## Leakage Analysis

***Activity shifting***. Likely the principal concern for project proponents. Five palm oil companies were granted illegal concessions inside the Seruyan buffer region. One company has already converted its concession to oil palm, overstepping concession boundaries and encroaching into the Project Area. Four of the companies had yet to commence operations when project proponents intervened, and their concessions have been extinguished. These displaced concessionaires may attempt to obtain other land suitable for oil palm development, in which case project emissions will to some degree have been displaced rather than avoided.

***Outsourcing***. No palm oil is currently under production within the Project Area, so outsourcing leakage is unlikely.

***Market effects***. Though relevant to any national leakage accounting system, market effects are too speculative to gauge on a project basis. For palm oil, moreover, the size of the market dwarfs any shifts in supply and demand likely to occur due to any one REDD project, and the economic incentives to convert any remaining forests to plantations are so overwhelming that added competition from REDD does little to increase them.

The rapid rate of deforestation of peatland has brought about great cause for concern. With the advent of REDD, there is potential to dramatically reduce the rate of global deforestation, which is critically important to both bio-diversity and climate stability. The primary challenge to the efficacy of REDD is the issue of ***leakage***, which suggests that the prevention of carbon in a localized project area may not lead to net carbon avoidance in a broader context if the carbon output activities merely shift to other areas, a practice referred to as ***activity shifting***.

The basic premise of REDD is to assign a market value to ***eco-systems*** services, namely carbon sequestration, that have previously not been factored into the total real cost of a given product. The idea is that if the fully burdened cost of the products we consume reflected the total real cost of production, including hitherto unpaid environmental services, then the price of environmentally damaging products would increase, thereby making them less competitive than more sustainable alternatives. This realignment of market pricing mechanisms is intended to bring into balance a system that currently is in disequilibrium because, up to now, there has been no cost associated with the green house gases released as a result of deforestation.
Therefore, any theoretical argument surrounding the benefits or consequences of REDD and possible risks of leakage, must necessarily entail a review of the basic economic concepts related to ***supply/demand elasticities*** and their relationship to ***price equilibriums and disequilibrium***. In the pages that follow, the following issues will be addressed:

- Due to the non-renewable nature of peat land given the hundred's and even thousands of years required to regenerate, peat land should be treated as a ***non-renewable resource*** that is being depleted at a rate from which it will not be able to regenerate, eventually yielding very volatile climatic outcomes.
- Unaccounted for economic costs, known as ***negative externalities***, will ultimately wreak havoc on eco-systems and long term regional and global climate stability.

Essentially, a negative externality is a cost, in this case to the environment and to all those reliant on its stability including plants, animals and people. In the current market paradigm, this cost is not reflected in the price of the palm oil and the products that use palm oil. Ultimately all costs are not accounted for when peat land is converted, which leads to an artificially sustained disequilibrium in excess short-term demand and long-term limited supply due to the fact that current environmental degradation is not being factored into the price today, but is rather being pushed off to the future.

- Because peat land is currently not considered, either socially or in terms of acknowledged importance, a non-renewable resource therefore peat land is significantly undervalued. Moreover, the arguments in favor of palm oil production for bio-fuel development are highly flawed when environmental costs, also known as externalities, are unaccounted for.
- Once enacted, REDD will assist in providing some revaluation to peat, both literal and figurative, as a result of the worth placed on stored carbon values and increased land use competition.
- Added competition to land will have upward pressures on short term palm oil prices due to increased demand. Ultimately, once palm oil producers shift production capacity to marginalized non-peat land the short term input price increases would equilibrate as lower cost plantation land will be identified and developed through ***allocative efficiency***. Moreover, the carbon credit market would settle at a higher equilibrium price and quantity as demand gains traction among REDD adopting developed countries.
- Increased input prices will cause ***activity shifting*** among palm oil producers due to the high level of ***demand elasticity*** for palm oil in commodities and consumer markets in order to keep costs competitive.
- This activity shifting away from the depletion and conversion of peat land to agricultural uses will ultimately yield positive leakages with respect to emissions, all else equal and the value placed on preserved peat will help to bring market outcomes closer to equilibrium as a result of ***external effect accounting***.

