51	225.09	0.64	45.19	25.12
Industrial Crops	107.14	0.30	182.23	0.52	75.09	70.09
Total	8,075.52	22.82	10,560.10	29.85	2,484.58	30.77

Table 2 The decrease and increase of land use patterns in Zone 2 of Baray district

Increased land use types	Decreased Grass Field		Decreased Burned Forest		Total (ha)	Percent (%)
	Area (ha)	Percent (%)	Area (ha)	Percent (%)		
Rice Field	2,187.98	94.79	176.32	100	2,364.30	95.16
Subsidiary Crops	45.19	1.96	0	0	45.19	1.82
Industrial Crops	75.09	3.25	0	0	75.09	3.02
Total	2,308.26	100	176.32	100	2,484.58	100.00

Agricultural land use in Kampong Leang district

The total area in Zone 2 of Kampong Leang district is 29,562.40 ha and their land use patterns included burned forests, cleared forests, fruits, forest, grass fields, industrial crops, rice fields, subsidiary crops, settlement areas, water, and flooded grass and forests. In 2005, the total agricultural land was 13,700.54 ha among which 31.51% were rice field, while subsidiary crops and industrial crops were 14.30% and 0.53%, respectively. In 2010, the agricultural land increased to 19,776.93 ha, with rice fields increasing by 22.63% and subsidiary crops and industrial crops by 80.60% and 359.29%, respectively, compared to the areas in 2005 (Table 3). In 2010, rice field, subsidiary crops and industrial crops increased with land from burned forests, cleared forests, grass fields, some of forest, flooded grass and forest, and some areas of water. Specifically, the burned forests, cleared forests and grass fields were all changed into rice fields and subsidiary crops (Table 4).

Table 3 Agricultural land use in Zone 2 of Kampong Leang district in 2005 and 2010

Land use patterns	2005		2010		Changed area (ha)	Growth's percent (%)
	Area (ha)	Percent (%)	Area (ha)	Percent (%)		
Rice Field	9,316.43	31.51	11,425.13	38.65	2,108.70	22.63
Subsidiary Crops	4,226.68	14.30	7,633.46	25.82	3,406.77	80.60
Industrial Crops	157.43	0.53	718.34	2.43	560.91	356.29
Total	13,700.54	46.34	19,776.93	66.90	6,076.38	44.35

Table 4 Changed categories of agricultural land use in Zone 2 of Kampong Leang district

Decreased land use types	Increased rice field		Increased subsidiary crops		Increased industrial crops		Total (ha)	Percent (%)
	Area (ha)	%	Area (ha)	%	Area (ha)	%		
Burned Forest	1.14	0.05	0.00	0.00	0.00	0.00	1.14	0.02
Cleared Forest	101.30	4.80	3.60	0.11	0.00	0.00	104.90	1.73
Forest	975.23	46.25	1,406.45	41.28	83.95	14.97	2,465.63	40.58
Grass Field	736.35	34.92	222.12	6.52	0.00	0.00	958.47	15.77
Water	294.68	13.98	743.77	21.83	476.96	85.03	1,515.41	24.94
Flooded Grass & Forest	0.00	0.00	1,030.83	30.26	0.00	0.00	1,030.83	16.96
Total	2,108.70	100.00	3,406.77	100.00	560.91	100.00	6,076.38	100.00

Discussion on the dynamics of agricultural land use in the studied areas

As shown in Table 1 and Table 3, total agricultural land use in Zone 2 of Baray district increased from approximately 23% to 30% during 2005-2010. As for Zone 2 of Kampong Leaug district, it increased from about 46% to 67% in the same period. Although the total area in Zone 2 of Kampong Leaug is smaller than Zone 2 of Baray, the growth of agricultural land in Kampong Leaug is higher than in Baray district. The change in agricultural land use in Baray district was mostly in the grass fields since it's covered in most of the area, while in Kampong Leaug, the agricultural land increased mostly in the forests because it covered almost half of the area. Regarding to the increases, rice fields presented the biggest growth in Baray in contrast to subsidiary crops that presented the highest growth in Kampong Leaug district (Fig. 1). Fig. 2 shows a map of the changing dynamics of agricultural land in Zone 2 of Baray and Kampong Leaug districts. The causes of the changes were the population growth in the areas, the high demand of agriculture products, the high fertility of the soil in the areas and illegal encroachment on the flooded forest in the protected areas.

