
Graduate School of Development Studies

# The Dynamics of Forest Clearance and Socio-Economic Development in West Kalimantan

A Research Paper presented by:

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in partial fulfillment of the requirements for obtaining the degree of
MASTERS OF ARTS IN DEVELOPMENT STUDIES

Specialization:
**Economics of Development**
**(ECD)**

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The Hague, The Netherlands
August, 2010

## *Disclaimer:*

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# Acknowledgement

First of all, I would like to thank Almighty God who gives me strength and guidance in my overall study in ISS. Nothing I can do without Him.

Next, I would like to thank my supervisor, Lorenzo Pellegrini, for his ideas and inputs on the process of finishing my research paper.

I would also say thank you to Arjun Bedi as my second reader. Thank you for the way out you had given to me when I could not find the solution for my data management.

My gratitude also goes to Robert Sparrow for his willingness to share the data I needed and the inputs and suggestion in my seminar. I really appreciate your time and willingness to discuss my data which is very helpful for me.

Thank you to Jan van Heemst as our convenor who always monitoring us and encourage us to finish our RP in time.

I would also say thanks to the Bappenas, NESO Indonesia, Universitas Indonesia, and ISS for giving me a chance to have this new experience in my life.

I also do not forget to say thank you to the Ministry of Forestry, *Balai Pemantapan Kawasan Hutan (BPKH) Wilayah III Pontianak*, with all its directors and staffs. Thank you for giving me trust, opportunity, and the material assistance to me to pursue my education in this country. To "Mas Hery", "Mas Ahmad", and Handayani who have bothered to help me in providing the data, I also thank you profusely.

Thank you deeply I also convey to the family who loves me and I love. I just cannot describe how lucky I am to have family who always support and pray for me, so that I can get through my degree here. Mom, Dad, my brother "Resvan", my sisters "Betty, Yanti, and Easter", thanks for always encourage me to do the best. My mother-in-law and my brothers-in-law and sisters-in-law, thank you for the support. I love you all and I dedicate all this for you.

From the deepest of my heart, thank you to my dearest husband for your pray, smile, love, patient, support, and understanding. I really blessed to have you in my life, love you. Hope now you will be relieved after this tough year.

Finally, many thanks to all the ECDers, ECD DD (Raja, Vale, Dina, Endra, and Shintong) for our friendship in the hardest year in ISS. Raja, thank you for the discussion and for helping me in dealing with Stata and the data management. Vale, Dina, Endra, and Shintong thank you for the discussion and motivation to finish my study here. I also would like to say thank you for the friendship and cooperation from friends in PPI Kota Den Haag (special for Tyka, thanks for always 'motivate' me to finish my RP "good luck for your RP too girl").

# List of Acronyms

| | |
|---|---|
| 2SLS | = Two Stage Least Squares |
| BPS | = Statistics of Indonesia-*Badan Pusat Statistik* |
| EDI | = Economic Diversity Index |
| GDP | = Gross Domestic Products |
| GIS | = Geographic Information System |
| HPH | = Forest Concession-*Hak Pengusahaan Hutan* |
| OLS | = Ordinary Lest Squares |
| Podes | = Village Potential-*Potensi Desa* |
| Susenas | = Indonesian National Socio Economic Survey-*Survei Sosial Ekonomi Nasional* |
| VDI | = Village Development Index |

# Abstract

This study tries to examine the relationship between income of local household and deforestation in forest area in West Kalimantan, Indonesia. This study conducted is based on village level data. There are two types of data used in this study: spatial data and village level data and household survey information. Spatial data is used to find the changes of forest cover in Province West Kalimantan from period1998 – 2004. Forest cover and forest cover change data are derived from Interpretation of Satellite Image Landsat 7 ETM+ 2002/2003 for forest cover in 2002 and 2003 which has been overlaid with Administrative Map by using ArcView, software of GIS. Data for income per capita and household characteristics are obtained from *Susenas* (National Socio-Economic Survey) in 2004. Village infrastructure condition is obtained from Village Potential Survey (*Podes*) in 2003.

Using those combinations of data, allow this study to implement spatial econometric approach to examine the impact of forest clearance on the household income.

The result shows that between period 1998 and 2004, forest clearance has non linear U-shaped relationship with income per capita of household. This result suggests that when deforestation starts to increase, income will be decreasing, but when deforestation rate reaches the minimum point, income will start to increase as the deforestation increase. It also indicates that people in our observation still dependent on forest activities.

Furthermore, we also investigate the relationship between income per capita, deforestation, and forest cover. We use threshold of 1% deforestation rate and 1% level of forest cover. The findings show that the there is a positively weak relationship between deforestation (forest clearance) and income.


## Relevance to Development Studies

Relationship between income and deforestation is different among the places. Lower level of observation such as household as unit analysis will give more significant impact of deforestation to the local people's welfare. The study tries to find out how deforestation impacts the welfare of the people who live with forest cover area. We will find out the dependency of local people on forest and how to increase their welfare when deforestation happened by estimating the relationship between deforestation and income.


## Keywords

Deforestation, income of rural household, welfare, West Kalimantan

# Chapter 1. Introduction

The issue of natural resources and economic growth has been widely studied in all over the world. Study across countries shows that countries with abundant natural resources tend to grow slower than countries with poor natural resources (Sachs and Warner, 2001). Region or countries with natural resource abundance are known as less developed countries. However, some studies also found that natural resources might give positively contribution to increase the income of the country (Naidoo, 2004).

In Indonesia in 1990's, forestry sector gave positive impact to the country by increasing the economic growth and absorbing employment. In 1992 – 1997 forestry sector give US $ 16,0 billion to Indonesia economy or average 3,5% from national GDP (Statistic of Indonesia, 2000). However, after the forest degradation happened in 1997 – 2003, there was a decreasing as 16,6% number of foreign exchange (Bappenas, 2003 in Ministry of Forestry, 2005).

Forest cover clearance in large scale is usually done as a way to enhance economic development and community. The proponent of deforestation argues that by opening the forest area, the economy of the people will be better-off. However, it is still not clear or doubtful whether the deforestation will cause economy better or worse. The other thing needs to be clarified is the impact of forest cover on the people's economy.

One of the causes of the decreasing contribution of Forestry sector is the decreasing number of timber production as an impact of deforestation. Rate of deforestation in Indonesia is increasing every year. Deforestation rate in period 1997- 2000 amounted to 2.83 million hectare / year (in forest areas for the five major islands) or 3.51 million hectare / year (outside and inside the forest area for the five major islands). In addition, between 2000 and 2005, deforestation rate for five large islands inside and outside the forest area is 0.84 million hectare / year or 1.08 million hectare / year for all of Indonesia on the inside and outside the forest area. In period 2003 – 2006 there is an increasing rate of deforestation into 1,17 million hectare/year (Ministry of Forestry*, 2008).*

Different studies about deforestation give different results about the causes and the actors of deforestation. Study by Kustiyana (2004) shows that the causes of forest cover conversion in Indonesia mainly are because of agriculture plantations, mining, road and building, forest concession, and migration. Another study in Indonesia by Tjandrakirana (2005) mentioned the causes of deforestation are many, such as the increasing number of forest area being converted to agriculture, government policy on region development, number of HPH (forest concession), illegal logging, and other causes. Noor (2004) in his study found that economy activities also impact deforestation. Trade, restaurant, and hotel are showed as the highest activities that cause deforestation in District Kutai Timur, East Kalimantan. These happened because timber is much needed for those sectors to run well, especially the use of fuel wood for cooking.

Furthermore, the actors of deforestation are different among places. It is difficult to sort out the role of different actors in the same location (Sunderlin et al., 1997). In Brazil, most deforestation case is in large scale and done by well equipped actors (Chomitz et al., 2007: 55-56). In Indonesia, Curran, et al. (2004) mentioned that the actors of deforestation in Kalimantan are not primarily local human population density, smallholder agriculture or paved roads. The most influence actors in increasing the number of timber extraction is firm timber or log concession. There are two reasons why number of logging in protected areas in Kalimantan increased. Those reasons are the implementation of decentralization in 2001 and the intensification of oil palm plantation. Since 1992 – 2002, the area of oil palm plantation was increasing 40 times, from 900 $km^2$ to 35.000 $km^2$. However, indigenous people are often blamed for the degradation of the forest cover. Although some evidence shows that indigenous people only give small contribution of deforestation.

In most places with high forest cover, indigenous people around the forest commonly live with poverty, inequality, underdeveloped. They usually very dependent and mostly they are corresponded to forest clearance. It is because they have little opportunity to find other job to earn the living. However, even they live near the forest resources; usually the poor people rarely get benefits from the forest abundant resource. They have no bargaining power to decide how to utilize the resources from forest and to convert the land use. Sometimes the decision to change the forest cover does not involve the people around the forest, although they are close to the source of resources. Indigenous people can only receive the policy that already decided by the government or by outer people.

Analyzing the relationship between the people's welfare and forest clearance (whether by local household, government, or firms) is important. We would be able to understand whether the impact of decision to change the forest cover will improve the livelihoods welfare or not by identifying and studying the relationship of people's welfare and forest clearance. In addition, when indigenous people are very dependent on the forest, forest clearance or deforestation will give negative impact on their welfare. In contrast, deforestation also can increase welfare of local people due to increasing in access to health, education, and market facilities.

This study will observe the relationship between decreasing of forest cover or deforestation on the local people economy. It will investigate the impact of deforestation as the main variables, other household characteristics, and development of infrastructure on the socio economic welfare of the people who live around the forest area in the study area. It uses local household as the basis of unit analysis due to the fairly homogeneous condition of the area and neighborhood and to the more significant impact of forest area on their living place. According to Kaimowitz and Angelsen (1998), research on economy and deforestation will be more productive if it is based on household and regional level.

The organization of this paper will be: Chapter two gives some literature about deforestation and economy. Chapter three describes some theoretical concepts and conceptual framework of this study. Chapter four explain data and variables included in the model. Chapter five shows model specification.

The empirical findings or result will be explained in Chapter Six. Finally, Chapter seven concludes.

## 1.1. Research Objectives

The aim of this study is basically to understand and identify the relationship between forest clearance (deforestation) and the economy of the rural livelihood in West Kalimantan.

## 1.2. Research Question

What is the relationship between forest clearance (deforestation) and economy (income) of local household around the forest?

## 1.3. Hypothesis:

In order to test the relationship between deforestation (forest clearance) and income (economy) of local household in West Kalimantan, our hypothesis is: when household dependent on forest resources, the result of relationship between deforestation and income will be statistically significant, whether positive or negative relationship.

## 1.4. Limitations of the Study

The study focuses on local household livelihood welfare while documenting the effects of deforestation. The household we discussed in this study is local household in West Kalimantan who lives around the village with forest cover. Income we used in this study is general income per capita from every household (not only forest income) we obtained from household survey data by Statistics of Indonesia (*BPS*). Deforestation data used in this study is percentage of forest clearance in period between 1998 and 2004 weighted by forest area in 1998.

The limitation of this study is that it is heavily relied on the secondary data from social economic surveys (*Susenas*) for the parameters of livelihood welfare. Some parameters might need to be observed by scientific methods or using primary data, but due to the time constraint, this was not possible to be conducted. This study also might not be able to capture all variables needed to explain the factors linking the income or the economy of the household to deforestation.

Another limitation of this study is the availability of the deforestation data that is very limited in time series and rarely can be overlaid into lower level, such as village. It makes somehow difficult to combine it with other data, such as Village Potential data. Moreover, it also hampered us to run panel data and give more comprehensive result of impact of deforestation on income.

In spite of the limitation, it is hoped that this study can give general description of relationship between deforestation and welfare of the rural livelihood.

# Chapter 2. Literature Review

The literature examining the relationship between economic growth and deforestation are huge, but the studies about the impact of deforestation on socio-economy are still limited. Those literatures usually compare the different condition across countries. Some of them are:

Chomitz et al. (2007) mentioned that the relation between forests, poverty, and deforestation is ambiguous. Area with high forest cover is usually remote area and there is high poverty. While deforestation also not always associated with opening agriculture field by smallholders, but sometimes it is also doing by commercial and rich people. Those relations make hard to find the solution for all the problems.

Study by Sunderlin, Dewi, and Puntodewo in 2006 shows the ambiguity of the relationship between poverty rates, poverty densities, and forest cover. This study was conducted at district level in seven countries. They found three countries from seven that have significant positive correlation, one country (Brazil) has negative relationship, and the others three have no significant relationship. Positive relationship is shown by Vietnam, where there are high poverty rates, low population densities, and high forest cover. While in Brazil, the relation is negative, where there is high poverty rates and low forest cover (Sunderlin, Dewi, and Puntodewo, 2006 in Chomitz et al., 2007).

Other study discussing the relationship between natural resource abundance and economic growth is by Brunnschweiler (2007) which argues that natural resource abundance has positive effects on economic growth. She examined the impact of natural resource endowment and the role of institutional and found that subsoil wealth has strong relationship with income by using OLS and 2SLS estimation.

On the other hand, the inverse condition that studies the impact of decreasing on environmental quality on economic growth is still not many being discussed. Some of literatures that already examine the impact of environmental degradation on the economy are:

Naidoo (2004) conducted a study about the impact of forest clearance on countries economy. It used GDP per capita in 1960 – 1999 as the dependent variable and included area of forest clearance in the independent variable. Many variables included to test the robustness, such as countries forest exports, economic development, agriculture area, and geography. He found that forest clearance give positive impact on economic growth by estimating economic growth of 70 countries.