By definition, a ***non-renewable resource*** is a natural resource that cannot be produced, re-grown, regenerated, or reused on a scale which can sustain its consumption rate (Wikipedia, 2009). The acceptance of REDD will address the critical importance of peat land and, in doing so will implicitly re-align peat land as a highly necessary source of climate stability and biodiversity. Conceptually, this will systemically motivate governments, private enterprises, NGO's and individuals to place higher value on peat land as a non-renewable resource as opposed to an inefficient land use when compared to agricultural production. Moreover, unaccounted external costs will be brought in line which will provide for a more realistic picture of market outcomes.

Therefore, it is appropriate to examine the market functions of peatlands, both before and after REDD, from the perspective of the economics of non-renewable resources, which will be examined at depth in coming paragraphs. Moreover, in subsequent paragraphs the implications of REDD on palm oil production, land use changes and resource allocation will be focused on.

Furthermore, the concept of ***leakage*** will be defined and addressed as it relates to the acceptance of REDD. A common argument in favor of degradation is the use of palm oil as a bio-fuel. This will be addressed in terms of flaws in the arguments and negative leakages associated with the development thereof. Additionally, an examination of the relationship between scarcity and resource allocation and how these relate to and influence activity shifting will be discussed. In addition, the market interactions that will likely take place as a result of the added competition, with respect to palm oil companies' activity shifting, relative to plantation land acquisition will be addressed.
The concept of leakage will be a critical component in measuring the success of REDD. Specifically, how impactful will REDD be on local, regional and global emissions levels, particularly as they pertain to the contribution of deforestation to greenhouse gas emissions. Opponents of REDD argue that it may merely shift emissions from deforestation to the developed world as carbon credits will be purchased without attempting to reduce domestic emissions levels.

This argument is flawed in the sense that it assumes no policy or market implications resulting from REDD. An important argument in favor of peat land use as a carbon store is simply the fact that it is extremely high in carbon content.

Converting peat to agricultural use has significant environmental effects that have a measurable economic cost. In the current market paradigm, this cost is not reflected in the price of the palm oil and the products that use palm oil. These unaccounted for economic costs, known as ***negative externalities***, will ultimately wreak havoc on eco-systems and long term regional and global climate stability. Essentially, a negative externality is a cost, in this case to the environment and to all those reliant on its stability including plants, animals and people.

Ultimately all costs are not accounted for when peat land is converted, both the costs to all impacted, as well as the costs to the degradation of the environment. During depletion significant levels of carbon are emitted as the peat is burned, as well as after oxidation through subsidence. Additionally, the ability of the peat to sequester carbon is lost after it is deforested. The ability of palm oil trees to capture carbon is low relative to peat and as a result the effect of degradation and lost ability to contain the carbon compounds the negative environmental impacts.
Assuming global emission levels are held constant, the result of converting peatlands yields a negative leakage into the environment. On the other hand, assuming the peat is no longer convertible to palm oil due to land use regulations, producers are now forced to find non-peat land for the new plantation development and therefore, the carbon is contained in the peat, the peat is still able to continue to contain additional carbon and the new plantation of palm oil trees also sequestering carbon, will result in a positive leakage.
Conservatively, the least positive impact REDD may have on the palm oil industry will simply be a substitution from peat land use to alternative marginalized land uses, which will still yield reduced emissions levels by way of shifts in the allocation of resources (to be elaborated upon in the coming paragraph). In terms of the impact on primary leakages, the palm oil companies, assuming industrial technology of palm oil farmers does not become more emission heavy, will simply shift to alternative land

uses thereby yielding positive impacts on adjacent forests, particularly with respect to long term climate stability. Market effects associated with secondary leakages will be illustrated below.

Ultimately, the result of REDD on emissions levels will yield positive leakages, all else being equal. A primary argument in favor of peat depletion in support of palm oil is the developing bio-fuel industry. The leakages associated with conversion in order to produce bio-fuels are both negative and substantial.

Vegetable oils, and in particular palm oil, are increasingly being used as bio-fuel due largely to crude oil price volatility and the societal inclination to ultimately reduce greenhouse gas emissions. The attraction to palm oil as bio-fuel is due in large part to its high yield, relative to other vegetable oils (Searchinger, et. al., 2005). However the long term benefits associated with bio-fuel infrastructure investment largely ignore the broader environmental impacts associated with cultivation, production and transportation of bio-fuels, which result in a significantly higher magnitude of greenhouse gas emissions in the short term.