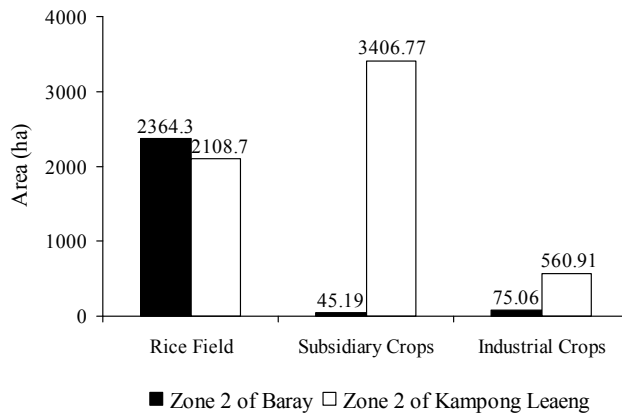


Fig.1 The changing dynamics of land use for agriculture in the two districts from 2005-2010

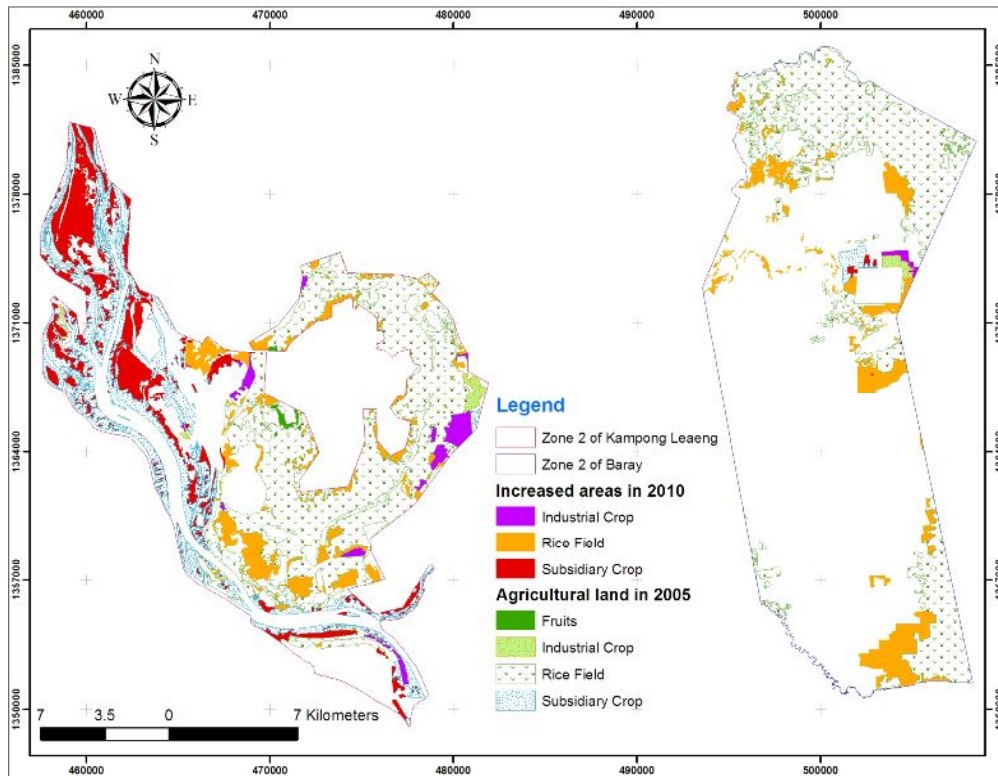


Fig. 2 Dynamics map of agricultural land in Zone 2 of Baray and Kampong Leaug districts

Socio-economic situation in Baray district

Baray district is comprised of 18 communes and 182 villages with a total population of 181,306 persons in 37,089 households and with an average of 5 members per household. Females make up 51.21% of the total population and people who are aged over 18 years old are 61.81% of the total population, 32.18% of which are female. Women are the head of household in 14.82% of the households. 84.06% of the total households are engaged in the agricultural sector (farming, fishing and animal raising), while the rest are engaged in the service sector, handicraft and integrated jobs with 8.83%, 0.30% and 6.82%, respectively. Furthermore, some members in the households are also employed in public and private sector in which 3.55% of households had members employed in the public sector, while other 10.75% were employed in the private sector.

Even though the people who aged 18-60 years seemed to have their regular occupations in the district, migration was still a problem. 9.94% of the total population migrated outside the district for employment, of which 8.05% were employed in regular jobs and the other 1.89% in irregular jobs.

