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OPPORTUNITIES AND CHALLENGES OF BIOFUELS IN AFRICA: A CASE STUDY OF THE MAKENI PROJECT IN SIERRA LEONE

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1. Introduction

In the Declaration on Climate Change, the G7 and the European Union agreed on a transformation of the energy sector. One of the objectives is to *«accelerate access to renewable energy in Africa and developing countries in other regions with a view to reducing energy poverty and mobilizing substantial financial resources from private investors, development finance institutions and multilateral development banks by 2020»* (G7, 2015).

Foreign Direct Investments (FDI) are on the rise in Africa. Especially biofuel projects have been very popular over the past decade. Many countries agreed on reducing their carbon footprint in an effort to prevent global warming. One solution has been to increase the use of renewable energy, such as, inter alia biofuels, to reduce the dependency on fossil fuels. Mandates regarding blends of alternative fuels have been introduced all over the world, resulting in high demands for biofuels. The US and Brazil are by far the largest agrofuel producers, and are responsible for three quarters of the global supply. Other countries, especially within the European Union, have been struggling to produce enough biofuels to meet the demand. Africa, with its favorable climate, its vast unused lands and its need for development, is seen as the ideal place to grow feedstock for fuel. These FDI are win-win deals as foreign investors bring money and much needed development to African countries. Companies also benefit from the support of the governments and the opportunity to produce cheap biofuels. Unfortunately, with large-scale projects come negative externalities for the environment and for people.

This thesis will identify the common industry-related benefits and downsides of a biofuel project in Africa. Land grabbing and food insecurity are two concerns that have been linked directly to the biofuel expansion of the 20th century. These impacts, among others, will be analyzed with a practical case of a renewable fuel project, in order to have a better insight on the consequences of such investments. Addax Bioenergy Sierra Leone (ABSL) has been labeled as *«a model for sustainable projects in Africa»* and a closer look at the key success factors can help more companies create

profitable investments that stimulate sustainable development as well. It is interesting to see how a sustainable project manages industry-related externalities.

A detailed analysis has been made possible with the help of several key stakeholders. Addax itself, the CSR manager at Addax, De Smet Engineers and Contractors, SiLNoRF, Bread For All, ActionAid, most involved Development Banks and True Price, all provided enough information to make a complete assessment of the project. Unfortunately, the EU did not respond the multiple requests to get in touch with the department in charge of reviewing and accepting the biofuels from Africa.

The Makeni Project was the largest agricultural investment ever made in one of the poorest countries in the world. The EUR 400 million sugarcane ethanol project will provide 1.7% of Europe's ethanol supply and 20% of the Sierra Leone's electricity consumption. ABSL's objective is to be a benchmark for sustainable investments. However, the Swiss Company has been under a lot of criticism right from the start. The objective of this thesis is also to put this criticism into perspective and identify which issues are material, requiring immediate attention from Addax. Studies on the subject do not monetize all the social and environmental costs or generalize them to the entire project. A lack of homogeneity and aggregation makes it impossible to get the bigger picture. In an attempt to fix this, material social and environmental impacts will be monetized. The objective is to increase the comparability between costs, and further, to find out the true price of ethanol.

The findings will help other investors in their cost calculations, as the identified issues are industry-related. Researchers will also find new numbers that could open some new discussions. Finally, Addax will be able to quickly see what the biggest social and environmental downsides are in terms of money, and how much it would cost them to fix it.

2. Biofuels in Africa

Despite the serious price drop of crude oil in the past year, the global biofuel production has increased by 3% in 2015 (REN21, 2016). The volume produced was a staggering 133 billion liters, from which less than 1% came from the African continent (Fielding, et al., 2015). To put this into perspective, around 4.6 trillion liters fossil fuel are consumed each year worldwide (Central Intelligence Agency, 2016). The largest biofuel producers are by far the US and Brazil, supplying 72% of the global market. The two main types of renewable fuels are bioethanol, made from sugarcane, wheat, manioc, sorghum and maize, and biodiesel, made from soya, palm and jatropha. They each represent respectively 67% and 33% of the biofuel production[1]. Ethanol can replace gasoline, whereas biodiesel can substitute regular diesel, without requiring any major modification to the engines. However, at gas stations they will always be blended with fossil fuel. Some countries have set mandatory blends and targets for the future in order to mitigate the global climate change (Annex 1: Examples of mandates worldwide). The African ethanol production increased significantly, from 0.10 billion liters in 2014 to 0.13 billion liters in 2015 (REN21, 2016). Only bioethanol and, to a lesser extent, biodiesel is produced on the continent. Africa is about 30 million km^2, or 3 billion hectares, wide. Most of this surface is unused, making it the continent with the highest potential in agrofuel production (Gasparatos, et al., 2015).

The food versus fuel debate has been one of the reasons why crude oil is still widely used in Europe. Belgium for example has a biofuel blend policy of 4%, whereas Brazil has just increased its mandatory ethanol blend to 27.5% due to its surplus in sugar production. The food versus fuel dilemma is based on a simple economics' principle: the Law of Supply and Demand. Because most first generation biofuels are made from edible plants, an increase in demand for biofuels will increase food prices. A consequence of Europe's obsession with biofuels was a substantial increase in food prices all over the world (ActionAid, 2010). This can lead to an ethical question: is it acceptable to

[1] Biogas, biomethanol and biohydrogen are also types of biofuel but they are less common

cultivate crops for fuel in a country where people are starving to death? But this paper will not try to answer that question. It will instead try to find the most significant opportunities and drivers of a biofuel expansion in Africa, but it will also identify the challenges and downsides of the global increase in biofuels.

