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Jamaican Deforestation and Bauxite Mining – the Role of Negotiations for Sustainable Resource Use

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Abstract

Bauxite mining is considered to be one of the most significant reasons behind deforestation in Jamaica. During the last decades, large areas of forest have been cleared on the island due to open pit mining for bauxite. Because private landowners own the bauxite land, the operating mining companies are in many cases forced to bargain with the private landowners to obtain access to the desired land. Several economic theories present solutions to the problem of sustainable resource use. The purpose of this paper is to examine if the Coase theorem can be applied to analyze if the deforestation caused by bauxite mining in Jamaica can be amended towards optimal resource management. The paper concludes that there exist no practical obstacles for bargaining to take place. However, since the market for bauxite mining is not characterized by perfect competition, an efficient allocation of the Jamaican forests according to the Coase theorem is not achieved. Yet we find that the antiquated Coase theorem can help us gain knowledge into some fundamental aspects of the prevailing market conditions surrounding Jamaican bauxite mining.

Keywords: **Deforestation** – **Coase theorem** – **Bauxite mining**

INTRODUCTION

Over 60 percent of the earth's biodiversity consists of forests, which is one of our most important ecosystems. The world's forests provide a wide range of services and benefits including everything from preserving traditional ways of life to enhancing environmental stability and security (Forestry Department, 2001a). Jamaica is a country with extensive forest cover. However, after decades of improper land use, the island has lost much of its original forest cover. This has lead to a number of negative effects, including soil erosion, deterioration of watersheds, and drying up of rivers and streams (Evelyn, 2000). However, it becomes increasingly obvious that the pressure on forests worldwide now primarily stems from forces outside the forestry sector. In most forestry debates, mining is hardly mentioned. Among the various pressures that have lead to the high deforestation rates in Jamaica, bauxite mining is considered to be one of the more significant.

Economics literature proposes different ways to achieve sustainable resource use. While some theorists advocate government intervention in terms of setting standards or taxes, others argue that, as long as property rights are well defined, the market itself will allocate the resources efficiently through market forces.[2] The latter approach was developed by Ronald H. Coase (1960) and is better known as the 'Coase theorem'. The seminal article, entitled *The Problem of Social Cost*, analyzed what happens when economic actions affect third parties, e.g., when railroads dump polluting materials on farmers' crops. Coase found that once property rights were well-defined and easily tradable an efficient solution would follow. Ever since the Coase theorem was introduced in the 1960s, it has been debated repeatedly, and generally been presented as a theoretical curiosity of no practical importance. However, an understanding of market forces requires an understanding of the advantages of market organization as well as the limits of markets. For this reason, we think that while the Coase theorem fails in many real life situations, we still can learn much by employing it for analytical purposes, bearing in mind that issues surrounding

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the theorem touch upon some fundamental aspects of market conditions. In addition, recent policy instruments such as, e.g., tradable permits or fishing quotas should be seen as real title to property (Sterner, 2003). These instruments which develop and assign new kinds of property rights are clearly viewed as distinct policy instruments for environmental management.

The purpose of this paper is to examine if the Coase theorem can be applied to analyze whether the deforestation caused by bauxite mining in Jamaica can lead towards optimal resource management. The analysis is carried out in two steps. First, we analyze the structure of property rights to the forests in Jamaica and analyze whether or not Tietenberg's (1996) criteria for efficient resource allocation are satisfied. These criteria include transferability, universality, exclusivity, and enforceability, which we consider in Section 2. The second step describes five main shortcomings of the Coase theorem (both in theory and practice) as identified in the literature. These five issues are then compared with the Jamaican design of forest resource management.

The study employed in-depth interviews and observations in Jamaica between November 2002 and January 2003. The area in focus of the study was the hills of the Mocho Mountains in the parish of Clarendon, which is one of seven parishes in Jamaica subject to bauxite mining. The primary reason why this particular parish was chosen is that it has been subject to bauxite mining for over 40 years and therefore has a long history of bargaining between mining companies and private landowners.

The paper proceeds as follows. Section 2 presents some theories regarding the problem of sustainable natural resource management, and outlines the Coase theorem. In Section 3, the Jamaican forest sector and the bauxite mining industry as well as some legal foundations are presented. Section 4 presents the legal aspects concerning bauxite mining in Jamaica, while Section 5 presents the empirical results of the study. Finally, Section 6 concludes the paper.

SECTION 2: THEORETICAL FOUNDATION

Several theories present solutions to the problem of sustainable resource use. However, considering the purpose of this paper, only solutions within the so-called property rights paradigm are presented here. Other possible solutions involve government intervention, e.g., by setting taxes or standards.

2.1 Property rights

Some economists argue that an economy with well-defined and transferable property rights will provide individuals and companies with sufficient incentives to use natural resources efficiently – known as the property rights paradigm. For this approach, the concept of property rights must be understood. Property rights refer to the entitlement defining the owner's rights and limitations for the use of a specific resource. These rights can either be private or public, where the latter is also known as common property. According to Tietenberg (1996), the structure of property rights should include four specific characteristics, illustrated in Table 1, in order to serve as a solid foundation for efficient resource allocation.