In the district, six types of houses were found including wooden houses with thatched roofs (30.41%), wooden houses with zinc roofs (19.14%), wooden houses with tiled roofs (49.44%), flat for multi-households (0.32%), concrete houses (0.64%) and villas (0.05%). Furthermore, the access to electricity was still very low in the whole district at 11% of the total houses and for the households who couldn't access electricity used the batteries instead.

Road infrastructure was seen to be better since there were five types of road transport infrastructure such as bituminous roads, paved roads, red-graveled paths, white-sandy paths and mountain trails. The educational situation was more positive since 73.14% of people aged 3-17 years had some education or schooling and 26.86% had no schooling. However, the illiteracy was still a problem. 14.23% of people aged 15-60 years were illiterate, of which 7.37% were female.

The surveyed farming households in the district had an average of 2.11 ha of rice land and 0.26 ha of cropland per household. On average, a household could earn income 1,452 \$/year from farming and spent 1,690 \$/year on agricultural inputs and daily living.

Socio-economic situation in Kampong Leang district

Kampong Leang district is comprised of 9 communes and 44 villages, with a population of 47,099 persons in 9,767 households with an average of 5 members per household. Females are 50.26% of the total population and people who are over 18 years old are 51.14% of the total population, 26.34% of which are female. In the district, women are the head household in 15.34% of the households. 93.95% of the total households are involved in the agricultural sector, while the rest are engaged in the service sector, handicraft and integrated jobs with 0.54%, 0.15% and 5.36%, respectively. Moreover, some members in the households are employed by both the public and the private sectors. 4.70% of households had members employed in the public sector, while 6.26% were employed in the private sector.

In the district, migration was also still a problem. 6.57% of the total population who aged 18-60 years migrated outside the district for employment, of which 5.99% were employed in regular jobs and the other 0.58% in irregular jobs.

In the district, four types of houses were found including wooden houses with thatched roofs (47.48%), wooden houses with zinc roofs (41.46%), wooden houses with tiled roofs (10.35%) and concrete houses (0.72%). Furthermore, the access to electricity was still very low in the whole district at 1.59% of the total houses and for those who couldn't access electricity used the battery instead.

Due to the island zone and flooded landscape geography, the Kampong Leang district has lacked of road infrastructure. Three types of roads were found to red-graveled paths, white-sandy paths and mountain trails. The educational situation was in positive since 63.28% of people aged 3-17 years had some schooling and 36.72% had no schooling. However, the illiteracy was still the problem. 15.93% of people aged 15-60 years were illiterate, of which 8.35% were female.

The surveyed farming households occupied an average of 1.41 ha of rice land and 0.67 ha of cropland per household. On average, a household could earn income 1,568 \$/year from farming and spent 1,840 \$/year on agricultural inputs and daily living.

CONCLUSION

The agricultural land use in Zone 2 of Baray district of Kampong Thom province and in Zone 2 of Kampong Leang district of Kampong Chhnang province changed dramatically from 2005 to 2010. In Baray district, the agricultural land increased by 7% from the grass fields and burned forests in the Zone 2 and the grass fields, which regarded into the flooded forest area on the periphery of the Tonle Sap Lake, presented a high decrease. Among the increased agricultural land, rice fields showed the highest growth.

In Kampong Leang district, the agricultural land increased by approximately 21% from the burned forests, cleared forests, grass fields, forest, flooded grass and forests, and some areas of water in the Zone 2. Along with the increased agricultural land, subsidiary crops presented the highest percent of growth.

The causes of the changes were the population growth in the areas, the high demand of agriculture products, the high fertility of the soil in the areas and illegal encroachment on the flooded forest in the protected areas that increasingly grow from year to year.

The changing dynamics of agricultural land use in both Zone 2 of Baray and Kampong Leang districts have devastated the flooded forest areas on the periphery of the Tonle Sap Lake which serves as the main protector of the Tonle Sap Lake and its biodiversity resources. If proper measures are not taken to lessen the illegal encroachment, these will shortly destroy the biodiversity and biosphere reserve of the Tonle Sap Lake.

The changing dynamics of agricultural land use in the areas are closely related to the socio-economic situation of the people. The people have tried to increase their income by extending their productive areas which reduce other land use patterns. However, their income is still shown to be lower than expenses, so they need to access more job opportunities to support themselves adequately. Additionally, in order to take any measures to lessen the impact of the changing dynamics of agricultural land, the socio-economic of farmers needs to be understood well in order to advance the measures effectively and efficiently.

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