The SWOT bellow is a nice overview over the benefits and the drawbacks of a biofuel project in Africa.

Strengths	**Weaknesses**
Decreased dependency on fossil fuel	Seasonal employment
Decreased exposure to international price volatility	Direct and indirect land use change
Reduced GHG emissions	Gender inequality
Available technology	
Opportunities	**Threats**
Development of infrastructure	Land grabbing
Energy diversification	Food insecurity
Sustainable development	Water consumption
Poverty alleviation	Biodiversity loss
Renewable energy from waste	

Opportunities and drivers of a biofuel expansion in Africa

Energy security: independence

With the exception of Libya, Nigeria, Algeria, Egypt and Angola, all African countries are net importers of fuel (Amiguna, Musango, & Stafford, 2011). Some because they don't have the resources, others because they don't have the capacity to extract the oils. Being a net importer means the country is highly dependent on oil prices, the currency exchange rates and on oil

exporters, like the OPEC. When the price of petrol sky rocketed well over USD 120 (EUR 106 [2]) per barrel[3] in 2008, biofuels gained a lot of interest. The cost of processing feedstocks into biofuels depends on the country where it is produced. Europe, for example, has a break-even price of USD 100 (EUR 89) per barrel for ethanol, whereas the US and Brazil break even at respectively USD 40 (EUR 35) and USD 30 (EUR 27) (Escobar, et al., 2009). This wide spread between Europe and Brazil is due to the available lands for crops and the experience in the latter. Brazil has been producing ethanol from sugarcane since the late twenties, early thirties, when the first cars were introduced. The larger the gap between the oil price and the cost of producing biofuels, the higher the incentive of further expanding its biofuel industry. This is also valid for African countries where oil can be very expensive, especially in remote areas. Savings on import can therefore be substantial when the government chooses to substitute part of its imported fossil fuels with homemade biofuels. A large scale project in Zimbabwe of 100 million liters of biodiesel a year can save USD 80 million in imported diesel (Amiguna, Musango, & Stafford, 2011).

Energy security: supply diversification

The African continent has about 1.2 billion people and it is expected to grow to a staggering 2.5 billion in 2050. Of the people living on the continent an estimated 47% lives without electricity and fresh water, compared to a global rate of 17% (Sekoai & Yoro, 2016), (REN21, 2016). With a fast growing population, the demand for energy will keep increasing. The new emerging markets, replacing the BRIC countries (Brazil, Russia, India and China), are expected to be African countries due to the rapid increase in population and purchasing power. The energy industry will therefore have to expand rapidly to meet the demand, which is expected to grow by 5% per year (Sekoai & Yoro, 2016). Biofuels can help to achieve this objective without increasing the country's exposure to currency exchange rate risk and price volatility of crude oil. People in Africa are still relying on

[2] Average exchange rate USD to EUR of June 2016 is 0.8866

[3] 1 US barrel = 158.99 liters

fuel for lamps, stove and off-grid electricity, and are therefore vulnerable to changes in oil prices (Gasparatos, et al., 2015). Biofuels can offer some security in the supply of energy, and prices should therefore be more stable thanks to diversification. If the price of crude oil spikes because of a political conflict in one of the OPEC members for example, biofuels will mitigate part of this price increase because of the 0 correlation it has with the conflict. When in 2008 one barrel of petrol sold for more than USD 120, or USD 0.75 per liter, it became more expensive than biofuels. At that time the price of one liter of ethanol was USD 0.65, or 13% cheaper (Platts, 2015). If a mandatory blend of 10% was introduced in 2008, gasoline prices would have dropped by 1.3%.

Energy security: enhanced infrastructure

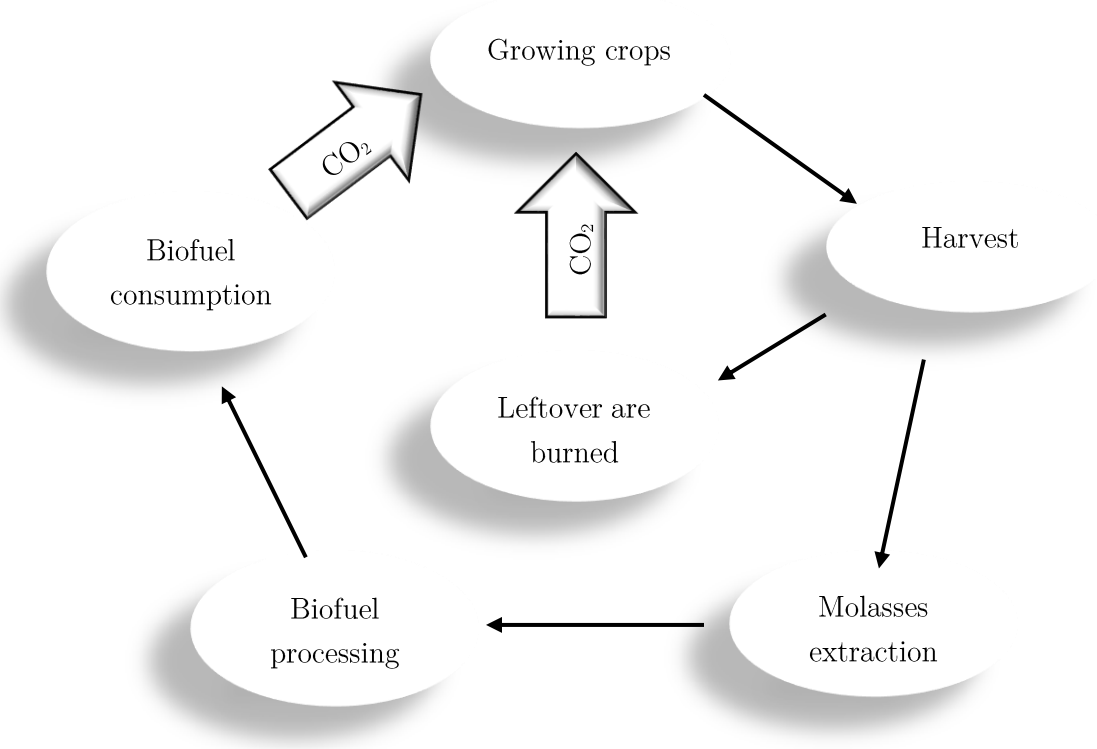
Besides gaining in independence from other countries and guaranteeing more stable energy prices, a biofuel expansion increases the development of infrastructure in the regions where the biofuels are produced. Improved roads, expanded national power grid and gas pipes, and modernized irrigation systems are examples of infrastructure improvements resulting from the investments made in the biofuel sector (Amiguna, Musango, & Stafford, 2011). Fuel is used by communities to generate electricity for their houses but also as is for their farming machines and transportation. With a better infrastructure people will have easier access to energy resources, resulting in increased energy security.