2.2 The Coase theorem

In an ideal economic system, goods worth more than they cost to produce are produced; goods worth less will not, and such a system is considered to be economically efficient. This only works if producers cover all the costs associated with the production. However, some goods may be produced even though their cost (including externalities such as pollution) is greater than their value, which is inefficient.

The Coase theorem argues that as long as property rights are clearly defined, market forces will allocate goods in an efficient way. Regardless of who owns the property rights, in a private enterprise system individuals will create markets for externalities, and thus abolish the need for government intervention (Pearce and Warford,1993). The theorem has found wide application not only in economics, but also in law, sociology and political science. It was partly due to the strength of this theorem that Coase was awarded the Nobel Prize in 1991.[3]

In order to demonstrate these ideas, we consider the example of mining in forest areas. A company mines land for bauxite, but the owner of the land (the only other affected party in this example) finds the mining harmful to his/her forest. Figure 1 presents these effects, the curve MB denoting marginal benefits to the company, and MEC denoting the marginal external cost of the mining to the affected landowner. The horizontal axis is measured in units of deforestation, d, while the vertical axis refers to US dollars. If the mining company behaved without regard for others, and were not subject to any external control, it would maximize its private benefit at the output level d_1,

Table 1. *Tietenberg's Property Rights Criteria*

Universality	Private ownership of all resources as well as completely specified entitlements.
Exclusivity	All costs and benefits taking place as a result of owning and using the resource should be accrued only to the owner of the resource.
Transferability	All property rights should, in a voluntary exchange, be transferable from one owner to another.
Enforceability	Security from involuntary seizure or encroachment of the property rights by others.

Source: Tietenberg (1996), p. 41.

where all the additional benefits from mining have been exhausted.

With reference to Figure 1, the Coase theorem propounds that if property rights were vested in the mining company it would have no legal liability for any deforestation, and the pre-bargaining level of deforestation would be d_1. However, one would expect bargaining to take place between the affected parties, leading to the bargaining outcome d_0, where the MEC of the landowner and the MB of the mining company are equal. This would be in the interest of both parties since the affected party would like to pay any amount smaller than $C + D$, while the mining company would accept any amount greater than C, the benefit the company otherwise would gain. Thus, the bargaining result, d_0, is the optimal bargaining solution. If, on the other hand, the property rights were in the hands of the landowner, the mining company would not be entitled to cause deforestation, and so the pre-bargaining level of deforestation would be d_2. However, the two parties still have the possibility of a mutually beneficial transaction. The landowner allows the mining company to produce d_0 without seeking redress through the courts. In return, the mining company would compensate the landowner by an amount maximally equal to A in Figure 1. Hence, whenever someone clearly possesses the right to pollute, social optimality will follow! This is what famously has become known as the Coase theorem. The theorem shows that the very existence of inefficiently managed resources triggers pressure for improvement. Furthermore, the existence of this pressure does not depend on the assignment of property rights (Pearce and Warford, 1993). Thus, the law of property determines who owns a resource, but the market determines how it will be used.

2.3 Critiques to the Coase theorem

The essential point of the Coase theorem is that clearly defined property rights triggers bargaining, which leads to an outcome consistent with efficient allocation of a resource. However, its importance should not be exaggerated. Several objections, both theoretical and practical, are raised in the literature to this bargaining method. Five main objections to the bargaining solution are presented below.

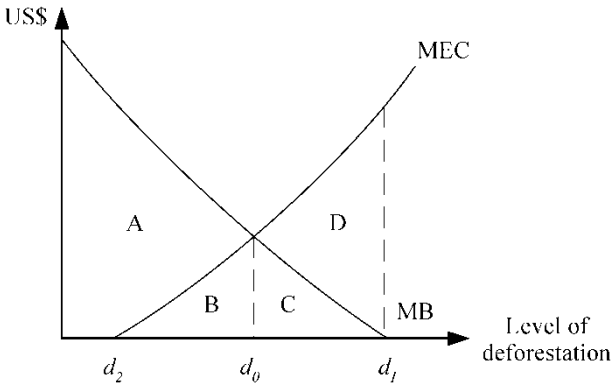
The existence of transaction costs and absence of bargains

The first criticism of the Coase theorem probably illustrates the most significant obstacle to bargaining actually taking place. This obstacle is the occurrence of transaction costs. In the presence of positive transaction costs, an effective resource allocation will not take place. It is often argued by his critics that Coase leads his readers through a surreal world of zero transaction costs. If transaction costs, which include the cost of bringing parties together, organizing the parties, and performing the bargaining itself, for any party is higher than the expected benefits of the bargain, that party will not participate in the negotiations. This obviously poses a problem when studying the Coase theorem, since the aim of the theorem is to optimize the resource management with regard only to the environmental costs (Pearce and Turner, 1990).