According to a recent report, agro-fuel expansion on a large scale may only have negligible effects on greenhouse gas emission reduction (Ernsting, et. al, 2007). One of the primary arguments against bio-fuel production and distribution is the level of fossil-fuels involved in the production process. In fact, the 2007 study found that between 74% and 95% of the energy in corn ethanol is derived from fossil fuel inputs.

Moreover, the study discussed the prevalence of coal use in many of the refineries, which is very high in carbon content. A large amount of data exists which suggests that large scale agro-fuel expansion could actually accelerate the climate change process, as opposed to mitigating it (Ernsting, et. al., 2007). It is argued that this increase would be due to the added level of deforestation, increased use of fossil fuel inputs and the use of nitrous based fertilizers (a critical component for high yield fields), among others. Essentially, a key argument opposing large scale agrofuel expansion is that there is a negative leakage associated with production and additionally, benefits are overstated while costs are understated suggesting disequilibrium within the palm oil market relative to bio-fuel expansion (i.e. a significant negative external effect).

The continued increase in deforestation rates associated with broad level bio-fuel production would have a multiplicative effect on carbon release, especially on peat land, as degraded peat land loses carbon storage capacity, becomes susceptible to fire and releases large amounts of carbon annually (Rieley, 2006).

- According to a study done by Holly Gibbs (2008), it takes nearly 900 years to receive payback to palm oil as bio-fuel that is cultivated on degraded peat land.
- A recent study, which examines the land cover change in Southeast Asia in order to meet bio-fuel market demand, suggests that nearly 30 times more carbon will be released as a result of the shift to palm oil plantations from peat land (Siegert, 2006).
- Moreover, results of the study suggest that producing one tonne of palm oil on peat land will result in the release of between 15 and 70 tonnes of $CO_2$ over the 25 year life cycle as a result of the conversion.

The growing understanding of the impact of greenhouse gas emissions from degradation and deforestation suggests that peatlands critical role in $CO_2$ emissions and storage should be highly protected and, according to Dr. Susan Page, "should be used as a 'bank' because they are worth more as biodiversity and carbon stores than oil palm or pulp tree plantations." The importance of peat land is essentially magnified as a result of their importance to climate control, biodiversity and the increasing scarcity as palm oil plantations threaten their preservation due to the non-renewable nature, or high level of terminal scarcity associated with peat land.

The concept of ***scarcity*** is critical to understanding the market functions associated with peat land use and preservation. In basic economic terms, scarcity is unlimited demand for a limited resource. As scarcity increases for a good, the price is generally bid up, causing quantity demanded of that good to decrease, all else being equal. In other words, in market economies with common convertible currencies, price functions as a rationing device; as quantity available decreases, price increases, which implies the growing level of scarcity of a good or resource.

Generally, all goods have some level of scarcity which is representative of a host of supply constraints. In the case of a non-renewable resource such as oil, it is understood that supply (either short- term or long-term) is finite so reductions in production levels or diminished reserves will lead to upward pressures on prices. Peat is effectively a finite resource since the replacement time is measured in hundreds and even thousands of years, far beyond the reference points of leakage arguments and the project life (25 years).

The difference between resources like peat and oil is that the level of dependence on, or scarcity of, is not necessarily implicit in its valuation. As a result, collective efforts and pressure for broad conservation are not of the magnitude they need to be considering the importance of peat land to overall climate stability. In other words, if the remaining oil supply was being depleted at a level of approximately 2-5% annually, as is peat, prices and behaviors would reflect as such on a broad scale.

The adoption of REDD should help to revalue peat land significantly as it would achieve the following: 1) more stringent land use regulation would impose an additional level of scarcity given the formal land classification that palm oil companies and REDD companies would have to compete for and 2) add value to the peat based on the carbon quantities contained therein, which would in turn make it competitive to palm oil in its natural state (not degraded). An illustration of the likely market outcomes is provided below. In addition to understanding scarcity of resources, the activity shifting that will likely take place as palm oil producers are forced to compete with carbon companies is an important contextual concept.

Economic theory suggests that there will be a shift in resource usage relative to land in competition with palm oil and carbon as a result of REDD. Another critical piece tying these arguments together are those that identify and measure the external costs versus the external benefits in order to get a true picture of the markets reflection of the benefits and costs to society. The influx of competitors for the land will likely result in displaced palm oil production resources, which could be considered a negative impact; however, once adjustments are made, the palm oil farmers do not become displaced in the long term indicating neither an external benefit nor cost but rather a long term constant state.

