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Contents

Reducing emissions from deforestation and forest degradation: the potential and challenges for Mozambique

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Abstract

This paper presents a preliminary discussion on the potential and challenges of implementing REDD+ activities in Mozambique. The starting point is the list of REDD+ activities suggested on the draft national strategy. The major activities and current practices in agriculture, energy and forestry, are evaluated in terms of their carbon emissions and the potential impacts and the challenges of their implementation. The analysis concludes that selecting efficient REDD+ activities is site specific, and the potential of these activities to reduce emissions varies among tree-based crops and annual crops.

Keywords: REDD+, Mozambique, agriculture, energy, forestry

1. Introduction and background

Mozambique has engaged in the process of preparing the national strategy for REDD+ in response to the global debates on the potential reduction of emissions associated with forest cover change. The proposed national baseline scenario, and the REDD+ objectives, suggest a significant reduction of emissions. The national REDD+ strategy suggests a set of measures to reduce deforestation and forest degradation and increase carbon stocks in forests. Yet, the amount of emissions that could be reduced and the amount of carbon that could be sequestered from each activity are still unknown. There is also no clear definition of how reduction of carbon emissions and carbon sequestration will be shared across sectors. This paper is a preliminary attempt to analyze (i) how deforestation and degradation drivers operate and affect forest conditions and carbon emissions, and (ii) the potential and challenges of reducing tree felling and planting. The starting point is the list of proposed activities for REDD+, which are evaluated in their potential to effectively reduce the carbon emissions. The list of proposed REDD+ actions is long, therefore, we do not attempt to cover all the aspects, but to concentrate on the technical aspects within three main sectors indicated as the main drivers of deforestation and forest degradation: agriculture, energy, and forestry.

2. Agriculture

2.1 How does slash and burn agriculture contribute to emissions

In Mozambique, agriculture is mainly done by smallholder farmers (99% of the farms are smallholders), with average cultivated land of 1.4 ha (INE 2011). The main aim of the household farmers is to ensure the provision of food production within the household, and the sale of surplus. Crops such as maize, cassava, beans, etc. are mainly consumed within the household. In addition, cash crops (cotton, tobacco, sesame) are largely produced by smallholder farmers through contract farming. Only 3.7% of the total smallholder farmers use fertilizers (INE 2011). Therefore, they use slash-and-burn practice as a mechanism to recover the nutrient lost during the cropping period. Burning biomass from the forests releases mineral nutrients to the soil, but also releases carbon to the atmosphere. Therefore, the conversion of forest into agricultural land by slash and burn agriculture is the major source of carbon emissions.

2.2 How REDD can improve the situation

Since agriculture is one of the largest drivers of deforestation, slash and burn agriculture has been targeted as a potential area for reduction of emissions. Tomich et al. (1998) suggest that since smallholder farmers have economic motivations to convert forests into agricultural land, any measure to reduce pressure over the forest will need to deal with alternatives to slash-and-burn farming. It was in this context that a global project was put in place to evaluate the alternatives to slash-and-burn (ASB) as measures to simultaneously meet local interests (poverty reduction, food security, profit, etc.) and global interests (supply global markets with agricultural commodities, biodiversity conservation, reduce greenhouse gas emissions, etc.) in the humid tropics. Palm et al. (2004) summarize part of the ASB experiments and conclude that many tree-based agricultural systems reduced net global warming potential by 11-35%, compared to annual cropping and pasture systems. In the situation of Mozambique, little has been reported in terms of technological alternatives to slash-and-burn options, however, local agricultural systems as well as the lessons learnt from other regions may be explored as potential alternatives.

