AN ECONOMETRIC ANALYSIS OF THE CAUSES OF DEFORESTATION OF SOUTHEAST ASIAN COUNTRIES

By

KHAING, Thandar

THESIS

Submitted to

KDI School of Public Policy and Management

In Partial Fulfillment of the Requirements

For the Degree of

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ABSTRACT

An Econometric Analysis of the Causes of Deforestation of Southeast Asian Countries

By
Khaing Thandar

The development of Southeast Asian region is mainly depending on natural forest resources which are important not only in production of wood and other wood related products but also in conserving global environment. And then forests in the region provide employment to people in manufacturing wood based forest products or value added forest products and in managing the forest areas and in establishing plantations. Due to the above advantages, forest conservation and protection is important not only in the region but also all over the world. Southeast Asia' deforestation and forest degradation rates were projected to be approximately two times of the rates of Latin America or tropical Africa (Mayaux et al., 2005). Knowing direct and indirect causes of deforestation is one of the best ways to reduce it. The objective of this thesis is to identify the serious drivers of deforestation in the Southeast Asian region.

This study examined the most serious responsible drivers or causes of deforestation among arable land, permanent agricultural land, round wood production, fuelwood production, annual population, per capita GDP - Gross Domestic Products (constant at 2005) and planted forest areas (plantations). Southeast Asia eight countries (Cambodia, Indonesia, Lao People´s Democratic Republic, Malaysia, Myanmar, Philippines, Thailand and Vietnam) were conducted 1991 to 2014 (24 years). Panel data fixed effects model was conducted with three approaches. After conducting regression model in three approaches, the most serious driver is expansion of permanent agricultural land and arable land expansion follows it. Fuelwood production and planted forest areas (plantations) are fourth and fifth drivers of deforestation respectively. Round wood production is only statistically significant in the second approach so it is not a serious driver by comparing other variables (drivers of deforestation) used in the

model. In the region, per capita GDP (constant at 2005) as economic indicator contribute the forest cover with positive ways (reduce the rate of deforestation).

Key words: Deforestation, Causes, Southeast Asian Countries, Agricultural expansion, Fuelwood, Round wood, Population, Per capita GDP

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I hope that the readers will, to some extent, get the sense and become aware of deforestation and drivers for it.

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1. Introduction

Approximately thirty three percent of the land surface of earth is occupied by forests which are rich with public and private goods such as timber and non-wood forest products, food, medicines, habitat of wild animals and plants, soil conservation, water quality control, climate change mitigation (Sheram, 1993). Forests act as an important actor in national economic growth such as production of wood are carried out by more than 145 countries all over the world (Anonymous, 1994a).

Forests also offer benefits for 1.6 billion of people for their livelihoods (World Wildlife Fund, 2016). Conversion of land uses from forests to other forms over time such as pasture and crop lands, urban area, is deforestation (Van Kooten, & Bulte, 2000). Although forests provide benefits for human beings, they are increasingly changed into other forms of land uses for getting tangible economic benefits, such as arable land, meadow and pasture land, urban areas, mining and road construction. Nowadays climate change and environmental problems are increased in both intensity and magnitude almost all over the world due to increasing of greenhouses gases emissions. Deforestation and forest degradation was responsible for 20 % of the global greenhouse gases emission during the 1990s (Gullison, 2007).

Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam, Southeast Asian countries are covered with forests that are hold with venerable tropical ecosystem of the world and biological diversity. According to FAO 2010, Southeast Asia, forests extend 214 million hectares of land in Southeast Asia (FAO, 2010). Forests in the region are losing steadily compare with other parts of the world; the primary forests will be totally destroyed within 10 years (The Tropical Rainforests of Southeast Asia, 2011). Forests are notably being changed into other form of land uses especially converted to agricultural lands, upgrading in agricultural sector, increasing population and improvement in infrastructure (FAO, 2011).

Wood and wood-based production, conservation of watershed area, biodiversity, balance of carbon cycle in the world and migration to urban areas was frighten by decreasing coverage of forestry sector (FAO, 2011). According to FAO subregional report for Southeast Asia, area of forest in the region is projected to decrease from 49 percent to 46 percent during periods of 2010 to 2020 (FAO, 2011) by amount about 16 million hectares (nearly close to the country area of Cambodia) especially losses happened in the countries' majority. The forest cover shrank up to 300 million hectares in size from 1990 to 2010. With the broad definition of deforestation (both changing land use from forest and forest degradation), the natural or primary forest areas are reduced since 2005 (FAO, 2011). Without taking any actions on the main and serious causes of destruction of forest areas and forestry sector, the coverage of forest will be fell shortly and the intangible and tangible values of forestry sector will be gone.

Many results from cross-sectional analysis proved that agricultural land expansion, growth of population, round wood and fuelwood production are most serious causes of deforestation in tropical forest of developing countries. But causes can be varying depend on different areas of world along with time and depend on socioeconomic and ecological effects. Most of the previous studies were conducted on deforestation of tropical forests but rare on tropical forests in eight countries among ten countries of Southeast Asia such as Cambodia, Indonesia, Lao People´s Democratic Republic, Malaysia, Myanmar, Philippines, Thailand and Vietnam. There is no new evidence about deforestation for Southeast Asian forests in my study but recommendations related to deforestation in the region will be delivered based on currently available data. The purpose of the study is to know direct and indirect drivers of deforestation in Southeast Asia and to determine the most responsible for the deforestation. Knowing the most responsible factors for deforestation of the region, most suitable policy recommendation for the region to reduce the negative consequences could be developed.