This inter-temporal displacement will cause activity shifting among palm oil farmers and companies. Specifically, in order to expand production, palm oil companies will be required to find alternative land uses for palm oil production, assuming the increased input costs are less desirable than finding less expensive land sources. In other words, there will be a shift in allocative efficiency of resources associated with palm oil production.

By definition, ***allocative efficiency*** is a theoretical measure of the benefits achieved, or utility derived, through the distribution, or change in distribution of resources. Meaning that through market functions, resources will continue to be distributed and redistributed such that the most efficient combination of resources will be used. Subsequently, the outcomes from these distributional shifts can be measured and “winners” and “losers” are determined based on these adjustments. When the benefits to the “winners” are greater than the lost benefits to the “losers” there is said to be an increase in allocative efficiency, and vice versa. This activity shifting that will occur as a result of REDD is simply an illustration of market forces at work.

Assuming governments uphold land use laws and markets are allowed to work freely within the constraints of the enforcement, the resources will be allocated efficiently, unused/marginalized land will be absorbed as displaced palm oil farmers are forced to be innovative with their production methods as a result of the change in supply and demand conditions for peat land in light of rapid depletion.

The external costs associated with REDD will likely be reduced from the pre-REDD condition, all else equal. This means that given the reduced emissions levels and the positive leakages associated with REDD, not only will negative externalities from deforestation be reduced, but ultimately the proposed revaluation of peat land will provide a more realistic cost given peats importance to bio-diversity and climate stability.

The levels of peat deforestation are so great that excessive levels of carbon are being released into the atmosphere on a daily basis. It is in this respect that peatlands should be examined as a non-renewable resource, particularly in areas where the rapid degradation threatens both the existence of the peat, as well as the future potential of the peat to regenerate. Land use patterns will likely be affected as more carbon credit companies move in to the area and create competition with palm oil producers.
Moreover, the market functions associated with the growing carbon credit market will likely have significant impacts on land use patterns throughout Indonesia, including the Rimba Raya project area in Central Kalimantan. Based on this determination, we introduce the first component supporting our arguments which was developed by Harold Hotelling.

The premise is that the ***equilibrium price*** trajectory for a non-renewable resource generally rises exponentially (attributable to the magnitude of the scarcity), until the point at which the price is so high that demand would be crowded out. Due to the non-renewable nature of the resource, in this case Kalimantan peat land, it is implied in the exponentially rising price, that the quantity of remaining land would be continuously falling until the resource was fully exhausted, or until such time that the resource would no longer be utilized due to substitution to alternative more cost effective resource types (see Figure 47).

While the existence of this condition empirically has not been examined at length, relative to peat land, the developing carbon credit market would have larger positive impacts on the magnitude of price exponentiation and ultimate depletion trajectory as the value of the land will be placed in its existence rather than in its degradation and conversion. This particular example illustrates the relationship between the price per unit of a finite natural resource over time, relative to remaining quantity.

