Is converting shrub land to palm oil plantation worth it? - an ecosystem services analysis

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Abstract

Palm oil is one of the most important commodities as a source of national income in Indonesia. Increasing demand for this commodity encourages land conversion from shrub land to palm oil plantation in Parinduregion, West Kalimantan. As the result thereof, the ecological function of shrub land is neglected. This research examines whether the full conversion of shrub land into palm oil plantation is worth using the concept of total economic value. This concept considers three ecosystem services from shrub land, which are regulating services, provisioning services, and cultural services. The valuation shows that the estimated economic value of shrub land for the local community is Rp830, 293 (for provisioning service), Rp20 to Rp40 (for cultural service), and Rp831, 613 to Rp831, 633 (for regulation service). This means that the economic value for shrub land until the next twenty years is in the range of Rp5,997,592to Rp7,782,421 (or equal to USD 454.019 to USD 589.131) per hectare. It is to prove that despite its small economic value, shrub land indeed appears to have considerable economic value. Hence, based on the cost-benefit analysis on the three ecosystem services, the palm oil plantations worth to build on shrub land. However, further research is suggested to complete the total economic valuation with other ecosystem services, since the cost of pollution decreases the monetary value of shrub land, so that in terms of long-term sustainability, the development of palm oil plantation is questionable.

1. Introduction

Palm oil in Indonesia is one of the major commodities with a very important role as a source of state revenue. Recorded during the year 2012, Indonesia gained as much as 28.3 trillion rupiahs from export tax or export duties from palm oil plantations (Pusat Informasi Kelapa Sawit, 2013). Palm oil plantations in Indonesia also have an important function as a source of income for the community as well as being the wheel of development in the region. It is based on the fact that more than 3.7 million heads of families are absorbed in industries and palm oil plantations (Antarnews, 2013).

Indonesian Palm Oil Association recorded until May 2013 that demand for palm oil from countries like India was increasing as much as 8.17% compared to April 2013; China rose 14.14%; America 265.9% from 9,700 tons in April to 35,500 tons in May 2013 (Kontan, 2013). Increasing number of demand leads to the expansion of palm oil plantations in Indonesia, especially in the island of Sumatra and Kalimantan. In 2012 the use of land in Sumatra reached 62.5% of the total national palm oil land (5,913,585 hectares) and Kalimantan by 31% (2,814,782 hectares) with projections of land use in the region in 2020 amounted to 7.84 million hectares of Sumatra, and 7,500,000 hectares of Kalimantan (Kompasiana, 2013).

It cannot be denied that the development of palm oil plantations in Indonesia also carries negative impact. Issues of environmental degradation, social conflict, deforestation, and fires become a major attention from various communities both local and international. The expansion of palm oil plantations in Indonesia, does not only occur in peatlands but also leads to the use of

community land, which are mostly shrub land in West Kalimantan. This is also done by PTPerkebunan Nusantara XIII (State-owned Enterprise for Agroforestry) in Parinduregion where the company bought community land to be managed together with the local people as palm oil plantations. Many people think that shrub land does not both, economic and ecological value. This premise then becomes the reason to convert shrub land into palm oil plantations because they think palm oil plantations are much more profitable. As a result, the ecological functions of shrub land are neglected. The surrounding communities who do not have the political and economic power often have to be the ones who bear the negative impacts of pollution and environmental damage caused by the certain party's desire to boost economic growth.

The purpose of this study is to compare the economic value gained from shrub land by the people in the region of Parindu, Sanggau, West Kalimantan, and net profit from converting shrub land into palm oil plantations. The social aspects and ecosystem services are also taken into account.

2. Literature Review

Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services, such as nutrient cycling, that maintain the conditions for life on Earth (Plieninger *et.al.*2014, Davis *et.al.* 2014, Millennium Ecosystem Assessment Board 2003).Ecosystem services can be divided into:

- *Regulating services*: Keeping the essence of ecological processes and life support systems for human wellbeing. One example of the regulation services is the biological regulation, which is the interactions between species, i.e. controlling diseases and pests.
- *Provisioning services*: A provider of natural resources and raw materials. One of which is food, Ecosystems provide plants and animals that can be consumed by humans.
- *Cultural services*: Provide emotional comfort, psychology, and cognitive wellbeing. One of them is as a place of recreation.
- *Supportive services*: The structure and the fundamental ecological functions for delivering ecosystem services. One of which is a habitat, which is a physical place where organisms live.