Study about relationship between forest clearances is also deducted in household and village level. Dewi, et al. (2005) was trying to discover the relationship between intensifying economic opportunities, forest dependence in East Kalimantan. Study was conducted in 73 villages and using two types of dependent variables, one is Economic Diversity Index (EDI) and the other Village Development Index (well-being). The result shows when there is higher accessibility to markets and deforestation, the diversity of economic will also increase. The other result shows that increasing of well-being of village has

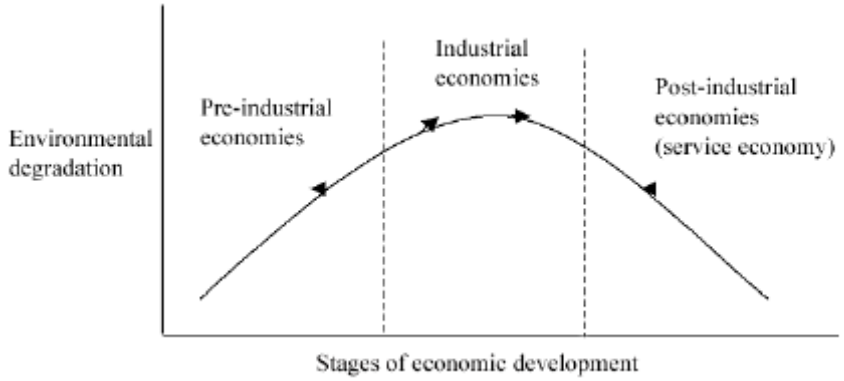
correlation with increasing economic diversity index, larger forest areas, intensive land use, higher endowments of agricultural and forest, also higher population.

Other relationship between economic growth and environmental degradation is by Panayotou (2003). There is an inverted-U relationship between environmental degradation and economic growth. When the development is in the low level, the environmental degradation will increase, but it will change at some point, when the stage of development reaches the maximum point. The environment degradation thus will continue to decrease when the stages of economic development getting higher. However, different country will have different sign and different way to changes.

The picture of relation between environmental degradation and economic growth as can be seen in Figure 1.

**Figure 1**

**Kuznets Curve**




Source : Panayotou (2003)

However, there is still little evidence regarding the impact of natural resources on economic growth within countries. In addition to that limitation, this study will try to observe the impact of liquidation of natural resource, in this case forest resource, on the economy of the indigenous people in Indonesia.

# Chapter 3. Conceptual Framework

## 3.1. Determinants of Deforestation

There are many causes of deforestation in different places in Indonesia. Sunderlin and Resosudarmo (1996) show causes of deforestation in Indonesia in Table 1.

**Table 1**

**Causes of Deforestation in Indonesia Overtime**

| SOURCE | TYPE OF CAUSE | | | | | | |
|---|---|---|---|---|---|---|---|
| | AGENT | | | | | UNDERLYING | |
| | smallholder | | | | | | |
| | shifting cultivation | spontaneous transmigrants | regular transmigrants | plantations & tree crops | timber industry | government / politics | economic development |
| World Bank 1990 | | | | | | | |
| FAO 1990 | | | | | | | |
| Dick 1991 | | | | | | | |
| WALHI 1992 | effects overstated | | | | | | |
| Barbier *et al.* 1993 | growing population density most important | | | | | | |
| Ascher 1993 | | | | | | Government - MOF alliance | economic diversification |
| Porter 1994 | | | | | | | |
| Dauvergne 1994 | | | | | effects understated | | |
| Thiele 1994 | effects overstated | | | | effects understated | | |
| World Bank 1994 | effects overstated | | | | effects understated | | |
| Angelsen 1995 | effects overstated | | | | | government land claims | exogenous price effects |
| MOF 1995 | effects overstated | | | | | | |
| Ross 1996 | | | | | | ruling coalition | |
| Fraser 1996 | population density | | | effects overstated | | | |
| Hasanuddin 1996 | small-holders blameless | | | | | | |
| Dove 1996 | effects overstated | | | | | national political economics | |

Source : Sunderlin and Resosudarmo (1996)

In Table 1, Sunderlin and Resosudarmo (1996) explain the actors and the causes of deforestation in Indonesia. The main actors are divided into smallholders and government. From different studies in Table 1, there are different causes of deforestation in Indonesia in different time. World Bank and FAO in 1990 found that the main cause of deforestation in Indonesia is smallholder through shifting cultivation and spontaneous transmigration. From the table, study by Dick (1991) shows transmigration, estate crops, and logging which are sponsored by government as the causes of 67% of all deforestation.

Kaimowitz and Angelsen (1998) also study the impact of various variables on deforestation. They include variables such as agricultural prices, population, transport cost, agricultural productivity, wages, off-farm employment, fertilizer prices, non-fertilizer input prices, credit, other input prices, and soil quality on their estimation to find the effect on deforestation. The effect of those variables on deforestation can be seen in Table 2. It shows that different causes give different impact on deforestation.

**Table 2**

**The Effect of Exogenous Variables on Deforestation in the Open Economy of Household Models**

| Variable | Effect on deforestation | Comments |
|---|---|---|
| Higher agricultural prices | Increase or reduce | Depends on assumptions |
| Population growth | Increase | May increase at a decreasing rate due to induced innovation |
| Lower transport costs | Reduce | Supports analytical models |
| Higher agricultural productivity | Reduce | |
| Higher wages | Reduce | Supports models with labour markets |
| More off-farm employment | Reduce | |
| Higher fertiliser prices | Increase or no effect | May increase shifting cultivation |
| Higher non-fertiliser input prices | Reduce | Other inputs complement land |
| More credit available | Increase or reduce | Reduces in surveys with indigenous people |
| Fertiliser price increase | Increase or no effect | May increase shifting cultivation |
| Other input prices increase | Reduce | Other inputs complement land |
| Higher quality soil | Increase | |

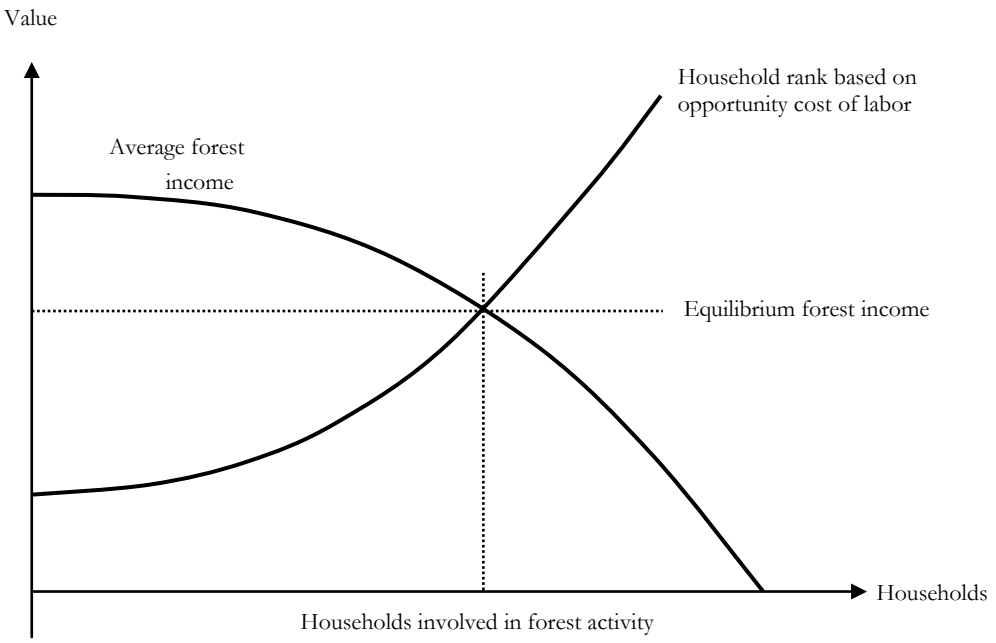
Source : Kaimowitz and Angelsen (1998)

## 3.2. Relationship between Income and Forest Dependency

Angelsen and Wunder (2003) show the relationship between numbers of household who depend on forest (doing forest activity) and income from forest as can be seen in Figure 2.

**Figure 2**

**The 'Employment of the Last Resort' Model**




Source : Angelsen and Wunder, 2003

Figure 4 shows the curve of employment on forest activity and the average income earned from it. The X axis is the number of households involved in forest activity. The Y axis represents the value. From the graphic we can see the upward curve showing the household opportunity cost to have another job rather than forest job. On the left curve is the position of household with the lowest opportunity cost to find another job besides forest job. On the other hand, household with higher opportunity cost to find another job is shown by inclining curve. Another curve is downward curve which shows average income earned by every household from forest job.

The opportunity cost to find other job is related to income to be earned from forest job. Furthermore, household income relates to resource base, technology, market prices, also number of people involved in forest activities. At some point, income of household from forest activities will be declining when there are more people dependent on forest. This happened because there is an increasing competition among households working on forest activities. When there are more poor people, the less income will be. Because they tend to depend on the forest

On the other hand, income of household could be increasing when the price of forest products increasing, but there is possibility that income will be lower compare to the increasing of the prices of things because more household will be interested in working in forest sector, so it will drive the income down. Income from forest is also increasing when people have more non forest income (job). It will decrease the competition on forest activities, so they will receive higher income from forest job. Assumptions behind the model are all households receive the equal share of income from forest, negative relationship between forest income and number of people involved in the forest activities, no seasonal fluctuations of demand of labor, household with better opportunities will find a job in different sector rather than activities from forest, while household with poor or little asset will get lower return from forest activities.

## 3.3. Benefits of Forest against the Income of Poor People

Forest communities are often associated with poor and backward communities. According to Angelsen and Wunder (2003), not the poor who usually get many benefits from the exploitation of the woods, but the rich people. Angelsen and Wunder (2003) explained some of the reasons why poor people often do not get much benefit from efforts to plant and harvest timber, which are:

1. Long time horizon
   Plant a tree takes a long time to return that cannot be ascertained; depending on the prevailing price of timber, other than it is vulnerable to risks (disease, fire).
2. High capital intensity
   To obtain high profits from timber-cutting activities, the amount of timber cut down should be a lot. Logging would require large amounts of equipment and adequate transport facilities, as well as an easy access to markets. Poor people generally do not have sophisticated equipment to harvest timber, as well as the means to transport the timber results. This causes the results that they could get would be much less than the logging companies that use more sophisticated equipment.
3. Advanced technology and skills
   Advanced technology and skills are needed in harvesting and processing the timber. Usually poor people have no ability to afford that.

## 3.4. The Effects of Deforestation

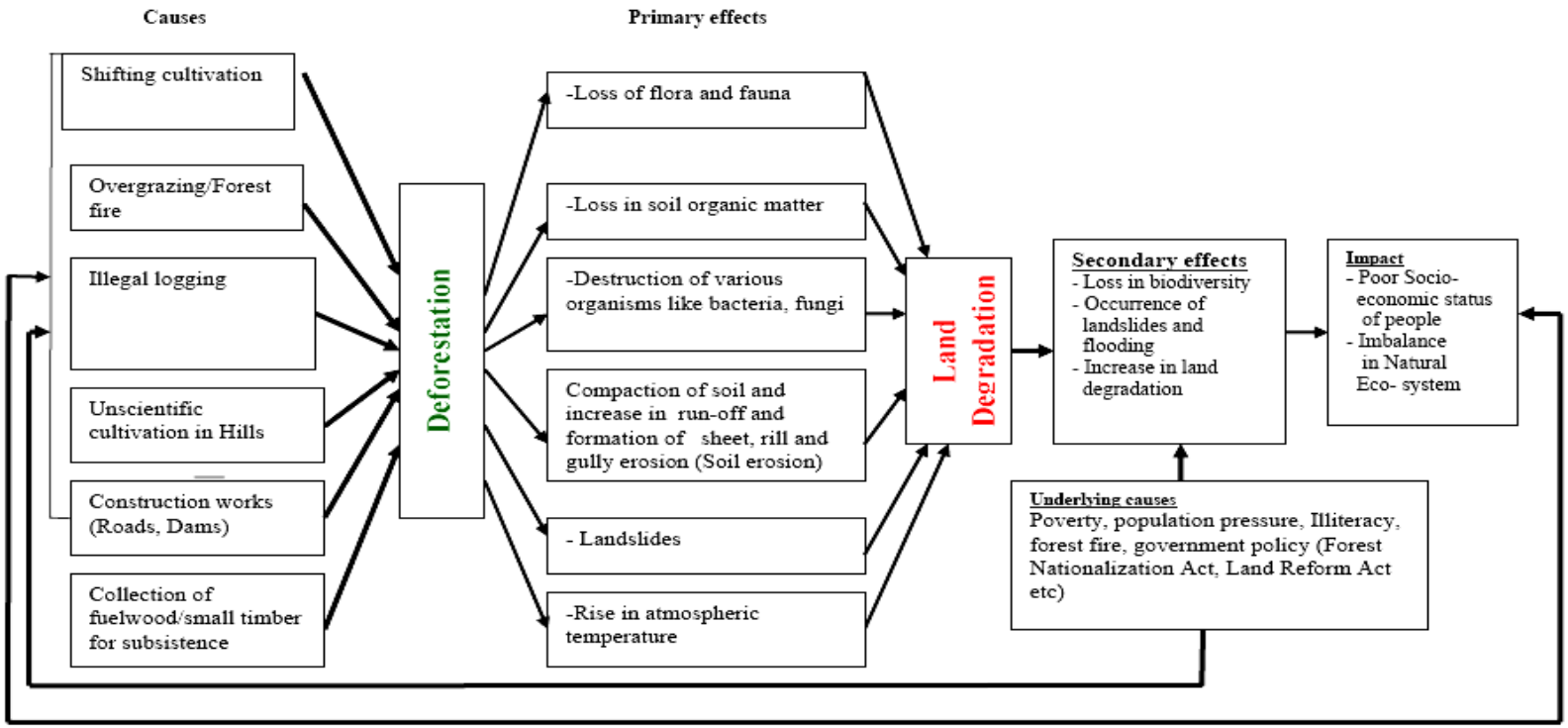
One study about the effects of deforestation in Nepal has been conducted by Karkee (2004). In this study, he drew the conceptual framework of relationship between deforestation and income as in Figure 5. In the left hand side, he shows the causes of deforestation in Nepal and in the right hand side he figures the impact of deforestation. According to his study, the causes of deforestation in Nepal are varies, such as shifting cultivation, overgrazing, illegal logging, unscientific cultivation in the hills, construction of physical infrastructures and collection of fuel wood. And one major cause is small timber of household.