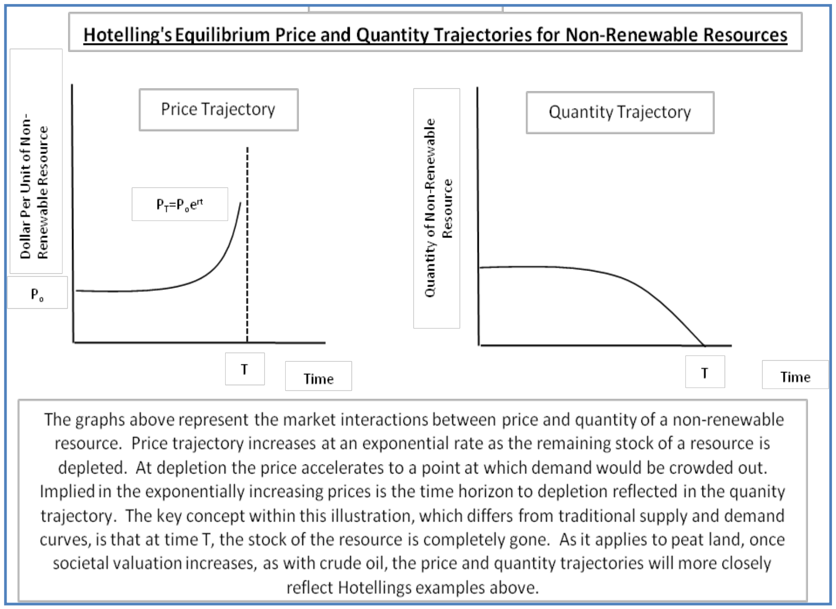


**Figure 47.** Hotellings Equilibrium Price and Quality Trajectories for Non-Renewable Resources

In Kalimantan the amount of peat land is declining at a rate of 5.42% per year (Wetlands International, 2002). If REDD is enacted the total store of land will be reduced further and competition for land will increase significantly engaging not only palm oil producers, but also those looking to capitalize on the carbon store in the peat land with the intention of selling credits. This level of heightened scarcity will have significant impacts on current and future land use plans. The market responses associated with this new, more limited quantity of available land will likely follow basic market principles, assuming limited government involvement in market functionality with appropriate enforcement of land use regulations and property rights.

The model in Figure 48 represents the market for peat land both before and after REDD in a basic supply and demand framework. Notice the initial supply curve (denoted ST) is completely vertical. This represents the fixed amount of agricultural (and to be converted to agricultural) land available in Indonesia. The initial demand curve (denoted DT) represents current demand for agricultural (and to be converted to agricultural) land in Indonesia.

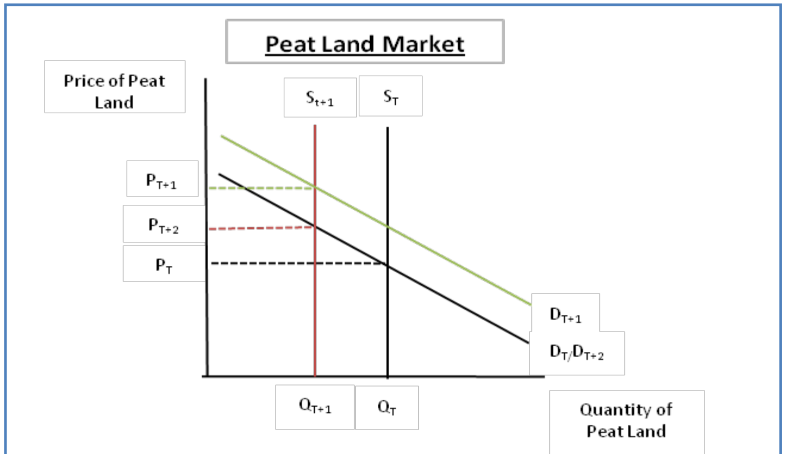


Figure two above is an illustration of the traditional supply and demand framework as applied to a non-renewable resource. Because the supply of available peat land is finite, the supply curve (represented by $S_T$ and $S_{T+1}$) is vertical. This indicates that irrespective of price, the quantity supplied is constrained by resource availability and can never exist beyond $S_T$. The supply curve can shift leftward (for example to $S_{T+1}$), as supply is reduced through deforestation or land use controls. In the example above $S_T$ represents the pre-REDD condition for peat land. The adoption of REDD will reduce the availability of supply shifting the supply curve to $S_{T+1}$. The short term impact would be a subsequent increase in the level of demand to $D_{T+1}$ (increased competition from palm oil and carbon companies simultanesouly) bidding up the price. Ultimately it is expected that palm oil companies will activity shift to marginalized non-peat land and the demand level will return to approximately $D_T/D_{T+2}$ at the elevated price level.

**Figure 48.** Peat Land Market Supply and Price Equilibrium

The intersection of the hypothetical demand and supply curves yields the market clearing equilibrium price for peat land in Indonesia, (denoted PT), where P stands for price (throughout the example) and subtext T represents the present time period (i.e. prior to REDD). If REDD were to be enacted, the total supply of available land demanded by palm oil farmers and carbon credit companies would be reduced based on REDD guidelines, which is indicated by the leftward shift in the supply curve (denoted ST+1). Independent of any changes in demand, the market clearing price would be bid up as a result of the diminished stock of available land (denoted PT+1), where subtext T+1 represents the subsequent time period after period T. Empirical evidence (Othman, 2003) suggests that the elasticity of demand for palm oil and other edible oils is very high (i.e. highly substitutable).

