修　士　論　文

熱帯国立公園から得る収入によって森林伐採を避けるための費用に関する考察

―インドネシア・スラベシ島のロア・リンデゥ・国立公園の事例分析―

Cost of Deforestation Avoidance through Income Substitution in Tropical National Park

Case Studies: Lore Lindu National Park, Central Sulawesi, Indonesia

東京大学　新領域創成科学研究科
国際協力学専攻
学籍番号　４７－４６８９３

氏名 **IDRIS Nassat Darajat**

本論文は，修士（国際協力学）取得要件の一部として，2006 年 7 月 18 日に提出され，同年 7 月 26 日の最終試験に合格したものであることを，証明する．

2006 年 7 月 26 日

東京大学大学院新領域創成科学研究科

国際協力学専攻

主査＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿＿

ACKNOWLEDGMENTS

This research was undertaken in partial fulfillment of a master degree in course of International Studies, Department of Frontier Science, University of Tokyo. I would like to extend my gratitude for all of kind support in completing my master thesis, especially for:

1. Professor Tatsuo Yanagita for kind supervisory;
2. Management of Lore Lindu National Park in Central Sulawesi, Indonesia especially for Head of Lore Lindu National Park, Mr. Amir Hamzah and Mr. Dudi;
3. Committee Member of Master thesis: Professor Eiji Yamaji and Professor Yoshida;
4. Ministry of Environment, Republic of Indonesia;
5. My lovely wife, Ratih, and also my ultimate family for understanding, support and patience in almost 2 years;
6. My entire friends in Indonesia and also in Japan.

CONTENTS

List of Charts

List of Graphs

List of Pictures

List of Tables

I. INTRODUCTION AND SUMMARY

There are two main objectives of this research. The first is applying the simulation analysis in regard with impact of deforestation both on carbon stock and beneficiaries agricultural production in the Lore Lindu National Park (LLNP). The second is applying general cost analysis of cash transfer program to community as a part of designing carbon offset place. There are two main conclusions of this research. The first is that the deforestation will give negative impact in reducing carbon stock but on the other hand, it is giving an opportunity income for beneficiary's agriculture population in the LLNP. The simulation analysis to LLNP in deforestation scenario shows that the carbon stock will decrease roughly 3 million tones carbon for the next 10 years from the base line year in 2004. However the opportunity per capita income of beneficiary's agriculture population will increase roughly 230% through agriculture land expansion. The trade off will give a consequence to the higher cost of forest conservation project in the future because of increasing cost of compensation. The second is that the cost of countermeasure to deforestation through perpetual cash transfer program to community for base line year in 2004 is still feasible in the range of carbon price unit for CDM project which is placed on the range US$ 5-35 per tones carbon. It will be demonstrated that the unit of carbon price for LLNP for the base line year 2004 is nearly US$ 10 per tones carbon. Throughout cash transfer program mechanism, the designed carbon price unit for LLNP will offer perpetual additional cash income transfer to beneficiary's community around US$ 25.29 per year which it will give an essential additional income for the first five years after project is implemented.

The deforestation impact could be seen as paradoxical circumstances from a view point of national park ecosystem and community. Under the status quo of present management, the LLNP has been experiencing with deforestation rate roughly 0.6% per year (Erasmi, 2001). It demonstrates that the illegal cultivation in LLNP's land might be increased in the future considering population growth as roughly 1.57% per year. Obviously, the maintenance of tropical forest through conservation gives many benefits beside biodiversity reserves. The deforestation will decrease all of national park's total benefit, including the global value as

carbon sequestering place (UNFCC, 2000). It will be demonstrated in our model that under deforestation scenario in LLNP, the carbon stock in base line year 2004 will decrease from 143.2 million to 140.2 million tones carbon in 10 years. However, on the other hand, the deforestation has been giving positive impact on increasing opportunity income of agriculture community through illegal cultivation into national park boundary. In the LLNP case, the beneficiary's agriculture product revenue in base year 2004 achieved US$ 14.68 million (BPS, 2004). The agriculture production predicted will increase as a coefficient US$ 821.3 for one Ha extension of beneficiary's agriculture cultivation. This will make the cost of compensation will much higher in the future if the LLNP is still in status quo of management. Even though the per capita income of agriculture population in 2004 was just only around US$ 142,8. The deforestation activities expected still will give more opportunity for increasing the income since the alternative income sources have not been available besides expanding illegal cultivation into national park boundary.

The Kyoto Protocol as a framework for emission mitigation is encouraging for setting up deforestation avoidance project in tropical national park and building incentive mechanism for developing country as carbon offset place. One of management option for carbon offset in protecting area that the management will act strictly protected for any extension agriculture cultivation in order to avoid a leakage at immediate area (Smith & Scherr, 2002). If it is implemented, the strictly protection will make the community on the condition better off without any alternative income (Hough 1988, 1991; MacKinnon et al. 1986; Nepal and Weber 1995; Ferraro, 2002). Since the social value of national park included many non-market values as like existence benefit, option benefit, bequest benefit, are difficult for a private owner to convert to alternative revenue (Chapman, 2003), the carbon price in deforestation avoidance project should be worth minimally for covering at least the loss of opportunity income from extension agriculture cultivation, and also could competitive with the other clean development mechanism (CDM) project type. Even less is known transaction cost about the actual transaction cost of communities in doing their business when smallholder involved in C trade. These cost are important because if they are too high

compared to the global price of C stocks smallholders, incentives will be inadequate to induce a change in behavior (Tomich et all, 2002).

Furthermore, the major questions will arise regarding how to make correlation between the community compensation program and conservation objectives. A lesson learned from the most of integrated conservation and development projects (ICDP), the in-kind assistance to community resulted in failure rather than successes particularly in execution phase (Hughes, 2001). This was because the participation of community at such of in-kind programs was very low which has made the project failed in integrating development and conservation. Since the community behavior and demand are very diverse, the designing perpetual cash transfer program might be responding to the individual requirement in the situation lack of information form communities ((Ferraro, P.J. and Kiss, A. 2002).

This research paper is organized into main six sections. The following section reviews the literature which consists of the recent capacity condition of conservation management, theoretical reviews about park management philosophies, deforestation and Kyoto Protocol mechanism, and countermeasure to deforestation. The section III explains the method that is applied in this research. The section IV explains the result that obtained from applying analysis the simulation of status quo management into carbon revenue and agricultural production. The section V is the discussion which emphasizes the analysis of deforestation impact and counter measure to deforestation throughout income substitution. This is followed by conclusion in Section VI.

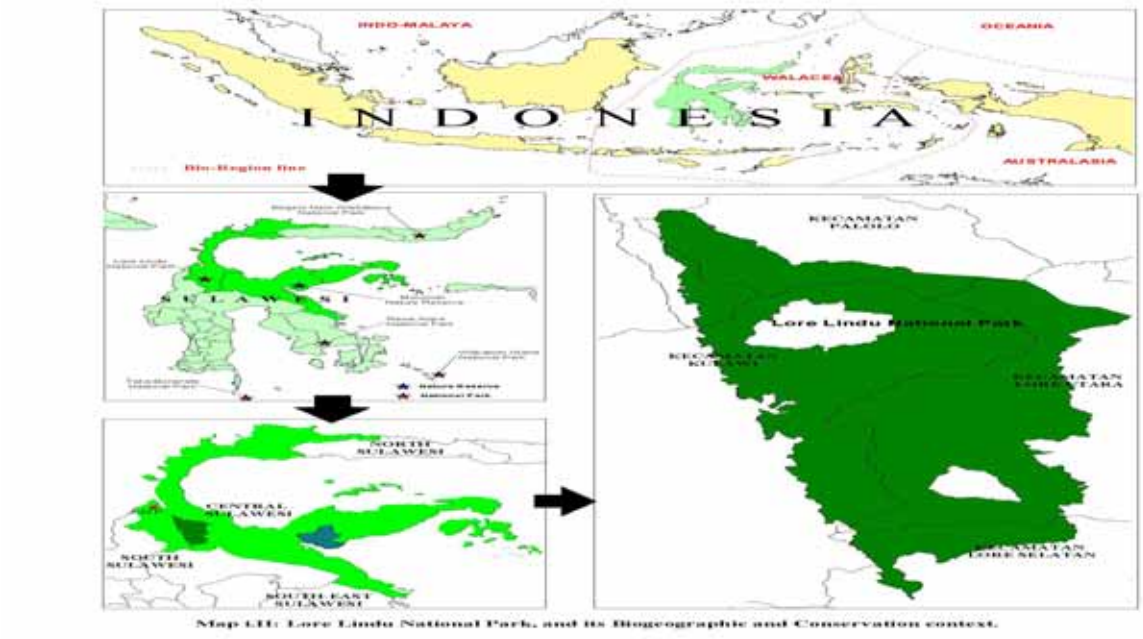
A. General Overview and Status of Research Area

The Lore Lindu National Park (LLNP) is one of valuable conservation site located at Central Sulawesi Province, Indonesia. It belongs between 119 90 – 120 16 east and 1 8 – 1 3 south. It has covered area roughly 217, 991.18 Ha which is around 1.2% of Central Sulawesi's main land or 2.4 % of Sulawesi remaining forest as 90.000 Km2. The LLNP is established in 1993 underlying law of Minister of Forestry Decree no 593/Kpts-11/1993.

Historically, the LLNP composed from the two existing protecting area and extension area at the north side. The LLNP has two enclaves (the community inside the National Park territory), those are the Besoa Valley in the south side and the Lake Lindu area in the north side. As administration, the LLNP is lied between 2 (two) districts: Donggala and Poso, and is adjacent by 5 (five) sub administration district: Kecamatan Palolo, Kecamatan Sigi Biromaru and Kulawi (Donggala District), and Kecamatan Lore Utara and Lore Selatan (Poso District). The total area of five sub-district within LLNP is reached as 6698 Km^2 (Bureau Statistic, 2004).

In terms of culture values, at LLNP site are also belongs as amount of 200 primitive megaliths which most of them needs to preserve. Therefore UNESCO declared Lore Lindu National Park as Biosphere Preserve on 1977. Beside that the LLNP has decided and proposed for specific status and special designation by various organizations.

Picture 1. The map of Lore Lindu National Park



Map I.H: Lore Lindu National Park, and its Biogeographic and Conservation context.

Those of LLNP's status are as follows: nomination as UNESCO world heritage, designation as an Endemic Bird Area (EBA), Center for Plant Diversity (CPD) and global 200 ecoregions.

Biodiversity

Sulawesi Island is one of interesting and unique ecosystem. Its located at transitional Biogeography zone between Asia and Australia continent which is presented endemic and restricted population of flora and fauna. It is stated by Whitten & Henderson (1987) that from 127 mammals living in Sulawesi, 79 (62%) are **endemic**. However, as like other region, community pressure and improper of development has been resulted in degradation of habitat and natural resources which has resulted extinction and endangered status of endemic wild animal. Then, in terms of ex- situ conservation in Sulawesi, Government of Indonesia underlying Department of Forestry has declared 3 (three) National Park and 3 (three) Marine National Park which is located at 4 (four) province.

As conservation site, the LLNP has a global value as habitat for above 266 species of flora and 200 species of fauna which most of them are Sulawesi endemic species. In regard with Sulawesi endemic animal, LLNP is the one of remarkable and priority for conservation site especially for endangered status of Sulawesi's endemic mammals and birds. If global biodiversity is to be conserved fully, the species and ecosystems with restricted range (endemic) should give more priority (Jepson,et. Al, 1995). Referring to ANDEC surveyed on 1997, it was stipulated, there were several Sulawesi' mammals and birds invented at LLNP that categorized by International Union for the Conservation of Nature and Natural Resources (IUCN) in endangered status as list in the table 1 below:

In order to execute conservation programs, the LLNP Authority Management has been developing capacity building at each of Sub Division of Conservation Unit where is located at 3 (three) main part of LLNP's site. However, the current status for the above endemic animals at LLNP has not provided comprehensively and successively. The small research

and monitoring regarding the above species has been conducting through LLNP's Annual Budget and collaborative action with personal researcher and NGO's.

Table 1. Sulawesi endangered endemic animals (IUCN) in LLNP

No.	Species	Local Name	Class	Status (IUCN)
1.	*Tarsius spectrum*	Hewan hantu Sulawesi	Mammal	Endangered
2.	*Macrogalidia musschenbroeckii*	Musang Sulawesi	Mammal	Endangered
3.	*Bayrousa babirusa*	Babi Rusa	Mammal	Endangered
4.	*Bubalus depressicornis*	Anoa Dataran Rendah	Mammal	Endangered
5.	*Bubalus quarlesi*	Anoa Gunung	Mammal	Endangered
6.	*Macrophelon maleo*	Burung Maleo	Bird	Endangered
7.	*Penelopides exarhatus*	Anggang kecil	Bird	Endangered

Beside that, there has developed a nesting place for Maleo (*Macrophelon maleo*). However the effort just could cover a small part of site area and conducting irregularly action. Recently, the habitat of endemic animals is threatened by community pressure and illegal logging.

Social Economic and Livelihood

The most of community surrounding LLNP is living under poverty and very depending with agriculture activity as income generation. For general portrait, the Central Sulawesi Province is categorized in the least development province in Indonesia. The gross regional product (GDRP) of Central Sulawesi Province was just Rp. 2.3 billion or 0.54% from total of Indonesia's GDP which was categorized smallest comparing with the other province (Statistic Bureau, 2002). The agriculture production accounted for 45% of GDRP in Central Sulawesi. The agriculture industry in surrounding LLNP was dominated with individual small scale enterprise with the average total area owned around 2 (two) hectares (Shawarze, 2004). Household livelihood around the LLNP is wet rice cultivation, dry land farming,

livestock, non timber forest product (NTFP) harvesting, and perennial crops production as like coffee and cocoa.

The LLNP region is demographically and culturally very diverse. The original ethnic in LLNP has been living in the site about 4000 years ago. It comprises the Kaili people, the Pekureha (Napu), the Behoa and the Bada ethnics. Each of these ethnic groups with distinct culture is natives to a specific geographic area. Currently, the population is a mixture of the indigenous and the migrants, from spontaneous migrant and official government resettlements (Central Sulawesi Cultural and Tourism Office, 2005). The traditional farming system of the people in the upland areas surrounding the LLNP was shifting cultivation (ANZDEC, 1997). Under the system, areas of forest were cleared using a slash and burn procedure, crops grown for one or two years and the natural vegetation allowed to regenerate as a means of restoring natural fertility over a period. Meanwhile, the population of LLNP was increasing successively from just around 20.000 peoples in 1971 to around 100.000 peoples in 1995 (ANZDEC, 1997), even though the population density in the area is about 6 (six) times lower than the Indonesian nation-wide population density of 116 Km2. The planned migration as well as spontaneous migration contributes significantly to population growth in the surrounding LLNP (Maertens, 2002). Under existing traditional farming system, the population growth would give more pressure to natural forest because the population needs more extension land for finding fertility of land and cultivating new plantation.

B. Problems

Referring to problems in the background, herewith the problems termination of this research:

1. What would be happened to LLNP if the management act in status quo?
2. How is the impact of deforestation occurred to potential carbon Revenue?
3. What is the impact of deforestation to income opportunity of agriculture extension?

4. What is countermeasure that might be built for deforestation avoidance in LLNP? How much is it cost?
5. How is the cost of countermeasure compared with the other CDM project and conservation project?
6. How is the cost-effectiveness of those countermeasures as a mitigation option?

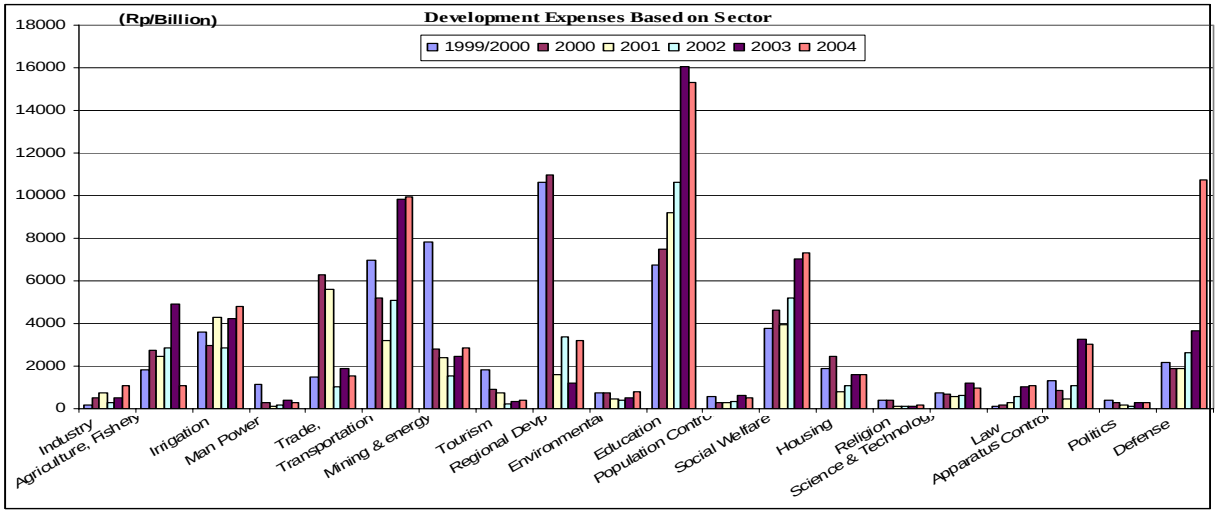
II. LITERATURE REVIEW

This research is developed broadly from 3 (three) strands background ideas: sufficient internal capacity of National Park Management in Indonesia, the deforestation, and how to stop deforestation. Those of ideas are elaborated on logical framework into section Indonesia's capacity in conservation management, economic value of LLNP, Deforestation, Kyoto Protocol and land-use changed and counter measure for stopping deforestation.

A. Indonesian Conservation Management Capacity

There are at least 2 (two) basis national law that authorized the creation of protecting areas in Indonesia, those are (1) act No. 5 in 1990 regarding the Conservation of Living Organisms and their Environment Act and (2) Act No. 41 of 1999 regarding forestry. However, endeavor for managing the protecting area under its basis law faces with internal constraint like financial problem and lack of human resources. Indonesia has been experiencing fiscal constraint for supporting annual budget particularly since economic crisis in 1998.

Chart 1. The allocation of development budget



Source: Ministry of Environment, 2004

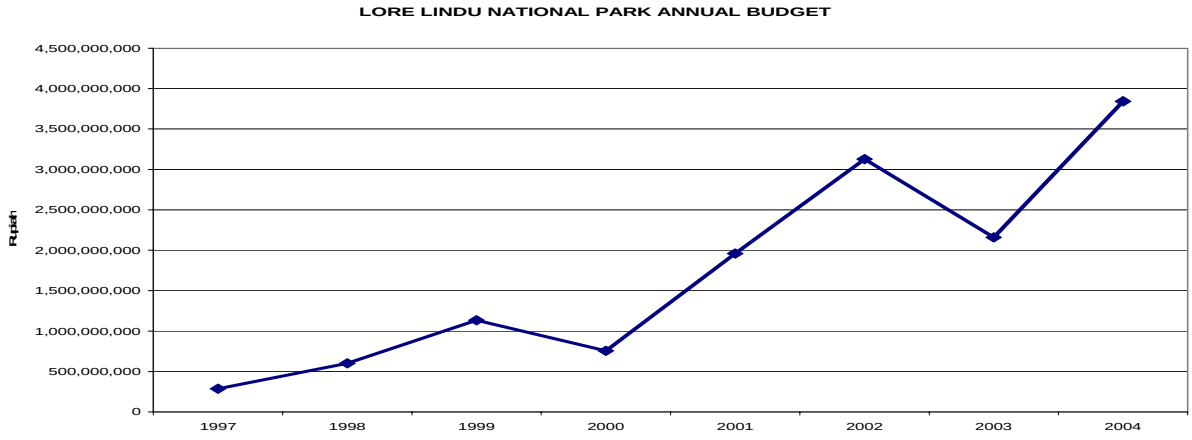
Since the economic crisis, the annual budget has been allocated as much priority to social security, education, national defense and economic recovery sector that more focuses on the education, defense, and the general election sectors. Nevertheless, environmental sector has not been a major concerned in regard with development planning environmental sector. It could be determined through budget allocation of environmental sector that was extremely low comparing with the other development sector, in term of percentage of GDP and per capita expenditure level (World Bank, 2001). The picture of Indonesia's development expense in each sector on the period 1999-2004 could be showed on the chart 1.

