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Analysis

Economic cost of deforestation in semi-deciduous forests — A case of two forest districts in Ghana

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ABSTRACT

The ecological, economic and socio-cultural roles of forests are under threat in Ghana due to the high rate of deforestation. Efforts are being made to combat this problem through rehabilitation measures. However, the costs of deforestation and restoration benefits are not adequately estimated. This paper fills in the gap in knowledge by providing an empirical estimation of the cost of deforestation in monetary terms. Primary data collected regarding timber, non-timber forest products and soils in semi-deciduous forests were analyzed using opportunity cost and replacement cost techniques. The results emphasize differences in the value of these forest goods and services lost annually. The largest losses were in stumpage fees, edible fruits, and avoided carbon emissions values. The results show that US$133,650,000 gross revenue, equivalent to 2.6% of the 2008 agricultural sector Gross Domestic Product, is lost annually. It can be concluded that restoring the degraded forest lands would bring benefits particularly to the local communities through increased stumpage revenues and harvest of non-timber forest products, as well as additional funds from carbon credits. It is recommended that stakeholders of forest resources are made aware of these costs in order to raise awareness of what they are losing through deforestation.

1. Introduction

The most rapid forest loss in Africa has occurred in Western and Central Africa with an annual rate of change of 0.6% in 1990–2000 and 0.5% in 2000–2005 (FAO, 2006). Ghana has one of the highest rates of deforestation in West Africa (Benhin and Barbier, 2001), and while the rates have been reported to be alarming it is becoming increasingly difficult to get precise figures for the state of the forest cover and the rates of deforestation in the country (Hansen et al., 2009). Despite this, positive benefits Ghana derives from deforestation include food from farming and foreign exchange earnings from exports of minerals, cocoa and timber (Mhango, 2010).

Ghana's forests are divided into outside reserve and on-reserve areas, the latter meaning forests that are under the principal management of government forest authority. Of the 266 forest reserves, 216 occur in the high forest, timber-producing zone. In the mid-1990s, many of these forest reserves were already in a degraded state as a result of over-harvesting for timber, forest fires, and farming (Hawthorne and Abu-Juam, 1995). Official data show that on-reserve forest timber harvest increased from 120,000 m^3 in 1994 to 660,000 m^3 in 2003 (Bird et al., 2006). This situation seemed to even have worsened as the annual allowable cut (AAC) has been increased from 1 million m^3 in 1989 to 2 million m^3 in 2006 (Blackett and Gardette, 2008), without commensurate replanting of trees. Although sustainable timber harvesting may not lead to deforestation, the selective logging of desirable tree species used in conventional timber harvesting is one leading cause of deforestation and forest degradation in Ghana (Palo and Yirdaw, 1996).

Over the years, the government of Ghana has been concerned about the extent of the forest degradation in the country. For this reason, efforts are being made to combat deforestation through sustainable management and rehabilitation measures, including tree planting on degraded forest lands. However, the on-site cost of deforestation in monetary terms and the benefits of plantation establishment are not adequately measured. While there is an increasing concern for the levels of forest degradation in the country, it is equally important to highlight what is likely to be lost in terms of money if the problem is not adequately addressed. Empirical studies in the country on the cost of deforestation in monetary terms are few (World Bank, 2006) despite the fact that in the period of 1990–2005, 1.9 million ha of Ghana's forest cover was lost (UNEP, 2009).

The monetary value of the loss of these 1.9 million ha of forest has not been adequately measured. Bojö (1996) has emphasized the importance of such estimates, noting that they provide useful inputs on the assessment of the magnitude of the land degradation problem in comparison to other priorities that a society faces and that they can

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be used to modify a country's National Income Accounts to better reflect the sustainable income. Additionally, Dreschsel et al. (2001) estimate Sub Saharan Africa (SSA) soil nutrient depletion to be about 7% of its Agricultural Gross Domestic Product (AGDP). In terms of monetary value, this was equivalent to US$4 billion per annum (Dreschsel et al., 2001). Although significant, it appears that this figure did not include many other goods and services that the tropical forest is endowed with and which are fast degrading.

It is this knowledge gap in the assessment of the economic cost of deforestation that this paper attempts to fill in the case of Ghana. The aim is to provide an empirical basis for the estimation of the cost of deforestation in monetary terms and an estimation of the benefits from restoring degraded forests by employing primary data collected on timber, non-timber forest product, soils, and tree carbon stocks from typical semi-deciduous forest lands. The paper seeks to determine the cost of the total loss of current standing forest in monetary terms from the value differences of the forest goods and services in three forest types: natural forests, degraded forests and plantation forests. The scope of the paper is limited to these four ecosystem services, and the rationale is to explain/show the minimum cost of deforestation to raise awareness about it and call attention to the need to address it.