Identifying the bargaining parties

Owing to the fact that many pollutants remain in the environment for long periods of time, it is sometimes impossible for the two parties to come together and negotiate. Because of this, bargains may not take place even if transaction costs are less than the benefits of the bargain. Such pollutants include toxic chemicals, radioactive waste, and global carbon dioxide, among others. Even in conventional pollution contexts, such as deforestation, it can be difficult to identify who the sufferers and polluters are. This mainly stems from the fact that even the sufferers themselves are unaware of the pollution and hence bargains are not likely to occur (Pearce and Turner, 1990).

Figure 1. *The Coase theorem*



Source: Common (1995), p. 148.

Threat making

If the polluter has the property rights and the sufferer compensates him, there is a possibility that other polluters will try to enter the situation and demand compensation as well. The potential for making threats like this does certainly not contribute to an optimal use of scarce environmental resources. However, since this mainly occurs when the property rights are poorly defined, it can be avoided by a careful definition of who is entitled to the property rights of the resource. Another problem that might occur is that the company's emissions are deliberately increased in order to obtain extra compensation from the sufferers. What this means is simply that the company gets paid for adding to the social cost. In addition to this, threat making can occur even when the sufferers have the property rights. In the case of bauxite mining in Jamaica, the polluter may for example threaten the sufferer to increase the damages done to the lands while prospecting for the ore (Tisdell, 1993).

The free rider problem

Another difficulty with Coase's approach occurs when a large number of people are affected. Not only will this cause the problem of organizing costly collective action, but it will also introduce the free rider problem. Some of the affected individuals may not wish to participate in collective bargaining in order to reduce pollution, because they expect others to act. In this way, they obtain the benefits of the bargain without incurring any costs themselves. This free rider problem makes it difficult for groups to act cohesively and effectively for the restoration of allocative efficiency (Tisdell, 1993).

The state of competition

The analysis of optimal externality assumed perfect competition. It was on that basis we saw that MB = P − MC and hence, MB = MEC, where P denotes the polluter's price and MC denotes his marginal cost. In terms of the bargaining approach, MB is assumed to be the polluter's bargaining curve. It is MB that decides how much the polluter will accept, or pay, in compensation. However, consider the same situation when the assumption of perfect competition no longer is valid, i.e., when P–MC no longer represents the polluter's bargaining curve since it does not equal MB. Instead, the polluter's bargaining curve will be his marginal profit curve, which under imperfect competition is equal to MR–MC, where MR represents the polluter's marginal revenue. Since MR is not equal to P (because the demand curve is above the MR curve), the bargaining solution will not produce an optimal resource allocation under imperfect competition (Pearce and Turner, 1990).

SECTION 3: THE JAMAICAN FOREST SECTOR AND BAUXITE MINING

In order to fully appreciate this case study, it is important to understand the historical as well as present contexts surrounding Jamaican forests and bauxite mining.

3.1 The forests

Jamaica is covered with heavy vegetation. The large forest areas contain a large number of tree types including bamboo, mangrove, broadleaf and palm trees. The rainfall determines the distribution of these tree types, but due to the high deforestation rates, 75 percent of the original forest cover in Jamaica has been lost.

Forests provide a long list of goods and services to humans worldwide. Unfortunately, the various economic and social values of forests are difficult to measure and therefore easily overlooked. However, in order for governments and companies in the developing world to take forest conservation seriously, these values need to be recognized by the public. The Jamaican Forestry Department focuses on eight different values that forests contribute to Jamaican society. These eight categories are presented in Table 2.

Approximately 335,900 hectares, or over 30 percent, of Jamaica is classified as forests.[4] Thirty-nine percent, or 427,600 hectares, is classified as non-forest. Non-forest areas consist of water, bare

rock, cultivated areas, bauxite mining, and buildings/other infrastructure.

Deforestation in Jamaica is relatively well documented. In March 2000, the Jamaican Forestry Department presented a study covering the island's total forest cover change between the years 1989 and 1998. The results from the study are presented in Table 3 and indicate that the loss of forestland over this ten-year period amounts to 3,063.6 hectares, which corresponds to an annual deforestation rate of almost 1 percent. Bauxite mining, which is argued to be the largest threat to the island's forests, has the largest increase of land use over this period, 4,989.6 hectares. This figure includes open pit mining which has not been restored. Two of the other main agents of deforestation in the country, agriculture and tourism (infrastructure and buildings) had a combined increase in land use of only 849 hectares during the same period (Forestry Department 2001b).

3.2 Bauxite mining

Bauxite is the most important mineral in Jamaica, and is currently the second largest industry in the country. Jamaica's over 1.8 billion tonnes of located reserves mainly occurs in pockets of limestone (Mines and Geology Division, 2002). Estimations show that at least one billion tonnes of the total amount of reserves are easy accessible, and are enough to last more than 100 years at current production rates. According to the Jamaican Bauxite Institute (JBI), the government agency responsible for monitoring the bauxite/alumina industry in Jamaica, approximately 85 percent of the country's bauxite reserves have been located (Interview JBI, 2002). The main deposits occur in the highlands, about 1,200 feet above sea level, in the parishes of Manchester, St Elizabeth, St Ann, Trelawny, St Catherine, St James, and Clarendon. The bauxite in Jamaica is of the terra rosa type and contains 45–55 percent alumina. Its colour varies from dark red to reddish brown, a peculiarity that indicates the occurrence of iron in the ore. Little overburden covers the bauxite in Jamaica, which makes the ore easy and cheap to mine. The size of the deposits can be as large as 125 hectares (Mines and Geology Division, 2002).