Comparing with the other development sector, the environmental sector takes small part of annual budget which was just 0.8%- 1.5% of total annual budget. Even though the increasing budget for development of environmental sector was insignificant and fluctuated, the attention of GOI for increasing capacity major institution as like Ministry of Environment keeps increasing every year which the ceiling budget for major institution increased 160.44% on the period 1999-2004 (SoE, 2004). The smallest budget was allocated on 2002 which it was around Rp 378.9 billion because the political and economic situation in the period took consequences for decreasing whole annual budget. The recovery of macro economic condition has been alleviating environmental development budget capacity that increased roughly Rp. 777.8 billion on 2004. Moreover, the restricted budget of environmental sector must be allocated to several programs as like pollution control, capacity building, rehabilitation, etc which is not only allocated for conservation.

The circumstances have been giving impact to the small proportion of budget for a Unit Management of National Park if compared with large area should be managed. Indonesia has established a network of 379 terrestrial protected areas covering 18.398 million hectares or 10% its land areas which are. 43 units designed as national park with the total large area roughly 14, 972, 690.33 Ha. The budget sources for operating those of protected areas are sourced from annual environmental sector budget (50.6%), reforestation budget (37,6%) and small grant from international assistance (7%).

The Graph 1. showed the annual budget for Unit Management of LLNP on the period 1997-2004. Even though the budget was increasing successively from Rp. 500 million in 1997 to nearly Rp 4 billion in 2004, but if its comparing with LLNP's large area the budget was just able to cover Rp 18.433,00/Ha/Year or nearly 2 Dollar/Ha/Year (US$ 1 = Rp. 9000). Although there has not been standardized of ideal budget, this budget is still far from ideal and under funded. Moreover, the National Park unit management has been experiencing with lack capacity quantity as well as quality of human resources. The total staff of LLNP is around 75 staff (2004) and if compared with total area, the proportion is just around 3050 Ha/ forest guard. Under this capacity the process of habitat degradation and extinction of endangered endemic animals at LLNP is still prolonging without stimulate budget for intensive conservation program. The essential supporting activities are seems hard to implement as like monitoring endangered endemic animal and boundary. It is causing the LLNP's potential economic activities as like tourism, education, etc value have not been developed as well.

Graph 1. The Lore Lindu annual budget (1997-2004)



Source: LLNP management, 2005

Besides facing with internal capacity problems, the park management is also facing with social economic problems of community surrounding national park that has been giving impact to degradation of national park and increasing cost of management. Although national Parks are primarily concerned with conservation of the environment and providing

such amenities as education and visitor facilities and parks management which are not set up or have the expertise to greatly improve social conditions, but the park management has to deal with social issues such as landlessness on a day to day basis (TNC, 2002). The LLNP management park is limited and does not allow for a large expenditure on community development. Even so, the park has the responsibility to do what it can particularly in defense of cultural right and practices.

Table 2. The fiscal capability of local government surrounding LLNP

National Rank	District	General Revenue	Wage	Poverty (N)	Fiscal Capability
176	Poso	210,944,407	127,240,713	68.39	1,223,918
292	Donggala	287,833,038	205,896,675	195.281	419,581

Poverty alleviation endeavor in surrounding national park are liabilities of local governments within national park, those are Kabupaten Poso and Kabupaten Donggala. However, the two of local governments also have been experiencing with restricted fiscal capability which are categorized in Kabupaten/District with low fiscal capability in Indonesia (Bureau of Statistic, 2005). Table 2. showed ranking of fiscal capability within 348 district in Indonesia which is determined from general revenue minus total wage and divided by total amount of poverty . Poso district belongs to 176th in national ranked with fiscal capability just around Rp. 1.2 billion and then Donggala district belongs to 292th in national ranked with fiscal capability just around Rp. 419 million. Obviously, the capacity of district within national park also has not been sufficient to support conservation through community development in these areas. In addition, the process of deforestation will continue without improving of local economic income and diversity income.

Furthermore, the one source of budget for national park from reforestation budget is now under threat which a number of policy studies have considered the decline in revenues from logging. Therefore, it is needed alternative financing scheme for national park that could be divided in to types: 1) those that could generate revenues at a scale to finance protecting

areas management trough the government (MoF) budget and 2) those which reduce cost of park management by building local by-in through improving the livelihoods of the rural peoples. The first category includes debt for nature swaps and carbon credit and the second low impact resources extraction and ecotourism (Rhee, 2004).

However, even the government, donor, and the NGO are spending and doing more than ever, the ultimately matters is whether these efforts are sufficient to slow, and ultimately stop, losses in the country's biological diversity. This effort could not be guarantee without local support, social and political opposition, problems with capacity among executing partners, and corruption (World Bank, 2001).

In order to generate revenues from those of environmental services produces from national park, that government has important roles in building market-based mechanism. In addition for developing policy and regulatory frameworks, governments are significant buyers and sellers of services and frequently active intermediaries as well. However, a government has been conducting market failure to natural forest resources. Responses to the problem market failure can take many forms. A common response has been decided by establishing new protecting area and extending large area of existing protecting area. Yet, governmental ambitions have rarely lived up to expectation. All too often governments lack sufficient information and how to provide them, or the lack funds to pay for necessary conservation. Government also are not immune to political pressure such lobbying from private sector that would be gained profit from forest use (Pagiola,S et al, 2002).

Effort to sell forest environmental services must begin by considering the potential market for them. The demand for forest environmental services may be local, national or global in scope. The nature of the demand has important implications for the type of market-based mechanism that will work in each case (Pagiola, et al, 2002).

B. Economic Value of Lore Lindu National Park

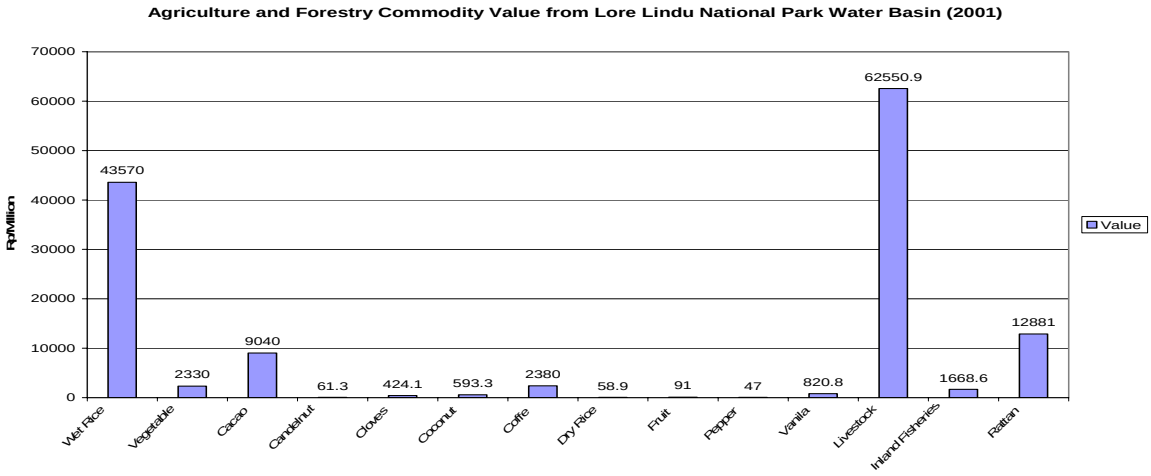
The LLNP has many variety potential economic values that has been giving directed and undirected impact to communities accrue in different spatial. The potential economic benefit of LLNP could be determined from essential values as conservation area, as follows:

1. Conservation site for Flora and Fauna
2. Culture
3. Tourism
4. Education
5. Carbon storage
6. Water supply for around Palu City (Capital City of Central Sulawesi)
7. Direct living hood supported for 62 villages with around the park as such soil protection, pest control, local climate, etc (LLNP management, 2002).

The direct benefits of LLNP ecosystem as like fresh water supply and tourism place are directed and enjoyed by local community and broader in Central Sulawesi Province. As local economic value, LLNP at least has 2 (two) main river catchments: those are the Lariang river catchments and the Gumbasa river catchments. Those of rivers are supplied essential water for large downstream basin in Central Sulawesi included Palu City (Capital of Central Sulawesi). From the LLNP's value of water resources studied that is conducted by The Nature Conservancy (TNC) on 2001, it could be described that the economic value of water resources roughly Rp 89.9 billion per year with the people dependent on LLNP's water supply around 304,607 peoples from 67,160 households.

The water coming from LLNP area is utilized for supporting agricultural activities, livestock and protein sources, industrial and household consumption. The major contribution gives for agriculture activities as a mainstay of the local economy which is value of each commodity describes at chart 2 below.

Chart 2. The agriculture and forestry commodities value from Lore Lindu National Park water basin (2001)



Source: TNC, 2001

The total agriculture asset that supported by water arising from LLNP is nearly Rp. 74. 8 billion which is included irrigating over 22,000 Ha in wet rice and vegetable production, providing water for livestock and fisheries as well as non irrigated agriculture in communities adjacent to the park. Although water resources services from LLNP has been giving much amount economic benefit, but the mechanism of repaying back from those user to LLNP ecosystem has not been developed yet.

Beside that, LLNP has many potential tourism place and attractions. The tourism objects present the unique Sulawesi's wild life, landscape, history statue and also traditional culture of local people that could be offered for various tourism groups like cultural based tourism, nature based tourism, and activity based tourism. The tourism objects that belong to LLNP could be described on the table 3 below. Considering the tourism place in LLNP, the tourism activities should have been able for getting interests from various tourism market either local tourist or foreign tourist.

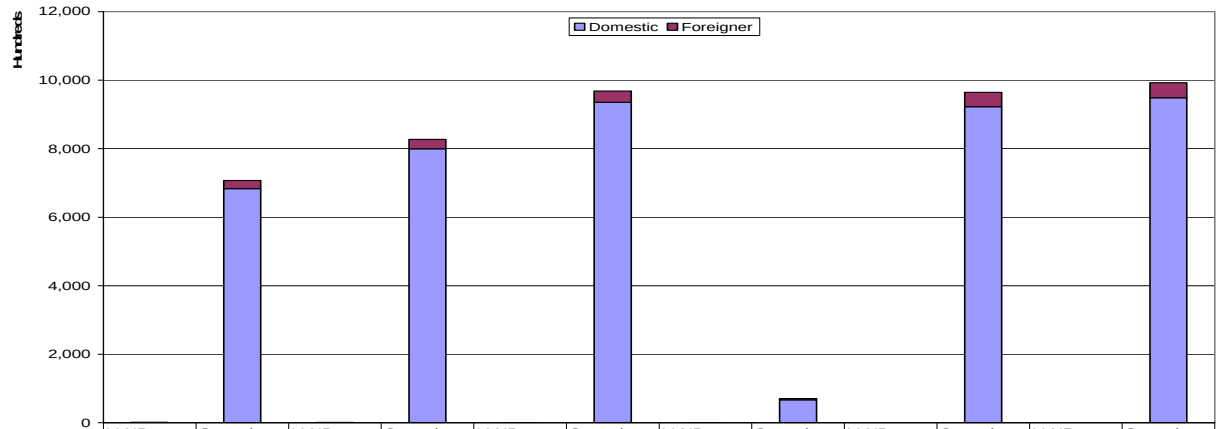
Table 3.The tourism object in Lore Lindu National Park

No	Tourism Object	Point of Interest	Market Constraint
1.	Lake Lindu	Scenic mountain and Lakeland views	Infrastructure and human resources
2	Megalith Statutes	Large stone objects, History	Accessibility
3	Kamarora	Birdwatching site	Lack of information and facility
4	Mt. Nokilaki	Mountain scenery and cloud forest	Lack of information, unsafety
5	Mt. Rorekatimbu	Montane	Lack of information, accessibility
6	Dongi2 Valley	Natural Forest	Occupation land, destruction site

However, those of tourism and ecotourism activities have not been able to give significant contribution to park management and also indirect income to local community. The income gaining for tourism to park management could be described nearly zero, comparing with opportunity cost of management which the revenue was just around Rp 1-3 million per year. There are many internal constrains to development tourism around the LLNP, at least: over development of access road, transmigration, lack of field guide and information, seasonality, the risk of Schitosomiasis disease (Cochrane, 1992).

Moreover, the LLNP also has not been able to competitive with the other tourism site even in regional level. The LLNP has not been placed as main tourism destination in Central Sulawesi. The chart 3 showed that proportion amount visitor to LLNP comparing with total visitor came to Central of Sulawesi. The LLNP has just been able to give contribution around 0.01% from total tourist in Central of Sulawesi. Recently, there has not been available the special travel agents arranging tourism for LLNP destination. Recently, the most of visitors to LLNP were composed of researcher and special interest tourist groups which are infamous in tourism market. Moreover, beside lack of internal capacity, the tourism developments in national parks are needed supported in integral national scheme. The tourism activity is very depending with national and regional security. Several national security issues as like terrorism, ethnical conflict, etc have been experiencing to Indonesia which is either directed or undirected influence declining tourism climate in regional stage (Department of Tourism, 2004).

Chart 3.The comparison amount of tourist between LLNP and Central Sulawesi



	LLNP	Central	LLNP	Central	LLNP	Central	LLNP	Central	LLNP	Central	LLNP	Central
	1997		1998		1999		2000		2001		2002	
Foreigner	189	23708	191	27738	88	32453	51	3621	40	41695	15	44063
Domestic	870	683451	1238	799638	167	935576	292	67044	100	922621	100	948704

Source: own calculation

Beside that, the Central Sulawesi pointed out as one of conflict area which has not been unresolved until now. From those of circumstances, there are many factors which are outreach of park management capacity in development tourism. This circumstances would make the tourism sector still seems hard to generate income in the near time.

C. Deforestation

There are much theoretical and empirical evidence explained caused of deforestation in developing countries. The basis hypothesis is Malthusian demographic (the stork) that universally cited as the major cause of deforestation. Traditionally peoples in tropical developing country enjoyed abundant land and practically slash-burn method for locating better fertility land. This method looks like sustainable under low both of population growth and agriculture production demands. Likewise, the agricultural production actors are dominated with smallholder farmer that evenly are more complicated for controlling the land expansion. The provision of agricultural expansion, primarily by smallholders, is the proximate cause of at least 50 percent of deforestation in tropical forest (Barraclough &

Ghimire,2000). Thus, in most developing economies the decline in forest and woodlands is mainly the result of land conversion, in particular agricultural expansion for crop production (FAO 1997 and 2003).

It is human nature that peoples always try to maximize their satisfying through improving their income. Majority of traditional smallholder farmers in developing country are lived under poverty which they lack of capital and technology on agriculture intensification. Apparently, the improving income in traditional agriculture is determined by expansion land which is broadly means opening natural forest. For instance, agricultural export share, growth in agricultural value added and rural population growth are positively associated with agricultural land expansion. In contrast, the share of permanent and arable cropland in total land area is negatively associated with land conversion (Barbier, 2002).

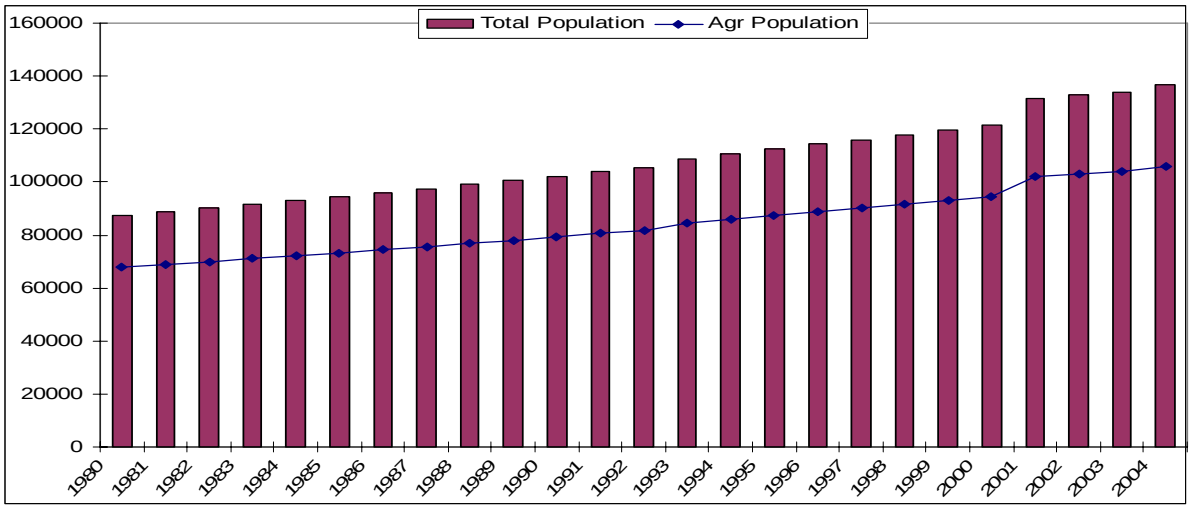
Moreover, the circumstances in population growth and poverty are obvious as major deforestation agent in developing countries. Several international development organizations as like (World Bank, 1989; IMF. 1993)) also notified relation between poverty and deforestation which fundamentally was caused by inequality in land ownership, tenure insecurity and landlessness (Rock, 1996).

D. Population growth surrounding LLNP

The population has been growing at margin boundary of national park. It grew from 82.422 peoples on 1970 to around 136.000 peoples in 2004 and around 77.4% (Chart 4) of them have profession as small scale traditional farmer (Maertens, 2002). Indeed over the past 20 years, population at 4 (four) administration district in surrounding national park grew around 60% or average around 2% per year. Nevertheless, the growth is still on the tolerant rate comparing with the availability of land which overall population density was just around 18.69 per Km2. This is about 6 (six) times lower than the Indonesia nation-wide population density at 116 per Km2 (World Bank, 2001).

The population growth has been driving by natural growth (birth growth) factor and also migrations form the other area of national park. On the past, the government had a program of planned migration that built resettlement communities coming form high density island as like from Java. The refugees form conflict area in Central Sulawesi (Poso) also comes to bordering national park looking for new opportunity live. It had resulted giving contribution to accelerate population growth around 200-2001.

Chart 4. Population growth in LLNP (1980-2004)



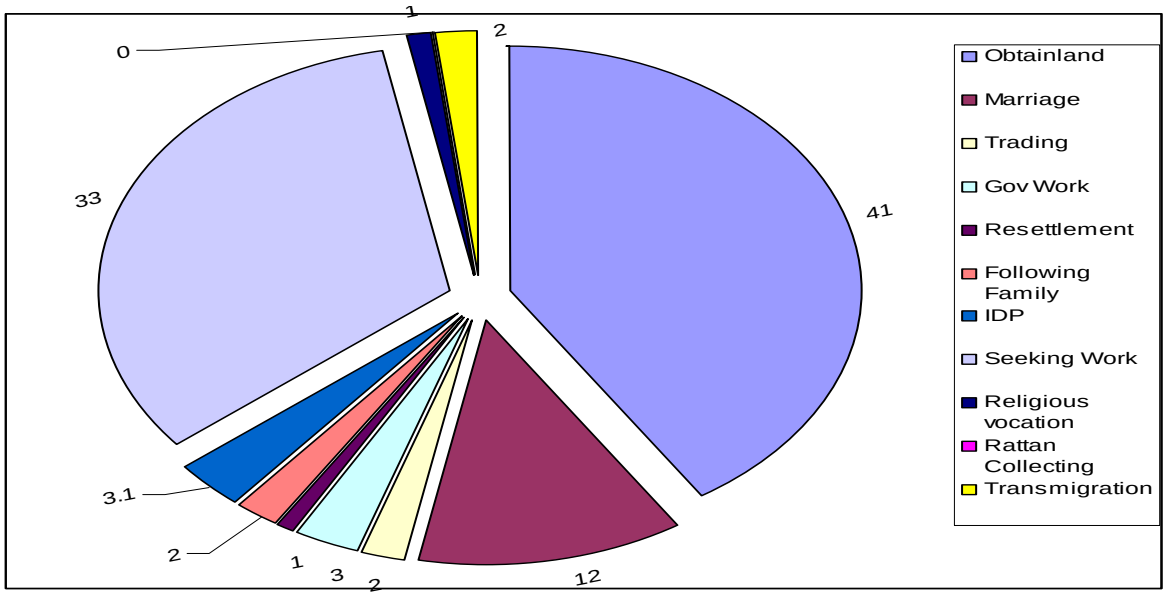
Source: BPS (2004) & TNC (2001

The both of population growth factors have been contributing impact to deforestation in different location within LLNP. The natural population growth occurred has impacted extension land clearing in 2 (two) enclaves. Even though, the deforestation rate in two enclaves have not been growing intensively as like surrounding national park, but it expected will grow to become threat in the future since their economic life very depending with extension of agriculture cultivation.