Reduced GHG emissions

In an effort to reduce greenhouse gas (GHG) emissions and limit climate change, all members of the European Union agreed on increasing their use of renewable fuel in transport. By 2005 a mix of fossil fuel and 2% of biofuel was achieved in every country of the EU (Directive 2003/30/CE). By 2010 at least 5.75% of the fuel consumption had to be from a renewable source. The next target to be achieved is 10% by 2020 (Directive 2009/28/CE). Other countries outside Europe have also put

in place biofuel strategies in order to slowly increase the use of renewable energies. Studies have proven the biofuel benefits on the environment through the lower emissions compared to fossil fuel. Ethanol and biodiesel can potentially decrease CO_2 emissions by at least 30% and 50% respectively compared to regular gasoline and diesel (Pradhan & Mbohwa, 2014). The objective is to produce ethanol or biodiesel which maximizes the reduction of GHG emission over its entire life cycle, and not only in the consumption phase. Therefore, the choice of crop and the management of process and transport is crucial (Amiguna, Musango, & Stafford, 2011). Figure 1 shows the closed carbon cycle of biofuels when no fossil fuels, or other carbon rich inputs, are used during the life cycle. Plants absorb CO_2 while growing, and that same amount of carbon will then be released into the atmosphere, through the consumption of its oils and through rotting or burning of the leftovers. When fossil fuel, electricity, fertilizers or pesticides are used, the CO_2 emissions are higher than the CO_2 absorbed by the crops. These levels are compared to fossil fuels in order to know if carbon emissions are saved with the alternative fuel.

Figure 1: Closed Carbon Cycle



The new EU targets, in order to achieve the objectives set in Kyoto, are creating a large demand for biofuels, which cannot be produced in Europe alone. Because Europe does not have enough lands available to dedicate to biofuel crops it needs to invest outside its borders, and Africa is an ideal solution (Pradhan & Mbohwa, 2014). With its underdeveloped agriculture and its available arable lands, Sub-Sahara Africa has the highest potential to produce large quantities of biofuels for export. But environmental drivers, like GHG reduction, are not the main drivers for these countries, where economic growth and poverty alleviation is prioritized. Biofuels offer both benefits because of a ripple effect on other sectors as the following sections will show. For this reason, these renewable resources are ideal investments for developed countries as well as for African countries.

Sustainable development

Sustainable development is development that meets the needs of present generations, without compromising the ability of future generations to meet their needs. Not only does biofuel expansion stimulate economic growth, enhance infrastructure and develop agriculture, but it is also a long-term project. Biofuels are a renewable resource and its production can therefore last for centuries, while fossil fuel is a short-term option with an expiration date. In order to have sustainable development in Africa, sustainable energy sources are required. Agrofuels can therefore be a catalyst for a development Africa desperately needs. The large areas of unused lands have contributed to a particular interest of foreign investors to develop biofuels in African countries. However, unsupervised deforestation and biodiversity loss are serious concerns that have to be dealt with in a sustainable way through industry-specific regulations. Official policies and strategies are still rare in Africa, but governments know there is a need for good management if it wants to have a sustainable development (Amiguna, Musango, & Stafford, 2011). There is a common belief that biofuels are by itself sustainable, but this is not always true. Therefore, to achieve a sustainable development it is essential to have official policies and strategies. In order to evaluate the sustainability of biofuels, an impact assessment needs to be done regarding the social, environmental and economic impacts over the entire life cycle.