Since the early 1950s, bauxite mining has been a vital part of the Jamaican economy. In the mid-1970s, the government enlarged its interest in the industry by purchasing a large portion of the island's bauxite operations as well as the majority of the company owned reserves. In return, 40-year leases were granted to the companies (JBI, 1996d). In 2002, only Australia and Guinea produced more bauxite than Jamaica. At present, there are four operators in the Jamaican bauxite industry. These are Kaiser Aluminum, Alpart (Alumina partners of Jamaica), Jamalco, and Windalco which all are assigned reserves by the government. According to the JBI, the industry contributes 60 per cent of the island's foreign revenues. It also contributes to labour productivity, occupational safety, and the development of science and technology on the island (Interview JBI, 2002).

Bauxite mining, which is performed by open pit mining, is land extensive, dusty, and noisy. The mining process begins with a careful removal of the topsoil, which is then stored and replaced following the depletion of the mine. The problem with this is that the mining itself can reduce the soil's water retention capability. When the topsoil is replaced, it is thus less capable of retaining water. As a result, mined lands are sometimes difficult to restore to their original state (American University, 2002). Another significant cause of deforestation linked to the mining of bauxite is the access roads. Not only are forests cleared in order to make way for access roads, but once they exist, loggers move in and illegally remove trees in and around the mining areas. According to JBI, which has been mandated by the Natural Resource Conservation Authority (NRCA) to monitor all environmental activities in the industry, the access roads present a serious threat to the forest cover on the island (Interview JBI, 2002).

Additional consequences that bauxite mining may have for the long-term survival of the forests include abnormal rainfall patterns as well as prolonged droughts. These consequences are in themselves an effect of the large scale clearing of the island's vegetation (Neufville, 2001). The environmental effects facing the industry have long been a matter of public attention and possibly this is the main reason why Jamaica is considered to have one of the best records of restored mined lands in the world (American University, 2002). According to the JBI, all four operating mining companies are demonstrating moral as well as legislative compliance with the existing laws regulating environmental protection. More specifically, each company has an environmental management team that plays an integral role in its organization, and is responsible for everything from environmental control and land restoration to education programmes and public awareness (JBI, 1996e).

Table 2. *Forest Values in Jamaica*

Forest value	
Water production	Primarily, the forests in Jamaica play a crucial role in maintaining a reliable supply of high quality water.
Biological diversity	Conservation of forests in Jamaica is a matter of survival for an extraordinary biodiversity of plants and animals, including 3,200 known species of flowering plants, 600 species of ferns, and 256 known species of birds.
Carbon dioxide sequestration	Carbon dioxide (CO_2) is the major factor behind global warming. The forests in Jamaica can be sources, sinks or reservoirs of this carbon dioxide. When destroyed forests are restored, they remove (sequester) the dangerous carbon dioxide from the atmosphere.
Timber and non-timber products	Aside from the formal economy, including timber products such as hardwood lumber, yam sticks, and fence posts, there is a significant market for minor forest products such as furniture construction and handicrafts.
Employment	Many jobs are provided by timber production, especially in rural areas.
Energy	Fuel wood consumed through burning is widely used in industrial processing as well as in household cooking.
Tourism and recreation	Jamaica is internationally known as the "land of wood and water" and the country's scenic beauty is a fundamental component of its attraction. Forests play an important role in maintaining this image of a green and beautiful paradise-like island. Therefore a destruction of Jamaica's visual amenities represents a serious threat to the country's tourism industry.

Source: Forestry Department (2001b), pp. 37–40.

SECTION 4: LEGAL ASPECTS

4.1 Mining legislation in Jamaica

In the late 19th century, when bauxite first was discovered on the island of Jamaica, no mining legislation existed. However, in 1943 the Commissioner of Lands underlined the need for mining legislation to control the future mining activities on the island. Four years later, following long and intense discussions about the content of this law, the Mining Act was signed on September 7, 1947 (Davis, 1989). At that time, the bauxite industry was at its initial stage of establishment in Jamaica and few people were aware of the potential effects the industry posed to the environment. However, the Mining Act heavily regulates the bauxite industry in Jamaica. Below, a short presentation of some of the environmental aspects of the law is given.

Where bauxite exists in Jamaica, it is owned by the government and not by the owner of the land. This signifies that all naturally occurring minerals in Jamaica are for the common benefit of the Jamaican people. The private landowner only has the surface rights, while everything below the ground belongs to the Government. Since bauxite mining is performed through open pit mining, it is obvious that a problem arises. The case when bauxite occurs on private land is however heavily regulated in the Mining Act (Interview JBI, 2002).