The effects of deforestation are divided into two types, primary effects and secondary effects. The primary effects include losing of flora and fauna, losing in soil and organic matter, destruction of bacteria, soil erosion, landslides, increasing in atmosphere temperature, which in general can causes land degradation. Second effects are coming from land degradation. Land degradation can cause losing in biodiversity, incidence of landslide and flood, and increasing in land degradation. Overall, the impacts on livelihood are: poor socio -economic status of people and imbalance in natural ecosystem (Karkhee, 2004).

The conceptual framework of this paper will follow the literature by Karkhee (2004) at some point. However, we consider that our study cannot fulfill all the variables included in Karkhee's framework. So we just try to make indirect relationship between deforestation and income. Due to the limitation of time, our research cannot obtain data of biodiversity, landslide, and flood. We try to eliminate the gap by using the lowest level of data so that the impact of deforestation might be stronger than using higher level of observation.

**Figure 3**

**Overall Hypothesized Mechanism of the Effects of Deforestation**




Source : Karkee, 2004

# Chapter 4. Data and Variables

## 4.1. Data

There are 2 types of data needed to work on this study:

### *4.1.1. Spatial Data on Forest Cover*

We use spatial data to see the changes of forest cover in Province West Kalimantan, Indonesia. It is estimated from digital data map based on the Interpretation of Satelite Image Landsat (land cover) 7 ETM+ 2002/2003 for forest cover in 2002 and 2003. In order to obtain the changes of forest cover in every village, the interpretation map of forest cover has to be overlaid with Subdistrict Administrative Map by using ArcView, software of GIS. The diagram of process of mapping overlay can be seen in Figure 1.

The data of forest cover used is in period 1998 – 2004. The data were obtained from *Balai Pemantapan Kawasan Hutan Wilayah III Pontianak (BPKH 3 Pontianak*), a unit of Planology Agency of Ministry of Forestry in Pontianak, West Kalimantan. The deforestation rate data is calculated by subtracting forest cover in 2004 with forest cover in 1998 of every village, and then divided by forest cover in 1998. There are 204 villages with forest cover included in this observation. List of villages included can be seen in Appendices.

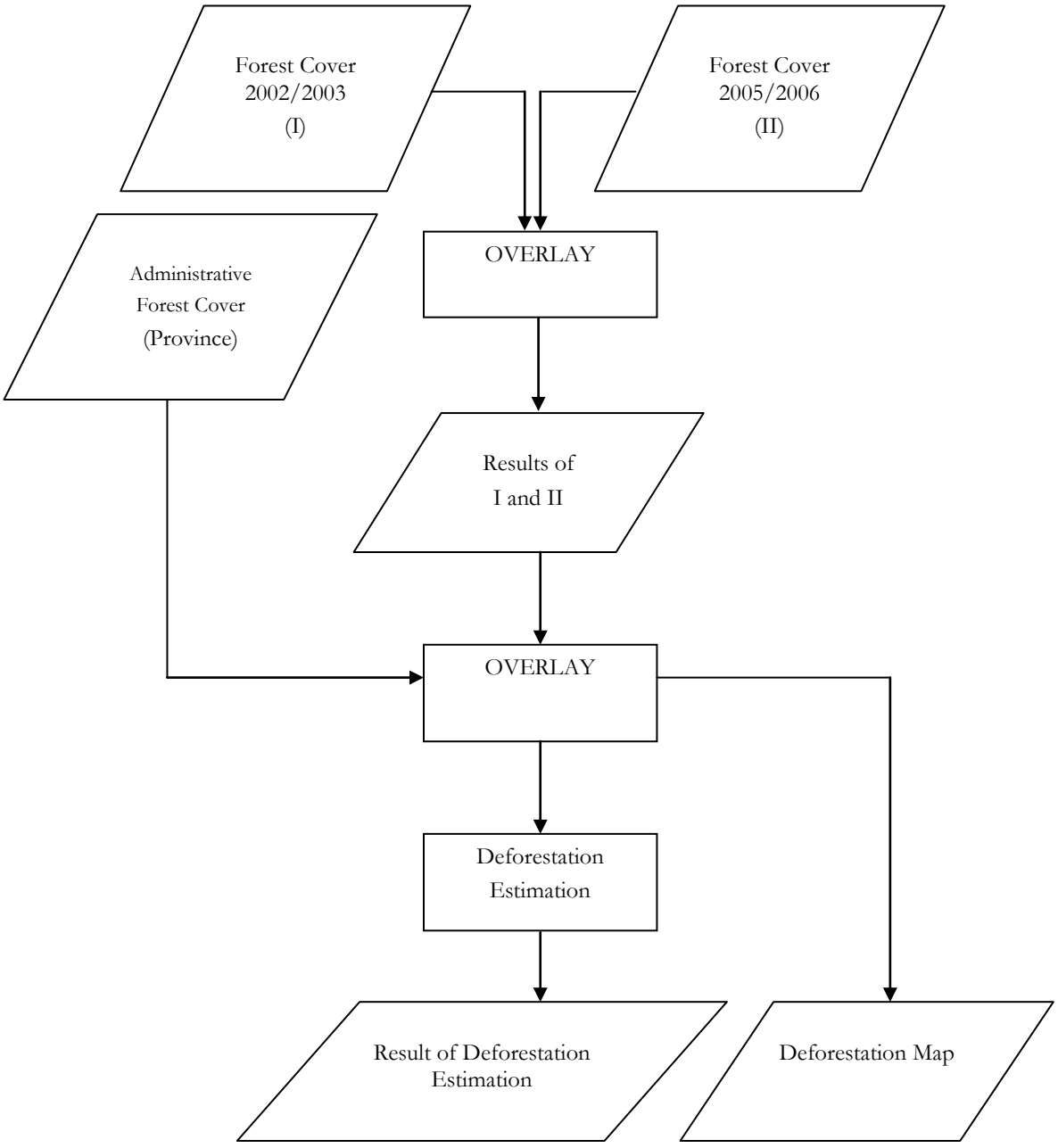
### *4.1.2. Village Level Data and Household Survey Information*

In order to find the socio economic of the indigenous people around the forest, it needs data from Indonesian National Socio Economic Survey (*Susenas*) conducted by the Indonesia Central Bureau of Statistics and Village Potential (*Potensi Desa*). *Susenas* data to be used is *Susenas* in 2004 which represents the result of survey conducted in 2003. The election of the year is based on compatibility with the forest cover data that is available in West Kalimantan Province. While for the Village Potential Data, the data used is in 2003 which described the condition of the village in 2002. We chose this because it contains or provides data which closely approximate to the results of the forest cover data interpretation.

*Susenas* data provide data about education, health/nutrition, housing/environment, criminal, social culture activities, consumption and household expenditure, tour trips, and the society's opinion on their household welfare. There are two types of *Susenas* data namely *Susenas* Module (Modul) and *Susenas* Core (Kor). *Susenas* Module consists of more detailed data and conducted every three years. *Susenas* Core consists of demography, health, education, employment, fertility, housing, consumption and household expenditure, and additional information which are conducted every year. In addition, *Susenas* Core divided into two types of data: household data and individual data. Household data include demography, housing, household and expenditure, while individual data include health, education, employment, and fertility.

**Figure 4**

**Flow Chart of Estimation of Deforestation**




Source : Ministry of Forestry of Indonesia, 2008

## 4.2. Data Combination

We combined the two data sources to create a household level estimation. In order to find the same level of data, we merge *Susenas* Core for individual data and household data. From individual data we include data of education, age, work hour, work field, and type of position, while from household data we include data of expenditure and household size.

In order to make the complete data set which includes household characteristics and deforestation, first we merge household data and individual data to obtain information of household characteristics. Then, *Susenas* data is combined with Deforestation data by searching the names of villages that existed at both of these sets of data. Our unit analysis of deforestation rate is village, which is the lowest level of analysis we can obtain.

Moreover, we also select the same villages from Village Potential Data. From Village Potential (*Podes*) data we acquire data of infrastructure (distance to sub district and distance to market) and data of village position to forest (inside forest, border forest, or outside forest). Finally, we compile those three data and make a new data set which already consists of household data with villages covered by forest in 1998.

Villages included in the observation are only villages that still have forest cover in 1998. The combination of *Susenas* data and deforestation data results number of observation for village as many as 204 observations and 3470 rural households. The names of villages observed can be seen in Appendix A.

## 4.3. Variables on Measurement of Relationship between Deforestation and Income

### *4.3.1. Dependent Variables*

Studies on relation between forest cover changes and economy have used many variables. Study across countries usually uses GDP per capita as an indicator of economy growth, while studying for lowest level, such as village or local area usually uses expenditure or income as an indicator of the economy. This study will use expenditure per capita as an indicator of the economy of local people around the forest. Expenditure per capita of household is obtained from expenditure of household divided by household size (numbers of member of the family). We use expenditure per capita as the dependent variable to see the condition of the economy of local people due to factors that influence it.

### *4.3.2. Explanatory Variables*

In addition, this study will use some variables to determine the expenditure/income of the household as the independent variables. Variables of household characteristics are added as control variables. Based on the previous study, variables considered the determinant of household expenditure are:

**Household characteristic**

- Sex

  Head of household is differentiated between male and female. It uses dummy variable to see whether the difference of the household sex will give different impact to the income of the household. Most of literatures find that having male as a household will give higher income than female.

- Age and Age2

  The relation between age and expenditure has been found by many studies as a positive relation. However, at some point, when the head of household is getting old then the income also will be declined, which is shown by $age^2$.

- Education

  Education also has been found as one of factors determining income. The higher the education, the higher the human capital might affect the income. Thus, the higher the income will be. In this study, education will be categorized into four categories, they are: no education, primary education (kindergarten and elementary school), secondary education (junior high school and senior high school/vocational high school), and higher education (university or academy).

- Work field

  Based on BPS (Statistic Central Bureau) there are 10 categories of work field, such as agriculture (food crop, cattle ranching, combination of food crop and cattle ranching, agriculture service, forestry, and fishery), mining, industries/manufactures, electricity and water, construction, trading, transportation, finance, service, and others. Instead of using 10 categories, this study will categorize it into 6 sectors, they are: agriculture, mining, manufactures, trading, services, and the rest will be categorized as others job. This was made due to the focus of this study and also because the frequencies of the households who work in the last 5 categories are only in small portion.

- Position

  There are seven types of position in the *Susenas* data, they are: own business, own business but helped by non permanent workers, own business, but helped by permanent workers, labor, free workers in agriculture, free workers in non agriculture, and unpaid workers. Instead of seven types, this study will only use five types of dummy variables of worker due to multicollinearity problem among the types of position. The types of position will be used in this study include own business, helped, free workers, unpaid workers, and no position.

- Infrastructure

  - Easy access to sub district will help household to connect to the center of facilities and infrastructure. Thus, it will help them increase their welfare.

- Easy access to the market is important to increase the economy of local people. Closest distance to market will help local household to buy or sell their product. The farther the household from market, the more isolated they will be.

- Location to the forest

  Based on Village Potential data, the villages are classified into 3 locations, namely inside the forest area, in the border of forest area, and outside the forest area. Usually villages located outside the forest area will be more developed compare to the villages inside the forest area, so that it might influence the economy of the households.

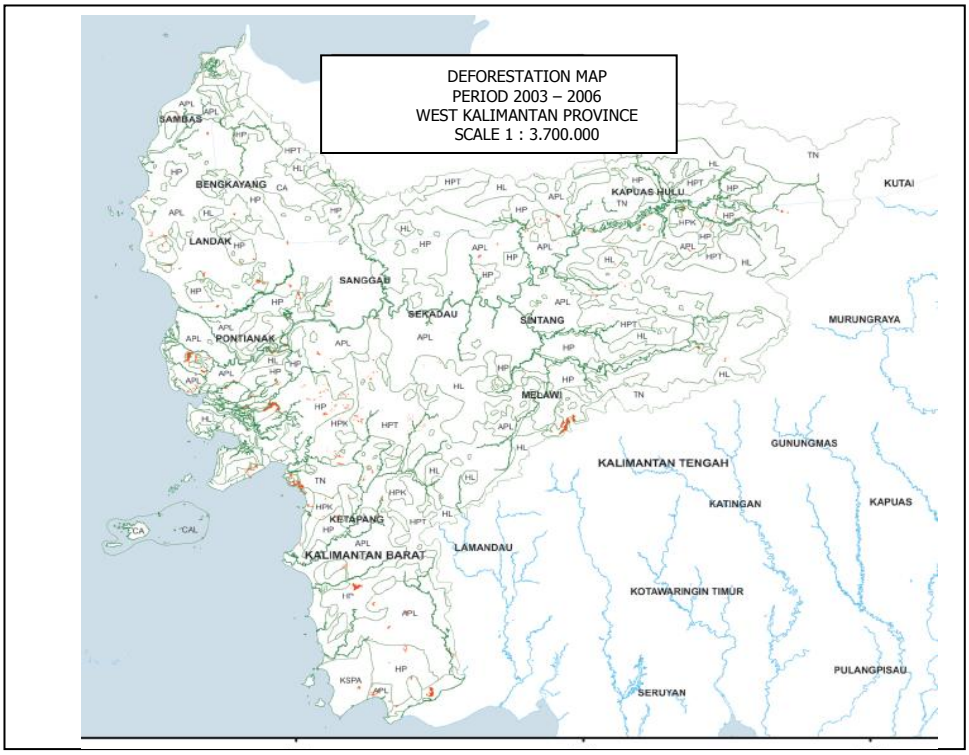
- Environmental condition
  - Forest Area in 1998
    Forest area in 1998 is proportion of forest area in the village over the village total area in 1998 (in percentage). The data are obtained from Interpretation of Satellite *Landsat ETM 2002/2003* and *Landsat ETM 2005/2006* by calculating the forest cover area in chosen village using GIS software.
  - Forest Cover Changes (Deforestation Area in 1998 – 2004)
    Deforestation area in percentage is obtained by calculating the changes of forest cover and re growth to non forest cover and then divided by forest cover area in 1998. It is obtained from Interpretation of Satellite *Landsat* ETM 2002/2003.