2.2.1 Tree-based crops

a) Cashew trees are commonly grown as monoculture or intercropped in the Nampula province (with almost a half of the cashew trees in the country) and in most of the coastal region of Mozambique, particularly Inhambane, Cabo Delgado and Zambézia. Currently, about 1.38 million farmers (of which 1.37 are smallholder farmers) grow cashew trees (INE 2011). Cashew ranks 8th in Mozambique exports (and third among agricultural products, after tobacco and sugar), with 28.5 million USD in 2009 (INE 2011). There is high potential to improve agriculture in this field. Presently a supporting institution, INCAJU, has been put in place to

promote and develop not only the production, but also the development of industry for cashew processing.

b) Coconut palm plantations cover approximately 160000 ha, mainly in four provinces (Cabo Delgado, Nampula, Zambézia and Inhambane) of which Zambézia has 110000 ha (or 70% of the total coconut palm plantations in Mozambique). Smallholder farmers, with an average 0.75 ha planted with palms, have the major share, and have shaped the coastal region economy[5]. Coconut was among the five most important agricultural export products during the decade of the 70´s, when more than 50000 tons/year were exported (in 1975)[6]. However, a combination of the war effects on the economy, aging of the palms (more than 75% of the palms are >45 years), and the outbreak of the lethal yellowing disease (LYD) that decimated the coconut palm plantations in Zambézia, production has been decreasing to about 10000 tons in 2008. Coconut is a major source of oil and soap, but alternative products include charcoal/brickets from the husk/fiber as well as timber from the stem.

c) Fruit trees are commonly grown in home gardens or in different agroforestry arrangements within agricultural fields. INE (2011) lists twelve fruit tree species grown mainly (99%) by smallholder producers. Among these, there are exotic species such as the naturalized mangos, oranges, guava, grown almost all over the country, and native species such as *Trichilia emetica* (mostly grown in the southern provinces) and *Ziziphus mucronata* (grown mainly in the central provinces). Mozambique has a large potential to grow fruit trees, and the current involvement of smallholder farmers in the production of a large variety of exotic and native fruit trees provides an important entry point to promote tree-based crops as sources of food and income. Presently, most of the fruit produced is consumed within the household (contributing to food security), and sold in the domestic market.

2.2.2 Agroforestry systems

Considering agroforestry a collective category for farming systems that mix tree crops and annual crops and/or animals in space and time, we can easily recognize that some of the tree-based options discussed above can be classified in the context of agroforestry systems. In fact, these trees are normally grown in arrangements that can be classified as woodlots, home gardens, boundary planting, etc. However, the ideal objective of agroforestry systems to maximize production, biodiversity conservation, and economic profitability is not given. Considering that the major motivation to slash and burn agriculture is nutrient availability, we suggest that alternative agroforestry techniques should focus on soil conservation, such as those that improve soil fertility (e.g. nitrogen fixing leguminous trees), and spatial and temporal arrangements that reduce the risk of nutrient loss and soil erosion, while ensuring good production levels over time. The use of improved fallows would also represent an advantage in terms

[5]http://pt.scribd.com/doc/39104654/OPORTUNIDADES-DE-INVESTIMENTO-NO-SECTOR-DO-COQUEIRO-EM-MOCAMBIQUE

[6] http://imigrantes.no.sapo.pt/page2mocEconomia.html

of reducing the time for soil nutrient recovery in cropped land and the rehabilitation of degraded lands. Little has been done in this area locally, therefore, some experiments should be conducted and capacity building will be required to ensure the adoption of these techniques by smallholder farmers.

2.2.3 Annual crops

Reducing carbon emissions from smallholder farmers while producing annual crops is not an easy task. Effective and durable changes would require changes in the current farming system procedures. If we consider low productivity and loss of soil nutrients together with limited access to agrochemicals as the underlying causes of slash-and-burn, then potential changes could be suggested in the farming systems on this basis. Conservation agriculture, where a combination of techniques such as composting, the use of green manure, intercropping with nitrogen-fixing crops and integrated pest management are used, has a great potential as alternative to slash-and-burn farming. Although there is a dispute in the literature regarding the effectiveness of most of these practices, Ching (2009) reports examples from 286 projects in 57 countries indicating that productivity of ecological agriculture increased by 79-92% when compared to that using agrochemicals. However, there are limited experiences with these practices in Mozambique (Singh, pers. comm.), and there is no adoption of the existing ones, although reported to have shown success on trial farms.