The Government may issue licences to anyone to explore the land, or mining leases to exploit it. Both local and foreign persons and companies are eligible for these licenses and leases. The Mining Act gives the lessee or the licensee the right to enter government land or privately owned land to search for minerals or to mine minerals after giving 14 days' notice to the landowner or to the person occupying the land. Fair and reasonable compensation is payable for all damages and for disturbance of the landowners' surface rights, or for any damages done to his livestock, crops, trees, buildings, or works (JBI, 1996a). According to the Act, the companies holding the mining license must, as soon as mining activities are finished, restore every mined area of land to the level of productivity that existed prior to the mining. This restoration must take place within six months after the activity has ended and failure to do so results in a penalty of US$ 4,500 per acre. Since the average cost of restoration for mined-out bauxite lands is US$ 4,000 per acre, the companies are encouraged to restore rather than pay the fine. According to the JBI, failure of restoration is very unusual (JBI, 1996b).

Another important piece of legislation regulat-

Table 3. *Land use/Cover change in Jamaica, 1989 to 1998*

Land use	1989 (hectares)	1998 (hectares)	Difference (hectares)	Loss/gain (percent)
Forest land use/cover				
Broadleaf	269,870.64	266,855.18	−3015.45	−1.1
Bamboo	2,791.20	2,979.41	188.21	6.7
Mangrove	9,751.46	9,731.37	−20.09	−0.2
Sub-total	338,979.17	335,915.55	−3,063.62	−0.9
Non-forest land use/cover				
Buildings/infrastructure	51,909.59	52,259.78	350.19	0.7
Fields	273,176.05	274,478.64	1,302.59	0.5
Plantations	83,145.25	82,341.34	−803.91	−1
Bare rock	866.98	933.88	66.90	7.7
Bauxite	1,193.29	4,921.94	3,728.66	312.5
Sub-total	423,025.41	427,599.70	4,574.29	1.1

Source: Forestry Department (2001b), p. 27.

ing the mining operations on the island is the Natural Resource Conservation Authority (NRCA) Act of 1991. Under this Act, before any physical development or construction can take place in the industry, a permit must first be obtained from NRCA. NRCA then reserves the right to grant or refuse this permit, as it sees fit. When any activity is likely to result in the discharge of industrial effluents into the environment, the application for a permit must be accompanied by application for a license to discharge effluents. NRCA reserves the right to refuse a permit if it believes that the operation is likely to be harmful to public health or to any natural resources. NRCA can enforce these controls by ordering immediate cessation of the offending activity, or even closure of the plant (NEPA and Statistical Institute of Jamaica, 2001).

4.2 Land acquisition practices

A central issue in Jamaican bauxite mining is land acquisition, whether by outright purchase or by other means. However, this process often tends to be both costly and difficult involving the interests of the bauxite companies, government, and the landowners. The land acquisition process has in the past proven to be lengthy, where landowners and companies bargain for most favourable terms. It is important to recognize that, in order to prospect and search for minerals, the companies do not need to purchase the land. When a company decides to begin mining operations, they have a number of different alternatives to acquire the desired land (JBI, 1996a), viz., (a) outright purchase of the property; (b) resettlement of landowners; (c) temporary relocation; and (d) cash compensation.

Outright purchase of the property

As companies and landowners negotiate for the most attractive terms, the process of property purchase can sometimes be difficult and demanding. The landowners naturally seek to maximize returns for their land while the purchasers (bauxite mining companies) want to minimize their costs. Problems arise when landowners try to increase the value of their property by e.g., quickly beginning construction of large buildings or hastily planted crops at unrealistically high density in order to obtain a higher compensation per acre. Due to problems of this kind, companies tend to prefer land resettlement programmes to cash purchases (JBI, 1996a).

Resettlement

The most widely used practice for land acquisition for mining in Jamaica involves the resettlement of landowners. This practice has taken place in Jamaica ever since the Jamaican bauxite industry emerged in the early 1950s. In this industry, resettlement means relocating persons or communities from their former homes, as well as replacing their assets and livelihood. Although the four companies currently operating in Jamaica have different resettlement policies, there are a few standard procedures that are followed by them all. One of these procedures is that once it has been decided that a certain area of land is to be mined, an offer is presented to the landowner by a representative of the company. When approached

by this company representative, the landowner is faced with a number of choices, among them resettlement. This means that the landowner and the company agree on the basis of the purchase of the land, and the resettlement of the landowner to another location. A compensation package for crops and structures on the land is also constructed. The Mining Act sets out the basis for calculating this compensation. In some cases, the resettlement involves moving whole communities and thus providing water, electricity and associated infrastructure. However, in most cases resettlement involves relocating only single families to a location near their former land. Through the development of resettlement lands, the companies try to ensure that affected persons improve upon, or at least retrieve, their former standard of living and earning capacity after a reasonable transition period (JBI, 1999b).