2. Materials and Methods

2.1. Study Areas

The primary data involving timber, edible fruit trees and soil samples were collected in Pamu Berekum and Mpameso, forest reserves in the Dormaa forest district, and Southern Scarp and Worobong South forest reserves in the Begoro forest districts in Ghana. These forest districts were chosen based on the extent of deforestation and the plantation activities taking place in these reserves. Pamu Berekum Forest Reserve (7°25N and 2°56W) covers a land area of 189.1 km^2 and its forest type is Dry Semi-deciduous to Moist Semi-deciduous (DS–MS) with a mean annual rainfall of over 1000 mm. Mpameso Forest Reserve (7°05N and 2°53W) has a land area of 322.5 km^2 and its forest type is Moist Semi-deciduous Northwestern (MSNW) with a mean annual rainfall between 1000 mm and 1750 mm.

The Southern Scarp Forest Reserve (6°33N and 0°40W) has a land area of 154.6 km^2 and its forest type is Moist Semi-deciduous Southeastern (MSSE) with a mean annual rainfall between 1000 mm and 1750 mm. The Worobong South forest reserve (6°28N and 0°28W) has a land area of 106.2 km^2 and its forest type is Moist Semi-deciduous to Dry Semi-deciduous (MS–DS) with a mean annual rainfall between 1250 and 1500 mm (Hall and Swaine, 1981).

There are six vegetation types in the high forest zone of Ghana, including Wet Evergreen (WE), Moist Evergreen (ME), Moist Semi-deciduous Southeastern (MSSE), Moist Semi-deciduous Northwestern (MSNW), Dry Semi-deciduous (DS) and Upland Evergreen (UE). The sample plots for this study were located in three of these (semi-deciduous) vegetation types, which in general record a higher level of deforestation compared to the remaining three (Hawthorne and Abu-Juam, 1995). In this way, the sampling was assumed to be representative.

2.2. Theoretical Framework

Total Economic Value (TEV) is a sum measure of the economic values of any services of a given ecosystem (Pearce et al., 2006), such as tropical (Pearce, 1993) or boreal forest (Saastamoinen, 1997). It is founded on a utilitarian paradigm of value that is based on the idea that utility is derived from ecosystem services by human beings (MA, 2005). In most cases, different forms of the TEV framework used to assess values have use and non-use value components. Consequently, many methodologies have been developed to measure the benefits of ecosystem services (MA, 2005). Like all methods of economic valuation, these methods are based on welfare economics, where the welfare change measure is captured in the willingness to pay (WTP) and the willingness to accept (WTA) compensation. In relation to these, the use value is WTP for making use of forest goods and services, and the non-use value is WTP for forest in a conserved state (Pearce, 2001).

In the present study, the value difference estimation of the four ecosystem services is rooted in the TEV framework, but focuses only on the use value part. Non-use value, although important, appears to be of limited relevance to the local communities (Vedeld et al., 2004) also in this study area. The methods of replacement and the opportunity cost techniques were selected to estimate the value of the four ecosystem services in this study (TEEB, 2010). The criterion used in their selection was data availability. Another choice to make in estimating the value of ecosystem services is how the actual change in the value of benefits is expressed: is it changes in the value of annual flows of benefits or change in the present value of all future flows (MA, 2005). As the future values of some of these ecosystem services were uncertain and difficult to be reliably estimated (e.g. future values of tree carbon, fruits and timber cannot be reasonably established due to lack of data), the former was adopted in this study (Chang et al., 2011).

The hypothesis for the study is that there are substantial differences in the economic values of forest benefits between the selected forest types. It was expected that estimating the cost of deforestation using valuation will raise awareness to minimize it. Moreover, it was assumed that its minimization will be achieved at the least costs since the sampled degraded forest reserves are state managed lands with no alternative uses, aside from the timber production.

2.3. Data Collection and Analysis

The values of timber, edible fruit trees, soil nutrient losses and timber tree carbon contents were estimated in a hectare plot of three forest types, namely natural, plantation[1] and degraded forests. These ecosystem services were selected due to their importance in sustainable forest management, the livelihood of local communities in the study area and the ease of empirical measurement. The estimates of the on-site cost of deforestation[2] were defined in terms of hectare (ha) in all the field plots. Assuming that the studied areas were reasonably representative, the aggregated total costs of deforestation were related to the 2008 AGDP (GSS, 2011) to obtain relative measures of the significance of these costs. The reference to the AGDP is based on the classification of forestry under agriculture in the national income accounting of Ghana. To obtain the national estimates of the monetary cost of deforestation in terms of the four ecosystem services studied, the aggregated total cost of deforestation was multiplied by 128,733 ha (Appendix B in Supplementary data (SD)).

2.4. Measuring the Diameter of Timber Trees

The physical tree stand characteristics were measured and derived first. The data for the diameters of the timber trees were collected in six plots in 2008 by laying 1 ha each in a plantation forest in Pamu Berekum and Southern Scarp; in a natural forest in Mpameso and Worobong South; and in a degraded forest in Mpameso and Southern

[1] This refers to former degraded forests that have been rehabilitated by local communities using indigenous timber species with the help of financial support from an international donor agency and technical guidance of a local research institution.

[2] The FAO definition of deforestation is followed, where it is defined as "the conversion of forest to another land use or the long-term reduction of the tree canopy cover below the minimum 10 % threshold"