3. Energy

3.1 Biomass-based energy as a major source of energy in Mozambique

Biomass is presently the key source of energy in Mozambique. Burning of firewood and charcoal is estimated to account for up to 80% of the total household energy use. The connection between biomass use for energy and GHG emissions is mainly due to biomass being obtained from unsustainable sources of energy. Reports (e.g. Pereira et al. 2001) indicate that more than 90% of the charcoal and firewood vendors are informal and without license. There is therefore a lack of management of the forests from where the biomass is collected. Wood biomass for energy and agriculture are indicated as the major drivers of deforestation and forest degradation in Mozambique (Saket 1994, Marzoli 2007).

3.2 How can REDD+ improve the situation

Among the mitigation measures to reduce emissions from biomass burning for energy, the actions that are suggested can be grouped as following: (i) continue the use of biomass, but improve efficiency of biomass burning such as improved stoves, improved efficiency of charcoal making process; (ii) produce biomass through tree plantations and the growing of crops for liquid biofuels; (iii) promote sustainable management of wood biomass source; and (iv) promote alternative sources of energy such as electricity, gas, coal, solar energy. These actions are not mutually exclusive and can be implemented in combination. An analysis of these actions for the conditions of Mozambique follows.

3.2.1 Efficient use of biofuels

Improving efficiency of energy use means making maximum use of each energy unit. That is, improving current energy use patterns. This action is suggested after studies have shown that making charcoal is only 18% efficient (Pereira et al. 2001). In addition, the cooking stoves are open, with high energy losses. Only 10-40% of energy produced in the traditional cooking stove is actually used for heating the pot (Kshirsagar 2009).

Studies (e.g. Pereira et al. 2001) suggest that increasing efficiency would mean changing the current practices, including the charcoal kiln form and procedures, and the type of cooking wood and charcoal stoves. Experiments conducted in Mozambique and Tanzania (Pereira et al. 2001) found that changing the traditional boat-like charcoal kiln to the Casamance kiln improves the charcoal production efficiency from 18% to about 35%. However, the workload of the charcoal makers also increases. In addition, changing the traditional open charcoal stove to the improved wood stove (IWS) may increase energy efficiency up to 30-50% of the traditional stove[7].

The Sitoe et al. (2007) simulation model for the region of Northern Sofala suggests that improving energy efficiency (if possible), may have limited impact on the forest if no additional measures are put in place to increase wood biomass production and management. Adoption of the Casamance kiln may not be easy as it implies increase in labor, while adoption of the IWS would require the establishment of a local maker of the stove, promotion and financing of the adoption, as well as energy saving discipline from the users. No reports were found indicating the level of adoption of IWS in Mozambique. However, we suggest that adoption is still very limited.

3.2.2 Energy plantations

Planting energy crops is generally seen as a sustainable way of energy use as indicated above. Plants use CO_2 from the atmosphere to grow and accumulate biomass. Therefore, if biomass production is done in an efficient manner, the CO_2 released during the combustion can be used back to grow biomass again, making it a closed cycle.

During the initial energy crisis of the 80´s, Mozambique conducted extensive campaigns to produce wood biomass from forest plantations for energy. Recognizing that urban use of wood biomass for energy was the major source of deforestation, reforestation projects were established close to large cities of Maputo, Beira and Nampula to supply biomass for these cities. While technical aspects of forest establishment were taken more seriously in these projects, economic and social aspects do not seem to have been given similar importance. These experiments were to fail before they could not produce the results for which they were established.

[7] http://other90.cooperhewitt.org/design/kenya-ceramic-jiko

With the global fuel crisis of the early 2000´s the world has experienced a biofuel rush. Mozambique became one of the major destinations for investments in biofuels, mainly with jatropha for biodiesel and sugar cane for ethanol (Batidzirai et al. 2006, Schut et al. 2010). Although there is clear indication that Mozambique´s production of liquid biofuels is mainly to supply international markets, there is a growing awareness that these biofuels could be used to supply domestic markets as well, particularly the use of jatropha oil as substitute for firewood and charcoal[8]. There is no clarity yet on whether biofuel production (and use) is a net sink or source of GHG as they require extensive areas of land and also use fossil fuels for mechanization. Land requirement would sometimes mean conversion of high carbon woodlands to grow biofuels feedstock. Biodiversity loss and food insecurity among others, are some of the side effects of biofuel use which still need to be properly scrutinized. For instance, Arndt et al. (2010) suggest that jatropha feedstock production through outgrower schemes would lead to replacement of food production areas by jatropha plantations.