Ecosystem services	Advantage	Disadvantage
Regulating Services (Biological services)	Assist farmers in managing agricultural pests without using pesticides and chemical fertilizers	If the regulating services decline, then the use of chemical fertilizers and pesticides will increase, and in the long term can damage the quality of the soil
Provisioning Services (Food and medicine)	Communities can take advantage of shrub land as a source of food and medicine	If this ecosystem service is lost, then the costs of local communities to meet their basic needswill increase
Cultural Services (Recreation)	Local communities can earn extra income without having to lower the quality of their land. This service can also serve as a stress reliever	Index of Happiness could decline due to the lack of open space for interaction and recreation.

Table 1. Advantages and Disadvantages of Ecosystem Services (Plieninger*et.al.* 2014, Davis *et.al.* 2014, Millennium Ecosystem Assessment Board 2003)

In this study, the observed shrub land possesses three above ecosystem services. Shrub land can help palm oil farmers in overcoming pests naturally *(regulating services)*. This is because shrub land is one of the habitats of predator insect and parasitoid that are natural enemies of pests. The loss of shrub land raises the potential of intensive use of chemicals in an effort to combat pests. But it is feared, that in the long term, this may impair the quality and fertility of soil.

In addition to functioning as regulating services, shrub land in this study is also used either directly or indirectly by local people as a source of food and medicine *(provisioning services)*. If the shrub land disappears, it will bring the potential to the increasing of cost of living of local communities because people have to meet their needs by buying from the market.

The last ecosystem service examined in this study is related to the benefits of shrub land as a habitat of various kinds of birds. The chirping of birds and the behavior of birds that live in the shrub land have potential as a stress reliever and recreational facilities for the local community and tourist *(cultural services)*. The loss of shrub land results in fewer open land for interaction and recreation.

In the context of development, ecosystem services are often overlooked. Many people think that development and environmental protection are two separate things. According to Djadjaningrat (1997), the natural environment is an essential element of economic growth. The importance of ecosystem as described previously is for instance to supply the resources and absorb the pollution and waste as the negative impact of economic growth (Kaufmann *et.al.*1994). This means that the environment can provide economic benefits. Resource supply will decrease if the natural resource is exploited too much so that the ability of ecosystems to provide services to be disrupted. Overexploitation leads to a decrease in natural resource capital ecosystem (Marten, 2001).

2.1. Shrub Land as Supportive Services and Regulating Services

Habitat of an organism is explained by Odum(1993) as a living organism or as a place to live for the organism. Habitat can also be interpreted as the place occupied by the entire community. Thus, habitat can be either physical or biotic and a biotic environment.

Shrubs, secondary forest, and grassy marshes affect the existence of predatory insects and are also as a place for parasitoids invasion (Ryanto *et.al.* 2011). The role of shrub land for the presence of insect predators and parasitoids, indicates that shrub land is one of the habitats of insect predators and parasitoids, as stated by Iskandar (2009) that certain types of animals in the natural habitat can have more than one habitat.

Anggraitoningsih *et.al.* (2012) explain that the insect predators and parasitoids can function as pest control. This is because both insect predators and parasitoids are natural enemies of pests. Concerning this, the palm oil entrepreneurs should use insect predators and parasitoid to cope with palm oil pests, using the concept of integrated pest management. According to Freemark *et.al.* (1993) and Flintandvan denBosch (1981), integrated pest management is a strategy to control the pest ecologically that relies on natural mortality factors, and look for ways to minimize disturbance to these factors. Besides being able to minimize the use of chemicals that are harmful to the environment, integrated pest management system can also reduce the cost of production.

2.2. Shrub Land as Provisioning Services and Cultural Services

Basically, ecosystems always provides its services to satisfy human needs both primary needs (food) as well as non-primary purposes (leisure/entertainment). Humans consume a wide range of plants (food), wherein the food itself contains a substance that is necessary to regulate

the chemical processes that occur in our bodies. Besides, humans also need recreation/entertainment to meet the inner needs by enjoying the beauty and wealth of nature (Iskandar 2009, Barnes 2000).