From the former survey was conducted by Yayasan Kayu Riva (2001), the motivation of peoples for coming to LLNP border was encouraged in several reasons as described in Chart 5. This survey described that the economic motive for finding new opportunity live

was the most factor encouraging people moving into LLNP's particularly for obtaining land (41%) and seeking work (33%). And the other minor reasons were marriage, trading, government work, following family, religious, etc. There are many reasons why peoples were more interested for obtaining land surrounding LLNP: (1) land ownership which the lack capacity in monitoring and uncertainty in private land regulation have made peoples more encourage occupying the LLNP as state ownership; (2) The LLNP location that near with capital city . The accessibility of LLNP is near with capital city which could reduce cost of their agriculture marketing; (3) the availability of agriculture source as like water availability and soil fertility.

Chart 5. People motive moving to bordering national park



Source: Yayasan Kayu Riva (2001)

Despite the role of population in driving agricultural land expansion and deforestation is much debatable. It was empirical studies concerning positive correlation between population growth and deforestation in LLNP. It demonstrated that the elasticity of population growth and land expansion is 0.93 which it means 1% increase in population leads to a 0.93% increase in area cultivated (Maertens, 2002).

E. Land-use around LLNP

The commercial lands used in five sub district around LLNP are dominated by crops production. The total area of agriculture in LLNP is estimated around 74.168 Ha excluding agroforestry activities on buffer zone in bordering national park and vicinity forest outside national park. Referring to survey data conducted by STORMA (2002), in the two most densely populated district, Sigi Biromaru and Palolo, about one third of the total area was used for agriculture while in the other three districts are lees than 10% (Table 4).

Table 4. Land-use per Sub district (2002)

SubDistrict / Land-use	**Sigi Biromaru**	**Palolo**	**Kulawi**	**Lore Utara**	**Lore Selatan**
Total Area	58.265	56.782	303.063	212.545	73.489
Total Area Outside TNLL	40.595	40.944	221.573	115.826	63.795
Agriculture area	19.379	16.880	23.898	11.609	2.401
% Total Area	33%	30%	8%	5%	3%

Source: STORMA A3 village survey and GIS data

The most dominant crops in those areas are paddy rice, the staple food crop, and perennial crop mainly in coffee and cocoa production. Coffee (*Coffea canephora*) and cacao (*Theobromo cacao*) are the primary tree crops commonly planted in the vicinity national park. Since the declining the Indonesian economy and being followed by the extremely depreciation Rupiah, there has been increased in farming of perennial cash corps particularly cocoa. Land cultivation of paddy rice was relatively constant because the government takes price control for sensitive commodity beside the land preparation is more expensive rather than perennial crops.

The cocoa and coffee are important crops to LLNP management in two reasons. Firstly planting in some areas has transgressed the Parks's border. Secondly, within the LLNP

community agreement model, the cash crops improvement could contribute to economic development initiatives in the buffer zone. The planting of perennial cash crops have been identified as a primary factor of forest degradation and deforestation within LLNP (Sieberet, 1998; Ruf, 2001). Moreover, the LLNP management (2002) also notified that increasing in large direct sun light cocoa plantation is considered as one of the greatest threats to the Park.

F. Kyoto Protocol and Land-use Changed

Protecting area has a global benefit value. There are several important principles included in the existing treaties which could be said as legal binding on forest conservation. Those are CITES, Ramsar Convention, ITTA, CBD, Convention to Combat Desertification (CCD) and potentially in Kyoto Protocol. From those of treaties, such compensation to local communities from world community in regard deforestation avoidance could soon become reality with agreement being reached on the core elements of the Kyoto Protocol at Marrakech in November 2001 (Smith, 2002).

One of national park's benefits is the capacity of carbon sequestering in which its benefit has become international treaties under The Kyoto Protocol accord. The Kyoto Protocol has been giving opportunities for developing global environmental services market on carbon sequestering that are supplied by natural tropical forest. As not like local benefit supplied, the tons of carbon sequestered in one place or in one way has the same mitigating impact on global warming as a ton of carbon sequestered in any other place or in any other way. It is precisely this equivalence that allows forests to be used to satisfy the demand for emission reduction. Consequently, there are large numbers of potential buyer all over the world (Pagiola, 2002). In addition to the fact that such areas in developing countries are more efficient engines of carbon storage by retarded deforestation than temperate forests and in addition lower opportunity costs of land than in developed country (Newell, 2000; Tomich et all,2002).

As a developing country, Indonesia can technically participate into one of three mechanism of Kyoto Protocol, namely the Clean Development Mechanism (CDM). The Indonesian Government has shown their commitment in ratification of Kyoto Protocol. The mean of commitment is determined thorough collaboration with some international and national institutions; they have explored possible national strategies for GHG reduction in all sectors including from Designated National Authority (DNA) as the primary requirement within national Strategies (Suyanto, et all, 2005).

Table 5. Possible types of forest carbon projects (Smith & Scherr, 2002)

No	Forest Project Type	Approach	Use of Carbon Payment
1	Large-scale industrial pulp or timber plantations	Establish plantation of fast growing trees for industrial use in deforested and degraded forest	To cover up-front costs of developing new industry
2	Agroforestry, community forest plantation	Increase tree growing and forest cover on farms or associated non farmed lands	To provide technical and marketing assistance; To subsides tree establishment; To pay farmer; To increase local organization capacity
3.	Agroforest	Convert land under annual corps or pasture to multi species agroforest	To provide technical and marketing assistance; To subsides tree establishment; To pay farmer; To increase local organization capacity
4.	Forest Rehabilitation and regeneration	Rehabilitate and regenerate severely degraded natural forests on community land	Local organization and planning; To pay cost of forest protection and management; To compensate users excluded form regenerating forest
5.	Strictly protected forest areas	Remove potential threats of deforestation and manage area so as to minimize human impact	To compensate sources of deforestation threats; To pay costs of forest protection; To develop local income sources, to reduce leakage
6.	Multiple-use community forestry within protected forest	Remove potential threats of deforestation and develop sustainable forest management system with local communities	To compensate sources of deforestation threats; To develop local technical business capacity for managing protected forest

There are several possibilities project scheme under Kyoto protocol related with forestry sector (Table 5). The conservation activities in national park might be incorporated with deforestation avoidance activities through schemes: strictly protected forest areas and multiple-use community forestry within protected area. Indeed, the deforestation of tropical forest gives essential impact to accumulation green house gas. The deforestation gives contribution to global emission as amount 25% (UNFCC, 1995). However, in the first commitment period of LULUCF mitigation (until 2012), the deforestation avoidance activities is not included in the role of Non Annex B parties which has been limited to afforestration and deforestation (AR) activities. It stated that the AR CDM credit by Annex B parties is limited to 1% of their base year emissions per year. The deforestation avoidance has been refused as in CDM activities in the COP 8 Marrakech Accord at least until 2012. The Kyoto protocol can affect forestry policy, but it is not certain what action will be required with respect to carbon sinks. Therefore, the Kyoto Protocol cannot indicate the principles for forest conservation at present time (Isozaki, 2003).

There are several reasons that deforestation avoidance is inclusion in CDM activities (Brown, 2001), as follows (Schlamadinger, B, 2001):

1. The leakage of deforestation avoidance projects using project baselines could be significant and difficult to estimates accurately. And then, refers to indirect effects of the mitigation project on GHG emissions out-side the project or even country boundaries ;
2. Uncertainties of estimates of how much deforestation has actually been avoided, compared to a business-as-usual baseline;
3. The scale of carbon credit from of deforestation avoidance is very large. Moreover, it leads industrialized countries to put less effort into emission reductions from burning of fossil fuels;
4. The cost of forest conservation in developing country seems have many risks and ambiguity.

Nevertheless the deforestation rate in developing country is running rapidly that accounted for nearly one-third of global greenhouse gas emission. Therefore a post of 2012 any comprehensive strategy for avoiding catastrophic climate change through stabilizing atmospheric concentration of the trace gases should consider these natural resources and sinks (Brown et al, 2001). Moreover, forest protection can only securely deliver C if significant stakeholders are meaningfully and transparently involved, traditional or customary rights are recognized and their loss is compensated for, and there are direct linkages between conservation and development objectives (Asquith, N.M, 2002).

G. Countermeasure to Deforestation

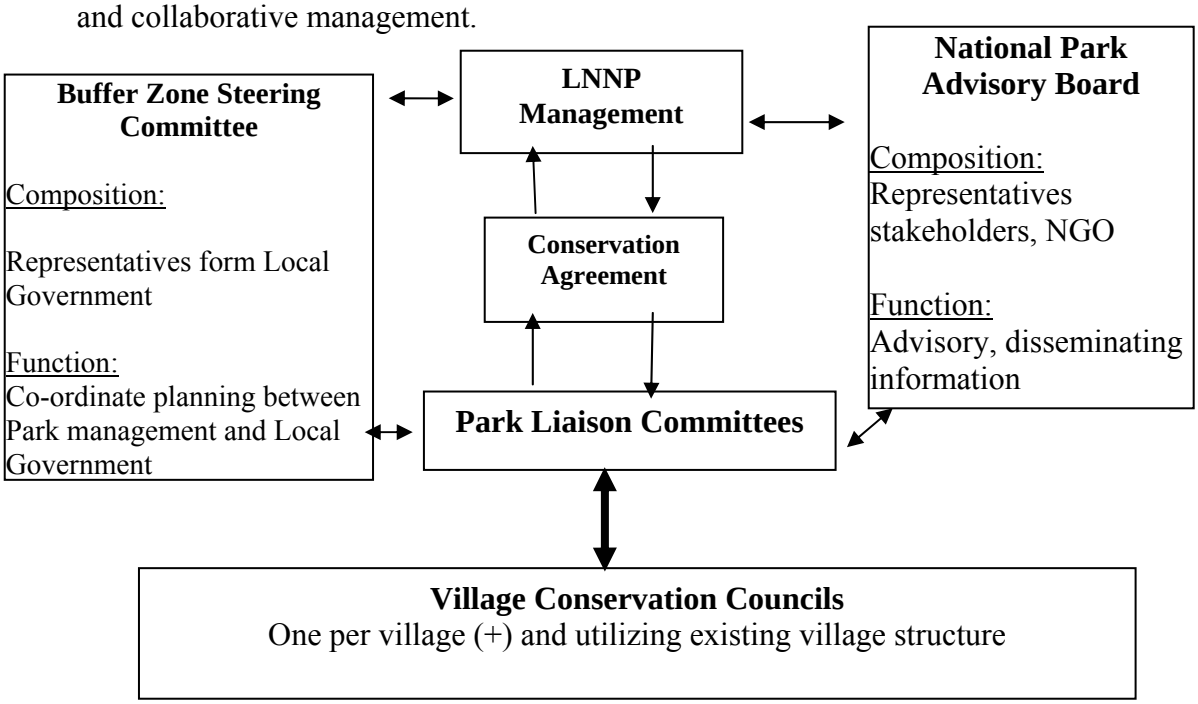
The deforestation is being a dominant factor of liquidated LLNP's natural resources. The countermeasure for stopping deforestation should meet with what the local communities need since they are living really depending with many valuable goods inside national park and extension land for their cultivation. Direct benefits for local inhabitants, such as new alternatives and possibilities must first be identified in order to solve the problem of protected areas (Hough 1988, 1991; MacKinnon et al. 1986; Nepal and Weber 1995). Without alternative methods of meeting these needs, restricted access to protected ecosystem will mean decreasing standards of living overtime for communities and furthermore it may generate serious conflict between park management and resident population (Ferraro, 2002). Moreover, the goals of conservationist have become inextricably embroiled with local communities who are often forced to accept conservation without compensation (Harada, 2003). To be successful in the long term, conservation must be incorporated into every aspect of natural development process, including a new national culture, rather than just the responsibility of park authorities conserving specific wildlife (McNeely, 1989).

There are three options available to reduce the threat posed in LLNP by kind of measures: (1) To increase enforcement of park boundaries; (2) To engage the agricultural sector; (3) To develop conservation agreement. From those of possible measurements, the developing

conservation agreement is the strategy with the highest leverage which it combines the strengths of the first two options, and integrates them into planned conservation activities (LLNP Planning Management, 2002). Then, the countermeasure for stopping deforestation program in LLNP should be integrated with empirical evidence of such deforestation agent measurement in the site. From research of Maertens, (2004) and Schawarze (2003) stated that there have positive correlations between population growth and deforestation. In addition deforestation in LLNP has negative relation with s income level and market access.

G.1 Management Philosophy: Community Participative and Collaborative Management

There is a general consensus that to achieve sustainable forest management, the participation of local people is essential in every domain of forest policy. Participation of the local peoples can make lower transaction cost and help avoid conflicts over forest utilization (Inoue, 2003). In order to solve complexity problem between stakeholders, the LLNP park management adopts the philosophy of community participative management and collaborative management.



Picture 2. The scheme of collaboration management in LLNP

The main aim of this collaboration is to achieve institutional and informal involvement of all stakeholders in national park management and decision making. The structure of collaborative management that explained correlation between LLNP management and the other stakeholders could be described on the picture 2 above.

Since the complex issues occurred in LLNP management which makes direct linkage to internal management capacity and secondary linkage with the other stakeholder, the collaborative management becomes one solution for answering complexity of environmental management (Pagiola, 2002). Obviously, it needs a new vision for collective action among the stake holder. It was a belief that fostering collaboration between the different civil groups and agencies with an interest in the outcomes would lead them to cooperate with one another more voluntary in implementing the decision arising from this collaboration. However, collaboration between the state and civil society may well be essential but it knows already that it is far from simple. The voluntary of civil society on collaboration is strongly correlated with economic framework suitable for analyzing institutional choice and cost involved (Marshall, 2005).

As showed in the picture 2 above, the LLNP should make collaboration face to face with local people that represented on park liaison committees. Under this collaboration, the LLNP management and park liaison committees would achieve output as conservation agreement between them. This purpose is for establishing legally binding agreements between Park Authority and villages around the park and ensuring that the community are monitored and enforced by both parties (LLNP Management Plan, 2002). Recently, the developing conservation agreement with local communities in LLNP meets many challenges and refusal from part of community particularly who are living within bordering national park because the following reasons:

1. Customary law in term of conservation in LLNP is indefinitely presented and general implemented because Lore Lindu is a hot spot of conflict. The causes are complex,

with claims to the land from adat (traditional) communities as well as various groups of immigrant (Sangaji, 2005);

2. Historically peoples have been living long time before the LLNP established and then the Conservation agreement surely give restriction to community for accessing natural resources;
3. The agreement brings about consequences assuage community obligation to ensure sustainability of forest resources used and also converted their traditional behavior in extension land for agriculture activities.

The refusal of community to the agreement is indicated with 3,800 hectares of the total 228,000 hectares of forest in the park had been badly damaged and another 1,000 hectares had been occupied for resettlement purposes (The Jakarta Post, 2002). The agreement just could be negotiated and suitable for original traditional community as like ethnic Toro, Doda, and Katu who have signed the agreement voluntarily. Therefore, such agreements should be supported with broader community development or the other welfare program as parts of incentives in conservation. The participatory top-down approach should not be included in the strategy for participatory management (Inoue, 2003).

Moreover, the effectiveness ways in promoting conservation are consist into two basic criteria: firstly the extent to which attracted participant and influence their behavior and secondly extent the nature of forest. However, conservation not only depends on the two basic criteria but also on the opportunity cost of conservation (Pagiola et al, 2002). The cost of conservation is also included the cost of compensation to community surrounding national park that reflected in the loss of profit. The building agreement should give mutual benefit between all of stakeholders.

Although under Indonesia's law, peoples are not supposed to live in national park or exploit the resources contain for commercial reason (LLNP Management Planning, 2001). Nonetheless, the community has been living dependently their economic activities within surrounding national park for long time before national park established, and some

economists have argued that the conservation of tropical forests will be difficult unless people who use these forests are compensated for the environmental services their forests provide to the world community (Pearce 1996). Under restricted local as well as national capacity in LLNP management, the compensation mechanism should consider participation of international community which has received those benefits from national park. Indeed, forest management systems should adopt the subsidiary system as general principle of governance that not only central governments, but also international treaties and organizations should support local people and indigenous people's participation (Isozaki, 2003).

Moreover, the community development program in surrounding protection area should consider providing an attractive alternative beside colonizing and clearing the forest. Moreover, in general terms, the government should promote rural economic diversification, the creation of agricultural processing industries or other value-added activities, the use more labor-intensive agricultural technologies and crops and also promoting ecotourism. At the same time, the government should strongly discourage agricultural policies and practices which could reduce local employment, such as mechanization when it is labor displacing (Ledec, 1992). Even though the preparation process of collaborative management seems related with high cost and effort but it argued that the ex post transaction costs arising after the system established are likely to be lower than those in centralized system due to increased legitimacy, leading to lower cost ensuing from monitoring and enforcement (Hanna, 1995).

The participation of local people in management process for protected areas is also emphasized, including the need for economic incentives or support for local people to ensure their participation (Isozaki, 2003). There are many international instruments that recognize and describe the importance of participation in environmental management, but they have certain limitation, even though some are legal instrument because the word of participation has taken several general interpretations (Komatsu, 2003). The cost of conservation management is classified as transaction cost and production cost. The cost

related with participation community in national park management might be categorized in transaction cost which is included (1) search and information cost, (2) Bargaining and decision or contracting costs and (3) Monitoring, enforcement and compliance cost (Challen, 2000). Moreover, Mburu et all in 2003 explained attributes of transaction in wildlife collaborative management:

1. Uncertainty that arises from an uncertain environment and complex activities and usually leads to incomplete contracts;
2. Asset-specificity, which lead to generation of appropriable quasi-rents;
3. Frequency with which the transactions occur such as the frequency of decision, meeting, etc;
4. Complexity of collaborative management arrangements which mainly arises from the diversity of stakeholder's interest, lack of social cohesion and the number of resources users or landowners.

Moreover market based mechanism can be powerful tools for poverty alleviation and rural development. Payments for environmental services can likewise help to diversify household income sources, thereby reducing risk and vulnerability.

G.2 Welfare System

There are many arguments that are explaining evidence correlation between poverty and deforestation; even it also explained evidence ambiguity correlation between them. Therefore in the case of deforestation, claims mutually-reinforcing environment and development policy must be justified on the basis of empirical evidence rather than theory (Zwane, 2002). In fact in LLNP, deforestation has been giving an opportunity for increasing community income through their traditional agriculture behavior in expanding land. In this regard communities may demand compensation or incentives as being part of loss their income opportunity beside that the park management assistance to alleviate their income is also necessary. Equally, previous studies of tropical deforestation may suggest

some of the possible effects of growth, per capita income and other macroeconomic factors on agricultural land expansion in the tropical developing regions of Latin America, Africa and Asia (Barbier, 2002).

Recently, the community is still under condition of low income which needs more intensive development assistance. Since their role in conservation is indispensable, the assistance to community might be developed as conditional welfare security system. The system is determined by providing eternal cash transfer provision to beneficiaries' communities as amount of loss opportunity income from agriculture extension behavior. It has been argued that direct payments to individuals for protecting habitats would be a much more cost-effective way of investing limited resources than in trying to build capacity in the protection agencies, increase awareness, and develop alternative income streams (Ferraro, P.J. and Kiss, A. 2002)

There appears to be general agreement that a good welfare system will have the following characteristic: (1) adequate benefits, (2) vertical equity, (3) horizontal equity, (4) target efficiency, (5) administrative efficiency, (6) adequate work incentives, (7) adequate work opportunities and (8) responsive to individual needs (Albrecht, 1982). Moreover, well design cash transfer program should be determined requirement, as follows (Tabor, 2002):

- Respond to market failures and well-understood poverty and vulnerability risk (address idiosyncratic risk: illness, old age, widowhood, destitution, hunger)
- Expectations are reasonable and programs coherent
- The needy do benefit from the program
- Financing strategy has a progressive incidence
- Assistance doesn't "trap" the poor in poverty or discourage them from working
- Assistance contributes to social integration and overcoming gender discrimination
- Administration is cost-efficient but effective
- Political support is sufficient to sustain programs

In the case of small increase in income for the poorest smallholders, it will not reduce the rates at which these households clear land, and are unlikely to increase their use of purchased inputs that increase yields, such as pesticide and fertilizer. More promising interventions to increase incomes of the poor while minimizing associated increase in deforestation are likely to be targeted supporting for the acquisition of capital inputs that forestall yield declines, or improvements in the functioning of local labor markets.

G.3 Agriculture Technologies

Cocoa has been becoming active deforestation agent in LLNP rather than the other cultivation as like paddy rice and coffee. It has been really a fundamental rapid change in rural ecology due to a rapid expansion of cocoa cultivation. Consequently, it does not only the change in sociological aspect of community but also the cultural, economical and political aspect and furthermore it includes the fundamental and rapid change in natural aspect In Sulawesi cocoa adoption by migrants is still a major deforestation agent around 1990 (Sitorus, 2002)..