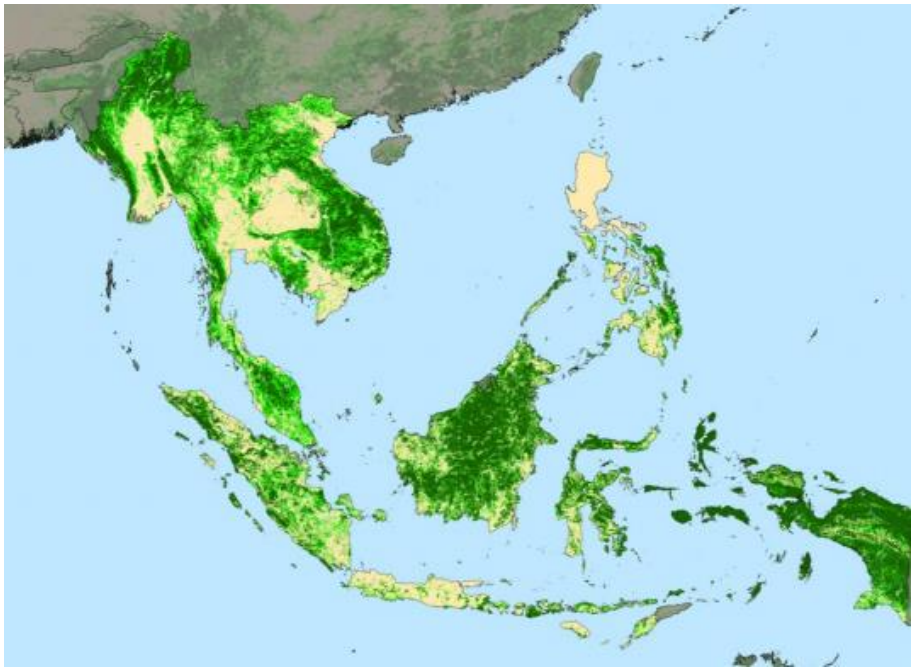


Figure 1: Forest Cover in Southeast Asia (FAO, 2010)

Table 1
Southeast Asian Primary and Planted Forests

	Total Forest 1000(ha)	**Primary Forest 1000 (ha)**	**% Primary**	**Planted 1000(ha)**	**% Planted**
Cambodia	9457	322	3.4	69	0.7
Indonesia	91010	46024	50.6	4946	5.4
Lao PDR	18761	1194	6.4	113	0.6
Malaysia	22195	5041	22.7	1966	8.9
Myanmar	29041	3192	11.0	944	3.3
Philippines	8040	861	10.7	1245	15.5
Thailand	16399	6726	41.0	3986	24.3
Vietnam	14773	83	0.6	363	24.8

Source: Food and Agriculture Organization of the United Nations (FAO), Global forest resources assessment 2015.

2. Literature Review

2.1 Concept of Deforestation

Deforestation has been described in different ways. Converting of forests land to other kinds of land practices can be defined as deforestation in which all other destructive form of forest lands (Dangi, 2009). According to FAO and UNEP (1982), deforestation is destroying of forest for a certain period or almost disappear. It is also defined as land use changing from forests to others or not more than 10 percent threshold level of the coverage of canopy with long period of time (FAO, 1990). An area with forest cover less than 10 percent is deforested area (FAO, 1993, p. 10). According to Collin (2001), deforestation is the totally damage of primary forests and other woodlands for a long period. In the context of Kaimowitz and Angelsen (1998), permanent reducing the coverage of forests.

According to the FAO, the meaning of deforestation is covered by only stating the effects from the logging and other economic activities in the forest which can be damage ecosystem of forests as it is indicated only the phenomenon of seriously destruction of forests (Myers , 1991). In 1991, Myers claimed that there must be included as timber extraction beyond the production capacity of forests as one of facts in the meaning of deforestation (Myers, 1991, p. 4). But there is another weakness in Myers assumption that is Myers was not considered on the case of degradation of forest resources. Grainger (1993) filled this gap by adding concept of forest degradation. In his study, he defines forest degradation as a temporary or permanent destruction in the density or composition of coverage of vegetation or its species composition (Grainger,1993, p. 46).

Most of the outcomes of studies are not same not only in the amount of deforestation but also the rate of annually deforested area because of defining deforestation in various ways. If the definition of deforestation combines both effect of logging and degradation of forest ecosystem, the rate is deforestation become higher. About 1,305 million hectares were covered

with forest by common definition of FAO at 1980s (FAO, 1993, p.ix) whereas nearly 800 million hectares of forest covers at 1980s was estimated by Myers's wider definition (Myers, 1991, p.3).

Therefore, the concept of deforestation varies widely from simple to broad meaning. Although it has been stated in different ways, deforestation in this paper denotes as the changing of the forests for other purposes for a certain period and also include with the concept of degradation of forests.

2.2 Deforestation in the World

The relative importance of the several economic areas in the deforestation can be crucially affected by the deforestation whether the meaning of deforestation is only focus on change of land uses from forests to others or whether the meaning covers both changing of land use and forest genetic values (van Soest, 1998). According to the changing of land use form forest covers, four causes of deforestation are shown in the table (van Soest, 1998). Table presents the two important industries such as forestry and agriculture that *decompose* forest areas but the effects are not same on the industries.

Table 2

Proximate drivers of deforestation (% of total deforestation)

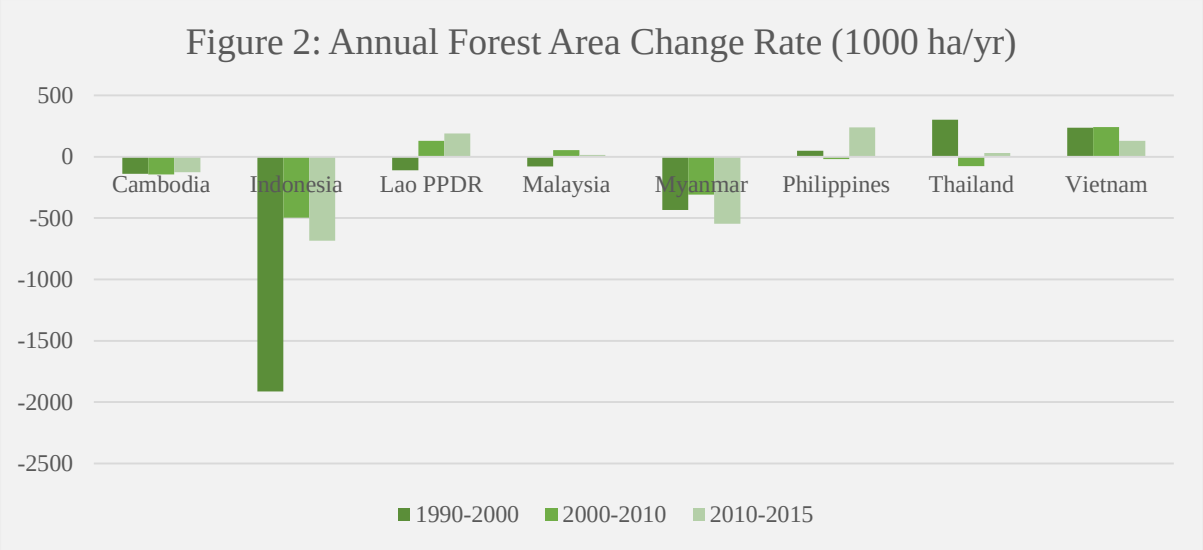
	Forestry Sector (e.g. logging)	**Agriculture**		**Mining Hydropower generation and other industries**
		Shifting Cultivation	Permanent Cultivation	
EK (1990), 1980-1985	10	40	50	0
Brunig (1989), 1980-1988	10	60	30	
Myers (1991), 1980s	21	61	18	
Amelung and Diehl (1992) 1981-1990	2-10	41-49	45	4