Poverty alleviation

Biofuels can be promoted as a solution to reduce poverty and boost the local economy. Regions with large quantities of unused lands are often regions where very poor people live. Agriculture development can help to raise the quality of life of the communities by providing jobs, energy, infrastructure and more (Amiguna, Musango, & Stafford, 2011). The main potential benefit for the local population has been the decrease in poverty through employment on the fields or through the establishment of a market for farmers' harvests. Companies can choose to buy lands and harvest them using local workforce or they can buy the feedstock directly from local farmers. In both cases employment increases significantly with the arrival of a biofuel company. Even though wages are often close to the legal minimum, people still look for a job on the fields. An explanation for this is the security offered by a stable wage. Small farmers relying on their harvest to feed their family may face hunger in times of low crop yields. Employment can mitigate famine risk and help to alleviate poverty. A wage, even if low, will also help with non-food expenses and farmers do not waste time and efforts trying to sell their products on local market anymore. In Ghana for example a wage on a plantation field earns 75 GHS (EUR 17.25 [4]) per month which is about 51% of the average household income (Gasparatos, et al., 2015). The World Bank has put the poverty line at USD 1.90 per day PPP[5]. Ghana's poverty line at PPP is 1.76 GHS (EUR 0.40) per day. One income on a plantation field therefore is barely enough for one person, but it is still preferred than unstable revenues from small-scale farming. In comparison, Belgium has a conversion rate of 0.86, and everyone earning less than EUR 1.64 a day is considered poor.

Therefore, from an economic point of view the major benefit is the employment opportunity linked to the project. In South Africa, a study showed that an increase of 15% of ethanol blended with regular fuel would add around 350 000 jobs in a country of 55 million inhabitants (Pradhan & Mbohwa, 2014). The employment promised by companies can therefore be attractive for a government. SEKAB for example, a Swedish firm operating in Tanzania, estimated the average

[4] Average exchange rate GHS to EUR of June 2016 is 0.23

[5] Purchasing Power Parity

worker per hectare to be 0.15. Its project would have been about 200,000 ha, meaning around 30,000 local jobs would have been created on one project, if not abandoned in 2012 due to low yields (Gasparatos, et al., 2015).

Available technology

One of the main drivers making the expansion of biofuels much easier is the fact that the required technology already exists and is used worldwide. The technology used in refineries to extract the oils from plants is similar to the one used to extract petroleum products from crude oil. The US and Brazil have been producing ethanol from corn and sugarcane for decades, with a total output of respectively 56 and 27 billion liters a year. Third in place is the European Union with only 5 billion liters, while the global production was at 97 billion liters in 2015 (Renewable Fuels Association, 2016). It is safe to say that today biofuel technology is mature, widely available and efficient. This means it can easily and cheaply be applied in Africa by foreign companies with a minimum level of knowledge and experience.

Car and combustion engines running on today's gasoline or diesel require little or no modification when blending the fuels with ethanol or biodiesel (Pradhan & Mbohwa, 2014). This allows blending rates to fluctuate and to increase much faster than if all cars had to be replaced with flexible fuel vehicles.

There are three types biofuels, first, second and third generation. First generation (1G) are agrofuels derived from plants, where sugar and vegetable oil are the most common inputs. Second generation (2G) are more advanced biofuels that are made by breaking down lignocellulosic biomass with specific enzymes that separate even more sugars from the feedstock. 2G biofuel producers can therefore extract additional fuel from waste material like woodchips, bagasse[6] or other agricultural leftovers. Finally, the third generation (3G) biofuels use microalgae to produce oils that have the

[6] Sugarcane residue after the juices have been extracted

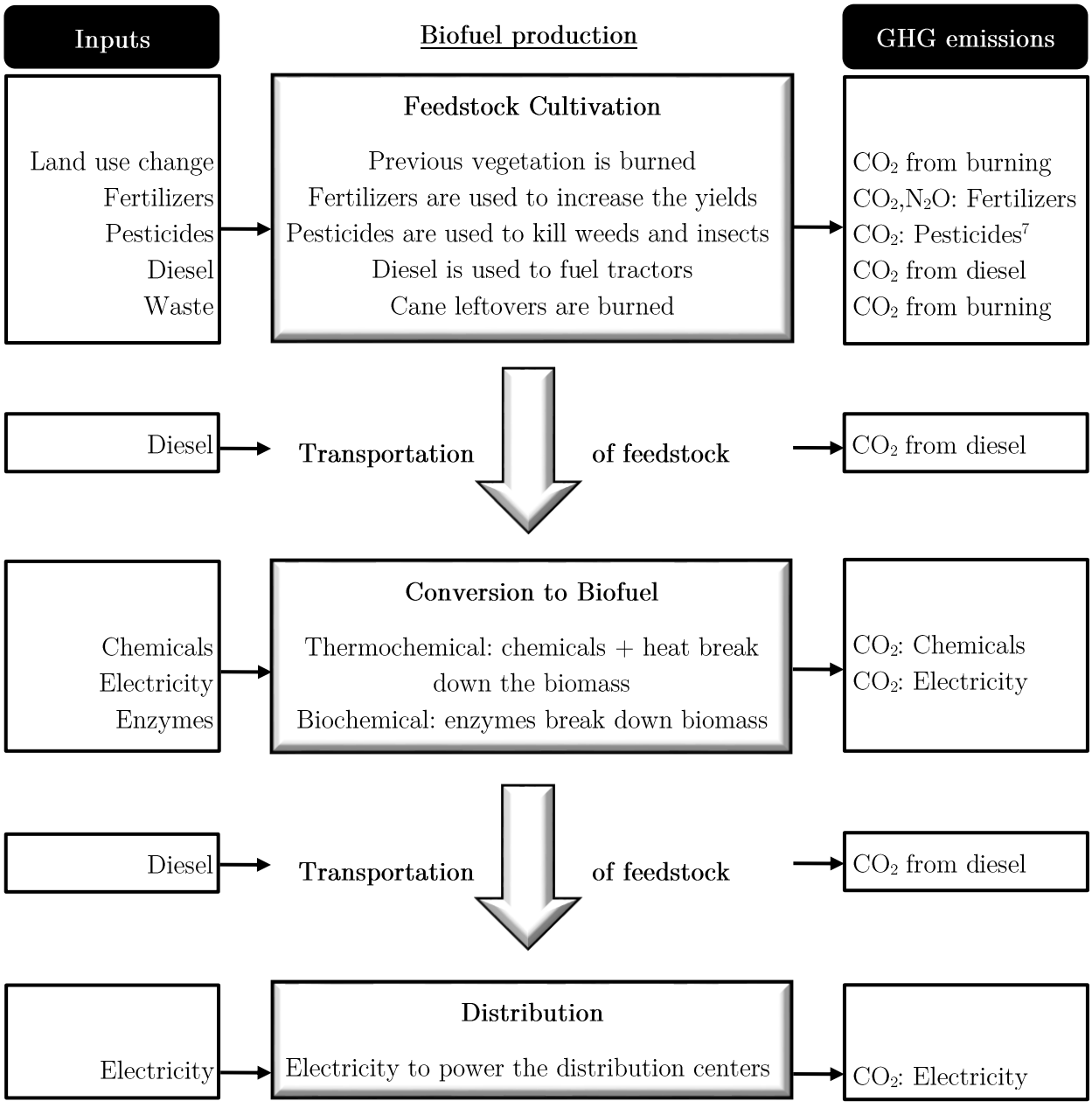
exact same properties as petroleum. Because crude oil is in fact fossilized algae, 3G biofuels can be refined into gasoline, biodiesel, ethanol, methane and even jet fuel with the same feedstock. 1G biofuels are the most common renewable fuels due to its widely available and simple technology, which is basically using the right enzymes, fermentation and distillation. They have a lower cost of production and are therefore cheaper for consumers. The exact price depends on the country where is produced because the cost drivers are labour, energy, climate, land and water, which price and quality vary in each country. This technology is ideal for African countries to invest in because 1G biofuels require a lot of land, which is widely available in Africa, and cheap workforce to harvest the crops, which is also very present. 2G biofuels are less labour intensive but they are more expensive to produce, therefore not suited for the African market. The same goes for 3G biofuels that need large volumes of water to grow the algae, hence algae fuel would be very expensive in Africa. Second and third generation still require a lot of research and development to make it a more attractive solution, even in developed countries.