## 4.4. Area of Study

The area of our study is in West Kalimantan Province in Indonesia. The area is chosen because it has significant forest cover in almost all the districts (*kabupaten*) and deforestation happens every year. Until 2003, West Kalimantan has eight districts and two municipalities, which are Sambas, Bengkayang, Landak, Pontianak, Sanggau, Ketapang, Sintang, Kapuas Hulu, Pontianak city, and Singkawang city. The location of study area is can be seen in Maps 1.

**Maps 1**

**Deforestation Map West Kalimantan 2003 – 2006**




Source : Ministry of Forestry of Indonesia, 2008

West Kalimantan is one of provinces in Indonesia with a large amount of forest cover. Based on Decree of Minister of Forestry in 2000, forest area in West Kalimantan is 9,178,760 hectare or 62,52% of total area.

Every year there is a change in forest cover of West Kalimantan. Based on FAO and Ministry of Forestry, in the period 1985 – 1997, forest loss in West Kalimantan is 1.987.574 hectare or 22,8% of total forest cover in 1985. The data of forest loss in Indonesia from 1985 – 1997 can be seen in Table 3 and Figure 5. Another data from Ministry of Forestry shows that until 2002, forest cover of West Kalimantan is decreasing to 8.943.000 hectare (45,3% of total area).

**Table 3**

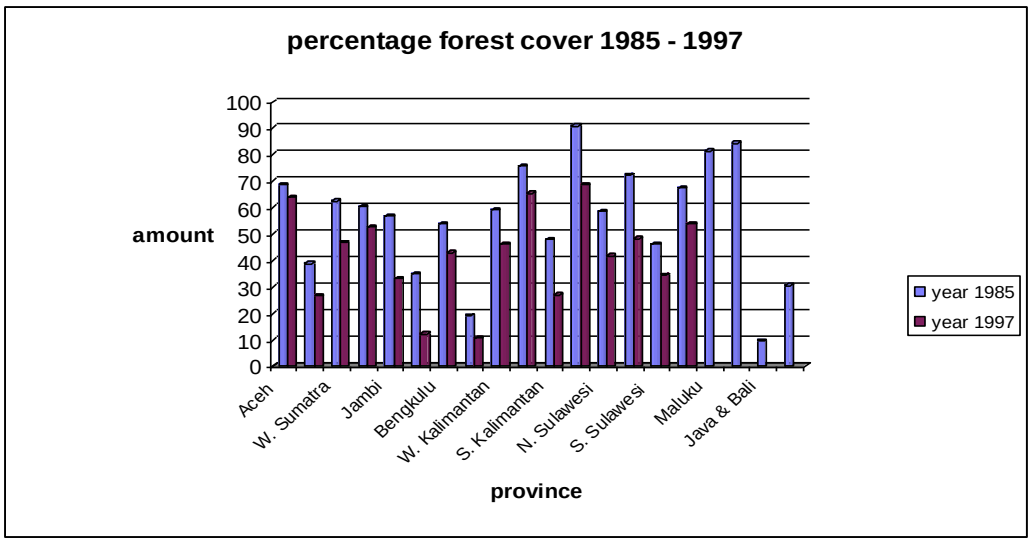
**Rate of Deforestation in Indonesia (1985 – 1997)**

| Province | RePPProT (1985) | | | MoFEC (1997) | | | | RePPProT - MoFEC | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Forest | % | Total | Forest | % | Other | Forest loss | %loss | Ha/p.a. |
| Aceh | 5.674.800 | 3.882.300 | 68,4 | 5.669.345 | 3.611.953 | 63,7 | 13.533 | 270.347 | 7,0 | 22.529 |
| N. Sumatra | 7.250.100 | 2.812.000 | 38,8 | 7.113.131 | 1.891.819 | 26,6 | 100.508 | 920.181 | 32,7 | 76.682 |
| W. Sumatra | 4.169.000 | 2.590.400 | 62,3 | 4.153.618 | 1.944.015 | 46,8 | 597.757 | 646.385 | 25,0 | 53.865 |
| Riau | 9.859.700 | 5.936.500 | 60,3 | 9.661.817 | 5.071.891 | 52,5 | 2.506 | 864.609 | 14,6 | 72.051 |
| Jambi | 4.873.900 | 2.765.800 | 56,7 | 4.855.923 | 1.603.079 | 33,0 | 232.890 | 1.162.721 | 42,0 | 96.893 |
| S. Sumatra | 10.226.300 | 3.562.100 | 34,8 | 10.149.068 | 1.248.209 | 12,3 | 913.789 | 2.313.891 | 65,0 | 192.824 |
| Bengkulu | 2.090.400 | 1.126.600 | 53,8 | 2.096.606 | 899.858 | 42,9 | 0 | 226.742 | 20,1 | 18.895 |
| Lampung | 3.386.700 | 647.800 | 19,1 | 3.359.906 | 361.319 | 10,8 | 237.929 | 286.481 | 44,2 | 23.873 |
| | 47.530.900 | 23.323.500 | 49,1 | 47.059.414 | 16.632.143 | 35,3 | 2.098.912 | 6.691.357 | 28,7 | 557.613 |
| W. Kalimantan | 14.753.000 | 8.700.600 | 59,0 | 14.546.318 | 6.713.026 | 46,1 | 243.571 | 1.987.574 | 22,8 | 165.631 |
| C. Kalimantan | 15.360.400 | 11.614.400 | 75,6 | 15.249.222 | 9.955.903 | 65,3 | 470.840 | 1.658.497 | 14,3 | 138.208 |
| S. Kalimantan | 3.749.000 | 1.795.900 | 47,9 | 3.703.550 | 999.182 | 27,0 | 288.120 | 796.718 | 44,4 | 66.393 |
| E. Kalimantan | 19.721.000 | 17.875.100 | 90,6 | 19.504.912 | 13.361.195 | 68,5 | 716.512 | 4.513.905 | 25,3 | 376.159 |
| | 53.583.400 | 39.986.000 | 74,6 | 53.004.002 | 31.029.306 | 58,5 | 1.719.043 | 8.956.694 | 22,4 | 746.391 |
| N. Sulawesi | 2.655.500 | 1.553.600 | 58,5 | 2.645.243 | 1.106.031 | 41,8 | 635.586 | 447.569 | 28,8 | 37.297 |
| C. Sulawesi | 6.032.900 | 4.359.100 | 72,3 | 6.001.253 | 2.892.697 | 48,2 | 1.152.403 | 1.466.403 | 33,6 | 122.200 |
| S. Sulawesi | 6.245.100 | 2.879.200 | 46,1 | 6.139.434 | 2.114.703 | 34,4 | 534.416 | 764.497 | 26,6 | 63.708 |
| SE Sulawesi | 3.681.000 | 2.477.500 | 67,3 | 3.676.422 | 1.975.726 | 53,7 | 329.540 | 501.774 | 20,3 | 41.815 |
| | 18.614.500 | 11.269.400 | 60,5 | 18.462.352 | 8.089.157 | 43,8 | 2.651.945 | 3.180.243 | 28,2 | 265.020 |
| Maluku | 7.801.900 | 6.348.000 | 81,3 | | | | | | | |
| Irian Jaya | 41.480.000 | 34.958.300 | 84,3 | | | | | | | |
| Java & Bali | 13.820.400 | 1.345.900 | 9,7 | | | | | | | |
| Nusatenggara | 8.074.000 | 2.469.400 | 30,6 | | | | | | | |
| INDONESIA | 190.905.100 | 119.700.500 | 62,7 | | | | | | | |

Source : Ministry of Forestry (2001)

**Figure 5**

**Forest Cover in Indonesia in 1985 and 1997**




Source : by Author

# Chapter 5. Model Specification

## 5.1. Model Specification

Model in this study combines forest cover data and household characteristics as control variables to find the relationship on income per capita of the household. It uses simple OLS (Ordinary Least Square) for the estimation.

In this study we will test four types of model to see the effects of deforestation on the general income of local household. In Model 1 we include only household characteristics, position to forest, and infrastructure as control variables to see the impact of those variables on household income. Model 2 include Model 1 by adding the forest cover variables in 1998 to see the impact of forest cover area on the income of the household. In Model 3 we include all the variables in Model 1 and 2 and add deforestation variable. Model 3 is the focus of our study in order to find the effects of deforestation rate on income of local household in the study area. Model 4 includes variables in Model 3 and added with deforestation squared. In Model 4 we are trying to see the possibilities of non linear relationship between deforestation and income.

Specification model on this study:

Model 1 :

$$\text{Ln exp per capita} = \alpha_0 + \beta_1 \text{Sex} + \beta_2 \text{Education} + \beta_3 \text{Age} + \beta_4 \text{Age2} + \beta_5 \text{Work hour} + \beta_6 \text{Work field} + \beta_7 \text{Position} + \beta_8 \text{Location to forest} + \beta_9 \text{Distance to sub district} + \beta_{10} \text{Distance to market} + \varepsilon$$

Model 2 :

$$\text{Ln exp per capita} = \alpha_0 + \beta_1 \text{Sex} + \beta_2 \text{Education} + \beta_3 \text{Age} + \beta_4 \text{Age2} + \beta_5 \text{Work hour} + \beta_6 \text{Work field} + \beta_7 \text{Position} + \beta_8 \text{Location to forest} + \beta_9 \text{Distance to sub district} + \beta_{10} \text{Distance to market} + \beta_{11} \text{Forest\_98} + \varepsilon$$

Model 3 :

$$\text{Ln exp per capita} = \alpha_0 + \beta_1 \text{Sex} + \beta_2 \text{Education} + \beta_3 \text{Age} + \beta_4 \text{Age2} + \beta_5 \text{Work hour} + \beta_6 \text{Work field} + \beta_7 \text{Position} + \beta_8 \text{Location to forest} + \beta_9 \text{Distance to sub district} + \beta_{10} \text{Distance to market} + \beta_{11} \text{Forest\_98} + \beta_{12} \text{Deforest98\_04} + \varepsilon$$

Model 4 :

$$\text{Ln exp per capita} = \alpha_0 + \beta_1 \text{Sex} + \beta_2 \text{Education} + \beta_3 \text{Age} + \beta_4 \text{Age2} + \beta_5 \text{Work hour} + \beta_6 \text{Work field} + \beta_7 \text{Position} + \beta_8 \text{Location to forest} + \beta_9 \text{Distance to sub district} + \beta_{10} \text{Distance to market} + \beta_{11} \text{Forest\_98} + \beta_{12} \text{Deforest98\_04} + \beta_{13} (\text{Deforest98\_04})^2 + \varepsilon$$

where:

| | |
|---|---|
| Ln exp per capita | = log expenditure per capita |
| Sex | = dummy variable of household head gender (=1 if male, =0 if female) |
| Education | = dummy variable of education of household head (no education as a reference, primary, secondary, higher) |
| Age | = age of head of household |
| Age2 | = age of household squared |
| Work hour | = amount of head of household work hour (hour) |
| Work field | = dummy variables of work field (manufacture as a reference, agriculture, mining, trade, service, other job) |
| Position | = dummy variables of position (free as a reference, own business, helped, employee, and no position) |
| Location to forest | = dummy variables of location of villages to forest (inside forest as a reference, border forest, and outside forest) |
| Distance to sub district | = distance from village to the capital of sub district (km) |
| Distance to market | = distance to the closest market (km) |
| Forest_98 | = forest cover in 1998 divided by total area of every villages (%) |
| Deforest98_04 | = deforestation rates of every villages (%) |
| Deforest98_04$^2$ | = deforestation rates of every villages squared (%) |

**Table 4**

**Definition of Variables in Model Specification**

| Variables | Descriptions | Expected Sign | Data Source |
|---|---|---|---|
| **Dependent Variables :** | | | |
| Log expenditure per capita | Natural logarithm of expenditure per capita.<br>Ln expenditure per capita = Ln (expenditure/household size) | | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| **Indipendent Variables :** | | | |
| Sex (= 1 if male) | Sex of household (=1 if male, =0 female) | Positive for male | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Education | Education of head of household using dummy variables (no education, primary, secondary, and higher education). No education as a reference. | Positive for primary, secondary, and higher education | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Age | Age of household head | Positive (+) | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Age2 | Age squared of household head. Obtained by squaring age and divided by 100. | Negative (-) | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Work hour | Amount of work hour per week of head of household (in hour) | Positive (+) | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Work field | Type of work field using dummy variables, classified into 6 sectors: agriculture, mining, manufactures, trading, service, other jobs. Other jobs include electricity and water, finance, transportation, and construction. | - / + | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Position | Position using dummy variables, classified into own business, own business but helped by non permanent or permanent workers (helped), employee, free workers in agriculture or non agriculture (free), and unpaid workers (no position). | - / + | Susenas, 2004<br>Statistics of Indonesia (BPS) |
| Location to forest | Location of village to forest using dummy variables. BPS classified it into : inside forest, border forest, and outside forest | Positive for outside forest | Village Potential/Potensi Desa 2003<br>Statistics of Indonesia (BPS) |
| Distance to sub district | Distance from village to sub district (km) | Negative (-) | Village Potential Survey/Potensi Desa 2003<br>Statistics of Indonesia (BPS) |
| Distance to market | Distance from village to the closest market. | Negative (-) | Village Potential Survey/Potensi Desa 2003<br>Statistics of Indonesia (BPS) |

| Variables | Descriptions | Expected Sign | Data Source |
|---|---|---|---|
| Forest area 1998 | Forest area in 1998 is area which is covered by forest in 1998 then divided by village area (in percentage) | - / + | Interpretation of Landsat Satellite ETM 7+ 2002/2003 |
| Deforestation 1998 - 2004 | Deforestation rate from 1998 to 2004 is amount of forest cover changes and re growth into non forest land divided by forest cover area in the initial forest cover or in 1998 (in percentage). | - / + | Interpretation of Landsat Satellite ETM 7+ 2002/2003 |

## 5.2. Estimation Issues : Heteroskedasticity, Multicollinearity, and Endogeneity Problems

This study uses cross sectional data and it usually suffered from heteroskedasticity problem. The problem arises when the variance of error is not constant, so that Standard Error could be very large resulting on not reliable the t-test and F-test and not appropriate the conclusion. To test whether heteroskedasticity is the problem of the estimation, we use Cook-Weisberg test and found that there is heteroskedasticity problem in some estimations. If we use OLS, the estimators are still unbiased and consistent, but it does not give the efficient and the best result. In order to correct heteroskedasticity problem, we use White-type standard error (robust standard error) that corrects for standard error in heteroskedasticity problem.