Except Myers (1991), the other three studies apply the definition of deforestation which reflected only value of timber. So forestry industry which is destroyed only almost 10 percent of tree cover is not a responsible sector for deforestation as wood extraction has been taken by selective logging in line with systematic forest management plan. However, wood extraction would damage ecological condition of forests and also will not exert damage to the tree cover less than 10 per cent. In Myers (1991, p. 18), rate of annual deforestation is higher in forest industry due to definition with the concept of ecological value (means including forest ecosystem degradation). According to the above table 1, the amount shared by agricultural industry for deforestation is noticeably destructive action with FAO definition. The figure can be seen easily because destruction to forest will be high with increasing agricultural activities.

2.3 History of Forest Cover and Deforestation Rate in Southeast Asian Region

The total coverage of forest in Southeast Asia is 214,000 thousand hectares, constituting 29 percent of total forest area in the Asia region (FAO, 2010). In the region, mixed deciduous forest is the major forest type while the insular subregion is composed of evergreen Dipterocarpus forests. In many coastal areas, mangrove and peat swamp forests, carbon rich ecosystem, occupy (Donato, Kauffman, Murdiyarso, Kurnianto , Stidham & Kanninen, 2011).

During the period of 1990 to 2010, about 42 million hectares of forest land is already deforested which is same with 8 percent of the land area (FAO, 2011). With FRA 2010, areas of forest increased since 2005 but the deforestation rate was continuously increased in the period before 2005 within the Southeast Asian Region (FAO, 2011). Annually deforested area was more than one million hectares from 2005 to 2010 and loss of forest area was decreased 2.4 million hectares annually in 1990s to 0.7 million hectares annually during 2000 to 2005 (FAO, 2011). Among the Southeast Asian countries, Cambodia and Myanmar is the highest in deforestation rate. Vietnam, Thailand and Philippines became increased in forest cover (FAO, 2011).



Sources: Food and Agriculture Organization of the United Nations (FAO), Global forest resources assessment 2015.

Tropical forests are not only important for environmental protection and biodiversity conservation, but also play a crucial role for socioeconomic and the livelihoods of forest dwellers in Southeast Asian region (Lee, 2009). Moreover, these forests also serve an important role in balancing global carbon emission. About 15 % of manmade global greenhouse gases emissions was contributed by deforestation in tropic areas (van der Werf et al., 2009), and the highest rate of deforestation in the tropic occurred in the Southeast Asian region (Achard et al., 2002). In addition, the total rate of changing in forest covers is described to have decreased from -0.1% annually in the 1990s to -0.3 % in 2005 after which the changing rate again raised to -0.5 annually (FAO, 2010).

2.4 Causes of Deforestation

In general, proximate causes and underlying causes can be distinguished for the causes of deforestation (Sharma, 1992). Mankind or direct actions on the degradation of tree covers are proximate or direct causes of deforestation such as expansion of agricultural land, logging activities and development of infrastructure. Activities or processes related with proximate causes such as increasing population, price of commodity, national policies are underlying or indirect drivers of destruction the forest areas (Geist & Lambin, 2002). The issues contributing

to deforestation are different in countries, based on the development of socio-economy, physical and political structure of the countries.

2.4.1 Agriculture

The demand for food is increased with the growing population, leading to agricultural land encroachment by temporary or permanent cultivation and keeps destroying forest areas (Eckhol, 1976, p. 39; Kartawinata 1979, p. 129-30; Mikesell 1960, p.445; Powell 1978; Ranganathan 1979, p. 14-15). Conversion of forest lands into cultivated land is occurred in many countries, especially in developing countries, with less development of agricultural industry (small land cannot produce many yields because of lack of technology) (World Bank 1978, 18-19).

In the Southeast Asian region, permanent agricultural and shifting cultivation are the main causes to expanse of agricultural land that secures the demand of food with increasing population. The expansion of agricultural land use was one of the major causes of instruction to forest areas. After that, plantation of cash and estate crops such as rubber and palm oil were increased with large amount (Wunder, 2004; Morel, 2007) which was one cause of deforestation from agricultural sector. According to FAO (2006), this type of plantation took place annually about 8.7% of forest cover in the region from 1990 to 2005.

2.4.2 Logging

Wood extraction for economic purpose is one factor that not only destroy forest but also degrade it (Eckholm, 1976, p. 39; Powell, 1978, p.116). Logging with systematic management plan will not largely destroy forest (Schmithusen, 1976), but over exploitation without considering sustainability of forest can cause deforestation (Kartawinata, 1979, p. 129-30; World Bank, 1978, p. 19). But road construction for logging, both systematic and unsystematic logging, was taken into account that could damage natural forests. So it is indirect cause because roads can provide more people to access to the forest and finally lead to

urbanization. Logging for commercial purposes was one of the major deforestation drivers in the Southeast Asia with increasing demand on forest products since 1950s (Sodhi et., Final Report al., 2004).

2.4.3 Fuel

Forests are destructed due to collection of fuelwood for rural areas like commercial logging in the developing countries. Wood fuel and charcoal are highly applied in household cooking and heating. Nearly 95 percent of energy use is from fuelwood not only in household level but also in small industries in most area of Africa (Cecelski et al., 1979; Dunkerley et al., 1981, p. 48-57). The need for fuelwood has been certainly increased with raising price in oil. So forests are cut by local people near forests that can lead to loss of forest cover (Allen 1983; Kolawole, 1975; Mikesell, 1960; Ranganathan, 1979, p. 14-15). Fuelwood gathering is not always main driver of deforestation in the tropical climate areas but it can be in some populated regions with degraded forest area such as in the Thailand and Philippines. In other drier area of tropic forest, it can be the main cause of deforestation.