Waste management

Figure 2, page 12, is a schematic overview of the life-cycle system with the inputs at each stage and their GHG emissions. Waste management can significantly increase savings in GHG emissions. The first phase of the life cycle of biofuels is responsible for a lot of biomass waste. Depending on the waste management of the factory those leftovers can be used as by-products instead of waste. Sugarcane ethanol, for example, comes with what is called bagasse, which are the dry sugarcane leftovers after the extraction of a sugar rich syrup called molasses. There are three options to choose from when managing bagasse. First, the easiest solution, is to do nothing and let it rot on the fields. The second option is to burn it in order to create bioelectricity, either to supply power to the factory, or to sell it and put it on the national grid. Finally, the most challenging choice, is to further extract sugar from the bagasse to obtain cellulosic, or second generation, bioethanol. Should all cellulosic waste worldwide be processed, an estimated 491 billion liters of biofuels could be produced each

year, which is almost four times the level of the current biofuel production (Sekoai & Yoro, 2016). Leftovers from maize have an additional alternative as they can also be processed into animal food.

Figure 2: Inputs and emissions during the life cycle of biofuel



Source: Based on (Le, et al., 2013, p. 229)

[7] Fertilizers and pesticides do not emit CO_2 directly, but their manufacturing process does

Waste biomass has the advantage of being very cheap, widely available and renewable. Agrofuels therefore offer the possibility of producing various outputs from which the local communities can benefit. An environmentally friendly waste management can potentially produce a biofuel with a zero GHG emission.

Figure 1 illustrates the carbon closed cycle of biofuels with proper emission management. Combined with Figure 2, a carbon-neutral biofuel can potentially be produced under the right circumstances. First, the crops that are converted into biofuel monocultures must be low carbon stocks. Fertilizers, pesticides and herbicides should be avoided because they are, directly and indirectly, responsible for greenhouse gases. The energy, used to fuel the machines and to power the refinery, should be renewable and carbon-neutral. Finally a biochemical conversion process should be favored over a thermochemical process, due to the lower energy requirements. The leftovers can be burned and transformed into bioelectricity to power the estate, and the ethanol output can replace the fossil fuel used in the farming machines and in the transportation trucks. In this ideal scenario, the energy produced will emit the exact amount of carbon that has been absorbed.

Hunger in Africa is primarily a consequence of low crop yields, bad infrastructure, insufficient investments in agriculture, poor local market organization and conflicts (Hamelinck, 2013). Biofuel expansion can help stimulate investments in agriculture and in infrastructure. With knowledge from the biofuel industry, farmers can improve their productivity and yields. And with more products to sell, local markets will be improved. With a stable economy, conflicts may decrease, resulting in a sustainable alleviation of hunger and poverty.