Another problem to be considered is multicollinearity among independent variables. We test the multicollinearity problem and found that there is a problem with dummy variables included in the model. In order to fix it, we eliminate some dummy variables regarding the work field variables and position variables and make new dummy variables which already free from multicollinearity problem.

The other potential problem concerning about the model is the use of expenditure (income) as the dependent variable. Usually, there is a potential for endogeneity problem resulting from reverse causality relationship between expenditure (income) per capita and deforestation rate. However, in this model we use cross sectional data with different year base of expenditure and deforestation. We use data of expenditure in 2004, while data of deforestation in period of 1998 – 2004. Besides, the unit analysis of deforestation is village, while income per capita based on household. Based on those conditions, we assume that there is a small possibility of reverse causality between expenditure and deforestation rate in this study.

## 5.3. Summary Statistics of the Variables

Table 4 presents the summary statistics of the variables included in the model. We use logarithm natural of expenditure per capita as the dependent variable. The explanatory variables of household income are subdivided into household characteristics, work field, position, infrastructure, location to forest, and forest condition.

Household characteristics include sex of the head of household, education, age, household size, and work hour. From the summary we can see that there are 3.470 head of house hold, while the proportion of males as the head of household are 92,2% and females are 7,8%, which is a very large difference. The age of the head of household is from 13 to 95.

By education, the higher percentage of education is no education with proportion of 39% of head of household. Primary and secondary educations have almost the same proportion where primary education is 27,7% and secondary education is 29,9%. The lowest proportion of education is higher education. There is only 2,6% head of household with higher education.

Household size that shows the number of member of the household of is varies from 1 to 14. The average of household size is 4 – 5 people per household. Summary of work hour shows that the longest time of head of household to work in one week is 98 hour.

Work field in the observation is divided into 6 types: agriculture, mining, manufacture, trade, service, and other job. From all the types, agriculture sector shows the largest proportion of head of household to work in (64,7%). The lowest is on mining sector (2,1%). Trade and service show similar proportions which are 7,4%, while manufacture is 4,6%.

Position describes the position of head of households in their work field. We divided position by own business, helped, employee, free, and no position. The highest proportion is head of household who has own business, but he is helped by other people whether they are paid or not (helped), which is 45,6%. The second largest proportion of the position of head of household in the observation is own the business as much as 25,4%. The third largest proportion is head of household who works as an employee (19,4%). The lowest is head of household with free job meaning they are who are has no permanent job and they freely to find and change their job whether in agriculture sector or non agriculture sector.

Location to forest gives the location of the village to the forest divided into three locations: inside forest, border forest, and outside forest. From all the observation, number of observation who lives outside the forest is higher than people who live inside and border the forest. There are 62,2% of household that lives outside the forest, while there are 32,3% in the border of forest, and only 5,5% inside the forest.

**Table 5**

**Summary Statistics of the Variables**

| VARIABLES | Observation | Mean | Std Deviation | Min | Max |
|---|---|---|---|---|---|
| Expenditure | 3,470 | 749,223 | 401,227 | 64,094 | 4,415,000,000 |
| *Household characteristics :* | | | | | |
| Male | 3,470 | 0.922 | 0.268 | 0 | 1 |
| Female | 3,470 | 0.0778 | 0.268 | 0 | 1 |
| *Education:* | | | | | |
| No education | 3,470 | 0.398 | 0.489 | 0 | 1 |
| Primary education | 3,470 | 0.277 | 0.448 | 0 | 1 |
| Secondary education | 3,470 | 0.299 | 0.458 | 0 | 1 |
| Higher education | 3,470 | 0.0259 | 0.159 | 0 | 1 |
| Age | 3,470 | 42.69 | 12.39 | 13 | 95 |
| Household size | 3,470 | 4.448 | 1.845 | 1 | 14 |
| Work hour | 3,470 | 37.50 | 15.89 | 0 | 98 |
| *Work field :* | | | | | |
| Agriculture | 3,470 | 0.647 | 0.478 | 0 | 1 |
| Mining | 3,470 | 0.0210 | 0.144 | 0 | 1 |
| Manufacture | 3,470 | 0.0461 | 0.210 | 0 | 1 |
| Trade | 3,470 | 0.0741 | 0.262 | 0 | 1 |
| Service | 3,470 | 0.0746 | 0.263 | 0 | 1 |
| Other job | 3,470 | 0.137 | 0.344 | 0 | 1 |
| *Position :* | | | | | |
| Own business | 3,470 | 0.254 | 0.435 | 0 | 1 |
| Helped | 3,470 | 0.456 | 0.498 | 0 | 1 |
| Employee | 3,470 | 0.194 | 0.395 | 0 | 1 |
| Free | 3,470 | 0.0349 | 0.183 | 0 | 1 |
| No position | 3,470 | 0.0617 | 0.241 | 0 | 1 |
| *Location to forest :* | | | | | |
| Inside forest | 3,470 | 0.0553 | 0.229 | 0 | 1 |
| Border forest | 3,470 | 0.323 | 0.468 | 0 | 1 |
| Outside forest | 3,470 | 0.622 | 0.485 | 0 | 1 |
| *Infrastructure :* | | | | | |
| Distance to sub district | 3,470 | 15.40 | 19.80 | 0 | 188 |
| Distance to market | 3,470 | 23.02 | 29.36 | 0 | 100 |
| *Forest Condition :* | | | | | |
| Forest_98 | 3,470 | 22.60 | 28.97 | 0.00131 | 100 |
| Deforest98_04 | 3,470 | 1.572 | 10.11 | 0 | 100 |

In the observation we only include distance to sub district and distance to market as the measure of infrastructure in the area of observation. The distance of village to sub district is from 0 km to 188 km. Distance to market is from 0 – 100 km, with the average is 23 km.

Forest condition describes the condition of forest in 1998 and deforestation rate in the village from 1998 to 2004. Percentage of forest area in 1998 compare to the overall of village area in the observation is very varies from 0,0013 % to 100%. The average forest cover in the observation is 22,6%. Moreover, deforestation rate also varies from 0% (no deforestation) to 100% (full deforestation). The standard deviation is quite high (10,1) it means that the variation of the data is quite large. The average of deforestation rate in the observation is 1,5 % which shows the distribution of the data is not normal.

# Chapter 6. Empirical Findings

In order to observe the relationship between the changes of deforestation rate and income on local household in West Kalimantan, this study use Ordinary Least Square (OLS) to estimate 4 (four) models specification.

The results of estimation as can be seen in Table 5 consist of Model 1, Model 2, Model 3, and Model 4. First, Model 1 includes household characteristics. Then, Model 2 includes all the variables in Model 1 added by forest area in 1998 to see the relationship between income and the existence of forest resources. Next, Model 3 is similar to Model 2, but here we include deforestation (forest clearing) rates in 1998 – 2004. Actually, this study will be focused on this model. It shows the relationship between forest clearance rates and expenditure of local household. Finally, Model 4 will test possibilities of non linear relationship between deforestation and income. It shows possibilities of U-shaped relationship between those variables. In this model we add deforestation squared as the independent variable.

From the estimation, Model 1, 2, 3, and 4 show almost the same results of the sign and the coefficient of household characteristics variables as the independent variables. They have the same number of observation that is 3.470 households. The R-squared is not very different among those models. R-squared in Model 1, 2 is 19,3% meaning that by using the independent variables together, they can explain the variation of dependent variables by 19,3%, and the rest is explained by other variables which are not included in the model. The highest R-squared is 19,5% in Model 4 which includes more variables than the other models, although the difference is not very big. It means that the variation of the dependent variable can be explained by independent variables by 19,5%, and the rest is explained by other variables.

## 6.1. Household Characteristics and Income

The empirical starting point was a regression including number of variables that usually used as determinants of income/expenditure (Table 3). After doing OLS regression, this study finds almost all variables statistically significant.

Model 1 shows that male as the head of household will give lower income to the household compare to female as a head of household. However, the sign is not what we expected. This might happen because we use expenditure per capita as the dependent variable. Based on the data we observed, we can say that when female as the head of household, the member of household is usually smaller than if male as the head of household. As a result, it seems that the female household gives higher income for every member of household

From education variables, the result presents that primary education, secondary education and higher education have statistically significant strong (1%) positive relationship with income. This result is in accordance with what we expected. Head of household with primary, secondary and higher education will have more income than those who do not have education. Primary education will increase the income for 6%, secondary education will increase income

for 17%, and higher education will increase income for 49.8 % compare to head household with no education.

The coefficient of age of head of household shows a different sign from what we expected, which finds that at the younger age, head of household will earn small and increase when they grow older, but at some point, income will decrease when the head of household getting older. However, in this study we could not find the same result. This study shows inverted U-shaped relationship between age and income, while the common study shows U-shaped relationship. As it can be seen in Table 3, we find that income for younger head of household will be low, but at some point when the head of household is getting older, the income will increase (shown by positive sign of age2).

From work field variables, agriculture and trade show strong statistically significant relationship with income. All the variables in work field are comparing to manufacture sector. The sign of the coefficient shows that agriculture has negative sign, while trade has positive sign. The negative sign of agriculture can be interpreted as the following; the head of household who works in agriculture will get income lower compare to head of household who works in manufacture. Income of people working in agriculture will be lower by 18,1% compare to them who work in manufacture sector. In this data set the Agriculture sector includes the forestry sector. Among all sectors including manufacture, trade gives the highest return. Coefficient of trade sector shows that people who work in trade sector will get income about 13,8% higher than those who work in manufacture sector.

The only position has statistically significant (10%) relationship with income in Model 1, 2, 3, and 4 is when the head of household own the business (own). It shows that when people have their own business, the return on income will be higher than people who work in the free position. The return for own the business 8,2% compare to free position.

## 6.2. Location to Forest and Income

Table 5 Model 1, 2, 3, and 4 gives the same result of coefficient for relationship between village position and income. Based on the positive sign we can conclude that household who lives in the border of forest and outside the forest has higher income compare to household who lives inside the forest. The coefficient shows that household who lives outside the forest will earn 20% of income higher than household inside the forest. In addition, household who lives in the border of forest will earn income about 12% higher than household inside the forest. This condition can happen because household who lives outside the forest might have more opportunities to find the job and easier access to afford more facilities.

## 6.3. Infrastructure and Income

We use distance between the village to the sub district and distance to market as proxies of infrastructure. From Table 5 Model 1, 2, 3, and 4 we can see that distance to sub district does not give statistically significant relationship with income. On the other hand, the distance to market shows statistically

strong negative relationship with income. The sign means that the farther the village from market, the lower the income will be earned. The increase of the distance per 1 km to market will decrease income by 0,09%. It shows that access to market is more significant to influence the income rather than access to sub district.