2.4.5 Burning and Grazing

Forest areas can be destructive by activities except for clear-felling or removal of trees. Natural regeneration was prevented by forest fire or burning annually in most areas (FAO, 1980c, p. 2-5), and also by pasturing animals (Mikesell, 1960; Ranganathan, 1979, p. 14-15; FAO, 1980c, p. 2-5; World Bank, 1978, p. 34). Erosion or soil compaction can also be delayed the productivity of forests and ability of forest regrowth (Eckholm, 1976, 39; Nkoma & Asman 1979, p. 5-6; Winterbottom 1980, p. 50).

2.4.6 Forest Management

The causes and consequences of deforestation cannot be fully controlled by forest department in developing countries. Most of the developing countries are not familiar with sound management of forests for getting sustain yields form forests. And policy of the countries

is usually focus on production not for protection (Allen 1983). Forest management institutions are not strong enough to conserve the forest even if they have good practices in managing forests (World Bank 1978, 35). Lack of interaction between local people and administrative agency for forest management because of poor policy and red tape in local cooperation or other incentives for local people participation in forest conservation (World Bank 1978, 34).

2.4.7 Economic Growth

Gross domestic product (GDP) in the world is developed with increasing consumption on products from agricultural and forestry sectors. World GDP is projected to raise in coming days if there is no financial crisis. The forest and agricultural products' demand not only in quantity but also space will obviously increase when world GDP and GDPs in all regions and nations increase in the future. The outcome form increasing demands is become one of the drivers of deforestation.

During 1970 to 2005, the world real GDP rose from 16 trillion USD to 7 trillion USD and is estimated to reach nearly 100 trillion USD in 2030 (European Commission, 2010). Consequently, competition related trade-offs between different land uses increases. Policies regarding such kind of competition on land use became a driver of deforestation in indirect way such as international trade and shifting regional balance and mining for minerals (European Commission, 2010).

2.4.8 Policy-making and Governance

The function of governance and institutions for making policies and legislation aiming at sustainability of forest can predict as an indirect cause of deforestation. Deforestation causes such as illegal logging can occur due to weak policies and law enforcement and weak in capacity of governance of a certain country. Rather than national policies and legislation, deforestation can be caused by international policy for example alternative energy usage like biomass, biofuel and so on. For example, the biomass or biofuel legislation of US and European

can increase the demand of raw materials so the forests from forest resources rich countries or from developing face with deforestation.

2.4.9 Population Growth

Population growth is another kind of indirect cause for destructing of forests. The world faced with bombing of population growth in past. In the context of US Census Bureau, global population has reach form 3,000 million to 6,000 million in 1959 to 1999 (European Commission, 2010) and then double rate after forty years. The more increasing population is the more increasing forest products and agricultural products that lead to more deforestation.

2.5 Previous Analysis on Deforestation

Due to many negative consequences of deforestation, many people in political sector, scientists were interested in causes of deforestation. Researchers and scientists were taken researches related deforestation with econometric models to answer the reason, location, period and amount of forests were changed into other form of land uses since 1990. Enough time series for all data are required to take empirical analyses on causes of deforestation for studying regional level and national level. In the subsection will discuss with two parts, the first one will be national level cross section analysis and the second will be regional level analysis.

According to Barbier and Burgess (2001), economic analysis related to deforestation defined as first wave since taking out regression models in amount and rates of deforestation among different countries. Economic condition of countries, density or growth of population, outputs or returns of agriculture, exports or share of agriculture, output and value of wood, construction of roads, factors of scale and institutions are indicators related with deforestation based on assessments of these analysis (Barbier and Burgess 2001: 417). The pattern of correlation among these causes of deforestation can be varied depending on regions or periods of time or econometric issues.

Most of studies used production of wood for both local and export or values of production for examining the relation between logging and deforestation. According to Burgess (1992), total change in closed forest areas have negative relation with industrial round wood production per capita. If there were afforestation activities in the deforested area, wood production per capita was insignificant with deforestation in the study of Allen and Barnes (1985). In their study with panel data, the level of deforestation will lag effect when planting activities are not taken in areas of clearing harvest areas so lack of timber supply will happen after five to ten years. Wood exports is not significantly variable in analyzing deforestation by Rudel in 1994. The analysis of the linkage between deforestation and price of timber for the period 1967-71 studied by Capistrano and Kiker (1995) showed that both negative and positive impacts on deforestation with the changing of timber price. During their study period, wood harvesting was high with increasing price of timber.

Some studies support the statement that is converting to agricultural land is a kind of direct cause of deforestation. According to Allen and Barnes (1985), Capistrano and Kiker (1995), there were positively relationship between deforestation of expansion of crop lands. Increasing pasture land leads to the rapid rate of deforestation that was proved by study of Chakraborty (1994). Another researchers Southgate (1994) concluded that there is positively relation between deforestation and the amount of exports of agricultural products. On the other hands, Lombardini (1994) and Rudel (1994) proved that there is no significant relation. The rate of deforestation is forced by other economic activities related to landuse changes such as getting more profit from agricultural products than conserving forest, clearing forest cover, finally resulting in high deforestation (Capistrano and Kiker, 1995). In 1994, Lombardini used labour force in the field of agriculture that indicate the role of agricultural land expansion but his study is came out with unexpected result and there is no evidence explanation for this result. All variables that can show the role of agricultural land expansion are more visible indicators

for increasing rate of deforestation due to human activities although other indicators are also noticeable.

Since population keep increasing, we expected that the more deforestation will occur due to using more products for forests and by increasing requirement of foods for their livelihoods. According to Allen and Barnes (1985), Burgess (1992), Rudel (1994) and Southgate (1994), the assumption had proved in their studies. But some studies written by Kahn and McDonald (1994) and Lombardini (1994) cannot prove that assumption. In the content of Deacon (1994), increasing population during study periods cannot affect the same period of deforestation so he pointed out lagged population growth rate can be good indicator. According to Capistrano and Kiker (1995), intrusion of human activities into the forests can be increased due to change of government policies for food security requirement in the countries.

Beyond the negative correlation to deforestation, there has also positive relation to forests such as increasing in yields with improvement in agriculture, decreasing price in alternative fuels and upgrading in technology. Deforestation can be reduced when unit area of agriculture field produces more yield than normal yield so the requirements of land for agricultural land expansion will be reduce. Many researchers do research under the above assumption. Southgate (1994) proved that assumption but Burgess (1992), Chakraborty (1994) and Lombardini (1994) didn't prove due to insignificant results. Shafik (1994) found that opposite assumption, falling prices in electricity (alternative fuels) has significant positive relation because of the variable should be interpreted not for alternative way of fuel wood consumption but for price distortions or market orientation.