Moreover, the difference cost between new and old cocoa plantation is directly related to the loss of benefits series provided by forest. The benefit is included low frequency of weeds, good topsoil fertility, moisture retention, due to high levels of organic matter in the soil, fewer problems with pests and disease, and provision the other forest product. High tree mortality in replanted field and the additional labor and other input need to control tree mortality that increases the risks and cost of replanting. In the Sulawesi uplands in Indonesia, planting cocoa on grassland was estimated to cost almost twice as much as planting cocoa in a recently cleared forest (Ruf & Zadi, 1998). Indeed, the smallholder cocoa farmers in surrounding LLNP are experiencing with capital constraint for improving their existence land. The establishment protected area has been returning into their opportunity to gain more revenue from reduction cost in cocoa production diminish.

Moreover, lack of land monitoring that conducted by park management has made land ownership evolves during the cocoa cycle. In most cases, when the cocoa boom begins, migrants find cheaper land and can acquire it easily. Most booms can be interpreted as situation where local ethnic groups, who control land, or at least have a moral claim to it, meet up with migrants, who bring and control labor. The Sulawesi's cocoa boom is much recent than other central cocoa placed. The once most of the available deforested alluvial plains had been converted into cocoa farm, more and more migrants got the cocoa fever and moved to the forested hillsides and the remaining forested plains. The Sulawesi deforestation case shows that adoption of a tree crop does not necessarily trigger deforestation in the short term. However, eventually, the high returns from cocoa led both established and new farmers to invest in clearing additional forest. Technological progress helps reduce deforestation only after large areas of forest are gone. Then a few reserves and national parks can be protected at reasonable price. Institutional rules with their enforcement have to keep access to these forest areas difficult and risky. Technological change will not save the forest alone but can help divert farmers to fallows and grasslands, rather than the remaining forests.

The trade off between loss opportunity in reducing cost of cocoa production and deforestation avoidance in LLNP should be solved by developing welfare system. Under this proposal, the community expected would be able to improve their agricultural technology. In order to increase agriculture production, there has no land choice except forest and agriculture land which it means that it must improve the capacity of existence land for increasing production. The green revolution as commonly known an effort in agricultural intensification has had a positive effect on forest cover. Green revolution has enthusiast often stress on new variety of rice, wheat and maize, combined with using fertilizer, irrigation and pesticides helped save a million saved tropical forest. However technological change at the forest frontier often has minimal impact on agricultural price (Angelsen, 2001). The impact of green revolution in slowed deforestation should assume with several factors: (i) lived close to subsistence level consumption;(ii) are primarily

concerned with meeting that subsistence target; (iii) only use family labour on their farms and (iv) have no alternative use for that family labor.

Table 6. The feature of the main technical changes studied in Sulawesi, Indonesia

No	Type (and cost)	Labor Saving	Farmer response	Deforestation Impact
1	Adoption of chain-show	Yes	Monopolized by relatively rich farmer but wide impact through an active market for cleared forest	Strong
2.	Hand tractor	Yes	Important in the paddy sector	Significant effect. It freed labor and pushed farmer and ex-share cooper to cocoa frontier
3	Herbicides	Yes	Massive and rapid adoption in the 1990s	Helped reduce deforestation in the short run.
4	Fertilizers	Yes	Massive and rapid adoption	Ambiguous. It helps farmers maintain their tress at a high level of productivity. But the increased return makes new planting more attractive.

Farmer responds to economic opportunities. The economic theory predicts that technological change will affect deforestation depend on:

(1) Type of technical change
(2) The presence of market imperfections
(3) The extent to which farmer can substitute between factors

(4) The way households balance work against leisure

(5) Whether the technology effect the intensive or extensive system

(6) How much people migrate in response to regional income differential

(7) How steep the demand and supply curves for outputs and inputs are

III. METHODOLOGY

A. Time and Location

The research site is located at Lore Lindu National Park. The collecting data in the field was executed from 5-17 September 2005

B. Data Collection

The research is developed from several secondary data, as follows:

- Deforestation rate
- Population growth at 5 (five) subdistrict within LLNP
- Time series of Agriculture production at 5 (five) subdistrict within LLNP
- Capacity carbon storage in different land-use and carbon price
- Community Income in LLNP

The deforestation rate in LLNP is predicted through analysis of land-use changed using landsat MSS/scene and Landsat ETM+ (Erasmi, 2001). Landsat data have been acquired over the study area for the time frame of 1972 to 2002. The scope of land-use change analysis included in the whole of boundary in five subdistircts within LLNP. Subsequently, the history of population growth was captured for period 1980-2004. The population data for period of 2000-2004 was available in Bureau Statistic of Central Sulawesi and for period 1980-2000 was collected by former research (Maertens, 2002) and LLNP Management Plan document (2002).

The agriculture production in 5 (five) subdistrict in LLNP data was collected from Bureau Statistic of Central Sulawesi and former research conducted by The Nature Conservancy (2001). The agriculture production data was selected for main crops within LLNP, those are: cocoa, coffee, and paddy rice. It was considered because those of plantation were

major production within LLNP and considered as deforestation agent. Thereafter, the analysis of capacity carbon storage in different land-used is referred to former research who explained carbon storage at several land-uses in Sumatra (Tomich, 2001). It is assumed that the capacity carbon storage of different land-uses in Sumatra is relatively equal if applied with tropical area in Sulawesi. Because the carbon price for CDM project has not been standardized, the carbon price will be assessed from the lowest, average and highest price. Moreover, Scharwze (2002) has conducted income survey in beneficial area in LLNP. The income survey has delivered in 63 villages through executing interview and distribution questionnaire to more than 300 respondents. From those of secondary data, the research was also compressively with field observation.

C. Analysis

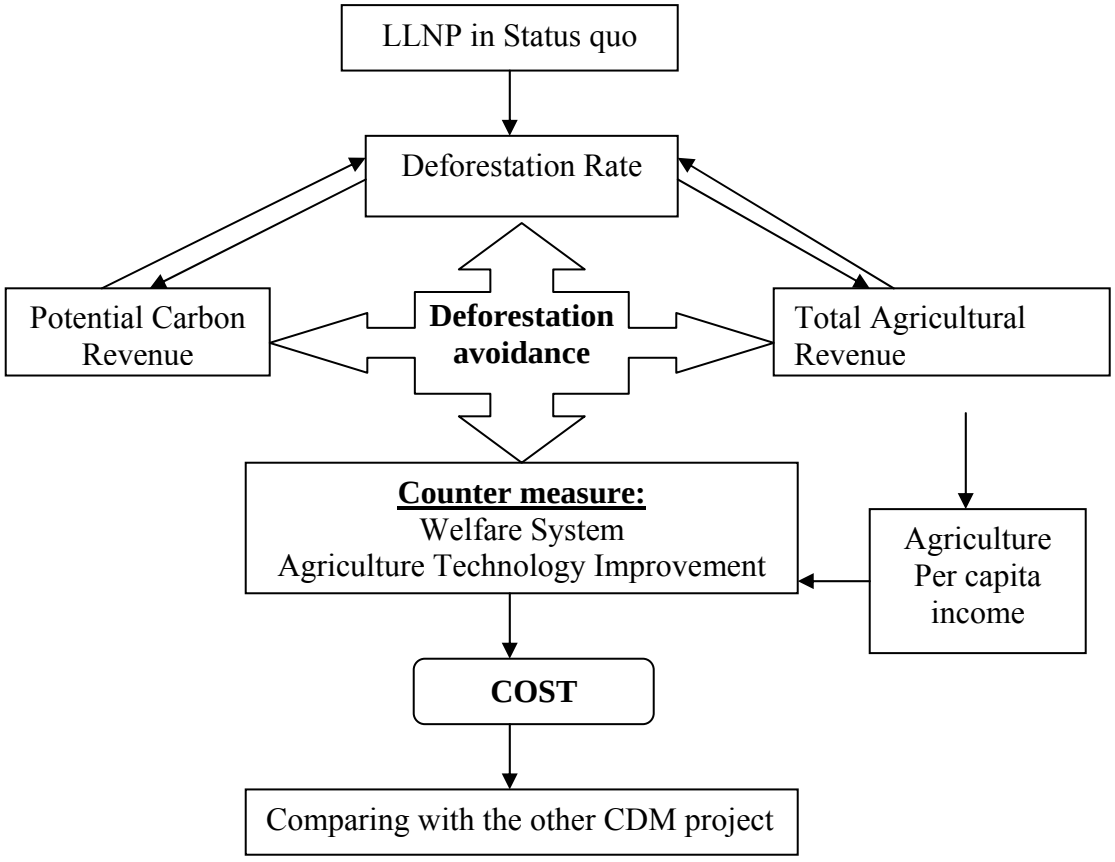


Chart 6. The analysis framework

The LLNP management has been experiencing with lack capacity of financial as well as human resources. Therefore, the park management status calls status quo if there is not improving of the management capacity in future. The status quo condition has deserved the LLNP with deforestation which is also determined as habitat degradation. Referring to deforestation rate data in LLNP (Erasmi, 2001), it will be predicted land-used change within LLNP for the next 10 years with the base line year 2004. The prediction model of land-used changed is determined by equation:

$$LUt = LUo\ (1 \pm (R\%)t \qquad (1)$$

Where LUt is land-used changed (Ha), t is period with 2004 as base year (to= 2006), R is deforestation rate for each of land-used. The land-used is categorized into natural forest, agroforestry, perennial crops, and annual crops, build up and grass. Because of deforestation, the land-used changed in equation (1) might be in positive or negative changed which the natural forest is experiencing negative change and the other land-used is positive change.

The former deforestation rate analysis was available including all of area in subdistrict within LLNP. This area is determined as immediate area of carbon offset place since the LLNP management is integrated with dynamic activities in five subdistrct administration. The design of carbon offset composes the analysis of leakage on deforestation outside of LLN boundary. The leakage of deforestation avoidance activities would be assessing by decision tree for identification of leakage (Auckland, 2003). The leakage impact analysis just could be explained in general analysis since the data for beneficiaries' district unavailable.

The deforestation occurred will give impact to potential carbon revenue and agriculture production. Since the natural forest has largest capacity in carbon storage (Sheeran, 2005), the deforestation will make the potential carbon revenue that possibly gained by the host country is decreasing successively. The potential carbon revenue in LLNP is analyzed for

the next 10 years simulation with the base line year in 2004 (t=o) and using assumption land-used change in status quo of management. The equation of potential carbon revenue simulation is determined by land-used changed (1) multiple by carbon price and carbon storage or explained in equation:

$$PCR = \Sigma \{(LUo (1 \pm (R\%)t * P * C) \quad (2)$$

Where the P is the carbon price (US$) and the C (Ton/Ha) is the carbon storage in different land-used. The carbon price is expected on the interval US$ 5-35/t c with average around US$ 10 /t c (Fearnside, P, 2000). The scope of potential carbon revenue analysis would be explained from both of interval and average price. The capacity of carbon storage is assumed constant linearly without fluctuation on each of land-uses although there is a fluctuation of carbon storage particularly on harvesting period and transition period.

Meanwhile, the agriculture production predicted would be positive increasing because of deforestation. The analysis of agriculture production would be explained by pooled data which combined element both of time series and cross section data (Gujarati, 2003). It is like potential carbon revenue simulation, the agriculture revenue also predict for the next 10 years with the base line year in 2004 (t0). The 10 years simulation will be explained by curve estimation using SPSS 13 software. Because the increasing of agriculture production is determined by extension land trough deforestation, therefore the agriculture production is determined as dependent variable and extension land is determined as independent variable. The equation for revenue agricultural production determined as:

$$TRt = \beta o + \beta 1 (TAt) \quad (3)$$

Where TRt is total agriculture revenue (US$) in particular time, βo is constant, β1 is coefficient of independent variable and TAt is expansion land area by deforestation (Ha). The total revenue of agriculture production is calculated in constant price per hectare in 2004 price for each of agriculture product. In regard with this model, the risk and

production probability in next 10 years (price changed, pest, etc) is be explained by confidence interval for coefficient of independent variable (β1) interval of standard error with ά = 0.5%. Moreover, the analysis of total agriculture revenue is continued for simulation of income in next 10 year. The prediction simulation of agriculture per capita income is determined by

$$I = TRt/Pt \qquad (4)$$

Where I is per capita income and Pt is prediction of agricultural population. The agricultural population is assumed nearly 77.4% from total population (Maertens, 2004) and the prediction will be analyzed by curve analysis of SPSS.13.

The deforestation occurred in LLNP should be stopped in order to build carbon offset place. The deforestation avoidance would be conserve potential carbon revenue and avoiding carbon loss from deforestation activities. However, the other side the agriculture production revenue would be stagnant unless any improvement on agriculture technology and it would be impacted to loss opportunity income of community surrounding national park in the coming year. The loss of opportunity income from deforestation activities would be replaced by welfare program and agriculture intensification. The cost of these programs would be integrated in cost of national park management.

At present, there is no standard method for evaluating the cost of forest management practices that expand, restore, or protect forest areas for climate purposes, and what estimates rarely comparable (IPCC, 2000). It therefore the cost of CDM project is predicted trough secondary measurement which on this research is analyzed through income substitution. The range of compensation cost would be analyzed as their opportunity loss as agriculture expansion production in coming 10 years with base year on 2004. Throughout equation (2), the beneficiaries of agriculture production in coming 10 years is predicted in net present value (NPV):

$$NPV = \sum PV/(1+R)t \quad (3)$$

Where PV is present value, R is discount rate. The NPV would be analyzed for different discount rate on 10%, 12%, and 15%. The total beneficiary's agricultural compensation would be calculated in per capita income which it is calculated by dividing present value of beneficiary's agricultural production in each of year prediction with total population prediction. The simulation of population growth for coming 10 years is assessed by developing regression from time series data.

Referring to the evaluation, compensation design would be assessed for cash transfer payment which is designed in acceptable value for encouraging income diversity and improving agriculture technology. The sustainability of the compensation program is followed up by developing perpetual fund for community which is analyzed by comparing the investment in agriculture with putting saving in commercial bank. After the scheme of counter measure developed, the programs proposed would be evaluated with the other conservation project which applied community development as mainstream program.

Under the compensation system, the community predicted is willing to integrate with conservation agreement. The main contain of conservation agreement is willingness of community in conservation program and concord about avoiding expansion traditional agriculture. The decision of communities in joining those of counter measure program is analyzed by decision tree analysis (Aukland, 2003).

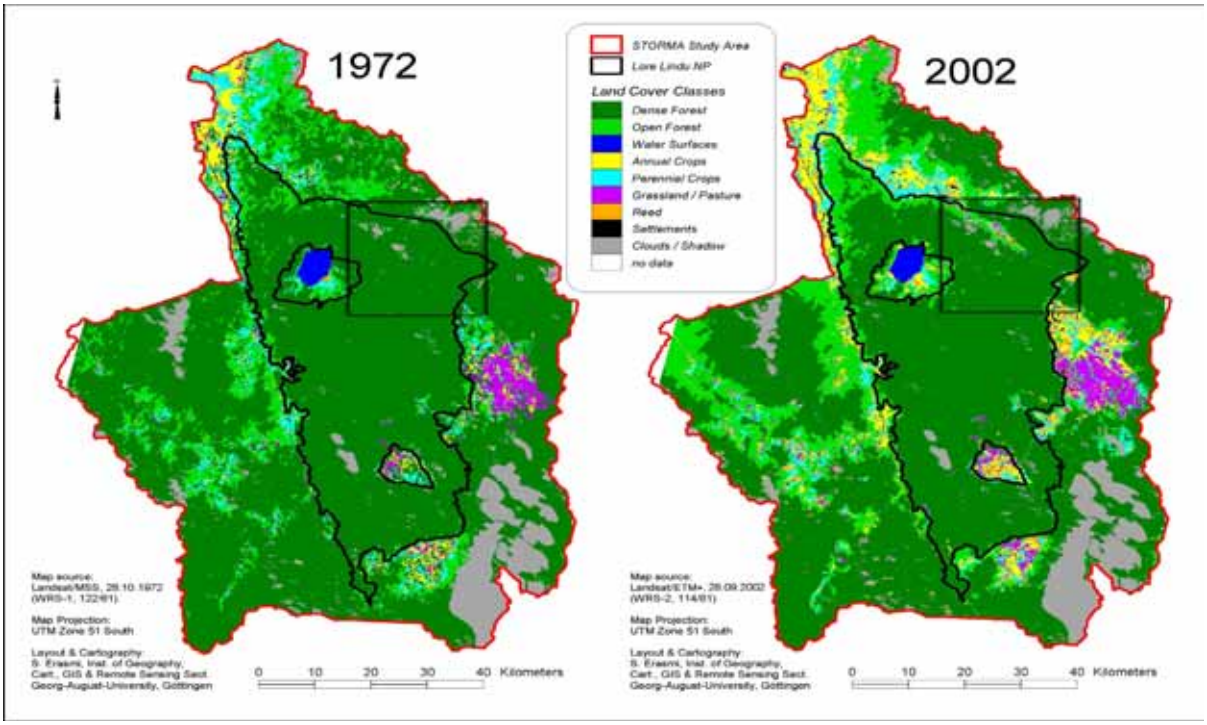
The one factor that carbon buyer countries would be interested on investing in national park as carbon offset if the portfolio investment is cheaper than the other CDM project. Therefore the attractive price of national park as carbon offset is considered by analyzing the cost effectiveness of forest conservation as carbon mitigation option which is calculated as dollar cost of carbon reduce. The total cost of effectiveness of forest conservation is determined by compensation cost to communities and transaction cost.

IV. RESULT

A. LLNP in Status Quo

Under status quo capacity, the LLNP has been experiencing with deforestation. The picture 3 below shows that the landsat image of land-used changed on the area within LLNP from 1972 to 2002 (Erasmi, 2001).

Picture 3. The Land-used changed on the area within LLNP (Erasmi, 2001)



The total area of landsat investigation covers approximately 7500.Km2. It constitutes 2200 km2 as the LLNP's boundary and the remains are administered under five subdistrict's area within LLNP. The satellite interpretations are classified into major land-used in Central Sulawesi and the main aggregated land cover classes derived from satellite image. From the interpretation of satellite image, several parts of investigation has degraded from natural forest to open forest which is pointed out with degradation area from weight green to light

green area. The degradation of natural forest has been occurred particularly on Kulawi subdistrict in north and Palolo subdistrcit in west of LLNP. The degradation of natural forest also occurred in the Lindu Lake enclave and Basoa enclave. The annual crop cultivation which is signed by yellow color also has been gradually larger particularly in the north of national park. Agglomeration population communities in those of areas were being factors of land-used changed from natural forest to agriculture which the infrastructure and accessibility to market have developed well at those areas.

From the landsat analysis on the table 7 below, the total area of natural forest in 2002 comprises 4468 Km2 or 66.7% from total land-used. Nevertheless, the total area of natural forest on 1972 achieved 5259 Km2 or 78.5% of total land-used which it has depleted roughly 791 Km2 or around 11.8%.

Table 7. The detail land-used changed of LLNP for the 1972 and 2002 (Erasmi, 2001)

Class	Area 1972 (Km2)	Cover-age (%)	Area 2002	Cover age	Change 1972-2002 (Ha)	% rel. Change 1972-2002	Annual Change rate (%)
Natural Forest	5259	78.5	4468	66.7	-791	-17.7	-0.6
Open forest/Agroforestry	727	10.9	1107	16.6	380	34.3	1.1
Perennial Crops	322	4.8	338	5.1	16	4.7	0.2
Annual Crops	180	2.7	415	6.2	235	56.6	1.9
Grassland	155	2.3	291	4.4	137	47.1	1.6
Build Up	21	0.3	24	0.4	4	16	0.5
Water	34	0.5	42	0.6	7	16.7	0.6

However, the non natural forest area includes agricultural fields and plantation (paddy, annual crops, perennials) as well as open forest in the from of agroforestry (mainly cacao), water basin area in 2002 increased roughly 2217 Km2 or 28% of total area. Historically, the

non natural forests on 1972 were only roughly 1439 km2 or 21.4% and then the cultivated land has expanded roughly 778 km2 or 6.6 % for 30 years.

The land-used changed phenomenon, the deforestation rate, in LLNP was roughly 0.6% per year. The main historical and present land cover conversion activities are: 1) an expansion of agricultural area especially in upland; 2) the conversion of formerly forest areas into agroforestry system and into cocoa and coffee plantation; 3) Selective and clear cut logging activities (Erasmi, 2001). From those of activities, the extension and conversion to cocoa plantation in forest margin were strongly influenced the deforestation.