Shrub land, based on the research from Gunawan (2003), has at least29 bird species that exist only in the bushes. This shows that shrub land has potential for recreational. One of the option is for the bird-watching activities. In addition, some types of wild plants found in shrub land can also be used as food ingredient, such as spinach family (Amarantaceae) that can be used as vegetables with high iron ingredient.

Either be used directly or through process management, the availability of food and recreation and entertainment give other options to utilize shrub land (Sathirathai and Barbier, 2001).

2.3. Total Economic Value: Contingent Valuation and Cost-Benefit Analysis

Contingent valuation is a survey-based methodology to bring the assessment of goods, services, and facilities (Boyle, 2003). Bishop and Heberlein (1979) in their study showed that in estimating the 'willingness-to-pay' (WTP), contingent valuation has the same level of validity with the travel cost method and cash transactions.

Cost-Benefit Analysis (CBA), according to Snell (2011), is a device for determining a decision by considering the costs and advantages. The main categories of CBA include financial, economic, and social CBA. Financial analysis focuses on the financial position of the individual, company or organization, so that both costs and benefits are measured in terms of money spent or received by certain parties (Snell, 2011). The economic analysis focuses on the welfare of a group of people in the area. Market prices and the flow of money is usually the starting point in quantifying costs and benefits. In the CBA, the purpose of the economic pricing is to regulate market prices with a view to justifying the price distortion and deliver at a price in the perfect market (Snell, 2011).

3. Methodological Framework

3.1. Data

The study is conducted from the beginning until mid of 2014 on oil palm plantations covering an area of 26.38 km^2 and in an area in the form of shrubs that will be converted into oil palm plantations in Parindu Village, West Kalimantan. Some relevant stakeholders in this study are the management of PTPN XIII, plantation employees, environmental practitioners, as well as local communities.

This study uses secondary and primary data. Secondary data is data that is related to the economic value of oil palm plantations and alternative value to other uses of shrub land obtained from palm oil company reports and also from previous studies linked with other utilization of shrub land. Primary data obtained from the interview with key informants i.e. head of administrator of the palm oil plantation in Parindu village, formal and informal community leaders, and head of local NGOs, which is selected by using purposive sampling method. Quantitative data is also collected with the use of questionnaire distributed to the respondents.

3.2 Population and Sample

Sampling process is conducted using Taro Yamane's formula and taken from the local population (farmers) around the plantation area of Parindu Village and from outside the region (in the city of Pontianak). According to the data from the local government, the population of Parindu is 30,018 people (Village monograph 2009). Meanwhile, the population of Pontianak city is 565,856 people (Village monograph2014).

Using the Yamane's formula, the amount of sample is 99 for local people of Parindu (around palm oil plantation) and 99 for people outside region (city of Pontianak).

3.3 Data Analysis

This study combines qualitative and quantitative method (mixed method) with explanatory design (follow-up explanations model). Cresswell (2007) in his book entitled "Designing and Conducting Mixed Methods Research" revealed that there are four important aspects to consider in designing a mixed method, namely: time, weighting, mixing, and theorization. Based on the results of the various aspects of the above considerations, the strategy used in mixed method in this study is a strategy of explanatory design: follow-up explanations model.

Figure 1. Explanatory Design: Follow-up Explanations Model (Cresswell2007)

Follow-up explanations model is a mixed method research in which qualitative data are used to support the outcome of quantitative results (Cresswell 2007). The purpose of the use of mixed methods explanatory design: a follow-up explanations is to determine the economic value of two alternative activities in the shrub land. In the first stage, the quantitative methods used to gather information related to the society knowledge of the palm oil plantation and the economic value of ecosystem services of shrub land. The second stage uses qualitative methods to get more in-depth information related to the benefits derived by the community and the community's assessment of the economic value of palm oil plantation as well as the value of ecosystem services of shrub land.

At the end, the interpretation of the overall stages of analysis is performed to compare the economic value gained by palm oil business with consideration of ecological aspects with the economic value of ecosystem services of shrub land as the results of quantitative and qualitative analysis.