When investment is used as explanatory variable for deforestation, technology is essential assumption but measurement for technology is difficult (Shafik, 1994, p. 92). Investment can have negative affects with increasing demand on forest products or positive impact with efficiently using forest products for reducing forest covers. According to Shafik,

investment in infrastructure is complement to forest products and technology is linked with the function of world trade. With increased share of trade in GDP, there is comparative advantage in manufacturing of products such as extraction of industrial round wood. On the other hand, positive outcome can be expected in relation between technology and international markets especially in developing countries (i.e. the more upgrading technology can reduce the deforestation rate). In the finding of Shafik, low rate of deforestation occurs in country with high trade with international markets but indicator for technology improvement haven't strong correlation with deforestation in the Shafik model.

Kahn and McDonald (1994) studied the relation between deforestation and per capita consumption (GNP). Long-term considerations are not important in the process of deforestation (i.e. per capita consumption should be above lowest level). Their assumption is that rate of deforestation is decreased by indicators that increase GNP otherwise deforestation is increased by indicators that decrease GNP. So they used labour force that have positive effect on GNP and then negative relation with deforestation. When GNP is applied as a scaling factor, the incorrect coefficient came out and then the labour force's coefficient became insignificant results if indicators were scaled by size of population. Technology can be alternative for labour force with lower values utilizing for more developed state or more modernized technologies in their explanation (Kahn and McDonald, 1994, pp. 64-65). The variables they used in the models are difficult to expect the coefficients' sign of the correlation with deforestation. Among these variable, income indicators have good sign for both production and environmental system of various tropical forests. On the other hand, the using of products from forests can be raised when income per person increases (see for example Capistrano and Kiker, 1995). Additionally, rate of deforestation is fallen when countries has high income which is invested in forest related industries (Rudel, 1994, pp. 99-100). On the contrary, destruction of

forests reduces with increasing per capita income levels by protecting and conserving forests (Barbier and Rauscher, 1994; Deacon, 1994).

There is different relation among deforestation and level of income indicators in various studies. Negative connection between deforestation and variables related with income found by Burgess (1992) and Deacon (1994), but positive correlation found by Lombardini (1994) and Rudel (1994). But sometime income variable cannot explain the deforestation significantly in the studies of Allen and Barnes (1985), Lombardini (1994) and Shafik (1994).

In 1994, Deacon studied the relationship between national security as political status indicator and rate of deforestation. The hypothesis is that the weakness of security in the management for forests sustainability has negative effect on the loss of forest covers. The outcome from his study proved the hypothesis. On the other hand, the result is opposite in Shafik (1994) study. He found that the more forest cover is lost with the more political strong nations. The reason for the result is that more democratic nations are forced by groups of lobby so enforcement for conserving forests will decline.

3. Methodology and Data

3.1 Methodology

In order to conduct the empirical analysis on the causes of deforestation, cross-sectional study was taken for eight countries in Southeast Asian region. According to Rajan R. G. and Subramanian, A. (2008), some weakness in cross sectional OLS is that cannot eliminate endogeneity problem due to possibility of omitting variables. After that applying lagged endogenous indicator in cross-sectional analysis create questionable for model of regression. This gap can be filled by panel data analysis because the analysis can solve the problem of endogeneity. Panel data analysis is conducted with both fixed effect model and GLS random effect model after that Hausman test uses to know best model form both. And eight countries for twenty-four years from 1991-2014 use in this study.

The dependent variable of a certain country in a certain period is determined by the areas of forest. Negative and significant coefficient would be signified that the independent variables except planted forests area and GDP per capita (size of population, areas of arable land, areas of permanent lands, production of round wood, production of fuelwood) have negative impacts on area of forests in certain country. The independent variables have either negative or positive and either significant or insignificant coefficient depending on studies areas, periods and different assumption on deforestation rate by various studies. The Null Hypothesis I will be testing is that all independent variables have no effect on the areas of forest.

The Hausman test for choosing best model between GLS random effect and fixed effect shows that the fixed effects estimation is adequate because chi-square value is significant on 1% level (Table-3). Table 3 show that null hypothesis is that no correlation among independent variable and error term, and test statistics is distributed asymptotically as chi-squared with degree of freedom equal to the number of independent variables. The value of calculated chi2 I rejected the null hypothesis due to the value of calculated chi2 is significant at 5 percent level. So fixed effect model is good for my regression.

Table 3

Hausman Test to choose good model

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                 ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       re           fe       Difference          S.E.
-------------+------------------------------------------------------------
lnPlantedF~t |   -.3019692    -.0853066      -.2166626        .0788486
lnPopulation |   -2.289417    -.6710747      -1.618342               .
lnArableLand |    1.507802    -.6660683       2.173871        .1781133
lnPermanen~d |    1.083444     -1.68994       2.773383        .1742313
lnRoundWoo~o |    1.081434    -.0302043       1.111639        .0857527
   lnFuelPro |    .2541236    -.3147873       .5689109        .2974942
   lnGDPReal |   -.0765856     .7955796      -.8721652        .1984996
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(7) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =     1006.67
                Prob>chi2 =      0.0000
                (V_b-V_B is not positive definite)
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So cross-sectional effects that are a group of dummy variables by country where each country gets its own variable will be used. The parameters of regression by ordinary least squares (OLS) was allowed by using fixed effects panel regression. It is safe to assume some differences in the level of economic development, politics, administration and finance in the panel of interested countries, cross-sectional residuals differences might occur, which would in turn signify heteroskedasticity.

For analyzing the causes of deforestation in the Southeast Asian countries use both descriptive and econometric method. The descriptive statistics for both explanatory variables and dependent variable was applied to tell the function of every country in the study. After that, panel data econometric analysis was applied in three approaches to measure the causes that destroyed forests areas. The reason doing three approaches is how direct causes, indirect causes and effect of plantation on primary forest covers. In the first approach, all causes (independent variables) will be used. In the second approach, I will use both direct and indirect drivers of

deforestation (arable land, permanent agricultural land, round wood production and fuel wood production, population, per capital GDP). In the third approach, use I will use only direct drivers of deforestation (arable land, permanent agricultural land, round wood production and fuel wood production).