Although the overall deforestation rate in the investigation area is just only -0.6% which is lower than deforestation estimation for Sulawesi Island as 1.7% (steve, 2004), the park management should improve their capacity in monitoring and enforcement the territory. Recently, the occupation of natural forest inside LLNP has been occurring rapidly. It showed by square spot on picture 3 that it recognized a recent loss of more than 2200 ha of natural forest on the nort-east of national park (dongi-dongi area). The forest clearing at north-east of national park was intensively happened around period 1999-2002.

B. Carbon Revenue Impact

Indeed, the natural forest provides several tangible as well as intangible benefits. Deforestation has been giving impact on the degradation of natural forest capacities in providing services for ecological system. The carbon sequestering capacity as one benefit of natural forest will deplete successively because of deforestation. The natural forest has the highest capacity on carbon storage rather than the other land-used. Although capacity of carbon sequestering capacity of natural forest is not highest as secondary forest (Brown, 2002), the conversion natural forest to the other land-used particularly as like using slash burn method will give contribution for releasing net storage of carbon stock. Since greenhouse gas emissions (methane and nitrous oxide) were also measured for the same

land-uses system, the carbon stock considers in calculation global emission (Tomich et all, 1998).

The carbon storage of different land-used that conducted by Tomich (2001) is explained on the table 8 below.

Table 8. The carbon stock at different land-used (2002)

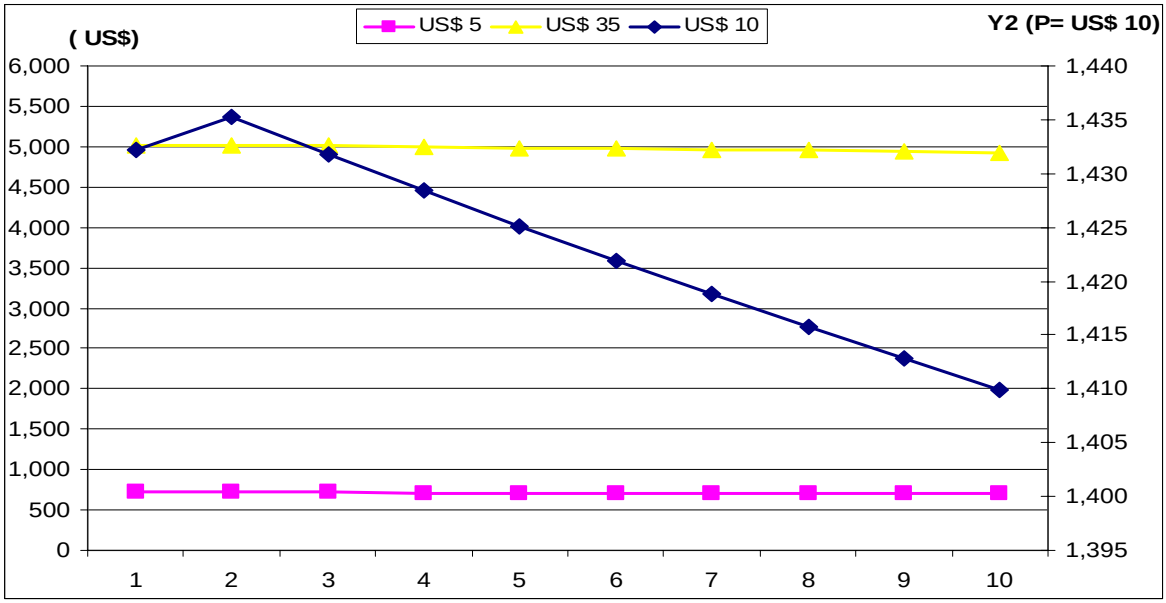
No	Land-use	Carbon stocks (Above ground; Tones/Ha)
1.	Natural Forest	254
2	Community based forest management/Agroforestry	176
3	Monoculture plantation	150
4.	Paddy field	74
5.	Grass land	39

Referring to the table 8, the parameter land-used in LLNP might be divided into natural forest, agroforestry, annual crops, perennial crops, grass land, build up and water. The simulation of potential carbon storage prediction in LLNP might be directly calculated since the land-used parameter on carbon storage relatively same with land-use parameter on land-used changed analysis. The parameter for perennial crops land-use was defined into monoculture plantation, and then the parameter for annual crops was assumed same with the paddy filed.

The stock of carbon storage in investigation area at LLNP predicted contained 143,222,600 tones in 2002 (detail calculation on Annex I). However, without any action of deforestation avoidance, the carbon stock would be decreasing by conversion of natural forest to the other land-use. The simulation of carbon stock for the next 10 years form project baseline 2004 showed that the carbon stock in LLNP will decrease roughly 3 million tones because of deforestation.

The decreasing of carbon stock is directly correlated with loss of potential income as carbon offset place. Recently, there has not been available standardization of carbon price for CDM project which the price of carbon is decided for particular project cost. The price assumptions are taken for average of carbon stock price is around US$ 10, the lowest around US$ 5 and the highest price around US$ 35 per tones.

Graph 2. Prediction of Potential Carbon Revenue in LLNP



The detail calculation for potential carbon revenue in LLNP at different carbon price is describing on the Annex I. The analysis of potential carbon revenue in LLNP with the range price assumption showed that the potential revenue would belong to around US$ 716 million until US$ 5500 million. In designed for average carbon price on US$ 10 per tones, the potential carbon revenue from carbon offset in LLNP achieved roughly US $ 1,432 million in 2004. And then because of deforestation, the potential carbon revenue would meet roughly US$ 1,410 million or it would decrease roughly US$ 30 million in 2014 (blue line). The total net present value (NPV) of potential carbon revenue for discount rate 10% in the period 10 years (2004-2014) predicted would be achieved US$ 8,758, 49.

Under the lowest carbon price scenario as US$ 5/tones C, the potential carbon revenue expected achieved as amount US$ 716 million in 2004 and it expected would be decreasing attained US$ 705 million in 2014 (the red line). The total loss of potential income expected on the period 2004-2014 would meet around US$ 11 million under the status quo of management. The total NPV of potential carbon revenue for discount rate 10% on the period 10 predicted (2004-2014) is expected as amount US$ 4, 379.25 million.

Moreover, under the highest price scenario as US$ 35/tones C, the potential carbon revenue might be achieved nearly US$ 5, 013 million in 2004 and it expected would decrease roughly US 4,932 million under deforestation assumption. The total loss of potential income from carbon offset place on the period 2004-2014 would be achieving US$ 81 million and the NPV of carbon stock for discount rate 10% is expected roughly US$ 30, 638 million. Furthermore, the graph 2 showed that, the potential carbon revenue expected would be increased on the first year of land-used changed for all of price assumption.

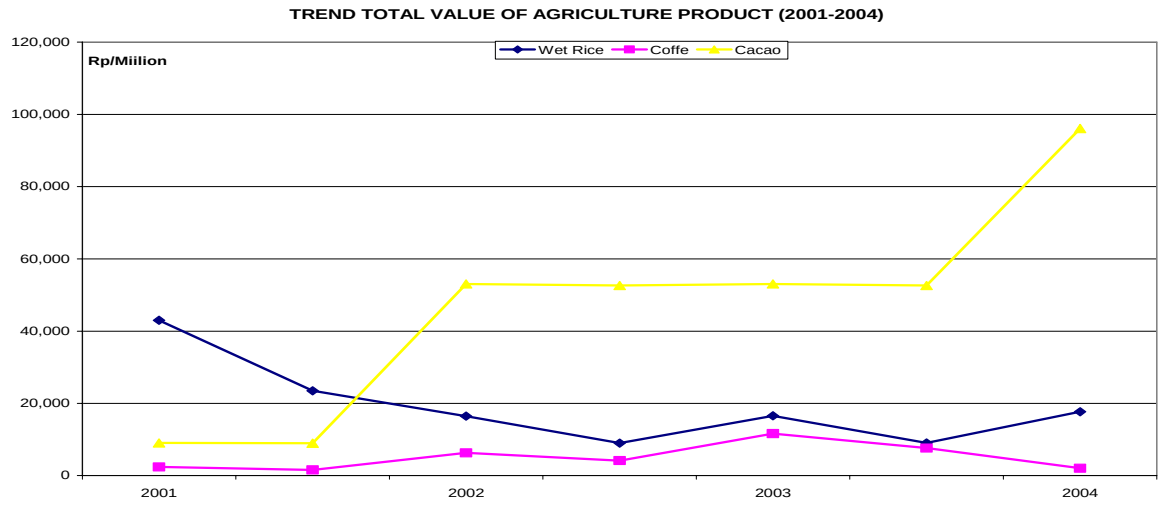
C. Beneficiaries Agriculture Production Revenue

The deforestation occurred has been creating expansion of agriculture cultivation. From the analysis of citra landsat on picture 3 above, the agricultural expansion sources are classified to several land-uses: agroforestry, perennial crops, and annual crops. The agroforestry and perennial crops are dominated by cocoa and coffee plantation, meanwhile the annual crops is corresponded with paddy field.

Since boom of cocoa price in 1998, the communities are more interested for planting cocoa because gives more opportunity for alleviating their income. From the graph 3, the total revenue of cacao has significant moved from around US$ 9, 040 million to around US$ 96,000 million which it was high corresponded with enlarge of cocoa cultivation area and boost of price. The other side, the total revenue from coffee production showed no significant fluctuation rather than cocoa production. In 2001, the total coffee production resulted around US$ 2030 million and then decreasing to around US$ 2025 million. There

was increasing total revenue of coffee production in 2003 which was achieved roughly US$ 11, 607. It was corresponding with increasing demand becaused of depreciation local currency.

Graph 3. The trend total value of beneficiary's agriculture product



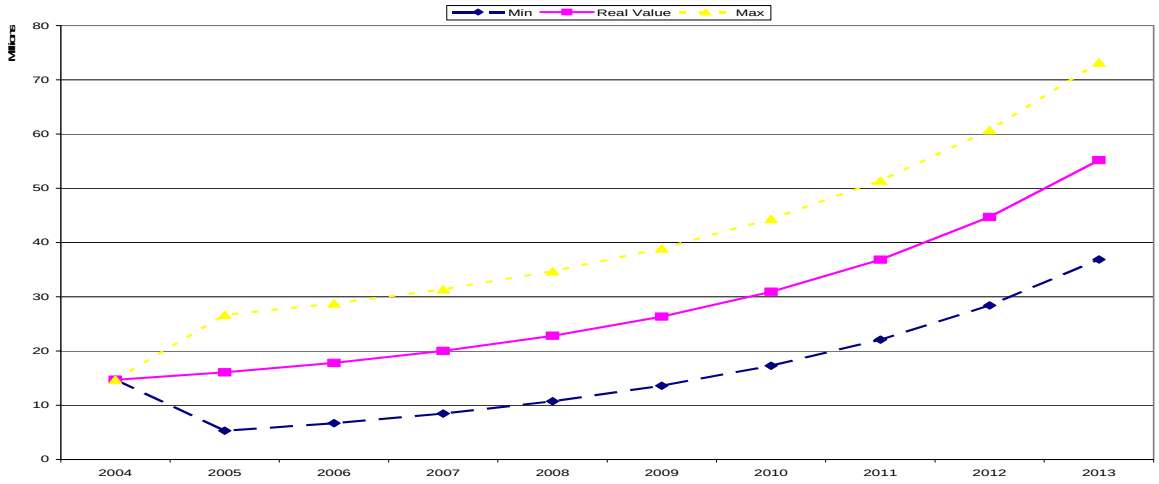
Moreover, even the total cultivation of annual crops increase as 1.9% annually, the total value of paddy rice is relatively stabile. The total revenue of paddy production in 2001 achieved US$ 43 000 million and it was decreasing successively to around US $ 17 000 million in 2004. There were many factors explained fluctuation of paddy rice's revenue since the rice production is very depending with natural behavior as production factor rather than the other corps production. According the trend of total beneficiary's agriculture production, it might be concludes that the deforestation was more influenced by cocoa production expansion rather than the other crops cultivation.

The empirical data of beneficiaries agriculture production above described that the correlation between increasing total revenue of agriculture product with deforestation activities. Throughout curve estimation analysis, the correlation is explained by equation TR = (-40,000,000) + 281.73 (TA); where TR is total revenue and TA is total area and with standard error 69.7. The total area (TA) would be growth constantly as deforestation

rate occurred. The equation has R2 value 0.944 and significant with t calculation is above the t value 4.05 (Annex III).

Commencing the equation, the prediction of agriculture production revenue under deforestation scenario might be explained by picture 4 below. Historically, the total beneficiary's agriculture production revenue in the base year (2004) achieved US$ 14.68 million and it might be increased as US$ 821.3 per Ha of extension agriculture cultivation. Under deforestation assumption in LLNP, the beneficiaries agriculture production revenue would be achieving US$ 55.18.million in the next 10 year (2013).

Graph 4. The prediction of agriculture revenue (2004-2013)

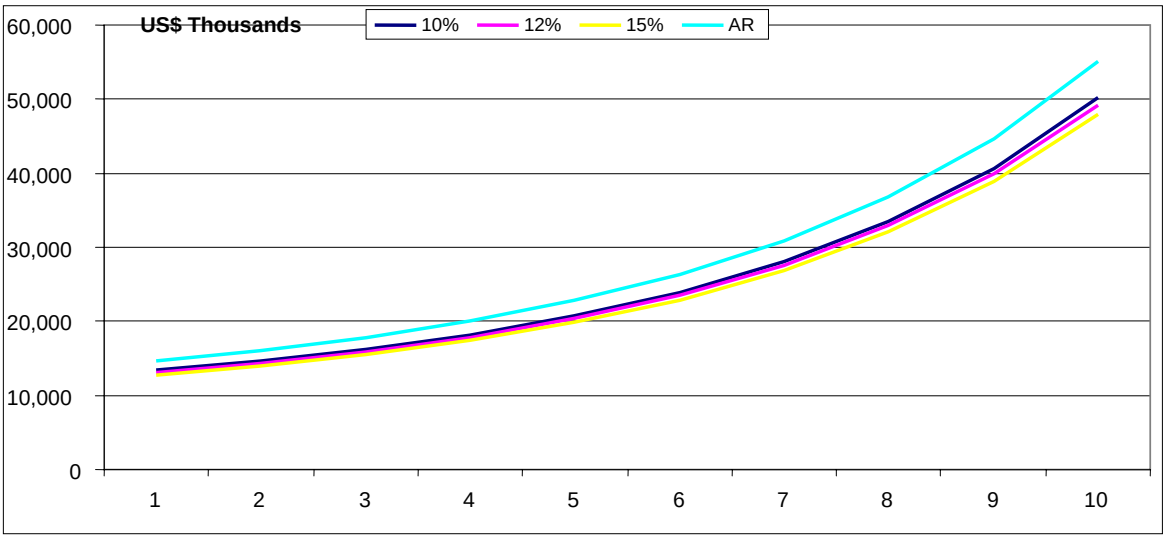


Moreover, the agriculture production revenue was closely associated with risks either from natural risk or fluctuation price which is particularly happens related with cocoa production. The maximum-minimum interval of production revenue is determined by standard error coefficient of total revenue. Designed for ά = 0.5 and standard error (SE) value as 66.7, the coefficient interval might be belonging to the range 227, 67 for minimum revenue, and 335, 25 for maximal revenue scenario. The minimum level scenario is described by black line below the best prediction line and the maximum revenue is described by yellow line on upper best assumption. Indeed, the total agriculture revenue predicted would be responding on the range US$ 36,8 million in minimum revenue to around US$ 73.19 million in

maximal revenue on next 10 years. Throughout those assumptions, the gap between minimum and maximal revenue would become wider on the future as long increasing agriculture revenue which in 2004 the difference conditioned roughly US$ 20.87 million and in the 2013 predicted becoming wider to be 36.3 million.

The net present value (NPV) in different discount rate (10%, 12%, 15%) for agriculture revenue is explained on the graph 5 below. The NPV become lower with increasing discount rate which it portrays the degree of risk. The NPV of beneficiaries agriculture revenue for next 10 year under discount rate at 10% is going roughly US$ 259, 4 million which is the PV value of income prediction is signed by blue line.

Graph 5. The Present Value (PV) of Beneficiaries Agriculture Production



Meanwhile the NPV with discount rate of 12% is going roughly 254, 8 million and for discount rate 15% is going roughly US$ 248,15 million.

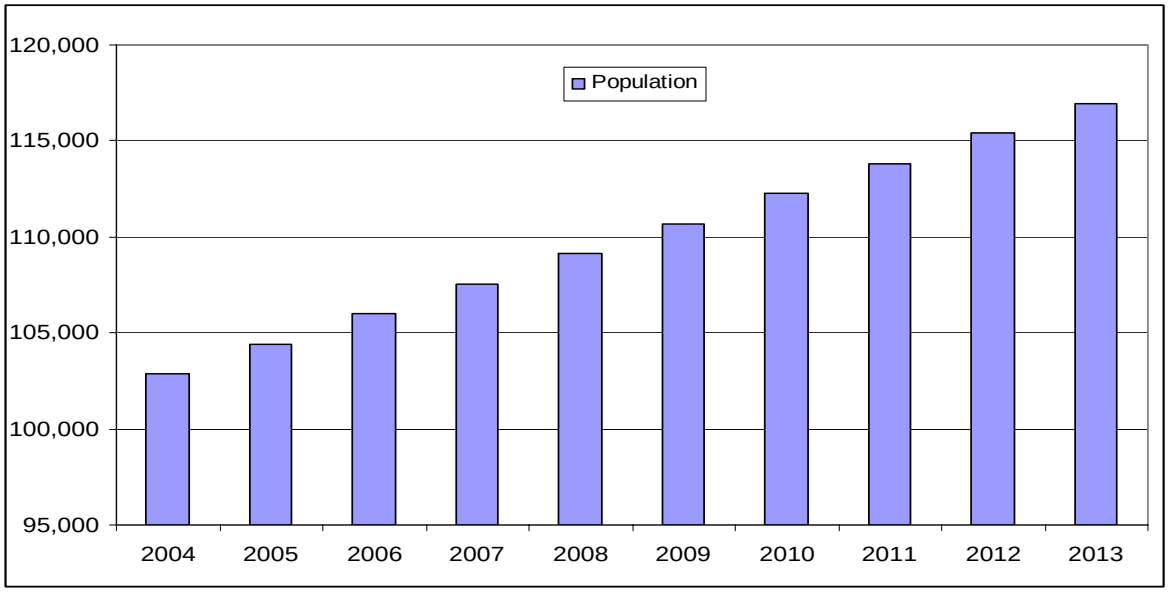
D. Per Capita Income

Even though the estimation of total revenue from beneficiaries agriculture production will increase successively in the next 10 years because of deforestation, but it would not be

directly correlated with alleviate to high per capita income of agricultural population. Since the agricultural population in LLNP and the agriculture land demand is increasing. Therefore, the increasing total revenue of beneficiary's agriculture is much caused by increasing population who is generating land expansion.

Throughout the time series data analysis, the model of agricultural population growth in LLNP is explained by equation P = 81942.05+20023.4(T), where T1 is 2004 as base year of calculation and with R2 is 0.986 and t value is 28.061; and standard error (SE) of coefficient is 28,01. Referring to the equation, the agricultural population growth is roughly 1.57% per year.

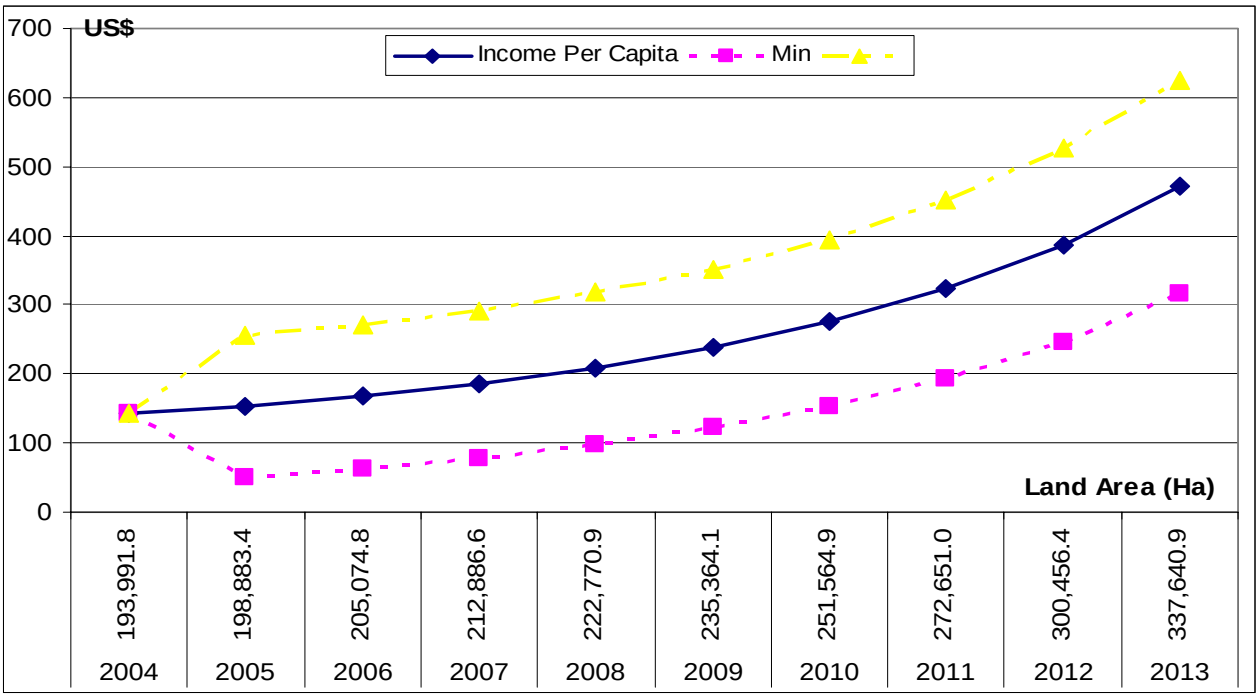
Chart 7. The prediction of agricultural population growth (2004-2012) in LLNP



Historically, in the 2004, the agricultural population in investigation area achieved nearly 102.841 peoples which were included primary agricultural population (farmer, agricultural labor) and secondary population (trader). The population estimated will growth achieve 116, 972 peoples in the next 10 year (2013).