3.4. Variable, Indicator, Source of Data

Target	Variable	Data Parameter	Type of Data	Source of Data
Revenue gained by the community from 3 ecosystems services of shrub land	*Regulation services*	1. Size of land (Agriculture/shrub) (ha) 2. Amount of agriculture production (kg/month) 3. Cost for pest control and eradication (Rp)	Secondary and Primary Data	Document/internet, Informant and Respondent

	Provisioning services (Food)	1. Type of food found in shrub land(Rp) 2. Market price for food (Rp) 3. Cost spent by the community for daily consumption (Rp)	Secondary and Primary Data	Document/internet, Informant and Respondent
	Cultural services (Recreation)	**1** Willingness To Pay (WTP) (Rp)	Primary Data	Respondent
Total net profits of palm oil plantations, by taking into account the social aspects and ecosystem services	*Financial Return*	1 *Gross Returns* (Rp/ha) 2 *Variable Costs* (Rp/ha) • Cost of harvesting and transport • Transport of palm oil 3 *Annualized Fixed Costs* (Rp/ha) • Plantation maintenance cost • Overhead cost • Head Office cost • Depreciation	Secondary Data	Document/internet
	Economic Return	1. Gross Returns (Rp/ha) 2. Variable Costs (Rp/ha) • Cost of harvesting and transport • Transport of palm oil 3. Annualized Fixed Costs (Rp/ha) • Plantation maintenance cost • Overhead cost • Head office cost • Depreciation 4. *Cost of pollution* (Rp/ha) 5. *Costs of soil rehabilitation* (Rp/ha)	Secondary Data	Document/internet

Table 2. Variable, Indicator, and Source of Data

4. Results and Discussion

Table 3 summarizes the values of the three ecosystem services from shrub land. The value of *provisioning services* is calculated by the net income earned by the villagers of Parindu from the field (Rp830,293/ha/year); the value of *cultural services* is represented by the willingness to pay of the people associated with the city of Pontianak from birdwatching recreation potential in the shrub area of owned by indigenous village of Parindu (Rp20- Rp40); and the value of ecosystem services associated with *biological regulation* is shown by the amount of funds spent related to society pest control (mice) (Rp1,300/ha/year).

Ecosystem services	Value (Rp) per ha
Provisioning services (food)	830,293
Cultural services (recreation)	20 – 40
Regulation services (pest control)	1,300
Total Value of Ecosystem Services	831,613 – 831,633
Net present value (10% discount rate)	7,782,234.45 – 7,782,421.61
Net present value (12% discount rate)	6,957,024.87 – 6,957,192.19
Net present value (15% discount rate)	5,997,592.96 – 5,997,737.20

Table 3. Net Present Value of Ecosystem Services in Shrub Land

Description: Value is calculated within a period of 20 years in the future

Source: Results of data calculation (February - March 2014)

The age of productive palm oil is normally up to 25 years. At the age of 1 to 5 years, palm oil has not been able to contribute economically, then at the age of 6 years until the age of 17 years, the production of palm oil began to rise and tend to be stable. Unfortunately, at the age of 18 years, palm oil productivity will start to decline. However, in the plantation company PTPN XIII still maintains the palm oil with the age of 30-31 years. Table 4describes the amount of produced palm oil plantation per hectare per year in the PTPN XIII and the NPV of palm oil plantations.

Value (Rp/ha)	Year					
	1[a]	2	3	4	5	6-20
Profit						
Gross Profit[b]	**37.572.177**	**37.572.177**	**37.572.177**	**37.572.177**	**37.572.177**	**37.572.177**
Cost[c]	**5.086.688**	**5.086.688**	**5.086.688**	**5.086.688**	**5.086.688**	**5.086.688**
Net present value (10% disc. rate)				**274.725.125**		
Net present value (12% disc. rate)				**242.489.774**		
Net present value (15% disc. rate)				**205.011.266**		

Table 4. Financial Analysis: Net Present Value of Palm Oil Plantations

[a] The first year of palm oil production.

[B] Gross profit was taken from the calculation of average production per ha/year (19,774.83 kg) multiplied by the price of fresh fruit bunches (FFB); the maximum price is Rp1, 900/kg).

[c] Cost includes fixed cost and variable cost.

The investment value of palm oil per hectare isRp3,840,641.