To capture the cause and effect relationship between forest cover and the factors that contribute to its destruction, a simple linear regression model is developed.

$Y_{it}=\alpha_{it} + \beta 1 lnpop_{it} + \beta_2 lnarable_{it} + \beta_3 lnpermanent_{it} + \beta_4 lnround_{it} + \beta_5 lnfuel_{it} + \beta_6 lnGDP_{it} + \varepsilon_{it}$

Where Y_{it}= natural log of forest area 1991-2011

$lnplanted_{it}$ = natural log of total population 1991-2011

$lnpopulation_{it}$ = natural log of total population 1991-2011

$lnarable_{it}$ = natural log of arable land 1991-2011

$lnpermanent_{it}$ = natural log of permanent agricultural land 1991-2011

$lnround_{it}$ = natural log of round wood production 1991-2011

$lnfuel_{it}$ = natural log of fuelwood production 1991-2011

$lnGDP_{it}$ = natural log of per capital GDP 1991-2011

ε_{it} = error term

3.2 Data

Annual primary forest land will be used as dependent variable. The independent variables will be total population, fuelwood production, round wood production, area of agricultural land, annual planted forest areas, and GDP per capita at constant price. Macro level secondary data will be collected from FAOSTAT and World Bank indicators for each countries in Southeast Asia. I will analyze only eight countries in the region (Cambodia, Indonesia, Lao PPDR, Malaysia, Myanmar, Philippines, Thailand and Vietnam) expect Singapore and Brunei because forest covers in both countries are relatively small and do not depend on forest resources for their economic growth.

Table 4

Types of Variable Used in Regression Analysis

No.	Variable	Unit	Acronym	Variable Description	Source
1	Primary Forest Area	Hector	PrimaryForest	Dependent	FAO
2	Planted Forest Area	Hector	planted	Independent	FAO
3	Population	Person	population	Independent	FAO
4	Arable Land Area	Hector	arable	Independent	FAO
5	Permanent Agricultural Land Area	Hector	permanent	Independent	FAO
6	Round Wood Production	Cubic Meter	round	Independent	FAO
7	Fuel Wood Production	Cubic Meter	fuel	Independent	FAO
8	Per Capita GDP (constant at 2005)	USD	GDP	Independent	FAO

3.2.1 Dependent Variable

Primary forest cover in hectares for each country was used as dependent variable to assess the main causes of deforestation. The variable is the total land uses as forest over total land areas and data for the variable in study periods was taken from Food and Agriculture Organization (FAO). Due to difficult access to data for forest cover changing or annual rate of deforestation which were used in most previous studies, I used primary forest land cover as dependent variable in the study. As I mentioned concept of deforestation in the literature review parts, concept of deforestation may differ from broad (consider both logging and ecological value of forests) to general (consider only wood extraction activities). So, I use primary forest cover to know destruction of forests by logging and deterioration of ecosystem (forest degradation) in the Southeast Asian region.

3.2.2 Independent Variables

Population growth indicates an increasing requirement for agricultural and forest outcomes. Steadied population in rural areas, increased food consumption per person and expensed urban areas and population in near future encourages the deforestation rate which is reinforced by global market demand and population growth. This paper hypothesized that coefficient of total population to forest areas should be negative because increasing in population is one of the commonly mentioned deforestation causes. Similarly, GDP per capital should reduce pressure on the forests because economic growth is correlated with alternative to wood production for commercial purpose and the indicator for GDP should positively relate to annual forest area. Wood production is one of the most serious destructive actors to the natural forest areas in the region. Thus round wood production is a kind of major driver of forest land reduction in the region and it is used as another explanatory variable in the study and the coefficient is expected to have negative. In addition to export of timber commercially, forest provide fuelwood for local populations in developing countries. Fuelwood are used at household level for cooking and heating especially in rural areas. In this study, the coefficient of fuelwood production variable is expected to have negative sign since higher fuelwood production is connected to a decrease in forest cover. Furthermore, planting forests have been taken place the areas for clearing felling and shifting cultivation in the region. Plantation forests can either decrease or increase the forest cover. So I expect either positive or negative coefficient from the coefficient of the plantation indicators. Increasing agricultural yields has been the predominant mode for increased food production for the last several decades, but intensification can lead to more deforestation in some circumstances. In my study, I divided agricultural lands into arable land (temporary crop land) and permanent agricultural land. As the increasing in areas of agricultural land in linkage with growth rate of population in a general

cited driver of deforestation, we would assume that changing in agricultural land in both types would affect negatively to change in forest cover.

4. Result and Discussion

4.1 Result

The table below present a descriptive analysis.

Table 5

Descriptive Statistics

Summary Statistics

	lnPrimaryForest	lnplanted	lnpopulation	lnarable	lnpermanent	lnround	lnfuel	lnGDP
OBS	24	24	24	24	24	24	24	24
MEAN	14.55	13.28	17.52	15.43	15.04	15.29	16.55	6.8
S.D	1.7	1.85	1.11	1.08	1.11	1.64	0.96	1.08
MIN	11.33	8.33	15.29	13.59	13.6	11.64	14.78	4.34
MAX	17.72	15.41	19.35	17.02	17.33	18.12	18.61	8.9

According to the regression result, it can be stated the same trend with some of the references papers that have been presented in the literature part. But the result deals with round wood production is not serious cause in the regions. The following table is the table (Table-5) below will present the results of the panel regression with fixed cross-sectional effects with all three approaches.