Challenges and downsides of a biofuel expansion in Africa

The benefits and downsides of agrofuels are still a much discussed topic. All around the world various actions related to biofuels are taken in order to increase the use of it: blend mandates, subsidies, tax cuts, and more. In Africa, despite its high potential of being one of the biggest producers, very little has been done to promote biofuels. Nevertheless, some African countries are trying to implement large scale production plants. Swaziland produced 480 million liters of ethanol in 2015, Kenya 413, Sudan 408 and Tanzania 254 million liters in that same year (Amiguna, Musango, & Stafford, 2011). All other Sub-Saharan countries are producing 150 million liters or less. There are various reasons why biofuels do not get the full support of all stakeholders, the main one being land grabbing. There has been a debate about the influence biofuel expansion has on food prices all over the world, but this issue has deflated since food prices have decreased since 2008 while biofuel production kept increasing. Other topics that have been challenged in the literature are the actual jobs created, the social impacts such as gender issues and displacement and environmental impacts when considering pollution and land use change.

Land grabbing

Because of the sudden interest in biofuels, most countries had no specific regulations regarding the subject and no real sustainable framework was put in place (Gasparatos, et al., 2015). Many foreign investors exploited this loophole by contracting long-term rents or purchasing large amounts of lands, resulting in what is commonly known as land grabbing. Africa has the largest unprotected grasslands and woodlands in the world, making the continent very vulnerable to land grabbing. 40 to 50% of all the international land deals in the world are on the African continent (Giovannetti & Ticci, 2016). According to Land Matrix, which is a website (landmatrix.org) that collects all the data on past, current and future land deals, almost 70 million hectares worldwide are linked to transnational deals. This is about the size of a country like France. More than half of the concluded

and intended international deals are on the African continent. The main targeted countries in Africa are the Democratic Republic of Congo, 3.2 million ha, South Sudan, 2.7 million ha, Mozambique, 2.4 million ha and Congo, 2.1 million ha. The majority of the land deals are used for biofuels, even though more than half of them were used for food prior land deals (ActionAid, 2014). These countries have to manage this rapid change in ownership and they have to be careful not to lose control over all their lands due to these heavy foreign investments. Some countries are buying arable lands in order to guarantee food security for their population because they do not have the appropriate climate and they do not want to be dependent on international commerce. Other lands are bought to grow crops for biofuels to sell to countries in need of renewable energy. In many African countries, lands are often owned by the government or by landowners. When those are sold for economic reasons, small farmers, who were using these lands, lose their way of generating income to feed their family. When foreign investors come and buy thousands of hectares of land, the local villagers are the most impacted on a social and economic level. Official policies and strategies, regarding land grabbing for biofuels, are still rare in Africa but governments know good management is essential if they want to have a sustainable development (Amiguna, Musango, & Stafford, 2011).

Food security: food versus fuel

Despite the high potential of growing food in Africa, because of its large amount of unused lands, it is still the poorest continent with the highest food insecurity. The reason behind this is the underdeveloped agriculture and its reliance on individual, low productive and small-scale farming (Gasparatos, et al., 2015). In 2008, when global food prices spiked, biofuels were said to be responsible for this inflation, that pushed millions into poverty (ActionAid, 2010). The food versus fuel debate was considered as the biggest problem related to biofuels when studies claimed that between 30% and 75% of the increase of food prices of 2008 was directly related to the increase in demand for biofuels. Global food prices increased by 75% between 2003 and 2008 whereas edible feedstock for agrofuels, such as wheat and maize rose by 126% in five years (ActionAid, 2010). This is especially troubling in countries where people spend up to 80% of their income on food. In such

cases a 30% increase in food prices means their income becomes insufficient to buy food. However, it has to be stressed that biofuels are a contributor to the problem, but they are far from being the only driver that pushed food prices up. Robert Zoellick (2008), the World Bank President, mentions 3 other drivers: energy prices[8], changes in diet[9] and climate[10]. The numbers found by ActionAid have since then been disputed and more realistic percentages have emerged. Instead of a liability of 30 to 75%, only between 1 to 10% of the food price increase is due to biofuels (Hamelinck, 2013). When fertile lands are being used for biofuels instead of food, food is being taken from the poor so that rich people can fuel their cars. This is very basic thinking but it is the general idea behind the food versus fuel debate. From the literature on this topic, it can be assumed that biofuels do in fact compete, directly and indirectly, with the food industry, putting upward pressure on food prices. Sugarcane ethanol, for example, can compete directly with the food industry when a farmer prefers to sell his molasses to a biofuel producer than to a sugar refiner. Crops sold for biofuels offer a higher profit for the farmer than if sold for food. The result is a decrease in food supply, which increases food prices. Jatropha[11] on the other hand does not compete directly with food, but it does compete for land.

However, if food prices go up, revenues for farmers go up as well. Increased food prices are seen as a negative consequence of biofuels, but farmers receive higher prices for their products and are therefore better off. Inflation is therefore not always a bad thing. Amiguna, Musango, & Stafford (2011) go even further by suggesting that the downsides of the price increase caused by the biofuel expansion, are offset by the benefits for the farmers and the hired employees.

Second and third generation biofuels are not concerned by this issue because they are made with non-food material. They do not compete for land or water either since waste is abundant.

[8] Crude oil spiked over USD 133 a barrel in June 2008 from USD 33.35 in 2003

[9] Increase in demand for meat for the average global consumer

[10] Bad weather decreases crop yields and therefore the food supply

[11] Non edible plant that requires very few water. Its oils are used to make biodiesel. Because it is not edible the food versus fuel debate does not apply to jathropha crops.

Unfortunately, due to its high price of production they cannot be produced on a commercial level yet in Africa.