Source: Field Data, February - March 2014

The initial investment of the palm oil per hectare is Rp29, 274, 081 (including the initial investment cost of the plant treatment from age 1 to 5 years). This value is relatively small when we look at the benefits of palm oil plantation per hectare per year; amounting to Rp32, 485,489. Table 4 above shows that palm oil is well worth economically, within the next 20 years, ranging between Rp205, 011,266to Rp274, 725,125 per hectare per year.

Financial analysis demonstrates the advantages from the standpoint of investors, or in this case PTPN XIII, as the company that manages palm oil plantations in the region Parindu village. PTPN XIII implements the pattern of 'plasma–core' to empower local communities. Until now, according to the Parindu community leaders, villagers gain benefits from palm oil

plantations through the 'plasma-core' pattern although there is still a debate related to the pattern of land distribution and credit system adopted by the company. The presence of palm oil in Parindu village according to community leader's information brings3 impacts:

1. Other economic needs can be met not only the needs of food
1. Increasingly opened-social conditions broaden the social and cultural perspectives towards a better way
2. Increasing public education (at the moment Parindu village has 15 young people with bachelor degree).

The loss of water resource for Parindu villagers is included as external costs. According to the results of the field survey, every household needs of clean water as much as 3 gallons of water (60 liters) per day. Price per gallon of water in the region Parindu is Rp6, 000. Thus, using the market price approach, the cost for Parindu village communities to meet the needs of water per month is Rp21, 600,000. Table 5 presents an economic analysis by incorporating external costs into the calculation of the NPV of palm oil plantations.

Value (Rp/Ha)	Year					
	1	**2**	**3**	**4**	**5**	**6-20**
Profit						
Gross Profit[a]	**37.572.177**	**37.572.177**	**37.572.177**	**37.572.177**	**37.572.177**	**37.572.177**
Cost[b]	**5.086.688**	**5.086.688**	**5.086.688**	**5.086.688**	**5.086.688**	**5.086.688**
Cost of Pollution[c]						**623.077**
Net present value (10% disc. rate)				**268.894.370**		
Net present value (12% disc. rate)				**237.277.299**		
Net present value (15% disc. rate)				**200.517.634**		

Table 5. Economic Analysis: Net Present Value of Palm Oil Plantations

[A]The gross profit of the calculation is calculated from the average production per ha per year (19,774.83) multiplied by the highest palm oil price (Rp1, 900/kg)

[b] Cost includes fixed cost and variable cost

[c]The cost of pollution is estimated from the water consumption of Parindu villagers per year divided by the size of area of palm oil plantation

Source: Field Data, February - March 2014

The results of the economic analysis above shows that the value of palm oil is still greater (Rp200,517,634to Rp268,894,370) compared with the value of the three ecosystem services of shrub land (Rp5,997,592.96 to 7,782,421,61) within a period of 20 years.

If we look at the economic value of the third ecosystem services (provisioning, cultural, and regulation services) calculated in this study, the palm oil plantations may be feasible to be built in shrub land. However, since this study only includes three aspects of the many ecosystem services that are owned by shrub land, further study is needed to complete the general assessment of ecosystem services in shrub land.

5. Conclusion

The study shows that the shrub land that formerly had been perceived by the local community and the company has no economic or ecological value, turns out to have considerable monetary value of the ecosystem and the economy. However, the economic benefits of palm oil plantation is in fact larger than that of shrub land if the calculation only considers three ecosystem services (provisioning, regulating, cultural services) owned by shrub land. Therefore, the attempt to build palm oil plantation in shrub land is feasible.

This study also confirms that palm oil plantation does not always bring negative impact. Palm oil plantation can provide positive benefits in the long term, especially for the community, if the development of palm oil plantation is conducted with precautionary principles and implementing the concept of sustainable palm oil plantation such as (RSPO 2014, RSPO 2013):

- Palm oil plantations are strived not to be built in peat soil, so as to minimize the release of carbon into the air that can trigger global warming
- Palm oil crops are not to be planted in the area of primary forest so as not to disrupt ecosystems and habitats of many plants and animals
- Palm oil companies must directly participate in overcoming or minimizing the negative impacts caused by oil palm plantations
- Palm oil companies empower communities around the plantation to provide economic benefits to the surrounding communities

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