Table 6

Panel analysis with fixed effects

lnPrimaryForest	**Fixed Effects Model**		
	First Approach	Second Approach	Third Approach
Constant	63.39(10.64)***	66.21 (10.82)***	30.98 (10.95)***
lnplanted	-0.09 (-3.71)***		
lnpopulation	-0.67 (-3.53)***	-0.63 (-3.21)***	
lnarable	-0.67 (-5.29)***	-0.912 (-8.24)***	-0.31 (-2.67)***
lnpermanent	-1.69 (-17.18)***	-1.69 (-16.56)***	-0.81 (.13.59)***
lnround	-0.03 (-1.57)	-0.037 (-1.89)*	0.034 (1.52)
lnfuel	-0.31 (-2.81)***	-0.35 (-3.03)***	0.0005 (0.00)
lnGDP	0.80 (9.30)***	0.76 (8.64)***	

Note: * reflects significance at 10 % , ** reflects significance at 5%, significance at 1%**

t-statistics are reported as parenthesis

First Approach – equation described in methodology section

Second Approach – equation both direct and indirect causes (excluding lnplanted)

Third Approach – equation only direct causes (lnpopulation, lnarable, lnpermanent, lnround, lnfuel)

According to the above table results, we can find that except round wood production, all variables are highly significant (at 1% level) while round wood production is not significant. This results approves that all previous studies still have carried out. The coefficient of planted forests is 0.09 with negative relation (which means primary forest covers reduce 0.09 % by increasing 1 % of planted forest). The annual population coefficient is 0.67 which means that 1 % increased in population is will roughly decrease 0.67 % of primary forests. Arable land

has 0.67 coefficient and negative relationship so increased 1% in arable land is associated with 0.67 % decrease in annual forest areas as it shows negative. By increasing 1 % of permanent agricultural area will decrease the primary forest cover by nearly 1.69 %. An increased of 0.76 % in primary forest areas will rise to 1 % increase in per capita GDP. With the increased of 1% increased in both round wood production and fuel wood production, the primary forest covers will be reduced to 0.03 % and 0.31 % respectively but not significant in round wood production.

Based on the above analysis, we can see different findings from regression results without planted forest indicator. In this result, all variables except round wood production are strongly significant at 1 % level. The reason for insignificance is that most of the round wood for commercial was extracted from the planted forest areas. Coefficient of annual population is 0.63 and also has negative relation. Both arable and permanent agricultural land have 0.91 and 1.69 coefficients with negatively correlation respectively. Increasing 1% in both round wood and fuel wood production in negatively related with the loss of forest cover 0.04 % and 0.35 % respectively. Per capital GDP (constant at 2005) is positively related by 0.76 % coefficient at 1 % significant level.

For the third approach, large different results come out after running with only direct causes of deforestation. Effects of round wood production and fuel wood production are changed into insignificance. The reason is that production of forest products cannot be apparently stated as one of the direct causes of deforestation. The coefficient of arable land is 0.31 with negative correlation at 1 % significant level. With relation of permanent agricultural land, 1 % increases in permanent land reduces primary forest cover by 0.81 %.

4.2 Discussion

Analyzing the relation between the dependent variable, annual forest areas and the independent variables, annual population, arable land area, permanent agricultural land area, round wood production, fuel wood production and per capita GDP variables was carried out

based on regression model with panel fixed effects model with three different approaches. According to regression results, present of forest areas is significantly related to all explanatory variables except round wood production indicator in the first approach, all explanatory variables (without planted forest variables) are significant in the second approach and only agricultural expansion indicators (arable land variable and permanent agricultural land variable) are significant but forest products indicators (round wood production and fuel wood production variables) are not significant.

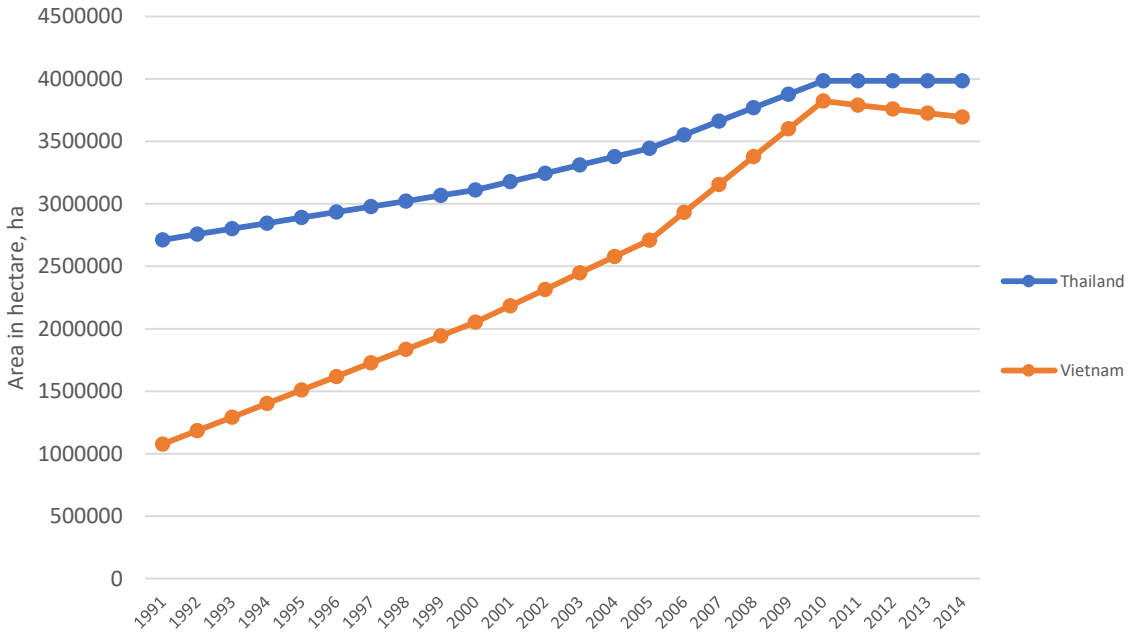
In the first approach, deforestation or loss in forest covers is caused by growing population, high agricultural expansion, expansion of plantation areas and fuel wood production during the period of 1991 to 2014 in the Southeast Asian Region. The outcomes proved the hypotheses described in the literature review section but did not provide any clues for rising round wood extraction (not significant result). All indicators except round wood production in the first approach kept increasing over time with the decrease in forest cover in the region. Among all causes of deforestation, permanent agriculture land is the most influencing indicators with the coefficient of nearly 1.69 % in the region, the second are arable land (approximately 0.67 % of coefficient) and annual population (approximately 0.67% of coefficient), the third is fuelwood production (approximately 0.35 % of coefficient) and the final or least destruction for forests is round wood production (approximately 0.04 % of coefficient with insignificant result). The indicator which shows strongly positive relation and increase the forest cover is per GDP capital with nearly 0.80 %.

After removing the plantation data, most results show that all causes have same effect on deforestation. In the second approach, round wood production is significantly responsible for deforestation which is opposite result of first approach but all other indicators are standing the same in their ranks. The reason is commercial round wood from plantation forests not form natural closed forests (primary forests). Two countries in the region (Thailand and Vietnam)

increases obviously their forest cover by planting forests. In Thailand, plantations are taken in the areas of temporary agricultural land. In Vietnam, government promote programme for replanting of trees like reforestation and afforestation activities. The figure shows that both countries perform planting activities since 1991. The planted forest areas (plantations) are increased, reaching around 531,000 hectares annually in the region by comparing with the existence in 1991. The growth rate of planted forest depends on government policies (which promote the establishment of plantation for wood production and forest conservation).