**Table 6**

**Model Estimation**

| **Dependent Variable : Ln Expenditure Per Capita** | | | | |
|---|---|---|---|---|
| **VARIABLES** | **Model 1 (Household characteristic)** | **Model 2 (Forest Area)** | **Model 3 (Deforestation)** | **Model 4 (Deforestation squared)** |
| Male | -0.120*** | -0.120*** | -0.120*** | -0.119*** |
| | (0.0307) | (0.0307) | (0.0307) | (0.0307) |
| *Education:* | | | | |
| - Primary educ | 0.0666*** | 0.0668*** | 0.0657*** | 0.0675*** |
| | (0.0184) | (0.0184) | (0.0184) | (0.0184) |
| - Secondary educ | 0.170*** | 0.170*** | 0.169*** | 0.168*** |
| | (0.0203) | (0.0203) | (0.0203) | (0.0203) |
| - Higher educ | 0.498*** | 0.498*** | 0.497*** | 0.496*** |
| | (0.0634) | (0.0634) | (0.0635) | (0.0635) |
| Work hour | 0.00272*** | 0.00273*** | 0.00270*** | 0.00267*** |
| | (0.000631) | (0.000630) | (0.000631) | (0.000630) |
| Age | -0.0125*** | -0.0125*** | -0.0124*** | -0.0124*** |
| | (0.00356) | (0.00356) | (0.00356) | (0.00356) |
| Age2 [a)] | 0.0158*** | 0.0158*** | 0.0157*** | 0.0158*** |
| | (0.00385) | (0.00384) | (0.00385) | (0.00384) |
| *Work field:* | | | | |
| - Agriculture | -0.181*** | -0.181*** | -0.176*** | -0.173*** |
| | (0.0374) | (0.0374) | (0.0377) | (0.0377) |
| - Mining | 0.0552 | 0.0558 | 0.0615 | 0.0671 |
| | (0.0642) | (0.0643) | (0.0645) | (0.0645) |
| - Trade | 0.138*** | 0.138*** | 0.142*** | 0.144*** |
| | (0.0458) | (0.0458) | (0.0459) | (0.0458) |
| - Service | 0.0602 | 0.0605 | 0.0657 | 0.0686 |
| | (0.0470) | (0.0470) | (0.0471) | (0.0471) |
| - Other jobs | 0.0657 | 0.0658 | 0.0709 | 0.0724* |
| | (0.0437) | (0.0437) | (0.0439) | (0.0439) |
| *Position::* | | | | |
| - Own | 0.0818* | 0.0812* | 0.0821* | 0.0815* |
| | (0.0457) | (0.0458) | (0.0459) | (0.0458) |
| - Helped | 0.0650 | 0.0645 | 0.0648 | 0.0652 |
| | (0.0448) | (0.0449) | (0.0449) | (0.0449) |
| - Employee | 0.0607 | 0.0601 | 0.0598 | 0.0607 |
| | (0.0493) | (0.0494) | (0.0494) | (0.0493) |

| Dependent Variable : Ln Expenditure Per Capita | | | | |
|---|---|---|---|---|
| **VARIABLES** | **Model 1 (Household characteristic)** | **Model 2 (Forest Area)** | **Model 3 (Deforestation)** | **Model 4 (Deforestation squared)** |
| - No position | 0.0419 | 0.0414 | 0.0413 | 0.0406 |
| | (0.0700) | (0.0700) | (0.0700) | (0.0700) |
| *Location to forest:* | | | | |
| - Border forest | 0.124*** | 0.124*** | 0.122*** | 0.120*** |
| | (0.0321) | (0.0321) | (0.0322) | (0.0323) |
| - Outside forest | 0.203*** | 0.203*** | 0.202*** | 0.202*** |
| | (0.0310) | (0.0310) | (0.0310) | (0.0311) |
| Distance to Sub district | -0.000360 | -0.000359 | -0.000357 | -0.000357 |
| | (0.000316) | (0.000316) | (0.000316) | (0.000316) |
| Distance to market | -0.000915*** | -0.000909*** | -0.000948*** | -0.000944*** |
| | (0.000260) | (0.000259) | (0.000264) | (0.000263) |
| **Forest_98 (%)** | | -4.65e-05 | -6.81e-06 | -5.33e-05 |
| | | (0.000260) | (0.000263) | (0.000265) |
| **Deforest98_04 (%)** | | | 0.000855 | **-0.00431*** |
| | | | (0.000568) | (0.00260) |
| **Deforest98_04 squared (%) [a)]** | | | | **0.00563**** |
| | | | | (0.00266) |
| Constant | 12.05*** | 12.05*** | 12.04*** | 12.04*** |
| | (0.107) | (0.108) | (0.108) | (0.108) |
| | | | | |
| **Observations** | **3,470** | **3,470** | **3,470** | **3,470** |
| **R-squared** | **0.193** | **0.193** | **0.194** | **0.195** |

**Note :**

**[a)] : coefficients are multiplied by 100**

**Robust standard errors in parentheses**

***** : Significant at 1%, ** Significant at 5%, * Significant at 10%**

## 6.4. Natural Resource and Income

The effect of natural resource (forest cover) on income is presented in Model 3. Thus, Table 3 shows that forest area in 1998 and deforestation in 1998-2004 are not statistically significant related to the income of local people. However, there is a difference when we use deforestation squared in Model 4. We found that in Model 4, deforestation and deforestation squared show weak statistically significant relationship with income of local household (statistically significant in 10% and 5% respectively). Based on the sign of the estimated coefficients on deforestation and deforestation squared, it suggests that there is non linear U-shaped relationship between deforestation and income per capita. Therefore when we calculate the point at which the slope of this relationship is zero (the deforestation at which the different equals to zero), we will identify

the minimum or turning point of the deforestation-income relationship, that is the deforestation's income is at the lowest level.

The point at which the deforestation and income function reaches its minimum is calculated by setting dY/dβ equal to zero. It indicates that income minimizes where dY/d$\beta$ = -0.00431+ 2 (0.563)$\beta$deforest=0, namely at deforestation = 0, 0038%[1]. It means that in the lower level of, income of household decreases but when deforestation rate reaches level of 0,0038%, household income start to increase.

In addition, the small coefficient of the return on income from deforestation implies that the benefit of deforestation on rural welfare is not economically significant, although it is statistically significant. It happens because the household in the study area only does smallholder deforestation which does not give high benefit on income, according to Angelsen and Wunder (2003). Other explanation is the high deforestation is usually done by the big companies not the local people, so they do not get much benefit from the deforestation, although they are also involved on the harvesting process.

## 6.5. Threshold of Deforestation Rate and Forest Cover

In this section, we use threshold to test more about our result and find the impact on income caused by different level of deforestation and forest cover. Data of deforestation rate in West Kalimantan shows that the data are not normally distributed and varies (standard deviation= 10,11). From Table 4, summary statistics of the data, we can see that the rate of deforestation in West Kalimantan in 1998 – 2004 is varies from 0% - 100%.

Villages with no deforestation rate are the biggest number of observation in the data set, with number of deforestation is 2.958. There are only two villages with 100% deforestation (number of observation = 32). The other villages have different level of deforestation varies from 0,0112% until 32,602% (total number of observation =480). Forest cover in 1998 in the study area also varies from 0,00131% to 100%, and the average is 22,60%.

In order to see the effect of more specific level of deforestation and forest cover on income per capita of the household, we examine the data using threshold higher than 1% (>1%) as higher level of deforestation and forest cover more than 1% (>1%) as a representation of high forest cover. The results of estimation from different levels of deforestation and forest cover on household income can be seen in Table 7.

### 6.5.1. Deforestation Higher Than 1% (> 1%)

In Table 7 we try to test higher levels of forest cover and higher level of deforestation. It includes two models, Model 1 to test linear relationship between

[1] From Table 5 we see that the coefficient of deforestation squared should be multiplied by 100. So, the coefficient of deforestation squared = 100 x 0.00563 = 0. 563.

deforestation and income while Model 2 to test non linear relationship between those two variables.

Model 1 shows that number of observations is 160 observations. It means that there are 160 households living in the area with high forest cover and high deforestation. R-squared equal to 31,5% suggests that the model can explain the dependent variable for 31,5 %, the rest is explained by other variables not in the model. The result for the coefficient of forest suggests that there is no significant relationship between forest cover and income. Meanwhile, deforestation variables show that there is a weak statistically significant positive relationship between deforestation and income when. We interpret the coefficient of deforestation as following increasing deforestation 1% will increase income by 0,0139% assuming other variables constant.

According to Model 2, we find that there is no significant relationship between forest cover and deforestation. For deforestation we find the statistically significant positive relationship with income, but no significant relationship for deforestation squared and income. Thus, it means there is no non linear relationship between deforestation and income if deforestation higher than 1% and forest cover higher than 1%. Thus, we only use Model 1 for the interpretation.

Based on the result on Table 7 Model 1, we can conclude that when the forest cover in one place is high even though deforestation rate high, deforestation might give positive effect to the people's income. This happens because when there is high forest cover, high forest resources still can be obtained. Although there is high deforestation; it will still give benefit on local household's income. However, the effect on income is not very strong (significant at 10%). It might suggest that the positive relationship only for household who dependent on forest resources and forest activities.

**Table 7**

**Estimation for Level of Deforestation Rate > 1%**

| **Dependent variable : Ln expenditure per capita** | | |
|---|---|---|
| **VARIABLES** | **Model 1** | **Model 2 (squared)** |
| | **Deforestation>1% & Forest cover >1%** | **Deforestation>1% & Forest cover >1%** |
| Male | 0.140 | 0.120 |
| | (0.114) | (0.115) |
| *Education:* | | |
| - Primary educ | 0.0194 | 0.0338 |
| | (0.0867) | (0.0900) |
| - Secondary educ | -0.0607 | -0.0445 |
| | (0.0871) | (0.0909) |
| - Higher educ | 0.386* | 0.344 |
| | (0.227) | (0.232) |
| Work hour | -0.00381 | -0.00392 |
| | (0.00365) | (0.00359) |
| Age | 0.00440 | 0.00273 |
| | (0.0124) | (0.0119) |
| Age2 [a)] | 1.38e-05 | 0.00159 |
| | (0.0136) | (0.0130) |
| *Work field:* | | |
| - Agriculture | -0.116 | -0.0594 |
| | (0.107) | (0.112) |
| - Mining | -0.201 | -0.215 |
| | (0.163) | (0.163) |
| - Trade | 0.157 | 0.188 |
| | (0.171) | (0.173) |
| - Service | 0.227 | 0.263 |
| | (0.179) | (0.176) |
| - Other jobs | 0.231 | 0.250 |
| | (0.182) | (0.177) |
| *Position::* | | |
| - Own | 0.0270 | 0.0378 |
| | (0.132) | (0.133) |
| - Helped | -0.0172 | 0.00328 |
| | (0.128) | (0.130) |
| - Employee | 0.0304 | 0.0284 |
| | (0.141) | (0.143) |
| - No position | -0.301 | -0.266 |
| | (0.347) | (0.321) |
| *Location to forest:* | | |
| - Border forest | 0.305** | 0.360** |
| | (0.137) | (0.141) |

| Dependent variable : Ln expenditure per capita | | |
|---|---|---|
| **VARIABLES** | **Model 1** | **Model 2 (squared)** |
| | **Deforestation>1% & Forest cover >1%** | **Deforestation>1% & Forest cover >1%** |
| - Outside forest | 0.106 | 0.144 |
| | (0.0785) | (0.0899) |
| Distance to Sub district (km) | -0.000586 | -0.000626 |
| | (0.00147) | (0.00148) |
| Distance to market (km) | 0.000948 | 0.00108 |
| | (0.00204) | (0.00199) |
| **Forest_98 (%)** | -0.00175 | -0.00242 |
| | (0.00295) | (0.00297) |
| **Deforest98_04 (%)** | **0.0139*** | **0.0517*** |
| | (0.00832) | (0.0294) |
| **Deforest98_04 squared (%) [a)]** | | -0.228 |
| | | (0.172) |
| Constant | 11.69*** | 11.59*** |
| | (0.383) | (0.379) |
| | | |
| **Observations** | **160** | **160** |
| **R-squared** | **0.315** | **0.322** |

**Note :**

**[a)] : coefficients are multiplied by 100**
**Robust standard errors in parentheses**
***** : Significant at 1%, ** Significant at 5%, * Significant at 10%**

## 6.6. Deforestation and Income

The result in Table 5 shows there is a U-shaped relationship between deforestation and income in West Kalimantan. The U-shaped relationship implies that income of local people is lower in the lower rate of deforestation, and then it is increasing when the deforestation rate also increasing. However, due to the limitation of data and observation, we are not able to observe whether it will continuously increase or will decrease again.

One possible explanation of the U-shaped relationship is that when the deforestation rate is low, it is usually done by smallholders. They work in forest sector and very dependent on forest resources because the variety of sources of income is still limited. Therefore, they still rely heavily on forest products as a source of livelihood. The more people work in forest sector; there will be more competitors to sell their product from forest, which leads to lower profits of income to the people. This condition is consistent with Angelsen and Wunderlan (2003) who shows the relationship between dependencies on forest with income of the household from forest activities.

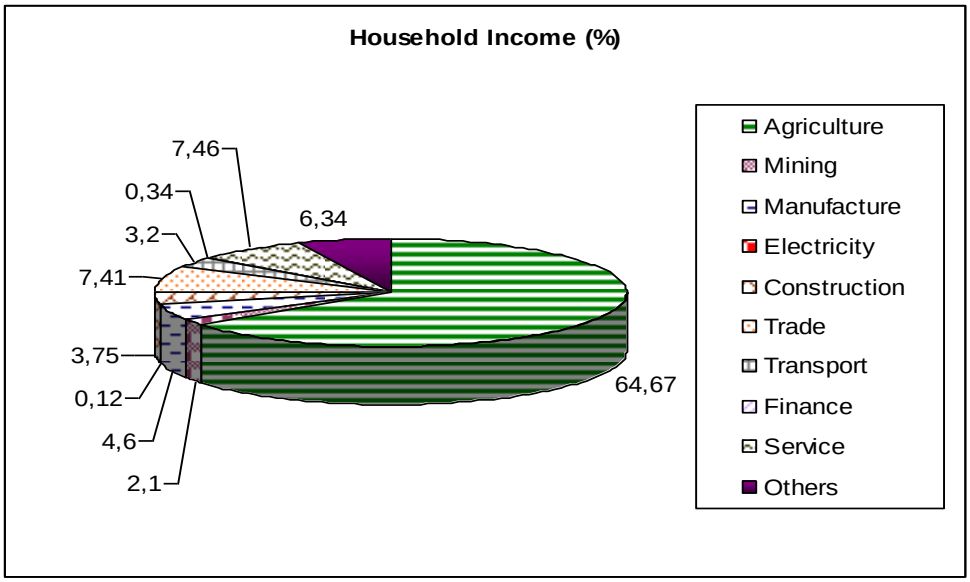
Furthermore, we interpret the positive sign as higher deforestation will relates to higher income. The explanation is that higher level of deforestation usually done by bigger companies, not smallholders. Poor people who are not able to do that will try to find other job. Due to Angelsen and Wunderlan

(2003) this happens because people start to find other alternatives job rather than work in forest sector. Other explanation is higher deforestation rate leads to lower forest resources, so that it leads to people to find other job rather than works in forest sector. These conditions will cause less competition on forest activities, and people will try to find other jobs that might gives higher income than works on forest sector. Less competition might increase the profits of the actor. Thus, income of people who do deforestation will increase similarly with people who work on different sector.