The per capita income of agriculture population in LLNP is small. In the 2004, the per capita income of agriculture population was around US$ 142,8 which the value was far below average Indonesian per capita income around US$ 400. (BPS, 2004). However, the deforestation will give opportunity for gaining income from extension agriculture land which the per capita income of agriculture from the deforestation activities estimated will increase achieving US$ 471.7 in the next 10 years (2013).

Graph 6. Estimation of agriculture population Per capita income



Under the assumption of the population growth is constant on 1.57%, the interval of maximum and minimum income opportunity gained from agriculture activities are described by yellow line for maximum income and the red line for minimum income. The minimum probability of per capita income will touch US$ 315.2 and the maximum revenue will achieve US$ 625.78 in the next 10 years. The range between expectation minimum and maximum scenario will become greater in the future which on the 2005 expectation the difference was around US$ 103.29 and will become greater roughly US$ 153.99. It means that the future probability is more uncertainty to be expected rather that the closer year.

V. DISCUSSION

A. LLNP as Carbon Offset Place

The scale of deforestation in LLNP is still in tolerant level although the observation land-use change on the period 1972-2002, the LLNP has been experiencing with deforestation rate roughly 0.6% annually. However it has been still occurring under average level of deforestation rate compared the general rate in the Sulawesi Island and Indonesia. The deforestation rate for Sulawesi Island achieved 1.7% annually and for Indonesia achieved 1.2% annually (USAid, 2004). Assuming the deforestation rate is constant, the natural forest on the investigation area in LLNP will be diminishing for more than 1000 year. Moreover, the biodiversity level might not degrade in short term since the most of community behavior is more interested to cultivate with agroforestry system among the natural forest

However, the trend of agriculture land expansion in LLNP should be observed more carefully where recently, the new illegal extensive land expansion has been occurring commenced in the northwest side of LLNP's border with the total land has been occupied achieving 2200 Ha or around 1% of LLNP's land area in just 3 years period (1999-2001). Beside that the farmer usually cut off the main tree in agroforestry system in order to give more space for under story crops for getting sun light. Even so, the traditional communities claimed the historical land ownership of LLNP which is causing the land occupation problem has not been solved until today.

In the future, the deforestation rate in LLNP expected will be larger occurred since there has not been endeavoring improvement in management capacity, structural position of LLNP on regional level, and population growth control. The LLNP has many benefits and it might give the benefit accrue different spatial. The deforestation will make the capacity of LLNP in supplying the total benefits of protecting area decreasing successively. However, the environmental impact of deforestation usually gives effect on the long term

which is not directly impacted to the recent generation. At many cases, the disaster caused of environmental problem might develop community awareness for environmental protection. Even more, the deforestation in LLNP argued has been giving impact locally as caused of extremely fluctuated watershed system in dry season as well as rainy season. It has effected disturbance of agriculture activities particularly paddy rice cultivation at the small scale area in LLNP's water basin. Therefore, the local public awareness for keeping the LLNP in suitable size is still low which it could determined by insufficient participation of local government in contributing rural economic development in the five administrative area within LLNP.

Moreover, besides decreasing the direct value, the deforestation makes the indirect value and unused value of LLNP also decreased. However, the quantified calculation loss of those value has not been developing properly that could be used for justification of the benefit to broader community. Elaborating indirect value of protecting area as like biodiversity and carbon sequestration on enacted community awareness seems hardly implemented to approach for avoiding land expansion if not those of value has not been appreciated by broader communities include international community who were more enjoyed those of value. The deforestation activities has been giving more direct income opportunity for community rather than involving in natural forest conservation activities. Likewise, the international community has not given much attention to benefit of tropical national park through income transfer to local community as part of compensation in conserving natural forest.

From the picture 3, the deforestation activities in investigation area were much located at outside LLNP's border. Nevertheless, the degradation of natural forest in five subdistricts will deliver leakage to LLNP and furthermore also will increase pressure to inside LLNP since the demand of agriculture land increasing. The leakage has become a consideration factor in inclusion of deforestation avoidance project in national park as a part of Kyoto Protocol mechanism (IPCC,2000). In order to keep LLNP in suitable size and evade leakage in the investigation area are very depending with buffer zone condition in

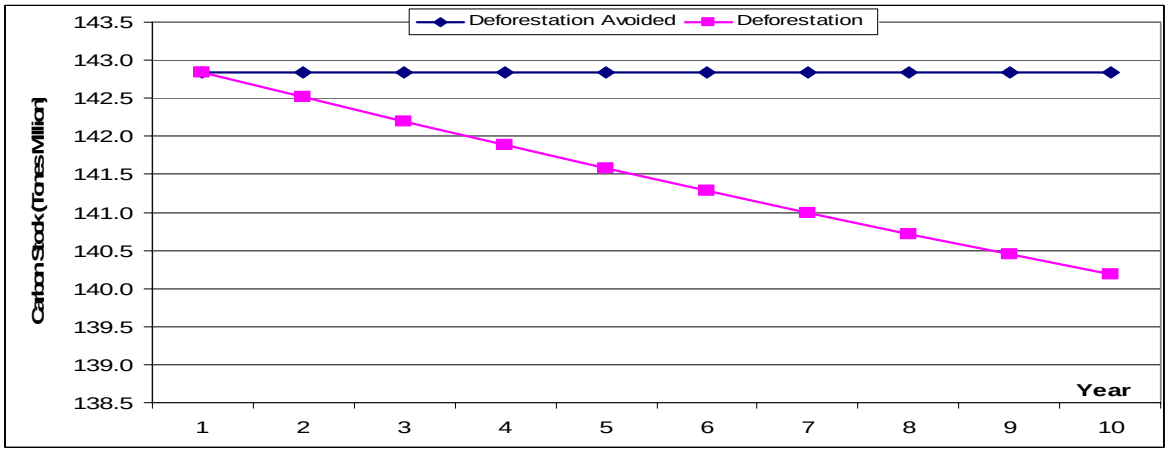
supporting economic life and rural development in five administration sub-district surrounding LLNP. There have many cases on integrated conservation and development project (ICDP) at national park management in Indonesia which the enormous projects were funded by loan. However, the evidence showed that the most of project performance might be categorized in unsatisfactory implementation and impacted to the conservation objectives of the project could not be achieved. Therefore the effort of community development should be developed throughout valuating total benefit of national park with enacting demand from all of stake holders included international community since the conservation responsibility does not only belong to host countries.

The designing carbon offset could give alternative for increasing conservation funding in national park and also present international community participation in conservation effort. From the calculation above the total carbon stock in LLNP achieved 14.23 million tones and its predicted have total value of carbon stock around US$ 142.3 million annually with assumption carbon price around US$ 10 per tones carbon. From this figure showed that if the tropical national park is valuated by carbon stock storage, it needs enormous investment for earning the LLNP's carbon stock since the stock of carbon were available very abundant. Otherwise, the natural forest supplies the carbon stock and storage permanently which it could not be implemented in the project base activity.

Each of country should have been had baseline counted for carbon emission accumulation. Its expected would be decreasing after Kyoto Protocol ratification. The deforestation activity will release the carbon stock and it will give contribution for higher carbon emission accumulation than baseline counted. From this assumption, the capacity of national park in carbon sequestration might be valuated from opportunity cost of endeavoring deforestation avoidance. However, recently, it has not been clear the cycle C accumulation and release at the one unit level would meet the permanence requirements of the Kyoto Protocol, even if modifications of such system resulted in increased C stocks at landscape level. If this model is being implemented to LULUCF project, the price of unit carbon will be difference from one site to the other site.

Using project baseline in 2004 (Graph 7), the carbon emission abatement project in LLNP might be determined by the opportunity in reduction gap of carbon stock with deforestation (red line) and without deforestation (blue line). If it assuming for next 10 years from baseline year, the project should be able to maintain the carbon stock on the base line level as 143.2 million permanently by mitigate the decreasing carbon stock risk until 140.2 million tones in the next 10 years. Therefore, since the deforestation as main factor of decreasing carbon stock, the LLNP's carbon price unit for the next 10 years project design might be determined by opportunity cost of deforestation avoidance divided with 3 million tones (Prediction of carbon loss in coming 10 years).

Graph 7. The prediction of carbon stock in deforestation scenario (2004-2013)



Obviously, conserving carbon stock on the highest permanent level in LLNP would maintain many benefits beside global warming benefit as like tropical biodiversity and the roles of forest in supporting life system. It is illustrating, throughout conserving carbon stock in the course of deforestation avoidance can still be a rational choice even if investments in the national park area had a high probability of achieving nothing (Fearnside, 2000).

B. Counter Measure for Deforestation Avoidance

There are two main concept of forest management that could meet requirement as carbon offset, those of are by designing strictly protected forest areas and developing multiple use community forestry within protected forest. Since the main driver of deforestation in LLNP is illegal expansion of cocoa cultivation from outer into inner national park, the carbon offset project would stimulate leakage to the vicinity forest at investigation area. Therefore the deforestation effort should deliver integration within economic activities of five administration sub district which is intended for avoiding leakage.

From the decision tree analysis of project design on Chart 8, the conservation projects in terms of the two projects design should offer compensation to source of deforestation for avoiding primary leakage. It is needed because their livelihood historically dependent to national park resources, and beside that the calculation in LLNP proved the deforestation would give increasing opportunity income for most of community.The alternative livelihood would be received as direct cash transfer income if the project is executed in strictly protected design and the for multiple-community forestry, the community would receive in-kind assistance program. Since the base line driver (beneficiary's agriculture production) is close related with commercial activities, the countermeasure of deforestation avoidance should consider the secondary leakage due to possibly market effect which in LLNP case is usually derived by fluctuation market price.

Recently, the LLNP park management has been implementing the multi-use community forestry scheme within park border throughout zonation management. However, the concept has not been resulted on mutual agreement on land-used between management park management and community since the land ownership has a critical issue on national park establishment. The leakage from social economic source expected would be more complicated since the LLNP experiencing with population growth. Moreover, the multi-used management would give impact on fluctuation carbon stock rather than strictly protected management because of agriculture harvesting.

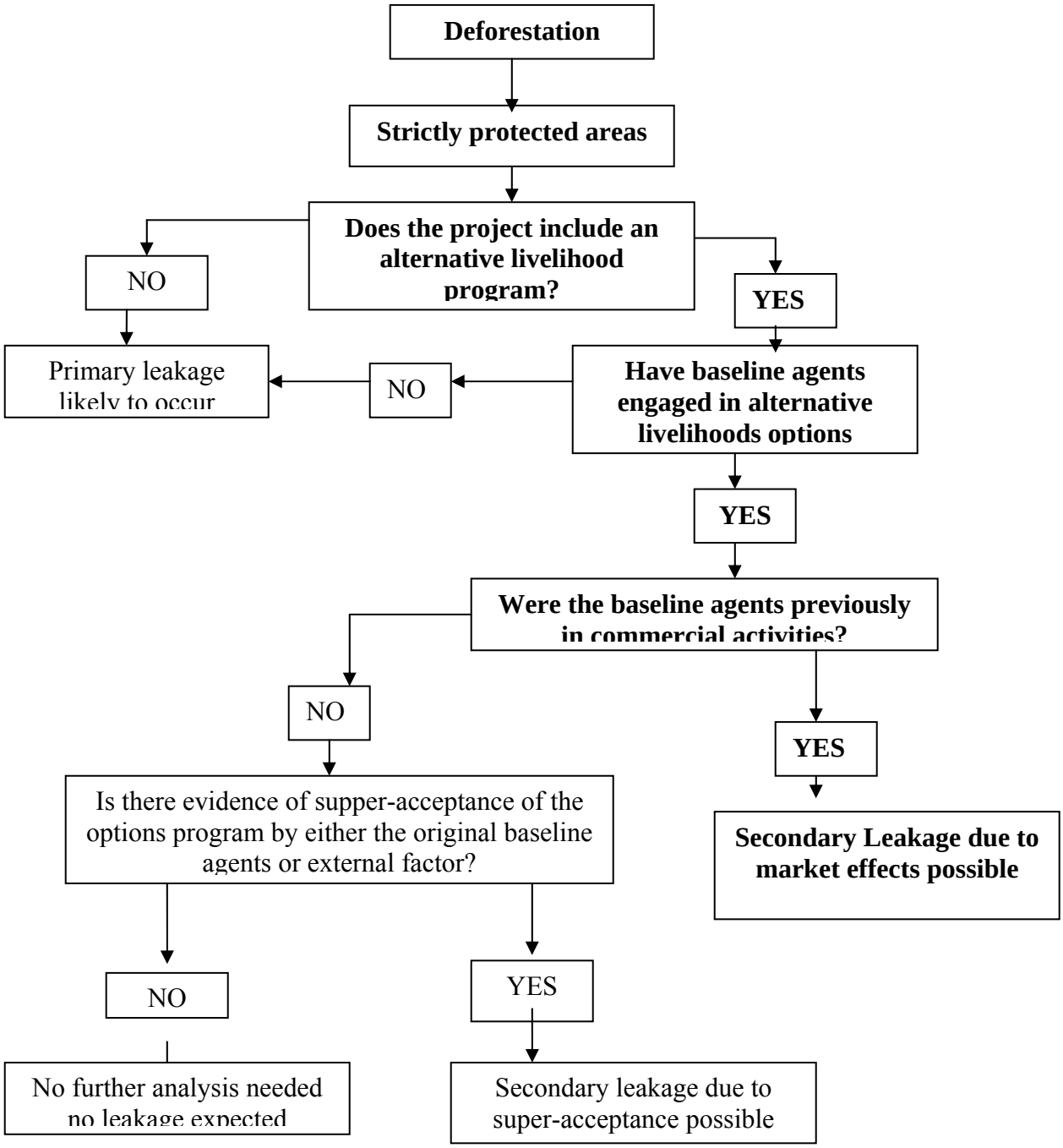


Chart 8. The decision tree for identification of types of leakage likely to impact land-use projects

C. Lesson Learned from Conservation Projects in Indonesia

Linked to the difficult issue of addressing external factors particularly from community livelihood is a growing recognition, the greater attention is needed to approach conservation and development within the broader context of regional planning. Moreover it is ensure the projects realistically consider institutional, legal and tenurial constraints in regard with securing rights and access to resources.

Table 9. The performance of huge ICDP in Indonesia

No	Project	Total Budget	Component	Performance
1	Kerinci Seblat National Park	US$ 46 Million	Revolving fund, Small credit, concession	Participation in signing VCA is less than targeted (50%) in target
			Agriculture technology assistance	Just small amount of farmer changed their behavior
			Revolving fund, program	Revolving program unsatisfactory performance: Small scale& Corruption
			Rural Area Development	The program benefit offered did not meet the community loss
				Sufficient time in technical supervision and conditioning
				Relationship between conservation and agreement undetermined
				Land-use right
				No direct indicators
2	Siberut Ruteng National Park	US$ 40 Million	Infrastructure Development	Environmental performance low
				Participation under targeted jus only 50 participants
				Unrealistic institutional arrangements
3	Leuser National Park	US$ 66 Million	Capacity building	Tourism climate uncondusive
			Ecotourism Development	Community participation is extremely low
			Research and Development	

However, most of studies pointed out that most of integrated conservation and development project (ICDP) resulted in failure rather than success particularly in execution phase.

(Hughes, 2001). Establishing ICDPs that actually has proven to be rather more challenging than marketing the concept and raising the funds. Moreover nearly a decade after first implemented, there is still a notable lack of successful and convincing cases where people's development needs have been effectively reconciled with protected area management.

It pointed out at least the three huge ICDP projects have been executing in several protecting areas in Indonesia (Table 9). Those are located at Kerinci Seblat national park (US$ 46 Million), Siberut Ruteng National Park (US$ 40 Million), and Leuser National Park (US$ 66 Million) which it mostly part of budget were funded by development loan from international organization. All of project endeavor to meet community needs through delivery in-kind assistance like as small credit, agriculture technology assistance, infrastructure development, education, alternative income as like ecotourism development and also park management capacity building. Those of community assistance program are intended to build community participation in conservation activities and also to reduce extensive exploitation of natural forest inside national park. It designed with expected the communities surrounding national park are willing to make consensus on village conservation agreement (VCA) which the main contains of agreement are involving community participation in securing border from outsider threat and also consensus on land-used in buffer zone area.

However, the performance those of projects on the implementation phase were very poor. The projects have been experiencing with less participation of community as well as local government. It showed that on the table, the main component of in-kind community assistance could not be disbursed as on project designed. The poor performance might be described on financial disbursement for the area and village development component in the Kerinci Seblat Project which the total actual expenditure disbursed just only US$ 6.3 million (7.7%) from US$ 25.9 million allocated (World Bank, 2003). Generally, because of less participation of related stakeholder on project implementation, the project could not be able to perform Village Community Agreement on the maximal outreach and moreover it

might not make linked between the community assistance program and conservation objectives.

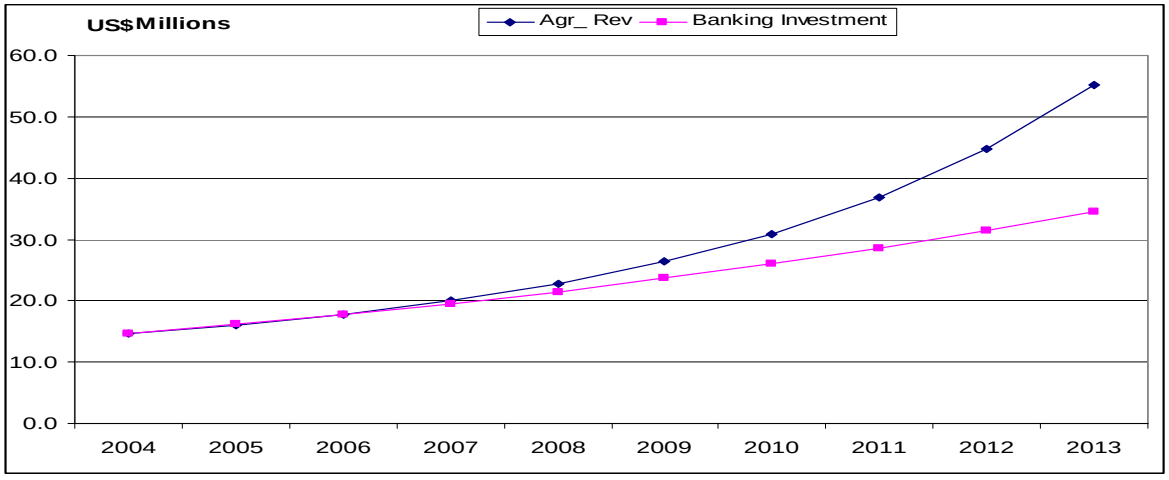
Indeed, there were many factors related with poor performance of ICDP projects in Indonesia. The major factor might be sourced from executing agency factor and community behavior as object of the project. The executing agencies usually consist from central government and local government and the most important problem between them is lack of internal coordination. Since decentralization regulation enacted on 1999, the national park management is notified as one of central government authorization in forest management located in district level but their relationships with local governments were not reconciled under the revised Forestry Law. Currently, the head of National Parks is of a lower administrative status than the head of the District Forest Service (*Dinas Kehutanan*) which is resulting in problems of coordination and joint program implementation. Consequently, the decentralization system has been creating dualism of authorization in project area because the project design has built more complex and involving multiple agencies at the national and local level. However, the various institutions had different and frequently conflicting agendas. Thus, BANGDA and provincial governments were primarily interested in development program whereas the Department Forestry main goal was conservation. Similarly, the ambivalence and tension between development and conservation means that neither conservation nor development objectives were successfully met. The projects design led to packaging different of components across different institutions, a lack of integration, and the anomalous situation of village development and monitoring activities starting long before the main park management component which they were supposed to support. There was little attempt to integrate activities, especially at the park level. From the several project cases, it might be concluded the several lessons learned from those of project, as follows: (1) Project design need to simple; (2) Linking development with conservation goals; (3) Conservation project needs longer time; (4) Comprehensive analyzing incentives structure ; (5) Detail information of local needs because of national park establishment (6) Internal coordination within government agencies.