The adoption of biomass production for biofuels entails social and economic aspects that need to be tackled. Managing biomass plantations successfully must not be seen as just planting trees, but also as taking into account the economic incentives, social and cultural aspects, and forest governance.

3.2.3 Sustainable management of biomass sources

The key issue of biomass burning being a source and not a sink of GHG emissions is that there is lack of sustainable management of the biomass sources. This is true for both natural woodlands and plantations. The previous section explained the contours of the plantations for wood energy, and concludes that lessons have been learnt, but little is being done to make energy plantations sustainable. Currently, firewood and charcoal are produced in natural woodlands without management, resulting in high deforestation rates around areas of high demand in urban areas. Sitoe et al. (2008) estimated that at national scale, burning of biomass for energy is surpassed by the wood biomass growth, making the use of wood for energy a clean process. However, it is at a subnational scale, particularly close to urban centers, where the use is higher that the production, creating areas of high emissions.

Managing the sources of biomass for energy sustainably, in the case of Mozambique, would mean not only reducing emissions, but also reducing the rate of deforestation associated with the use of forests as sources of energy. Although not currently producing net emission at national level, in the long term, unsustainable use would result in a net source of emissions. Sustainable management, in the long term, would result in resource use efficiency by promoting good forest governance. There are costs associated with the management: social and economic (affecting mostly those involved in informal trade of firewood and charcoal, and those who have been using woody energy).

[8]http://www.theecologist.org/News/news_round_up/529755/jatropha_better_suited_to_local_communities_not_biofuel_markets.html

3.2.4 Alternative sources of energies

Reducing emissions from deforestation caused by the demand for wood biomass as source of energy may be attained by moving from the wood biomass-based energy (as presented above) to alternative sources of energy. This option suggests that if people have access to reliable and viable alternative sources of energy they will be willing to adopt them. There are studies (e.g. Egas 2006), however, that show that changing from wood-based energy to their alternatives may be highly complex. It takes more than just the comparative low price, including social, cultural, and economic aspects needed for the change.

The potential for alternative sources of energy is high, but mostly remains unexplored. Mozambique has the largest hydropower generating dam in Southern Africa, the Cabora Bassa, with the installed capacity to generate 2075 Mega Watts[9]. This is by far the demand of domestic energy, but currently most of the energy generated is exported to South Africa. Another smaller hydropower dams is located in Manica, the Chicamba dam, while plans are well progressed to build another large hydro power dam on the Zambezi river in the locality of Mpanda Nkua[10]. There are challenges yet to come, as even within the urban areas a significant proportion of the population does not have access to electricity. In addition, part of the urban population with access to electricity, still relies heavily on charcoal for cooking.

Mozambique has one of the largest natural gas reserves and coal, but currently only a small proportion is being explored and it is fully exported. Other alternative sources of energy include solar and wind power which are also not explored.

4. Forestry

4.1 How forestry activities contribute to emissions

This section focus mainly on industrial wood, while wood used as firewood and charcoal is dealt with in the section of energy above. Although most of the logging is classified as unsustainable, it rarely produces deforestation directly. The selective nature of logging, based on species and size, which typifies the timber sector in Mozambique, removes few trees per hectare. Saket (1994) estimates an average of 3-4 mature commercial trees per hectare, out of a total of 175-250 tees/ha (>10 cm dbh) in Mozambique. Even in areas with high density of gregarious species such as *Millettia stuhlmannii*, the number of mature trees that are logged is relatively small (up to 10 trees/ha). In addition, given the openness of the forest, with scattered trees, little or no logging damage is done to the remaining stand. Products from forest logging are normally used as structural timber (sawn timber or sold as logs). Sawmills have little efficiency and may have up to 50% of the log volume produced as timber, with the by-products being burnt locally (in the industry) to generate energy. However, the current pattern of forest industry in Mozambique, means that the majority (90%) of wood is exported as logs,

[9] http://en.wikipedia.org/wiki/Cahora_Bassa_Dam
[10] http://www.gpz.gov.mz/documentos.html

mainly to China (Canby et al. 2008). GHG emissions from the forestry sector may not be a direct effect, but have an indirect one, mainly in tandem with the collection of firewood and charcoal making, and eventually agriculture. Among the indirect effects, there are wildfires, which propagate and cover extensive forest areas, affecting the regeneration and growth of the trees. Outside forest concessions, in areas logged under simple annual logging permit, the forest roads opened by loggers are later used by firewood explorers and charcoal makers.