In order to find out the dependency of household in our study area, one of the indicators is the variety of sources of income in the area.[2] We use the data from *Susenas* 2004 to observe types of income sources of the household in our study area. From the data we used, we find that BPS divided sources of income into 9 main sector, they are: agriculture, mining, manufacture, electricity, construction, trade, transportation, finance, service, and other jobs. Percentage of household working in each sector is varies. From Figure 6, we can see that the highest percentage of income sources is from agriculture sector with 64,7% proportion from all the observations. The second position is service sector (7,5%), continued by trade sector (7,4%). The lowest proportion is electricity sector. It implies that more than a half of households in our study working in agriculture sector.

**Figure 6**

**Sources of Income of Household**



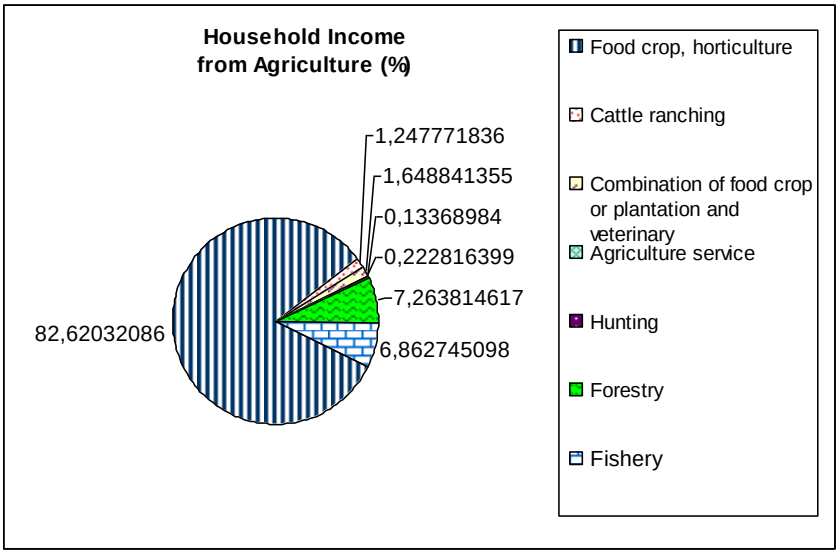

Source : Estimation from Susenas data by author

[2] See study by Dewi, et al. (2005)

In Susenas data, BPS includes forestry sector as the subdivision of agriculture sector. In Figure 7 we can see that agriculture sector divided into 7 sub sectors, which are: food crop and horticulture, cattle ranching, combination of food crop or plantation and veterinary, agriculture service, hunting, forestry, and fishery. It shows that horticulture and food crop occupies the highest percentage of source of household income (82,6%) from agriculture sector. The next is forestry (7,2%), continued by fishery (6,8%). It indicates that the proportion of people working in the forestry sector as a major source of income is still quite high compared to other sectors.

**Figure 7**

**Sources of Income from Agriculture Sector**




Source : Estimation from *Susenas* data in 2004 data by author

Furthermore, in Table 9 we also can see that BPS also includes forestry industries in manufacture sector. Forestry manufacture also occupies large proportion on manufacture sector. From all the sub division of manufacture sector, the calculation shows that more than a half (78,8%) household works in forestry manufacture sector. It might be happened due to many woods or timber industries still available and operated in the period 1998 -2004 in West Kalimantan. Thus, the calculation indicates that many household in our observation still dependent on forest resources.

The different sources of income suggest that for some of households who are not working in forest sector, their income will not affected by the changes in forest cover. In contrast, for households who are still working in forest sector will be affected by the forest degradation.

In our estimation in Table 5, there are two types of work field have statistically significant relationship with income namely agriculture and trade. We find that, by comparing to manufacture sector, the highest return on income from different work fields comes from trade sector. It implies that although many people works and dependent on agriculture sector (forest sector includ-

ed) but the income earned from forest is not as much as income from trade sector.

**Table 8**

**Types of Sources of Income of Households**

| Source of income | Number of household | |
|---|---|---|
| | **Absolute** | **Percentage (%)** |
| Agriculture : | 2244 | 64,7 |
| - *Food crop, horticulture* | *1854* | *82,6* |
| - *Cattle ranching* | *28* | *1,2* |
| - *Combination of food crop or plantation and veterinary* | *37* | *1,6* |
| - *Agriculture service* | *3* | *0,13* |
| - *Hunting* | *5* | *0,2* |
| - ***Forestry*** | *163* | *7,3* |
| - *Fishery* | *154* | *6,9* |
| Mining | 73 | 2,1 |
| Manufacture : | 160 | 4,6 |
| - ***Forestry manufacture*** | *126* | *78,8* |
| Electricity | 4 | 0,1 |
| Construction | 130 | 3,7 |
| Trade | 257 | 7,4 |
| Transport | 111 | 3,2 |
| Finance | 12 | 0,3 |
| Service | 259 | 7,5 |
| Others | 220 | 6,3 |
| Total | 3470 | 100 |

Source : Estimation from Susenas by author

The study we conducted represents that people in our observation is still dependent on forest resources although the income they earn from it not as big as working in other sectors.

# Chapter 7. Conclusion

This study examines the relationship between deforestation and income at the level of local household in West Kalimantan. The empirical results obtained in this household level study show that there is U-shaped relationship between deforestation and household income. It shows that the lower level of deforestation, the lower income per capita of the household, but as the deforestation increases, the income will increase too. The positive and negative sign relationship between deforestation rates and income implies that there is dependency of people on the forest resources in our study area. We also investigate the forest dependency through variety of income sources in our study area, and find that there are still many household rely on forest activities as their income source. The income of people who rely heavily on forest will be affected when there is deforestation, while people who work in other sector will be not affected as much as forest dependent people. Based on the estimation, we find that, the return from forest sector is not as much as when household works in trade or manufacture sector.

Furthermore, we use more than one percent level of deforestation and forest cover to observe the impact of forest condition on income. The findings show that when there is higher deforestation rate with higher forest cover, the relationship between deforestation rate and income is statistically positive. The result indicates that when forest cover and deforestation rate is high, even there is an increasing of deforestation rate, income will still high.

In conclusion, to increase the income of people around the forest and to reduce dependency on forest resources, varieties of sources of income in area with forest cover are needed. Moreover, the development on the villages including access to market might be some solution to increase the welfare of rural livelihood.

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# Appendices

## Appendix A

**Table 1. List of Villages**

| *No* | *Village Name* | *Sub District/ Kecamatan* | *Disctrict/ Kabupaten* |
|---|---|---|---|
| 1 | SEMELAGI BESAR | Selakau | Sambas |
| 2 | BUDUK SEMPADANG | Selakau | Sambas |
| 3 | SEPINGGAN | Pemangkat | Sambas |
| 4 | PEMANGKAT KOTA | Pemangkat | Sambas |
| 5 | BUKIT SEGOLER | Tebas | Sambas |
| 6 | TEBAS SUNGAI | Tebas | Sambas |
| 7 | SEI RAMBAH | Sambas | Sambas |
| 8 | LUMBANG | Sambas | Sambas |
| 9 | TANJUNG BUGIS | Sambas | Sambas |
| 10 | JIRAK | Sambas | Sambas |
| 11 | SEI DEDEN | Subah | Sambas |
| 12 | PARIT SETIA | Jawai | Sambas |
| 13 | SARANG BURUNG KOLAM | Jawai | Sambas |
| 14 | SUNGAI BARU | Teluk Keramat | Sambas |
| 15 | SEKURA | Teluk Keramat | Sambas |
| 16 | MERPATI | Teluk Keramat | Sambas |
| 17 | SEPANTAI | Sejangkung | Sambas |
| 18 | NIBUNG | Paloh | Sambas |
| 19 | SUNGAI DURI | Sungai Raya | Bengkayang |
| 20 | SUNGAI JAGA A | Sungai Raya | Bengkayang |
| 21 | CAPKALA | Sungai Raya | Bengkayang |
| 22 | SEI PANGKALAN II | Sungai Raya | Bengkayang |
| 23 | SUNGAI RAYA | Sungai Raya | Bengkayang |
| 24 | KARIMUNTING | Sungai Raya | Bengkayang |
| 25 | BABANE | Samalantan | Bengkayang |
| 26 | GODANG DAMAR | Samalantan | Bengkayang |
| 27 | GERANTUNG | Monterado | Bengkayang |
| 28 | GOA BOMA | Monterado | Bengkayang |
| 29 | BHAKTI MULYA | Bengkayang | Bengkayang |
| 30 | SUKA BANGUN | Bengkayang | Bengkayang |
| 31 | TUNAS BARU | Teriak | Bengkayang |
| 32 | CEMPAKA PUTIH | Ledo | Bengkayang |
| 33 | LOMBA KARYA | Ledo | Bengkayang |
| 34 | PISAK | Sanggau Ledo | Bengkayang |
| 35 | SINAR TEBUDAK | Sanggau Ledo | Bengkayang |
| 36 | SANGO | Sanggau Ledo | Bengkayang |
| 37 | MAYAK | Seluas | Bengkayang |

| *No* | *Village Name* | *Sub District/ Kecamatan* | *Disctrict/ Kabupaten* |
|---|---|---|---|
| 38 | TERABUNG | Jagoi Babang | Bengkayang |
| 39 | SEI SEGAK | Sebangki | Landak |
| 40 | KUMPANG TENGAH | Sebangki | Landak |
| 41 | BALAI PELUNTAN | Ngabang | Landak |
| 42 | AMBOYO SELATAN | Ngabang | Landak |
| 43 | AMBAYO UTARA | Ngabang | Landak |
| 44 | SEKAIS | Ngabang | Landak |
| 45 | AMBARANG | Ngabang | Landak |
| 46 | AMANG | Ngabang | Landak |
| 47 | TONANG | Sengah Temila | Landak |
| 48 | S I D A S | Sengah Temila | Landak |
| 49 | KERANJI MANCAL | Sengah Temila | Landak |
| 50 | RABAK | Sengah Temila | Landak |
| 51 | SIMPANG KASTURI | Mandor | Landak |
| 52 | LAMO ANAK | Menjalin | Landak |
| 53 | SEPAHAT | Menjalin | Landak |
| 54 | PAK KUMBANG | Mempawah Hulu | Landak |
| 55 | SOMPAK | Mempawah Hulu | Landak |
| 56 | S A L A A S | Mempawah Hulu | Landak |
| 57 | S A B A K A | Mempawah Hulu | Landak |
| 58 | TAHU | Meranti | Landak |
| 59 | NYAYUM | Kuala Behe | Landak |
| 60 | TENGUWE | Air Besar | Landak |
| 61 | SEPANGAH | Air Besar | Landak |
| 62 | ENGKANGIN | Air Besar | Landak |
| 63 | NIPAH PANJANG | Batu Ampar | Pontianak |
| 64 | MUARA TIGA | Batu Ampar | Pontianak |
| 65 | SUNGAI TERUS | Kubu | Pontianak |
| 66 | SERUAT II | Kubu | Pontianak |
| 67 | SELAT REMIS | Telok Pakedai | Pontianak |
| 68 | SUNGAI KAKAP | Sungai Kakap | Pontianak |
| 69 | JERUJU | Sungai Kakap | Pontianak |
| 70 | RASAU JAYA III | Rasau Jaya | Pontianak |
| 71 | SUNGAI RAYA | Sungai Raya | Pontianak |
| 72 | ARANG LIMBUNG | Sungai Raya | Pontianak |
| 73 | KUALA DUA | Sungai Raya | Pontianak |
| 74 | TEBANG KACANG | Sungai Raya | Pontianak |
| 75 | SUNGAI BULAN | Sungai Raya | Pontianak |
| 76 | SUNGAI ASAM | Sungai Raya | Pontianak |
| 77 | PULAU LIMBUNG | Sungai Raya | Pontianak |
| 78 | SIMPANG KANAN | Sungai Ambawang | Pontianak |
| 79 | PANCA ROBA | Sungai Ambawang | Pontianak |
| 80 | JUNGKAT | Siantan | Pontianak |
| 81 | WAJO HILIR | Siantan | Pontianak |