The increasing demands in both forest land clearance and forest products has inclined to losing forest cover and degraded forest quality in the region. Growth rate of population induced increasing demand in both agricultural products and forest products and also services in the region. Besides, as world's agricultural market was gradually growing, land-use was changed from naturally closed forests to agricultural land. So all explanatory variables related with agricultural lands in this study show negatively relation with forest cover.

Figure 3: Status of Plantation Forests



Sources: Food and Agriculture Organization of the United Nations (FAO), Global forest resources assessment 2015.

In the third approach (only considering direct causes of deforestation), the results revealed deforestation in forest production indicators (production of round wood and fuel wood). The means is that forest production does not affect the changes of forest coverage in relation with the direct drivers of deforestation due to the decline in production of forest products. According to FAO, the decreasing pattern in sharing portion of forest products is 9.9 % to 9.2 % in all commercial plantations, 6.4 % to 4.7 % in production of industrial round wood and 6.0 % to 5.1 % in world's forest cover (FAO 2005a; FAO 2009). Table-6 presents the rank of causes of deforestation from the most serious to the least in the region based on the regressions with three approaches of this paper. Table-6 shows only the ranks of variables with significant results in three different approaches of regressions with fixed effect model.

Table 7

Ranking of Impacts by explanatory variables on Primary Forest Cover

No.	**Variable**	**Sign of Impact with three approaches**			**Strength of Impact with three approaches**		
		1st	**2nd**	**3rd**	**1st**	**2nd**	**3rd**
1	Permanent Agricultural Land Area	Negative	Negative	Negative	1.69	1.69	0.81
2	Arable Land Area	Negative	Negative	Negative	0.67	0.91	0.31
3	Population	Negative	Negative	-	0.67	0.63	-
4	Fuel Wood Production	Negative	Negative	-	0.31	0.35	-
5	Planted Forest Area	Negative	-	-	0.09	-	-
6	Round Wood Production	Negative	Negative	-	-	0.04	
7	Per Capita GDP (constant at 2005)	Positive	Positive	-	0.80	0.76	-

5. Conclusion and Policy Recommendation

5.1 Conclusion

This study examined that the most serious causes of deforestation with rank indicators using in the study with panel data fixed effect model with three approaches (only direct causes, mixture of direct and indirect causes and planted forests, indirect and direct causes). Annual population, arable land areas, permanent agricultural land area, round wood production, fuelwood production, per GDP capital (constant at 2005) and planted forest areas (plantations) are used to know the most responsible causes of deforestation in the region. The variables are based on both previous literatures and reports from Food and Agricultural Organization (FAO). Data are collected from FAO for period 1991 to 2014 (24 years) in eight countries in Southeast Asia (Cambodia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Philippines, Thailand and Vietnam).

After conducting regression model in three approaches, permanent agriculture is the most responsible cause among other indicators, and arable land expansion follows it. The population growth is the third responsible causes. In only two approaches (except only direct causes), fuel wood production is the fourth and round wood production is fifth. In the combination of planted forest areas to direct and indirect causes, planted forests became the fifth responsible factor and then followed by round wood production with insignificant result. In the region per capita GDP (constant at 2005) as economic indicator contribute the forest cover with positive ways (reduce the rate of deforestation).

In this study, most data which can easily collected are used. So all indicators in this study will not cover both direct and indirect causes of deforestation in Southeast Asian region and also need to analysis on indicators which increase the forest areas and reduce deforestation.

5.2 Policy Recommendation

Natural forests in the Southeast Asia play an important role in maintaining services of ecosystem, reducing carbon emissions, protecting watershed areas and conserving wildlife. Malaysia, Thailand, Philippines and Viet Nam have various trends in forestry sector because of a differencing in relation for long-term among forest resources and drivers for destroying forests such as growing population, expansion of agricultural land and wood productions. Remaining countries (Cambodia, Indonesia, Lao PDR and Myanmar) are facing with decreasing in forests areas because of weakness in forest law enforcement and unsystematic extraction of woods.

If forests of Cambodia will keep losing in the same way as the past decade, the rate of economic concessions allocation should be reduced since rate of deforestation could be reduced by international economic downturn. And then shrinkage of forests could be reduced by carrying out REDD (Reducing Emission on Deforestation and Forest Degradation) programme. Like Cambodia, Indonesia can face with continuous forest area losing gradually during recent years. The rate of losing forests will be maintained by establishing more commercial planted forests, implementing REDD related activities, recovering from international economic slowdown and then promoting governance roles related in forestry sector. In Lao PDR, forests are destroyed by growing population, instruction of agricultural land, unsustainable agricultural practices and wood extraction practices and infrastructure development. Improved efficiency of government and increasing transparency in all sectors will recover the forest cover by making law enforcement in forest related sector. Like above two countries, REDD related strategy will be an opinion to reduce deforestation and then to build capacity in all level in the forestry sector for better conservation of forest. In the case of Myanmar, the consequences of the past decade such absent of systematic land-use strategy, extreme dependency on extraction of natural resources for economic growth, weakness in political condition and economic status

could reduce forest areas. Like Lao PDR, active participating in REDD programme, increasing transparency in government sector, reducing corruption, adopting sound land use plan and reducing dependency natural resources for economic growth can be solutions to reduce deforestation. The remaining four countries did not face with serious deforestation in the region but suffering with forest degradation. Governments in those countries encouraged establishment of forest plantations and participation in REDD-related activities. Most of the degraded areas (areas leaving after carried out agriculture) were established plantations. Participating in REDD related activities will be one available option to reduce deforestation.

We need to increase the yield of agriculture per acre within the limited arable land and permanent agricultural land and then need to protect natural forest resources by increasing productivity form agricultural and livestock enterprises to secure food. So proper land use mechanism requires for sustaining security of food as well as fuelwood, forest related products and other intangible services. Practicing agroforestry system is one solution to reduce expansion of agricultural land. Agroforestry system is a kind of land use system which uses advantages of crops and plants and trees. The system can offer not only increasing productivity and income but also improved sharing benefit equally, and then can get sustainable management and use of forest resources and agricultural crops.

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