4.2 What can REDD+ do to reduce emissions associated with logging

Although the emissions associated to logging itself do not seem to be important, as indicated above, the forestry sector can contribute to the enhancement of carbon sequestration through a series of activities that promote forest regeneration, forest conservation, sustainable forest management, and the establishment of forest plantations. Particular observation should be done on the fact that logging in unmanaged forests opens roads for further forest damage by firewood collectors, charcoal makers, and slash-and-burn agriculture (see sections on agriculture and energy above).

a) Forest concessions: promoting sustainable forest management through a system of concessions is one of the main aims of the forest regulation in Mozambique. Presently, 179 forest concessions have been approved, covering more than 4 million ha (Sitoe et al. in prep.). The appropriate implementation of the SFM principles in these concessions is still a challenge. In fact, most of these just work as annual logging licenses and little is done for the implementation and enforcement of the management plans. The timber market structure, dominated by log exports and illegal operations, and the institutional weakness of the Forest Service, are commonly indicated as the main limitations for the appropriate implementation of the SFM principles (Sitoe et al. in prep.).

b) Natural forest conservation: Mozambique has about 8.9 million hectares of forest within conservation areas. Estimations of the deforestation rate, although not giving specific figures of the amount of forest loss within conservation areas, make clear that deforestation and degradation takes place within these areas as well, for the same reasons as those outside the conservation areas (Marzoli 2007). Conservation areas in Mozambique have the particularity of also being settlement areas, with the population practicing all sort of subsistence activities, including slash-and-burn agriculture, hunting (with fire), extraction of wood for local use as well as for commercialization (e.g. growing cotton and tobacco). One of the big challenges for the implementation and enforcement of conservation measures is related to the need of integrating community development activities which are compatible with conservation objectives. Suggestions for the use of non-timber products, such as honey, wood carvings (from dead trees), proved to not be efficient compared to the extractive activities such as charcoal making, or the conversion of forests to agriculture.

c) Commercial and community forest plantations: planting trees may represent an option for fast carbon sequestration. To make a contribution to REDD+, plantations (i) should not re-

place native trees, (ii) should represent higher carbon stocks compared to the original vegetation, (iii) should contribute to the reduction of deforestation and degradation of neighboring forests, and (iv) integrate the interests of people who may have caused deforestation or degradation and avoid leakage. Whether industrial forest plantations should be classified as potential REDD+ is to be defined, but the lack of additionality of these plantations is a common reason to exclude them from REDD+. That is, industrial wood production will continue to take a place independent of REDD+.

Several forest plantation setups can be established with a potential to contribute to REDD+. These may include energy plantations, agroforestry systems (discussed above), and other initiatives of tree planting that can be established with the purpose to generate income for local communities, while diverting them from makin their living from extractive activities. Attention should be paid to the fact that impact of forest plantations (on carbon sequestration, and on the local economy) may not be evident in the short term. Note that planting trees may have social and cultural dimensions (see above on energy plantations).

5. Conclusion

There are potential and challenges for REDD+ implementation in Mozambique. Lessons of good practice and carbon saving land use options exist. Some of these practices, particularly the use of tree-based crops became traditional practices, resulting in large areas of agriculture with high carbon stocks. For some other practices, such as agroforestry systems, energy plantations and conservation agriculture, small scale experiments exist, but a large scale adoption is still to come. Challenges to implement REDD+ activities include not only the need for extensive investments, but also experimentation, and adaptation (social and cultural). Deforestation and forest degradation may also result from unharmonized sector policies and technological limitations. Choosing a REDD+ activity from the long list of options, where resources are limited, may not be easy. First, the options should be in line with the local (subnational) causes of deforestation and forest degradation. Second, cost efficiency is desirable to make REDD+ worth using. Activities with a high impact on carbon stocks and low risk (likelihood of success) are the ones that would eventually deserve higher priority.

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