Although companies usually put in much effort to ensure the satisfaction of resettled families, the process is sometimes problematic. Some of the factors that may create problems and delays in the resettlement process are presented below (JBI, 1999b):

- The resettlement sites often contain bauxite deposits and will eventually be required for bauxite mining. Resettled households then have to resettle again in alternative locations.
- It is often difficult to arrive at a mutually agreeable price. The asking price for land and other assets is often more than the company's policy will allow it to pay. It therefore requires the use of private valuers and an agreement on a final valuation.
- Absence of legal documents, disputed land ownership, and absentee owners.
- Delays in transfer even in the cases where required legal documents are available.
- Resistance to severing family, friendship and cultural ties and the adjustment to new location.

Temporary relocation

The option of temporary relocation is exercised when the bauxite company is given access to the property to mine, but does not acquire the title. Usually, temporary relocation takes place when: a) the owner cannot be located; b) legal documents are unavailable; c) the property is needed urgently; or d) the property owner is ill and located too close to the mining area.

When this option is undertaken, the company restores the property after the mine is depleted to a level which meets the standards set by the Ministry of Agriculture and Mining (JBI, 1997b). Standard procedures for all companies are that the landowner is entitled to compensation, including full payment, for:

- Damage to the surface of the land.
- Damage to crops, trees, buildings or works.
- Rental of property during mining or reclamation operations.

Depending on the speed of the negotiations, this process can take between six months and two years. Although this option may seem very complicated and demanding, the JBI assures that a settlement is usually concluded with the landowner emerging with a favourable outcome (JBI, 1997b).

Cash compensation

In some cases, the landowner is content to allow the mining company to mine his land and to pay him compensation for damages. These damages include disturbance of surface rights, damages to crops, trees, buildings and other valuables. This is a rare occurrence, and when it happens, the landowner is also entitled to 5 percent of whatever royalties are payable to the government (JBI, 1996b).

According to the Mining Regulations Act, 1947, it is a requirement that all mined-out lands must be restored as nearly as practicable to the level which existed prior to the mining. Usually, these mined-out lands are restored to pastures, root crops, tree orchids, or housing. If the restored lands are deemed as unsatisfactorily restored by the Commissioner of Mines, fines to the companies are issued (JBI, 1996b). According to the JBI, all four companies operating in Jamaica have satisfactorily reclaimed hundreds of acres of land that have been re-forested or put into agricultural production (JBI, 1996c).

SECTION 5: THE CASE OF THE MOCHO MOUNTAINS, CLARENDON

This section presents the empirical findings from the Jamaican field study. Using Tietenberg's (1996) criteria for property rights structures that support efficient resource allocations, information was

gathered regarding whether or not a good basis for bargaining did occur in the Mocho area. Subsequently, we examined whether or not the five main shortcomings of the Coase theorem, discussed above, were valid in the case of the Mocho area. The case study was mainly done by interviews with a number of government agencies monitoring the industry, but also with representatives from the operating bauxite company, *Jamalco*. However, it was not possible to carry out interviews with local private landowners. This introduces weaknesses in the reliability of the study. Considering that much useful information from other agents with environmental concerns was acquired, it was still possible to make a valid analysis as to whether the Coase theorem could be applied to the case of the Mocho area.

Clarendon is a parish on the southern side of Jamaica, about half way between the eastern and the western ends of the island. It has an area of approximately 1,167 sq km and a population of just over 200,000 citizens. Clarendon possesses a number of mountain ranges. The Mocho Mountains rise over 600 m above sea level and are situated to the west of Chapleton, an important area for bauxite exploitation. Like most other parts of the island, the Mocho Mountains are covered with dense forest. Clarendon is also one of the major bauxite producing parishes on the island. For over 40 years, the industry has been operating in the parish through the bauxite/alumina company *Jamalco. Jamalco* is an enterprise owned by the Jamaican Government and the *Aluminum Company of America* (ALCOA). ALCOA is the world's leading producer of primary aluminum, fabricated aluminum and alumina, and was the last bauxite/alumina company to come to Jamaica. The mining operations primarily take place in the Breadnut Valley mines in the Mocho Mountains. The bauxite is then transported by rail to the refinery, where the ore is made into alumina (Morris, 2002).

To acquire the desired land to mine in the Mocho Mountains, *Jamalco* almost exclusively exercises the practice of resettlement. The other three alternatives, cash compensation, outright purchase, and temporary relocation are hardly ever undertaken. According to JBI, this choice is almost entirely based upon the wishes of the landowners (Interview JBI, 2002).

Cash compensation is in most cases an impossible alternative because the actual property is needed for the mining operation. However, in cases when it is possible, landowners tend to prefer it to resettlement (Interview JBI, 2002). Because of the long duration of the mining operations in the area, temporary relocation is not a suitable alternative. If, for example, a family has been relocated to another location and lived there for as long as five years, it is very likely that the family will have adjusted to the new community and therefore does not wish to move back to their old property. Why most individuals prefer resettlement to outright purchase is a question of risk and security. With a resettlement property, the landowners know with certainty what they are obtaining, and this represents the security that most of these relatively poor people need. This security is not provided in the case of outright purchase.