Actual employment

One of the main selling points of a biofuel project is the number of jobs it will create for the local community. This positive externality increases well-being and economic growth in the region, resulting in a decrease in poverty and hunger. In practice, the jobs required for a biofuel project are rarely stable. At the start of the project a lot of workforce is needed, but as it progresses less workers are active on the fields. Even when a project is fully implemented, a lot of employees are still seasonal and hired only when crops need to be planted and harvested. Between these stages the number of employees is low. In the end the jobs promised by companies are often overstated resulting in communities, with high expectations, left disappointed. When a project is abandoned because of a low return on investment, jobs disappear and people are left with worthless monocultures. Cases of such incidents can be found in various Sub Saharan countries like Tanzania[12], Mozambique[13] and Madagascar[14] where investors had to leave or sell the project due to financial difficulties (Gasparatos, et al., 2015).

Other issues related to the employment in the African biofuel sector are illegal workers on the fields, and in some cases even child labour (Pradhan & Mbohwa, 2014). Low wages, as mentioned before, are unfortunately common practice in the industry as well (Gasparatos, et al., 2015). Finally, health and safety when using fertilizers or machines is too often neglected in Africa. It is the government's responsibility to monitor the activities and try to minimize these social issues as much as possible.

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[12] "The collapse of Sun Biofuels has left hundreds of Tanzanians landless, jobless, and in despair for the future" (Carrington, UK firm's failed biofuel dream wrecks lives of Tanzania villagers, 2011)

[13] ProCana sugar plantation would have created 7,000 promised jobs (Environmental Justice Atlas, ProCana Sugar Plantation, Limpopo, Mozambique, 2014)

[14] GEM Biofuels abandoned a 55 ha plantation due to low yields (Lane, GEM Biofuels jatropha crops underperform "significantly" in Madagascar, 2012)

Environmental impacts: Land use change

One of the main opportunities that biofuels offer is the reduction of CO_2 in the atmosphere. Ethanol and biodiesel can for example decrease the emissions by as much as 30 and 50% compared to regular gasoline and diesel (Pradhan & Mbohwa, 2014). However, there is an ongoing discussion on the actual environmental benefits of biofuels. Direct and especially indirect land use change could in fact reduce the benefits of biofuels on the environment. Biofuels require large areas of lands to be transformed into crops. Direct land use change is when forests, grasslands or other crops are converted into crops for fuel. A more troubling phenomenon, because harder to measure, is the indirect land use change. If the lands before conversion were used to farm for food, those crop would be displaced elsewhere in order to keep the same level of food supply. It is therefore an unintended consequence of land alteration that often results in higher CO_2 emissions than first thought. Deforestation is a primary concern linked to direct land use change, but deforestation can also be an indirect consequence. For example, when a farmer sells his lands, where he used to grow rice, to a biofuel company, he will have to clear out a piece of land elsewhere in order to keep growing his rice. Cutting and burning trees not only releases CO_2 into the atmosphere, but it also reduces the capacity of absorption of the planet. When taking into account direct and indirect land use change, emissions from biofuels often increase by a lot (Giovannetti & Ticci, 2016). Biofuels in Indonesia are known to cause more carbon emissions than fossil fuel due to the massive deforestation that is required for the palm tree plantations.

Environmental impacts: heavy water use

Energy from feedstock is a water intensive solution, 70 to 400 times more than other sources of energy like nuclear, wind, solar, petrol and natural gas (Giovannetti & Ticci, 2016). Each type of crop requires a different amount of water irrigation or rainfall. Sugarcane ethanol, for example, requires high quantities of water and can therefore only be cultivated in regions with significant rainfalls or near large rivers. Jatropha plants on the other hand can grow with very low levels of

water, and they, therefore, do not compete for water resources. Sugarcane does, which can result in competition over water. In a country where water is already scarce, biofuel production can create tensions with the surrounding communities. Because food crops need water irrigation too, the competition for water can endanger the food security as well. Not only does the water use have to be monitored if a project is to be sustainable, but water quality can also affect the available water and food resources. This issue has not been fully investigated and quantified yet in research studies, but every expert agrees on the fact that fertilizers and other agrochemicals used on crops have a potential risk of polluting fresh water in rivers and water wells (Gasparatos, et al., 2015). There is a negative correlation between clean water and crop yields with agrochemicals as variable. The more fertilizers or herbicides are used on lands, the higher the yields, but the lower the available amount of drinking water. And the less fertilizers, the lower the yields, but the higher the quality of water for the local community. The environmental impact of biofuels can be assessed through a Life Cycle Assessment (LCA) (Sekoai & Yoro, 2016). This tool estimates the level of water and agrochemicals used at every step of the life cycle in order to evaluate the entire burden of the project on the environment.

Environmental impacts: biodiversity loss

There are various drivers of biodiversity loss linked to biofuels. As mentioned before, direct and indirect land use change destroys fauna and flora on the lands transformed to monocultures for biofuels. Deforestation removes all the different trees and plants, while pesticides and other agrochemicals kill the animals surrounding the plantations. In the area, suddenly only one crop matters, even for farmers. Because feedstock for biofuels are more profitable for farmers, less people choose to grow food (Amiguna, Musango, & Stafford, 2011). Crops are not seen as food anymore but as cash, hence the name of cash crop. Biodiversity loss needs to be anticipated before the projects starts in order to minimize the loss as much as possible.

Environmental impacts: choice of crop

A challenge faced by biofuel companies is the choice of the optimal type of feedstock considering the climate, water availability, soil quality, yield target, biofuel type, level of sustainability and others constraints. In countries with very little rain, dryland crops like jatropha, maize and soybeans will be favored as sources of oil. The decision of whether or not to use food for fuel lies in the hands of the government. In countries like South Africa for example, they have the capacity to produce a surplus of maize and use this excess for biofuels (Pradhan & Mbohwa, 2014), but further research is needed to see if export would not be a better option. Besides having to identify the ideal crop and choosing between export and import, a biofuel producer also has to opt for the best solution between first, second and third generation biofuels. Second and third generation, although environmental friendly, are still too expensive for most countries to produce.