D. Compensation Design

Changing the behavior of societies is complex and slow, and understanding the incentives for certain types of behavior is important. In the condition forests are also under threat from outsiders, unenforceable covenants of uncertain value are unlikely to be successful. Therefore, the carbon offset project should be able to give sustainable compensation or alternative income for community at least its giving as amount of loss opportunity income after the strictly protected management is implemented. If the project is delivering strictly protected, the compensation program is prefer to receive perpetual direct cash transfer income rather than in-kind assistance because the extension agriculture activities will be strictly prohibited in investigation area. Beside that, the in-kind development assistances have not been effective for enacting community awareness in conservation since the community demand and linked rural development to conservation is undetermined well.

The graph 8 showed that the growth of beneficiary's agriculture production might be relatively equal compared with interest income form putting saving in the commercial bank in the next 6 years (base line year 2004) assuming the interest rated around 10%.

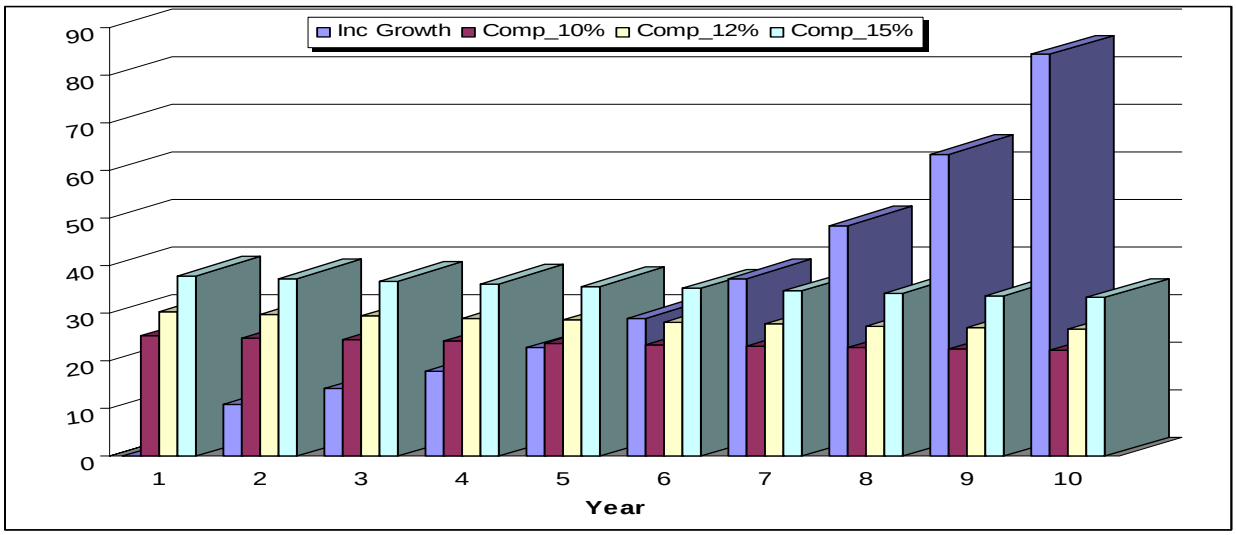
Graph 8. The comparison between growth of agriculture revenue and saving in commercial bank



This assumption described that the compensation mechanism is possible to be realized by providing perpetual fund for community assuming the deforestation rate is not more than 0.6% per year and the population growth also is not more than 1.57%.

The distribution of income might be realized through putting saving in commercial bank as amount 6th of beneficiary's agriculture revenue or around US$ 26.34 million (Chart 9). The interest income will give a constant perpetual income which the amount income received would be correlated its interest rate fluctuation. Historically, the Indonesian commercial bank interest rate was belonging to 10% until 15% which is depending with macro economic condition.

Chart 9. The compensation scenario through perpetual fund distribution



By this mechanism, the per capita of community would be provided additional income in the range US$ 25.29 (10%) until US$ 37.94 (15%) and it would be decreasing to the range US$ 22.4 (10%) until US$ 33.3 (15%) because of population growth. The additional income distributed might give higher compensation than increasing opportunity income from expansion land of beneficiary's agriculture production for next 5 years and for extraordinary interest rate (15%), the compensation would be covering amount of loss opportunity income for around next 7 (seven) years. Although the compensation design

predicted just could cover the income loss for around 5-7 years but it would give essential additional income on the first five or seven years. The compensation designed at least provides the community as a perpetual social income security and also gives an opportunity to improve their existing agriculture land.

E. Implementation Scenario

From the lesson learned of ICDPs project in Indonesia, the park management should more involve in giving assistance to community in order to build legitimization on park boundary.

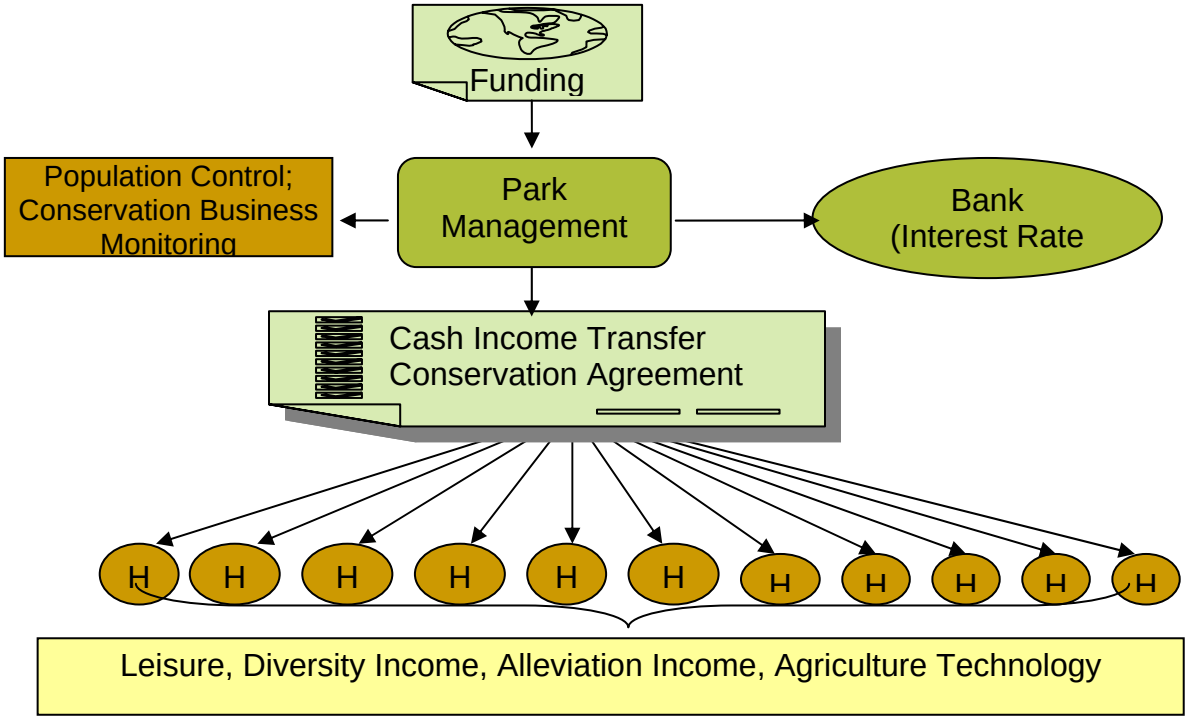


Chart 10. The Implementation design on integrating cash transfer program with conservation

Recently, the public opinion states that the national park establishment could not give solution for diversification opportunity income which it has been making national park management on the position against the community cause of coercing conservation

activities. Therefore, the cash income transfer should be managed by LLNP's management for building better public opinion about national park.

The mechanism of income distribution might be described on the chart 10. The funding from carbon buyer or the international organizations is invested by park management in commercial bank as perpetual funding. Then, the interest income from perpetual funding is distributed to per capita household assuming each of households are consist around four family members. The other hand, the community expected is willing to join with the conservation agreement offered by park management. The main consensus is about prohibition of expansion agriculture land but they still allow making improvement on their existing land. Furthermore, the park management should be given authorization on population control to avoid much migration into immediate area after cash transfer implemented.

F. Leakage Assessment

The types of leakages for the strictly protected management in LLNP with could be classified to primary and secondary leakage. The primary leakages of activity shifting might exist because of lack alternative option and refusal of the alternative livelihood options. Then, if the proposed project provides the suitable alternative livelihood, the secondary leakage might occur because super acceptance of alternative livelihoods option and market effect.

From the above description, the countermeasure of deforestation avoidance in LLNP endeavors proposing alternative livelihoods through cash transfer income. The incentives perpetual cash transfer program expected would meet the community needs on agriculture land expansion.

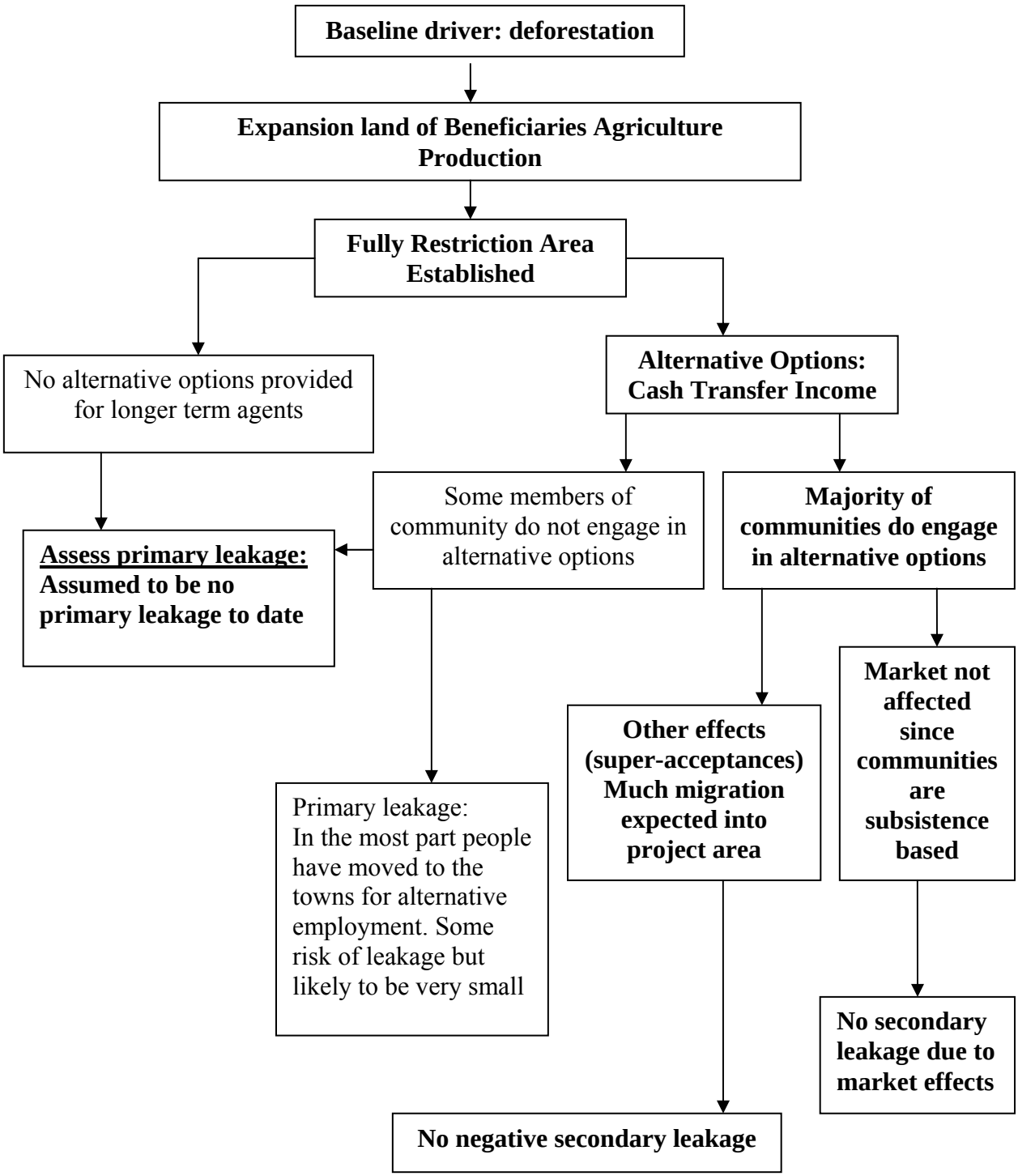


Chart 11. Decision tree applied for cash transfer program in LLNP

From the decision tree analysis (chart 10), the estimation of primary leakage will not inappropriate occur because the cash transfer income program provides suitable alternative livelihood. Through this program, the majority community expected will engage in alternative option. However, the Central of Sulawesi province is one of remarkable poverty area and it will stimulate the super acceptance to the alternative livelihoods offered. The super acceptance will endeavor the community outside project area migrate into immediate area in order to find perpetual income. The cash income transfer program has a one benefit that will not give correction to market price rather than in-kind program. It therefore the estimation of secondary leakage from market effect will not extremely occur whereas will make the market more active cause of additional income.

G. Cost of Carbon Mitigation Option in LLNP

The cost of compensation to community through perpetual cash transfer income in LLNP case is around US$ 26.34 million. The best assumption from the cash transfer program that the deforestation will be stopped and then the carbon stock will be saved roughly 30 million tones carbon. With the assumption transaction cost of carbon offset project around 10 % from total compensation to the community, the total opportunity cost of deforestation avoidance in LLNP for base line year 2004 achieves nearly US$ 29 million. The expectation cost effectiveness of forest conservation as a mitigation option in LLNP is around **US$ 9.6 /Tones Carbon.**

Considering the unit carbon price of CDM project is expected on the interval US$ 5-35/t c with average around US$ 10 /t c (Fearnside, P, 2000), the expectation of carbon price unit in LLNP is still on the attractive price comparing to the other CDM project. In addition, comparing to the other huge conservation project in the from of ICDP project at the other national park, the expected total cost of cash transfer program is still reasonable which the total cost of existing projects were belong to US$ 40 million until US$ 66 million.

F. Policy Recommendation

In order to integrate conservation activities in Indonesian's national park with LULUCF activities, it is needed several policy reforms on the forestry sector, as follows:

- Incentives program

Recently, the legal context for community incentives program in surrounding national park is restricted only to community forestry at buffer zone area which legalize under Ministerial Decree No. 31 year 2001. However, the designing of carbon offset requires broader scale of incentives program in order to mitigate leakage outside national park and could sustain in long term implementation. Therefore, the legal context incentives program should be reformed particularly regarding structure and scale of assistance.

- National park management authorization

The authorization of national park management is limited in park boundary. The management does not have authority to control livelihood activities as like population growth and land-used changed at near sub-district administration within protecting area. Therefore, the authorization of national park management should be broadly expanded for particular livelihood activities since leakage of the carbon offset is strong influenced by land-used changed and social activities in immediate area.

- Internal coordination between local government

Since the decentralization reform implemented in 1999, the internal correlation between national park management and local government has not been determined clearly. The authorization and job description among the government agency should be addressed clearly on the legal context.

- Capacity building of government agency and local communities

.

VI. CONCLUSION

The paradoxical circumstances between reducing carbon stock and increasing beneficiary's agriculture production in deforestation scenario lead to two consequences. The first consequence is the decreasing potential revenue from environmental services in term of carbon sequestering supply. Moreover, the loss of carbon stock through deforestation will give consequences to decreasing carbon price unit because the supply of conservation activity will increase, but the demand of carbon abatement from Annex B parties is constant. Even though the deforestation rate in LLNP is still under tolerant level comparing the other area in Indonesia, the carbon stock in the baseline year 2004 will decrease nearly 3 million tones carbon for the next 10 years. The model of potential carbon stock revenue assuming the price of carbon unit on US$ 10 per tones carbon demonstrates that the potential revenue from carbon stock in LLNP in the base line year 2004 might be achieving US $ 1,432 million, but the potential carbon revenue would decrease to nearly US$ 30 million in 2014 because of deforestation.

The second consequence is that the project cost of carbon offset through strictly protected management in national park will be much higher in the future if the park management is still under status quo. The cost of compensation to community which is determined by beneficiary's agriculture production is increasing because of agriculture land expansion. It demonstrates that the total beneficiary's agriculture production revenue in base year (2004) achieved US$ 14.68 million and it will increase to US$ 821.3 per Ha of extension agriculture cultivation. Under deforestation assumption in LLNP, the beneficiary's agriculture will be growing roughly US$ 55.4 million in the next 10 years (2014). However, it will not directly correspond with high of per capita income since the agriculture population is growing nearly by 1.57% per year or it will be growing from nearly 102.841 peoples in the 2004 to roughly 116, 972 peoples in the next 10 year. The per capita income of agriculture population in 2004 was just only around US$ 142,8 per capita but the deforestation will give an opportunity to increase the per capita income nearly 230% or to achieve US$ 471.7 per capita in the next 10 years. Therefore, the high cost of deforestation

avoidance project will make the tropical national park more difficult to compete with the other from of CDM project in the global carbon market.

A lesson learned from the most of integrated conservation and development project (ICDP) resulted in failure rather than success, particularly in execution phase (Hughes, 2001). The Establishing ICDPs actually works giving in-kind assistance to community as a part of conservation compensation. However, the participation of community in involving with such a kind of program was very low which has made the project failed in integrating development and conservation. Therefore, the perpetual cash transfer program seems more acceptable to the community since the community behavior and needs are very diverse. The cash transfer program assumed could replace loss of opportunity income of beneficiary's agriculture population from agriculture land expansion activities. The growth of beneficiary's agriculture production for the next 6 years from baseline year in 2004 might be relatively equal if compared with saving in a commercial bank assuming its interest rate is around 10%. Therefore, the distribution of income would be realized by putting cash saving as much as revenue income of 6^{th} years from beneficiary's agriculture production or around US$ 26.34 million. The interest income from the saving will give a constant perpetual income, and the amount of cash transfer to community would be correlated with interest rate fluctuation. By this mechanism, the additional per capita community income in the community would be between range US$ 25.29 (10%) until US$ 37.94 (15%) and it would decrease to the range US$ 22.4 (10%) until US$ 33.3 (15%) because of population growth. Although the compensation designed in the simulation model just could cover the income loss for around 5-7 years but it would give an essential additional income input in the first five or seven years. The compensation designed at least provides the community with perpetual social income security and also gives an opportunity to improve their existing agriculture land. Although the program looks promising, the financial or technical assistance to the park management is indispensable for ensuring the conservation agreement implemented properly.

The total opportunity cost of counter measure to deforestation through perpetual cash transfer program in LLNP in the project baseline 2004 will achieve nearly US$ 29 million and the total carbon stock could be saved nearly 30 million in the next 10 years. It could be said that the expected cost to forest conservation as a mitigation option in LLNP is around US$ 9.6 /Tones Carbon. This still relies on the attractive carbon price considering the unit carbon price of CDM project which is expected on the interval US$ 5-35/t c (Fearnside, P, 2000).

The leakage analysis already discussed in this paper shows that the cash transfer program will deliver the super acceptance leakage which will stimulate community's migration into project area in order to find perpetual income. Therefore, this research proposes several policy reforms of national park management in Indonesia which include incentive program to community, extension of national park management authorization, internal coordination between park management and local government, and developing internal capacity building. Moreover, further research might be complied with this research in regard to the subjects: project risk of cash transfer program in tropical national park, detail monitoring on dynamic carbon stock and perception of community surrounding national park.

REFERENCES

Albrecht, W. 1982. Welfare Reform: An Idea Whose Time Has Come and Gone.Kluwer.London

Anzdec. 1997. Working Paper: Central Sulawesi Integrated Development and Conservation Project . Anzdec International. New Zealand

Asquith, N. M., Ríos**,** M. T. V. and Smith, J. 2002. Can Forest-protection carbon projects improve rural livelihoods? Analysis of the Noel Kempff Mercado climate action project, Bolivia. *Mitigation and Adaptation Strategies for Global Change* **7** (4): 323-337.