The resulting impact on demand for peat land to be used for palm oil would be diminished by palm oil producers as a result of the relatively higher input costs associated with the increasing peat land prices. Palm oil producers would be able to either: 1) compete for the land, 2) move to other less competitive non-peat land or 3) transition productive endeavors to other industries. One likely outcome would be activity shifting due to the fact that the input costs would increase (discussed in more detail below) and the transaction costs associated with redirecting industrial production into an alternative industry would likely be significantly high enough to inhibit a substitution.

The reason for this competitive adjustment is that carbon credit companies have moved on to peat land (or conversion forests) in order to capitalize on the expected value of the carbon stored within the peat, effectively bidding up the price of the land previously demanded by palm oil companies. This is the impetus through which palm oil producers move to marginalized non-peatlands, which are not directly impacted by REDD, in order to maintain competitive cost structure within their palm production operations.

The short term impact on the carbon credit market is an increased supply of available credits (see Figure 49) due to the value added to stored carbon by the implementation of REDD. We see current market equilibrium price and quantity (PT and

QT) at intersection of initial pre-REDD supply and demand curves (DT and ST). The initial increase in carbon credits will shift the supply curve to the right (to ST+1). In the longer term, assuming countries, firms and individuals adopt the policies required by REDD, the demand for the carbon credits will increase (to ST+!) yielding an increase in the longer term horizon of equilibrium price and quantity (intersection of DT+1 and ST+1).

The longer term impact of added carbon store profitability exhibits a multi-stage effect as policy implementation and land use enforcement are crucial. Specifically, the time in which it takes for users of the carbon credits to create the market breadth in order to see significant market traction will occur over time as the industry expands. At this juncture government regulation is crucial as indicated by Othman (2003), higher supply elasticities exist, wherein governmental organizations fail to enforce policies, this failure enables higher risk activities to persist, which could ultimately result in no significant additionality as palm oil producers could recapture peat land or other land gazzeted for agricultural use. In other words, higher levels of profitability to one use reduce the elasticity of supply to other uses.