With regard to land reclamation, *Jamalco* has performed well over the years. The mined-out lands on the hills of the Mocho Mountains are now restored to productive use. *Jamalco* has never been fined for unsatisfactorily reclaimed mined-out lands in the Mocho area (Interview JBI, 2002).

Applicability of the Coase theorem

Can we utilize the Coase theorem to evaluate the case of *Jamalco* and the Mocho Mountain forests? To be able to answer this question, the property rights arrangements of these forest areas must be studied. We attempted to check whether the property rights are clearly defined and if they satisfy the four conditions required for efficient resource allocation according to Tietenberg's criteria outlined in Section 2.

As displayed in Table 4, the property rights characteristics completely fulfil the requirements of universality, exclusivity, and transferability. The requirement of enforceability is only partly fulfilled due to the legal right of the miners to, with or without the approval of the landowner, enter private land within 14 days' notice. However, since this right so far has not been exercised in the Mocho area, it can still be argued that private property at the moment is secure from involuntary seizure and encroachment.

Thus, a good foundation for efficient allocation of the forests exists on the bauxite land in the Mocho area. Owing to the fact that the property rights structures of the forests to a large extent fulfil these four characteristics, the landowners on the hills of the Mocho Mountains are provided with a strong incentive to use their land in an efficient manner – a decline in its value would represent a personal loss to them. Therefore, we can move on to the question of whether the Coase theorem is

applicable. As outlined above, the mining company's MB curve and the private landowner's MEC curve must be identified in order make definitive conclusions about the optimal amount of externality. In order to gain information of the MNPB and the MEC, knowledge about the household preference system as well as production technologies are required. This is easier said than done. However, this is where the attraction of markets and bargains enters the analysis. Bargaining situations reveal this information, which in turn identifies the efficient allocation of the resource.

Thus, by studying how well each of the five main shortcomings of the theorem, outlined earlier in the paper, fit the case of the Mocho area, conclusions regarding the Coase theorem can be drawn. We discuss each critique in turn, and present its impact on the outcome of the theorem.

The existence of transaction costs and the absence of bargaining

In the case of *Jamalco* and the Mocho area, Clarendon, the presence of transaction costs is negligible and does not pose an important obstacle for bargaining taking place. Since *Jamalco* has been active in Clarendon for over 40 years, the company has established headquarters in the parish and because of this, the cost of transportation can be disregarded. In order to set the compensation sum for households, *Jamalco* performs property assessments where they study the value of the property, including the trees. According to the JBI, these assessments are performed within a few hours or a day at the most, and the cost of performing them is budgeted for as part of the acquisition cost. These surveys are sometimes, but not always, performed by a qualified valuer. The process usually begins with *Jamalco* sending a company representative to value the property, but if the landowner is not satisfied with this, a private valuer is appointed. By performing land and household surveys, *Jamalco* determines whether or not it is profitable to resettle a household or community. The factors that are studied include the location of the property, land classification, quality of nearby roads, details of water supply and the distance from a main town.

When this is done, *Jamalco* sends out a company representative to meet the individual who owns the land, with an offer. Since this is a relatively short journey, the transportation cost is close to zero. Regarding the private landowner's transaction costs, these are also negligible. Apart from the possible opportunity cost of time, the initial transaction cost is in fact zero since these individuals are approached in their own homes with the offer. In cases when the company's first offer is rejected, negotiations follow, which will increase transaction costs (Interview JBI and Jamalco, 2002).

The major reason why transaction costs are low in this case is that *Jamalco*, like all the other three bauxite/alumina companies in Jamaica, deals with the private landowners individually. If this were not the case, the landowners would be forced to organize collectively and that would lead to increased transaction costs.

Even though, unfortunately, no interviews with resettled landowners were achievable during this field study, several examples tell us that *Jamalco*'s resettlement programmes are received well by concerned inhabitants of the Mocho area. Interviews with local landowners are performed on a regular basis by JBI. One of these interviews tells us about a woman who was relocated from her farm on Mocho road to her present location in Pusey, Mocho Land Settlement. According to the interview, the relocated house was of equal size and the land was twice the area of the former one. In addition, *Jamalco* planted citrus trees on her land and, for five years after the resettlement, provided a resource for weeding and fertilizing her crops (JBI, 1999c). Another of JBI's interviews tells us of a man who was one of the first to be relocated on reclaimed land by *Jamalco*. He too stressed that he was better off on his new land than he was on the former property. In addition to this, we find from the interviews that both of the resettled landowners were offered regular visits from *Jamalco*'s agricultural specialists where they both received advice and help (JBI, 1996f, JBI, 1999b).