| *No* | *Village Name* | *Sub District/ Kecamatan* | *Disctrict/ Kabupaten* |
|---|---|---|---|
| 82 | WAJO HULU | Siantan | Pontianak |
| 83 | PENITI BESAR | Siantan | Pontianak |
| 84 | PENIRAMAN | Sungai Pinyuh | Pontianak |
| 85 | SUNGAI RASAU | Sungai Pinyuh | Pontianak |
| 86 | SUNGAI PINYUH | Sungai Pinyuh | Pontianak |
| 87 | TERUSAN | Mempawah Hilir | Pontianak |
| 88 | SENGKUBANG | Mempawah Hilir | Pontianak |
| 89 | SEI KUNYIT HULU | Sungai Kunyit | Pontianak |
| 90 | KUALA MANDOR A | Kuala Mandor-B | Pontianak |
| 91 | RETOK | Kuala Mandor-B | Pontianak |
| 92 | TERAJU BARAT | Toba | Sanggau |
| 93 | PAMPANG DUA | Meliau | Sanggau |
| 94 | CUPANG | Meliau | Sanggau |
| 95 | NANGA SURI | Nanga Mahap | Sanggau |
| 96 | MERAGUN | Nanga Taman | Sanggau |
| 97 | CUPANG GADING | Sekadau Hulu | Sanggau |
| 98 | NANGA MENTERAP | Sekadau Hulu | Sanggau |
| 99 | LINTANG PELAMAN | Sanggau Kapuas | Sanggau |
| 100 | SUNGAI MUNTIK | Sanggau Kapuas | Sanggau |
| 101 | MUNGGUK | Sekadau Hilir | Sanggau |
| 102 | MERBANG | Belitang Hilir | Sanggau |
| 103 | BALAI SEBUT | Jangkang | Sanggau |
| 104 | KETORI | Jangkang | Sanggau |
| 105 | BANTAI | Bonti | Sanggau |
| 106 | LALANG | Tayan Hilir | Sanggau |
| 107 | MELUGAI | Tayan Hilir | Sanggau |
| 108 | BULU BALA | Balai | Sanggau |
| 109 | THANG RAYA | Beduwai | Sanggau |
| 110 | SEI TEKAM | Sekayam | Sanggau |
| 111 | AIR HITAM BESAR | Kendawangan | Ketapang |
| 112 | KENDAWANGAN KIRI | Kendawangan | Ketapang |
| 113 | SUKA RAMAI | Manis Mata | Ketapang |
| 114 | SUKASARI | Marau | Ketapang |
| 115 | RUNJAI JAYA | Marau | Ketapang |
| 116 | PENYARANG | Jelai Hulu | Ketapang |
| 117 | KESUMA JAYA | Jelai Hulu | Ketapang |
| 118 | SERENGKAH | Tumbang Titi | Ketapang |
| 119 | SUNGAI NANJUNG | Matan Hilir Selatan | Ketapang |
| 120 | PEMATANG GADUNG | Matan Hilir Selatan | Ketapang |
| 121 | PADANG | Matan Hilir Selatan | Ketapang |
| 122 | MULIA KERTA | Matan Hilir Selatan | Ketapang |
| 123 | KANTOR | Matan Hilir Utara | Ketapang |
| 124 | MULIA BARU | Matan Hilir Utara | Ketapang |
| 125 | SAMPIT | Matan Hilir Utara | Ketapang |

| *No* | *Village Name* | *Sub District/ Kecamatan* | *Disctrict/ Kabupaten* |
|---|---|---|---|
| 126 | SUKAHARJA | Matan Hilir Utara | Ketapang |
| 127 | SUKA BANGUN | Matan Hilir Utara | Ketapang |
| 128 | TANJUNG PURA | Matan Hilir Utara | Ketapang |
| 129 | KUALA SATONG | Matan Hilir Utara | Ketapang |
| 130 | SUTRA | Sukadana | Ketapang |
| 131 | NANGA TAYAP | Nanga Tayap | Ketapang |
| 132 | BETENUNG | Nanga Tayap | Ketapang |
| 133 | SANDAI | Sandai | Ketapang |
| 134 | PETAI PATAH | Sandai | Ketapang |
| 135 | CINTA MANIS | Sandai | Ketapang |
| 136 | SEMPURNA | Sungai Laur | Ketapang |
| 137 | MEKAR RAYA | Simpang Hulu | Ketapang |
| 138 | BALAI PINANG | Simpang Hulu | Ketapang |
| 139 | KUALAN TENGAH | Simpang Hulu | Ketapang |
| 140 | PENJALAAN | Simpang Hilir | Ketapang |
| 141 | TELUK MELANO | Simpang Hilir | Ketapang |
| 142 | TELOK BATANG | Teluk Batang | Ketapang |
| 143 | DUSUN BESAR | Pulau Maya/Karimata | Ketapang |
| 144 | KELUING TAJA | Sokan | Sintang |
| 145 | PELITA JAYA | Tanah Pinoh | Sintang |
| 146 | LAMAN MUMBUNG | Menukung | Sintang |
| 147 | SUNGAI SAMPUK | Menukung | Sintang |
| 148 | NANGA SERAWAI | Serawai | Sintang |
| 149 | NANGA AMBALAU | Ambalau | Sintang |
| 150 | ENTOGONG | Kayan Hulu | Sintang |
| 151 | RIAM PANJANG | Kayan Hulu | Sintang |
| 152 | NANGA KAYAN | Nanga Pinoh | Sintang |
| 153 | NUSA KENYIKAP | Belimbing | Sintang |
| 154 | BATU NANTA | Belimbing | Sintang |
| 155 | BALAI HARAPAN | Tempunak | Sintang |
| 156 | BONET LAMA | Sungai Tebelian | Sintang |
| 157 | MERARAI SATU | Sungai Tebelian | Sintang |
| 158 | TANJUNG PURI | Sintang | Sintang |
| 159 | KAPUAS KANAN HULU | Sintang | Sintang |
| 160 | KAPUAS KANAN HILIR | Sintang | Sintang |
| 161 | KAPUAS KIRI HILIR | Sintang | Sintang |
| 162 | MELINGKAT | Kayan Hilir | Sintang |
| 163 | KEBONG | Kelam Permai | Sintang |
| 164 | DAK JAYA | Binjai Hulu | Sintang |
| 165 | SETUNGKUP | Ketungau Hilir | Sintang |
| 166 | ARGO MULYO | Ketungau Tengah | Sintang |
| 167 | MARGA HAYU | Ketungau Tengah | Sintang |
| 168 | NANGA BAYAN | Ketungau Hulu | Sintang |
| 169 | SETUNGGUL | Silat Hilir | Kapuas Hulu |

| *No* | *Village Name* | *Sub District/ Kecamatan* | *Disctrict/ Kabupaten* |
|---|---|---|---|
| 170 | BARU | Silat Hilir | Kapuas Hulu |
| 171 | LANDAU BADAI | Silat Hulu | Kapuas Hulu |
| 172 | NANGA DANGKAN | Silat Hulu | Kapuas Hulu |
| 173 | NANGA TEPUAI | Hulu Gurung | Kapuas Hulu |
| 174 | LANDAU KUMPANG | Hulu Gurung | Kapuas Hulu |
| 175 | BUGANG | Hulu Gurung | Kapuas Hulu |
| 176 | NANGA SEMANGUT | Bunut Hulu | Kapuas Hulu |
| 177 | TEMUYUK | Bunut Hulu | Kapuas Hulu |
| 178 | TEKALONG | Mentebah | Kapuas Hulu |
| 179 | NANGA TUBUK | Manday | Kapuas Hulu |
| 180 | NANGA SEBINTANG | Kalis | Kapuas Hulu |
| 181 | NANGA KALIS | Kalis | Kapuas Hulu |
| 182 | KEDAMIN HULU | Kedamin | Kapuas Hulu |
| 183 | CEMPAKA BARU | Kedamin | Kapuas Hulu |
| 184 | KELILING SEMULUNG | Embaloh Hilir | Kapuas Hulu |
| 185 | PENYELUANG | Embaloh Hilir | Kapuas Hulu |
| 186 | BUNUT HILIR | Bunut Hilir | Kapuas Hulu |
| 187 | NANGA SANGAN | Boyan Tanjung | Kapuas Hulu |
| 188 | BATU DATU | Batu Datu | Kapuas Hulu |
| 189 | KARYA JAYA | Batu Datu | Kapuas Hulu |
| 190 | CINTA DAMAI | Embau | Kapuas Hulu |
| 191 | KARYA BUDI | Embau | Kapuas Hulu |
| 192 | NIBUNG | Selimbau | Kapuas Hulu |
| 193 | GUDANG HULU | Selimbau | Kapuas Hulu |
| 194 | SUHAID/NANGA SUHAID | Suhaid | Kapuas Hulu |
| 195 | GURUNG | Seberuang | Kapuas Hulu |
| 196 | KENERAK | Semitau | Kapuas Hulu |
| 197 | SEMITAU | Semitau | Kapuas Hulu |
| 198 | PURING KENCANA | Puring Kencana | Kapuas Hulu |
| 199 | BADAU | Badau | Kapuas Hulu |
| 200 | PULAU MANAK | Embaloh Hulu | Kapuas Hulu |
| 201 | HILIR KANTOR | Putussibau | Kapuas Hulu |
| 202 | PUTUSSIBAU KOTA | Putussibau | Kapuas Hulu |
| 203 | HARAPAN MULYA | Putussibau | Kapuas Hulu |
| **204** | BANGKA BELITUNG | Pontianak Selatan | Pontianak City |

# Appendix B

## 1. Test for Heteroskedasticity

```
reg  lexhpc male primary secondary higher workhour age age2 agriculture3
mining3 trade3 service3 other_jobs3 own2 helped employee2 no_position bor-
der_forest3 outside_forest3 dis_subdist distancetomarket forest_98  defor-
est98_04percent  deforest98_04sq
```

```
      Source |       SS       df       MS              Number of obs =    3470
-------------+------------------------------           F( 23,  3446) =   36.19
       Model |  147.353942    23  6.40669313           Prob > F      =  0.0000
    Residual |  609.988252  3446  .177013422           R-squared     =  0.1946
-------------+------------------------------           Adj R-squared =  0.1892
       Total |  757.342194  3469   .21831715           Root MSE      =  .42073

------------------------------------------------------------------------------
      lexhpc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        male |  -.1189374   .0278568    -4.27   0.000    -.1735548   -.0643199
     primary |   .0675343   .0191066     3.53   0.000     .0300729    .1049957
   secondary |   .1676687   .0203385     8.24   0.000      .127792    .2075455
      higher |    .496254   .0522698     9.49   0.000     .3937711     .598737
    workhour |   .0026743   .0006128     4.36   0.000     .0014729    .0038757
         age |  -.0124351   .0034727    -3.58   0.000    -.0192438   -.0056264
        age2 |   .0157667   .0037173     4.24   0.000     .0084784     .023055
agriculture3 |  -.1732178   .0375663    -4.61   0.000    -.2468723   -.0995633
     mining3 |    .067124   .0603152     1.11   0.266    -.0511332    .1853811
      trade3 |   .1442743   .0446998     3.23   0.001     .0566336    .2319151
    service3 |   .0686425   .0453235     1.51   0.130    -.0202212    .1575063
 other_jobs3 |    .072412   .0426927     1.70   0.090    -.0112936    .1561176
        own2 |   .0814856   .0411945     1.98   0.048     .0007175    .1622536
      helped |   .0651942   .0404189     1.61   0.107    -.0140532    .1444415
   employee2 |   .0607087   .0439249     1.38   0.167    -.0254128    .1468303
 no_position |   .0406282   .0608216     0.67   0.504    -.0786217    .1598782
border_for~3 |   .1201663   .0333549     3.60   0.000      .054769    .1855636
outside_fo~3 |    .201644   .0323985     6.22   0.000     .1381218    .2651662
 dis_subdist |  -.0003575   .0003626    -0.99   0.324    -.0010684    .0003535
distanceto~t |  -.0009437    .000254    -3.72   0.000    -.0014416   -.0004457
   forest_98 |  -.0000533    .000255    -0.21   0.835    -.0005533    .0004468
deforest98~t |  -.0043144   .0027812    -1.55   0.121    -.0097674    .0011386
deforest98~q |     .00563   .0029236     1.93   0.054    -.0001021    .0113622
       _cons |   12.04457   .1038947   115.93   0.000     11.84087    12.24827
------------------------------------------------------------------------------
```

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of lexhpc

         chi2(1)      =    29.10
         Prob > chi2  =   0.0000
```

## 2. Robust Standard Error Test

```
. reg  lexhpc male primary secondary higher workhour age age2 agriculture3
mining3 trade3 service3 other_jobs3 own2 helped employee2 no_position bor-
der_forest3 outside_forest3 dis_subdist distancetomarket forest_98  defor-
est98_04percent deforest98_04sq, robust


Linear regression                                      Number of obs =    3470
                                                       F( 23,  3446) =   32.75
                                                       Prob > F      =  0.0000
                                                       R-squared     =  0.1946
                                                       Root MSE      =  .42073

------------------------------------------------------------------------------
             |               Robust
      lexhpc |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        male |  -.1189374    .030741    -3.87   0.000    -.1792098    -.058665
     primary |   .0675343   .0184293     3.66   0.000     .0314009    .1036677
   secondary |   .1676687   .0203454     8.24   0.000     .1277785     .207559
      higher |    .496254   .0635255     7.81   0.000     .3717027    .6208054
    workhour |   .0026743   .0006302     4.24   0.000     .0014387    .0039099
         age |  -.0124351   .0035582    -3.49   0.000    -.0194115   -.0054588
        age2 |   .0157667   .0038446     4.10   0.000     .0082288    .0233046
agriculture3 |  -.1732178   .0376647    -4.60   0.000    -.2470651   -.0993705
     mining3 |    .067124   .0645137     1.04   0.298    -.0593651     .193613
      trade3 |   .1442743   .0457838     3.15   0.002     .0545083    .2340404
    service3 |   .0686425   .0471254     1.46   0.145    -.0237541    .1610392
 other_jobs3 |    .072412   .0438781     1.65   0.099    -.0136177    .1584417
        own2 |   .0814856   .0458298     1.78   0.075    -.0083706    .1713418
      helped |   .0651942   .0449078     1.45   0.147    -.0228545    .1532428
   employee2 |   .0607087    .049345     1.23   0.219    -.0360396    .1574571
 no_position |   .0406282   .0699831     0.58   0.562    -.0965843    .1778407
border_for~3 |   .1201663   .0322751     3.72   0.000     .0568861    .1834465
outside_fo~3 |    .201644   .0310776     6.49   0.000     .1407116    .2625764
 dis_subdist |  -.0003575   .0003164    -1.13   0.259    -.0009779    .0002629
distanceto~t |  -.0009437   .0002634    -3.58   0.000    -.0014602   -.0004272
   forest_98 |  -.0000533   .0002651    -0.20   0.841     -.000573    .0004665
deforest98~t |  -.0043144   .0025967    -1.66   0.097    -.0094057    .0007769
deforest98~q |     .00563   .0026617     2.12   0.034     .0004114    .0108487
       _cons |   12.04457   .1076623   111.87   0.000     11.83348    12.25566
------------------------------------------------------------------------------
```

# Appendix C

## Map 1. Forest Cover Change in West Kalimantan in 1998 - 2004