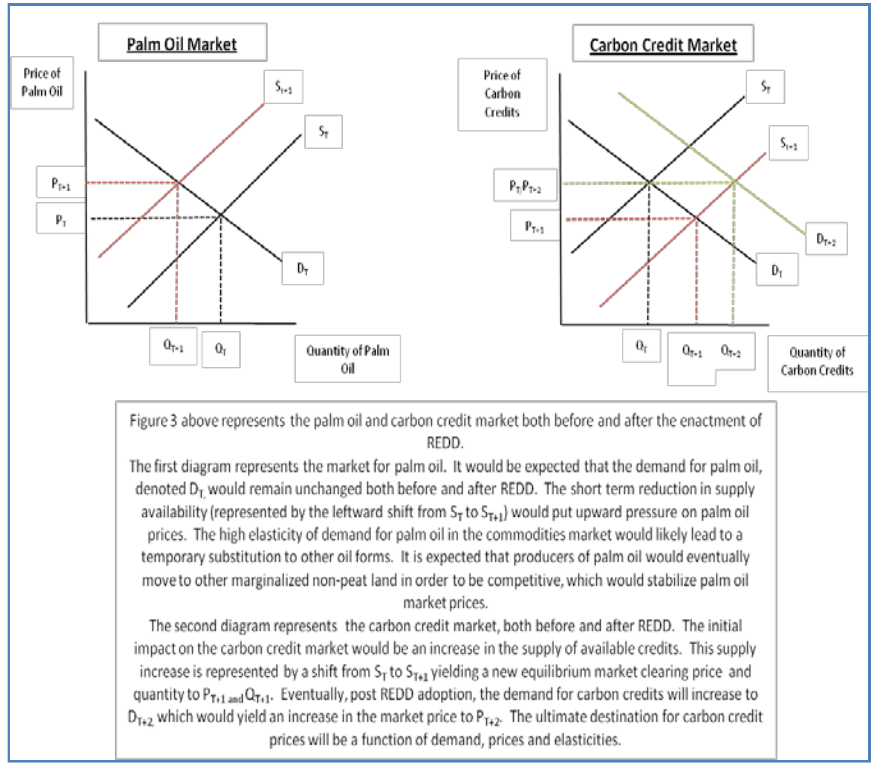


**Figure 49.** Short-Term Supply Reduction

This dynamic implies that REDD provides a direct incentive to companies to acquire peat land to hold in order to sell carbon credits. As long as the land use regulation is enforced to the newly designated use, the elasticity to other uses, or opportunity cost, diminishes over time solidifying the newer less greenhouse gas intensive uses. The resulting impact on the Indonesian palm oil market is shown in Figure 49. Specifically, the impact REDD would have on the palm oil market would yield a short term supply reduction, which would reflect in upward pressure on prices, the supply curve would shift from ST to ST+1.

Eventually, through substitution to other non-peatlands, price impacts on palm oil may be mitigated. Palm oil producers would be able to compete with carbon credit companies for the same land; however, the cost structure of the domestic palm oil industry would increase, possibly creating a substitution away from palm oil in the consumer market as a result of its high elasticity.

In order to maintain competitive advantage palm oil producers would need to identify less expensive land, which after REDD would likely be to marginalized non-peatlands, or lands not as abundant in carbon. The longer term impact would result in lower input prices to agricultural land uses, although cultivation time and subsequent production costs may increase bidding up the price slightly, the long term market clearing price would likely be lower than if palm oil companies were to attempt to compete for REDD lands.

Ultimately the adoption of REDD will be a step in the right direction in terms of emissions reductions. Although, the short term impacts on the palm oil industry will consist of minor displacement of producers eventually, through efficient resource allocation, they will adapt to the change in the policy landscape and will adjust business practices accordingly.

The added level of scarcity brought about by REDD, along with the societal repositioning and pricing of palm oil as being derived from a non-renewable resource, will provide added value to peat land, which was previously only associated with palm oil production, thereby yielding a price adjustment that is more representative of the external costs associated with the production. While palm oil proponents suggest that a better use for peat land is as a land resource for palm oil plantations dedicated to bio-fuel production, there is a large body of research validating the flaws in this argument when environmental costs are taken into account.

Moreover, with the implementation of REDD, saving even one parcel of peat land will have positive leakage effects due to the high level of carbon released both during and after deforestation along with the lost sequestering capacity of peat land. Activity shifting may occur, but since there is a ***finite supply*** of peat and since it is a non-renewable resource, the activity must necessarily shift to non-peatlands. The carbon output from the re-directed production onto non-peatlands will be less than the "without project scenario".

The market will respond to the changing demand for carbon credits and peat land. Through direct and indirect price adjustments for palm oil and carbon credits, along with the elevated level of competition brought about through the scarcity imposed by REDD, both producers of palm oil and carbon credit companies should be made better off as land previously not demanded will ultimately be utilized in a more allocatively efficient way with an elevated knowledge and understanding of the external costs associated therein.

This paper has attempted to cover the fact that peat land, given the hundred's and even thousands of years required to regenerate, should be treated as a non-renewable resource that is being depleted at a rate from which it will not be able to regenerate, eventually yielding volatile climatic outcomes.

Because peat land is currently not considered, either socially or in terms of acknowledged importance, a non-renewable resource, it is therefore significantly undervalued. Moreover, the arguments in favor of palm oil production for bio-fuel development are highly flawed when environmental costs, also known as externalities, are unaccounted for.

The adoption of REDD into a global compliance scheme, will provide for the revaluation of peatlands, both literal and figurative, as a result of the cost and benefit placed on stored carbon values and increased land use competition.

Added competition for peatlands will have upward pressures on short term palm oil prices due to increased making alternative, more sustainable oils more competitive. Ultimately, once palm oil producers shift production capacity to marginalized non-peat land the short term input price increases would equilibrate as lower cost plantation land will be identified and developed through allocative efficiency. Moreover, the carbon credit market would settle at a higher equilibrium price and quantity as demand gains traction among developed countries adopting REDD. Increased input prices will cause activity shifting among palm oil producers due to the high level of demand elasticity for palm oil in commodities and consumer markets in order to keep costs competitive.

This activity shifting away from the depletion and conversion of peat land for agricultural uses to marginalized land will ultimately yield positive leakages with respect to emissions, all else equal and the value placed on preserved peat will help to bring market outcomes closer to equilibrium as a result of external effect accounting.