Identifying the bargaining parties

In the case of deforestation due to *Jamalco*'s mining operations in the Mocho area, Clarendon, there is no problem in identifying the bargaining parties. This is entirely due to two factors. First, each bargain made by *Jamalco* includes only two parties, *Jamalco* itself and a single private landowner. Since *Jamalco* deals with every private landowner separately, there never exists any problem in identifying who this is. Secondly, in the Mocho area, almost all property rights are legally documented with clearly defined entitlements. In cases where legal documents are missing, exchange agreements are entered into while the landowner is required to obtain a legal title for exchange for a resettlement

Table 4. *Property Rights characteristics in Mocho Mountains*

Criterion	Grade of Achievement	Authors' comments
Universality	Yes	According to the JBI, the forest and woodland areas on the hills of Mocho Mountains, Clarendon, are almost entirely privately owned. The entitlements are completely specified. This has been the case ever since *Jamalco* started their mining activities in the area in the early 1960s.
Exclusivity	Yes	Following that the property rights to the forests and woodland areas are clearly defined and privately held, all benefits and costs accrued as a result of owning and using them are accrued to the owner. Common use of the forest areas does not exist.
Transferability	Yes	All property rights are transferable from one owner to another. These transfers are completely voluntary.
Enforceability	Partly	Even though the mining company has the legal right to enter and mine the property of a private landowner within 14 days' notice, this legal right is not exercised at *Jamalco.* By acting in this way, *Jamalco* sustains the positive company-community relationships, which have proven to be invaluable for their profitability and success on the market. Hence, it can be argued that the property rights are secure from involuntary seizure of encroachment by others.

location. However, these cases are very rare, and are therefore not representative in this analysis. Since legal documents stating the ownership of the land exist, *Jamalco* has no problem of identifying whom to bargain with in order to access the land they desire (Interview JBI, 2002).

Threat making

No evidence was found to give credence to private landowners threatening *Jamalco* to receive higher amounts of compensation in the past. Concerning the issue of possible threats made by *Jamalco* aimed at private landowners, no complaints have been made over the years (Interview JBI, 2002). However, one major caveat in this study is the fact that interviews with local landowners were not performed during the field study, which in turn weakens the reliability of this information.

The free-rider problem

The free-rider problem is avoided in the case of *Jamalco* and the Mocho Mountains, Clarendon, simply because the bargain only includes one sufferer and one polluter. Thus, there is no room for any of the parties to act as a free rider and draw benefits from this, regardless of who owns the property rights to the forest.

State of competition

As has been shown in the previous section, perfect competition does not prevail in the Jamaican bauxite/alumina market. First, there are only four companies currently operating on the market. Second, the Jamaican Government assigns each company long-term licenses to mine certain areas, which imply that no competition at all exists on the market. In the case of Mocho Mountains, *Jamalco* is the only operating bauxite/alumina company performing mining activities. In terms of the Coase theorem and the bargaining approach, this means that the MB is no longer representative of *Jamalco*'s bargaining curve. This in turn implies that the solution reached in the bargaining process will not be optimal.

SECTION 6: CONCLUDING REMARKS

The purpose of this paper was to examine if the Coase theorem can be applied to analyze whether Jamaica's deforestation problem caused by bauxite mining can help towards optimal resource management. Not surprisingly, we find that the hypothesis that the forest and woodland areas in bauxite mining areas in Jamaica are optimally allocated – according to the Coase theorem – must be rejected. It was clear that the property rights structures in the Mocho area provided a solid foundation for a bargaining solution to the problem of deforestation due to bauxite mining. When the focus was turned to the applicability of the Coase theorem in analyzing that deforestation, we found that, much due to *Jamalco*'s practice to bargain separately with all private landowners,

none of the four practical obstacles to the bargaining approach applied in this case. Nevertheless, the theorem assumes perfect competition and since this evidently does not exist on the Jamaican bauxite/alumina market, our hypothesis must be rejected. Thus, an optimal allocation of the forests in the Mocho area is not taking place.

Nonetheless, we should not dismiss forest management in this area as a total failure. Several positive aspects of negotiation solutions are displayed in the forest and woodland management in the parish of Clarendon and even if the solution is not optimal, we believe that bargaining solutions like these frequently can prevent the worst excesses of environmental degradation from taking place. Among these positive aspects are the low transaction costs, the absence of free riders, as well as the simplicity of identifying the bargaining parties. We therefore find it safe to claim that the antiquated Coase theorem can help us gain important knowledge about fundamental aspects of the prevailing market conditions in Jamaican bauxite mining.

Notes

1. Christer Berglund is currently visiting researcher at IIASA, Laxenburg, Austria. Corresponding author Tommy Johansson works at the Swedish Energy Agency, 631 04 Eskilstuna, Sweden. Email: tommy.Johansson@stem.se
2. In this paper, only allocative efficiency is considered, which is achieved when resources are allocated in a way that allows the maximum possible benefits from their use. This is different from productive efficiency, i.e., when output is being produced at the lowest possible unit cost (Boutiga, 2002).
3. Coase received the Nobel Prize in Economics in 1991 "for his discovery and clarification of the significance of transaction costs and property rights for the institutional structure and functioning of the economy" (The Nobel Prize Internet Archive).
4. Ecosystem characterized by a dense and extensive tree cover, usually consisting of stands varying in characteristics such as species, composition, structure, age classes, and associated processes. Forests may include meadows, streams, fish, and wildlife (Forestry Department, 2001b).

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