Aucland, L; Pedro Moura Costa, Sandra Brown. 2003. A conceptual framework and its application for addressing leakage: the case of avoided deforestation. Climate policy (3) 123-136

Bernhard S; L Ciccarese, M Dutschke, P M. Fearnside, S, D Murdiyarso. 2000. Should we include avoidance of deforestation in the international response to climate change? CIFOR

Bureau of Statistic. 2004. Central Sulawesi in figure 2004. BPS. Palu

Chapman, D. 2003. Management of national parks in developing countries: a proposal for an international park service. Ecological economics (46) 1-7

Fearnside, P. 2000. Uncertainty in land-use change and forestry sector mitigation options for global warming: Plantation silviculture versus avoided deforestation.

Ferraro, P. 2002. The local cost of establishing protected areas in low income nations: Ranomafana National Park, Madagascar. Ecological Economics 43 (2002): 261-75

Ferraro, P.J. and Kiss, A. (2002). Direct payments to conserve biodiversity. Science **298,** pp 1718 - 1719

Gujarati, D. 2001. Basic Econometrics. Mac Graw-Hill. New York

Hanna, S. 1995. Efficiencies of user participation in natural resources management, In: Hanna, S; Munangsinghe, M.(Eds.), property rights and the environment, social and ecological issues. The Beijer International Institute of Ecological Economics and The World Bank. Washington DC

Hough, J.L.1988. Obstacles to effective management of conflicts between national park and surrounding human communities in developing countries. Environmental Conservation 15 (2): 129-136

Hughes, R, Fiona F. 2001. Integrating conservation and development experience: a review and bibliography. IIED. London

Inoue, M.2003. Participatory forest management policy in South and Southeast Asia. People and forest : policy and local reality in Southeast Asia, the Russian Far East, and Japan. IGES. Japan

Isozaki, H. 2003. Sustainable and participatory forest management. People and forest: policy and local reality in Southeast Asia, the Russian Far East, and Japan. IGES. Japan

Komatsu, K.2003. Public participation in international environmental agreements. People and forest: policy and local reality in Southeast Asia, the Russian Far East, and Japan. IGES. Japan

Ledec, G. 1994. The role of Bank Credit for cattle raising in financing tropical deforestation. UMI. Michigan

MacKinnon, J., K.MacKinnon, G. Child and J Thorsell. 1986. Managing protected areas in the tropics.IUCN and UNEP, Switzerland

McNeely, J. A.1989. Protected areas and human ecology: How national parks can contributes to sustaining societies for the twenty first century. In Conservation for the twenty-first century, ed.D Western and M.Pearl, 150-157. Oxford Universities Press.New York.

Marshall, graham.2005. Economics for collaborative environmental management. Earthscan. London

Maertens, miet; Manfred Zeller. 2002. Explaining Agricultural Land-use in Village Surrounding the Lore Lindu National Park in Central Sulawesi, Indonesia. STORMA. Palu

Newell, Richard and Robert N.Stavins. 2000. Climate change and forest sink: factors affecting the cost of carbon sequestration. Journal of Environmental Economics and Management (40), 211-235

Pearce, D.1996. Global environmental value and the tropical forests: demonstration and capture. Forestry economics and the environment, 11-49.CAB International. Wallingford/UK

Pagiola, Stefano & Joshua Bishop. 2002 Selling forest environmental services. Earthscan publication. London

Rhee, steve. 2004. Report on biodiversity and tropical forest in Indonesia. USAID. Jakarta

Ruitenbeek, jack. 1991. The rainforest supply price. a tool for evaluating rainforest conservation expenditure. Ecological economics 6 (1992) 57-78.

Rock, M. 1996. The strok, the plow, rural structure and tropical deforestation in poor countries. Ecological Economics (18) 113-131.

Smith, joyotee & Sara J. scherr.2002. Forest carbon and local livelihoods: assessments of opportunities and policy recommendations. CIFOR occasional paper no.37.Bogor

Sitorus, F. 2002. Revolusi coklat: social formation, agrarian structure, and forest margins in upland Sulawesi, Indonesia. STORMA. Palu

The Nature Conservancy. 2001. The value of water resources in Lore Lindu National Park Central Sulawesi, Indonesia. ESG International. Canada

The Nature Conservancy. 2002. The Lore Lindu National Park Management Planning (2002-2027). The Nature Conservancy. Palu

World Bank. 2003. Kerinci Seblat integrated conservation and development project. Asia Pacific Regional Office. Jakarta

Potential Carbon Revenue on Deforestation Scenario in Lore Lindu National Park

Land Use	Area 1972/ Km2	Coverage	Area 2002/Km2 (A)	% Cover-age	Change 1972-2002 (Km2)	(%) Change	Annual change rate (d) (%)	Carbon stock (Ton/Ha)[1] (C)	Total Carbon (TC) Stock (Tonnes) AXCX100	Total Carbon Revenue (TR) (US$ 10/Ton)[2] (P) TCXP
Natural Forest	5259	78.52%	4468	66.83%	-791	-17.7%	-0.6	254	4468x254x100= **113,487,200**	113,487,200X25= **1,134,872,000**
Agroforestry	727	10.85%	1107	16.56%	380	34.3%	1.1	176	1107X176X100= **19,483,200**	19,483,200X25= **194,832,000**
Parrenial Crops	322	4.81%	338	5.06%	16	4.7%	0.2	176	338X176X100= **5,948,800**	5,948,800X25= **59,488,000**
Annual Crops	180	2.69%	415	6.21%	235	56.6%	1.9	74	415X74X100= **3,071,000**	3,071,000X25= **30,710,000**
Grassland	155	2.31%	291	4.35%	136	46.7%	1.6	39	291X39X100= **1,134,900**	1,134,900X25= **11,349,000**
Build-Up	21	0.31%	25	0.37%	4	16.0%	0.5	39	25X39X100= **97,500**	97,500X25= **975,000**
Water	34	0.51%	42	0.63%	8	19.0%	0.6	0	0	0
Total	**6698**	**1**	**6686**	**100.00%**	**-12**		**5.3**	**758**	**143,222,600**	**1,432,226,000**

1)Carbon surface (above the ground): Adapted from Tomich et.al (2001)
2)Daily carbon price.www.pointcarbon.com

$$\text{Carbon Revenue} = \sum\{A(1-d)^n]xCXP\}$$

Deforestration Scenario (Price= US$10)

Land Use	Year 1	2	3	4	5	6	7	8	9	10
Natural Forest	4468X254X25X100 = **1,134,872,000**	2,837,180,000(1-0.6%)^2= **1,121,294,391**	2,837,180,000(1-0.6%)^3= **1,114,566,625**	2,837,180,000(1-0.6%)^4= **1,107,879,225**	2,837,180,000(1-0.6%)^5= **1,101,231,950**	2,837,180,000(1-0.6%)^6= **1,094,624,558**	2,837,180,000(1-0.6%)^7= **1,088,056,811**	2,837,180,000(1-0.6%)^8= **1,081,528,470**	2,837,180,000(1-0.6%)^9= **1,075,039,299**	2,837,180,000(1-0.6%)^{10}= **1,068,589,063**
Agroforestry	1107X176X100X25 = **194832000**	487,080,000(1+1.1%)^2 = **199,141,879**	487,080,000(1+1.1%)^3= **201,332,439**	487,080,000(1+1.1%)^4= **203,547,096**	487,080,000(1+1.1%)^5= **205,786,114**	487,080,000(1+1.1%)^6= **208,049,761**	487,080,000(1+1.1%)^7= **210,338,309**	487,080,000(1+1.1%)^8= **212,652,030**	487,080,000(1+1.1%)^9= **214,991,203**	487,080,000(1+1.1%)^{10}= **217,356,106**
Parrenial Crops	338X176X100X25= **59488000**	148,720,000(1+0.2%)^2 = **59,726,190**	148,720,000(1+0.2%)^3= **59,845,642**	148,720,000(1+0.2%)^4= **59,965,334**	148,720,000(1+0.2%)^5= **60,085,264**	148,720,000(1+0.2%)^6= **60,205,435**	148,720,000(1+0.2%)^7= **60,325,846**	148,720,000(1+0.2%)^8= **60,446,497**	148,720,000(1+0.2%)^9= **60,567,390**	148,720,000(1+0.2%)^{10}= **60,688,525**
Annual Crops	415X74X100X 25= **30710000**	76,775,000(1+1.9%)^2= **31,888,066**	76,775,000(1+1.9%)^3= **32,493,940**	76,775,000(1+1.9%)^4= **33,111,324**	76,775,000(1+1.9%)^5= **33,740,440**	76,775,000(1+1.9%)^6= **34,381,508**	76,775,000(1+1.9%)^7= **35,034,757**	76,775,000(1+1.9%)^8= **35,700,417**	76,775,000(1+1.9%)^9= **36,378,725**	76,775,000(1+1.9%)^{10}= **37,069,921**
Grassland	291X39X100X 25= **11349000**	28,372,500(1+1.6%)^2= **22,228,601**	28,372,500(1+1.6%)^3= **22,584,258**	28,372,500(1+1.6%)^4= **22,945,606**	28,372,500(1+1.6%)^5= **23,312,736**	28,372,500(1+1.6%)^6= **23,685,740**	28,372,500(1+1.6%)^7= **24,064,712**	28,372,500(1+1.6%)^8= **24,449,747**	28,372,500(1+1.6%)^9= **24,840,943**	28,372,500(1+1.6%)^{10}= **25,238,398**
Build-Up	25X39X100X 25= **975000**	2,437,500(1+ 0.5%)^2= **984,774**	2,437,500(1+0.5%)^3= **989,698**	2,437,500(1+0.5%)^4= **994,647**	2,437,500(1+0.5%)^5= **999,620**	2,437,500(1+0.5%)^6= **1,004,618**	2,437,500(1+0.5%)^7= **1,009,641**	2,437,500(1+0.5%)^8= **1,014,689**	2,437,500(1+0.5%)^9= **1,019,763**	2,437,500(1+0.5%)^{10}= **1,024,862**
Water	0	0	0	0	0	0	0	0	0	0
Total (US$ Million)	**1,432**	**1,435**	**1,432**	**1,428**	**1,425**	**1,422**	**1,419**	**1,416**	**1,413**	**1,410**

Price US$ 5

Land Use	Year									
	1	2	3	4	5	6	7	8	9	10
Natural Forest	4468X254X25X100 = **567,436,000**	2,837,180,000(1-0.6%)^2= **560,647,196**	2,837,180,000(1-0.6%)^3= **557,283,313**	2,837,180,000(1-0.6%)^4= **553,939,613**	2,837,180,000(1-0.6%)^5= **550,615,975**	2,837,180,000(1-0.6%)^6= **547,312,279**	2,837,180,000(1-0.6%)^7= **544,028,405**	2,837,180,000(1-0.6%)^8= **540,764,235**	2,837,180,000(1-0.6%)^9= **537,519,650**	2,837,180,000(1-0.6%)^{10}= **534,294,532**
Agroforestry	1107X176X100X25 = **97,416,000**	487,080,000(1+1.1%)^2 = **99,570,939**	487,080,000(1+1.1%)^3= **100,666,220**	487,080,000(1+1.1%)^4= **101,773,548**	487,080,000(1+1.1%)^5= **102,893,057**	487,080,000(1+1.1%)^6= **104,024,881**	487,080,000(1+1.1%)^7= **105,169,154**	487,080,000(1+1.1%)^8= **106,326,015**	487,080,000(1+1.1%)^9= **107,495,601**	487,080,000(1+1.1%)^{10}= **108,678,053**
Parrenial Crops	338X176X100X25= **29,744,000**	148,720,000(1+0.2%)^2 = **29,863,095**	148,720,000(1+0.2%)^3= **29,922,821**	148,720,000(1+0.2%)^4= **29,982,667**	148,720,000(1+0.2%)^5= **30,042,632**	148,720,000(1+0.2%)^6= **30,102,717**	148,720,000(1+0.2%)^7= **30,162,923**	148,720,000(1+0.2%)^8= **30,223,249**	148,720,000(1+0.2%)^9= **30,283,695**	148,720,000(1+0.2%)^{10}= **30,344,263**
Annual Crops	415X74X100X 25= **15,355,000**	76,775,000(1+1.9%)^2= **15,944,033**	76,775,000(1+1.9%)^3= **16,246,970**	76,775,000(1+1.9%)^4= **16,555,662**	76,775,000(1+1.9%)^5= **16,870,220**	76,775,000(1+1.9%)^6= **17,190,754**	76,775,000(1+1.9%)^7= **17,517,378**	76,775,000(1+1.9%)^8= **17,850,208**	76,775,000(1+1.9%)^9= **18,189,362**	76,775,000(1+1.9%)^{10}= **18,534,960**
Grassland	291X39X100X 25= **5,674,500**	28,372,500(1+1.6%)^2= **11,114,300**	28,372,500(1+1.6%)^3= **11,292,129**	28,372,500(1+1.6%)^4= **11,472,803**	28,372,500(1+1.6%)^5= **11,656,368**	28,372,500(1+1.6%)^6= **11,842,870**	28,372,500(1+1.6%)^7= **12,032,356**	28,372,500(1+1.6%)^8= **12,224,874**	28,372,500(1+1.6%)^9= **12,420,472**	28,372,500(1+1.6%)^{10}= **12,619,199**
Build-Up	25X39X100X 25= **487,500**	2,437,500(1+ 0.5%)^2= **492,387**	2,437,500(1+0.5%)^3= **494,849**	2,437,500(1+0.5%)^4= **497,323**	2,437,500(1+0.5%)^5= **499,810**	2,437,500(1+0.5%)^6= **502,309**	2,437,500(1+0.5%)^7= **504,821**	2,437,500(1+0.5%)^8= **507,345**	2,437,500(1+0.5%)^9= **509,881**	2,437,500(1+0.5%)^{10}= **512,431**
Water	**0**	0	0	0	0	0	0	0	0	0
Total (US$ Million)	**716**	**718**	**716**	**714**	**713**	**711**	**709**	**708**	**706**	**705**

Price US$ 35

Land Use	Year									
	1	2	3	4	5	6	7	8	9	10
Natural Forest	4468X254X25X100 = **3,972,052,000**	2,837,180,000(1-0.6%)^2= **3,924,530,370**	2,837,180,000(1-0.6%)^3= **3,900,983,188**	2,837,180,000(1-0.6%)^4= **3,877,577,289**	2,837,180,000(1-0.6%)^5= **3,854,311,825**	2,837,180,000(1-0.6%)^6= **3,831,185,954**	2,837,180,000(1-0.6%)^7= **3,808,198,838**	2,837,180,000(1-0.6%)^8= **3,785,349,645**	2,837,180,000(1-0.6%)^9= **3,762,637,547**	2,837,180,000(1-0.6%)^{10}= **3,740,061,722**
Agroforestry	1107X176X100X25 = **681,912,000**	487,080,000(1+1.1%)^2 = **696,996,575**	487,080,000(1+1.1%)^3= **704,663,538**	487,080,000(1+1.1%)^4= **712,414,837**	487,080,000(1+1.1%)^5= **720,251,400**	487,080,000(1+1.1%)^6= **728,174,165**	487,080,000(1+1.1%)^7= **736,184,081**	487,080,000(1+1.1%)^8= **744,282,106**	487,080,000(1+1.1%)^9= **752,469,209**	487,080,000(1+1.1%)^{10}= **760,746,370**
Parrenial Crops	338X176X100X25= **208,208,000**	148,720,000(1+0.2%)^2 = **209,041,665**	148,720,000(1+0.2%)^3= **209,459,748**	148,720,000(1+0.2%)^4= **209,878,668**	148,720,000(1+0.2%)^5= **210,298,425**	148,720,000(1+0.2%)^6= **210,719,022**	148,720,000(1+0.2%)^7= **211,140,460**	148,720,000(1+0.2%)^8= **211,562,741**	148,720,000(1+0.2%)^9= **211,985,866**	148,720,000(1+0.2%)^{10}= **212,409,838**
Annual Crops	415X74X100X 25= **107,485,000**	76,775,000(1+1.9%)^2= **111,608,232**	76,775,000(1+1.9%)^3= **113,728,788**	76,775,000(1+1.9%)^4= **115,889,635**	76,775,000(1+1.9%)^5= **118,091,539**	76,775,000(1+1.9%)^6= **120,335,278**	76,775,000(1+1.9%)^7= **122,621,648**	76,775,000(1+1.9%)^8= **124,951,459**	76,775,000(1+1.9%)^9= **127,325,537**	76,775,000(1+1.9%)^{10}= **129,744,722**
Grassland	291X39X100X 25= **39,721,500**	28,372,500(1+1.6%)^2= **77,800,102**	28,372,500(1+1.6%)^3= **79,044,904**	28,372,500(1+1.6%)^4= **80,309,623**	28,372,500(1+1.6%)^5= **81,594,577**	28,372,500(1+1.6%)^6= **82,900,090**	28,372,500(1+1.6%)^7= **84,226,491**	28,372,500(1+1.6%)^8= **85,574,115**	28,372,500(1+1.6%)^9= **86,943,301**	28,372,500(1+1.6%)^{10}= **88,334,394**
Build-Up	25X39X100X 25= **3,412,500**	2,437,500(1+ 0.5%)^2= **492,387**	2,437,500(1+0.5%)^3= **494,849**	2,437,500(1+0.5%)^4= **497,323**	2,437,500(1+0.5%)^5= **499,810**	2,437,500(1+0.5%)^6= **502,309**	2,437,500(1+0.5%)^7= **504,821**	2,437,500(1+0.5%)^8= **507,345**	2,437,500(1+0.5%)^9= **509,881**	2,437,500(1+0.5%)^{10}= **512,431**
Water		0	0	0	0	0	0	0	0	0
Total (US$ Million)	**5,013**	**5,020**	**5,008**	**4,997**	**4,985**	**4,974**	**4,963**	**4,952**	**4,942**	**4,932**

The Next 10 Years Simulation of per Capita Income and Compensation (Base Year 2004)

No	Year	Agriculture Area Projection	Agriculture Revenue (US$) TR=(-4.04E+10)+281.93(TA)	Incremental Revenue	Bank Revenue (I= 10%)	Interest Income of Bank Saving (6 th)	Agriculture Population P=81942.05+2023.4(T)	Income per Capita (Extensive Activities/ (US$)	Incremental Income/capita (Agriculture Activities)	Compensation per Capita
1	2004	193,991.8	14,686,295.7	0.0	14,686,295.7	2,634,914	102,841	142.8	0.0	25.6
2	2005	198,883.4	16,065,233.4	1,378,937.7	16,154,925.3	2,634,914	104,411	153.9	11.1	25.2
3	2006	205,074.8	17,810,596.6	1,745,363.2	17,770,417.8	2,634,914	105,981	168.1	14.2	24.9
4	2007	212,886.6	20,012,728.2	2,202,131.6	19,547,459.6	2,634,914	107,552	186.1	18.0	24.5
5	2008	222,770.9	22,799,110.8	2,786,382.6	21,502,205.5	2,634,914	109,122	208.9	22.9	24.1
6	2009	235,364.1	26,349,142.4	3,550,031.6	23,652,426.1	2,634,914	110,692	238.0	29.1	23.8
7	2010	251,564.9	30,916,141.4	4,566,999.0	26,017,668.7	2,634,914	112,262	275.4	37.4	23.5
8	2011	272,651.0	36,860,322.1	5,944,180.7	28,619,435.6	2,634,914	113,832	323.8	48.4	23.1
9	2012	300,456.4	44,698,647.5	7,838,325.4	31,481,379.1	2,634,914	115,402	387.3	63.5	22.8
10	2013	337,640.9	55,180,972.8	10,482,325.3	34,629,517.0	2,634,914	116,972	471.7	84.4	22.5

Total
TR : Revenue
TA : (Ha)
TA : Sequence Time; T1≥24

Curve Fit

Population

Linear

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.986	.972	.970	2599.859

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	5322402606.820	1	5322402606.820	787.423	.000
Residual	155463193.427	23	6759269.279		
Total	5477865800.247	24			

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Case Sequence	2023.402	72.107	.986	28.061	.000
(Constant)	81942.053	1071.950		76.442	.000

Curve Fit

Agr_Revenue

Linear

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.944	.891	.837	1488955.896

The independent variable is Total_Area.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	36274666572482.100	1	36274666572482.100	16.362	.056
Residual	4433979319252.654	2	2216989659626.327		
Total	40708645891734.760	3			

The independent variable is Total_Area.

Coefficients

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
Total_Area	281.938	69.700	.944	4.045	.056
(Constant)	-43358127.678	12853984.886		-3.373	.078