Gender issues

Women are often the ones providing energy and water for the family. Biofuels can therefore help women in the communities by making energy and water easier to access, through roads, water wells and an enhanced power grid. The work on the fields is also often their responsibility in order to provide food for the whole family. Unfortunately, when foreign investors acquire their lands, men are the ones cashing in because women rarely own the lands they work on. In Cameroon for example, women are doing 75% of the agricultural tasks, while only 10% of the lands are owned by women (Amiguna, Musango, & Stafford, 2011). Food security is therefore threatened; on one hand, they lose their most fertile lands and on the other hand women are driven away from the fields without any form of compensation.

African countries can still benefit a lot from agricultural development. Instead of using more arable lands and converting unused areas into croplands, productivity should be improved first. This is more environmentally friendly, because there is no direct or indirect land use change, therefore no increase in carbon emissions. Impact assessments are essential in order to identify the biggest social and environmental issues. Only when the impacts are identified and quantified will the management of the externalities be as efficient as it can be. Governments also play an important role in this story. They have the legislative power to sanction or stimulate certain behavior in order to maximize economic, social and environmental well-being. Unfortunately, official policies and strategies are still rare in Africa but governments know there is a need for good management if it wants sustainable development.

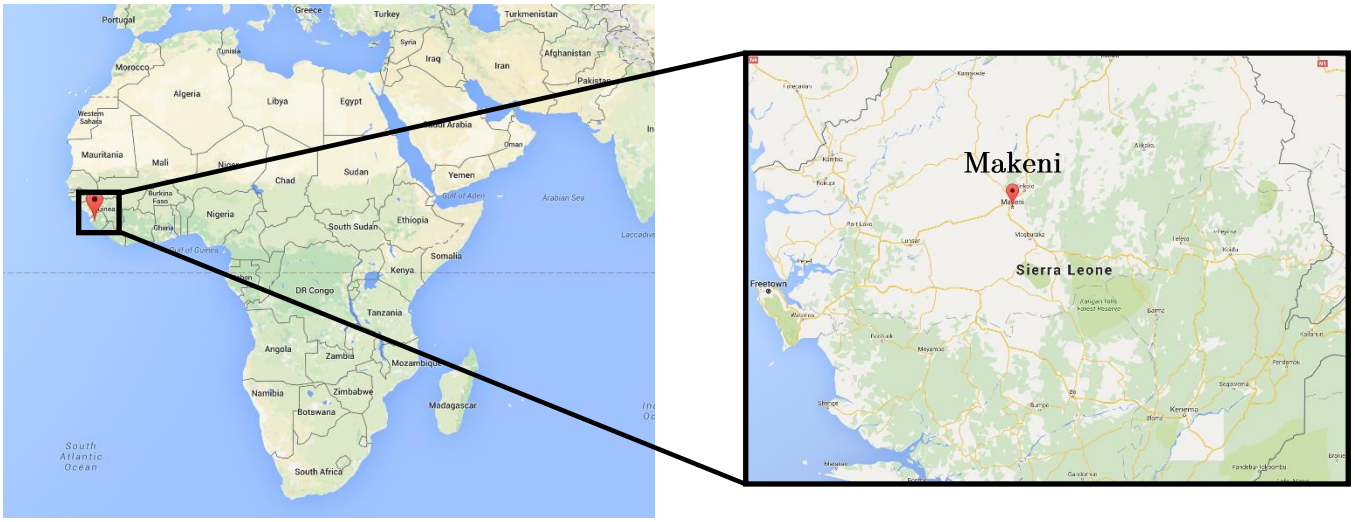
Large-scale projects have more chance of succeeding when using proven crops like sugarcane, which has been used in Brazil for decades, and maize, which is used by the US to produce half of the global ethanol supply. Even proven crops still need close monitoring to have the highest yields possible, especially for export where a stable output is required. Unproven crops like Jatropha need even more monitoring because they are riskier and the agricultural output is uncertain. On one hand, sugarcane ethanol is said to be the best option for biofuels in Africa because it has proven itself over the years. On the other hand, jatropha, which output is still very low compared to sugarcane, does not compete for food and water. It is also a feedstock for diesel, which is the most common type of fuel in Africa (Gasparatos, et al., 2015). More experience with jatropha could increase the use of it in the biofuel industry. Nonetheless, governments have to be very careful when allowing biofuel projects because many have failed in Africa, often due to low yields. Examples among many are SUN Biofuels in Tanzania, D1 Oil in Mozambique, GEM Biofuels and Tozzi Green in Madagascar (Gasparatos, et al., 2015).

3. Addax Bioenergy - The Makeni Project

Project description

Addax Bioenergy is part of a Swiss energy company called Addax & Oryx Group (AOG). In 2008 they started a biofuel project near Makeni, in Sierra Leone, with a clear objective of producing sustainable biofuels for the European market. Sierra Leone has a total surface of 7.1 million ha, which is about twice the size of Belgium. Freetown, Bo, Kenema and Makeni are respectively the capital and the three major cities of Sierra Leone (Figure 3: Location of the Makeni project). The country only recently emerged from a civil war, caused by government's corruption and mismanagement of natural resources (Fielding, et al., 2015). This war lasted from 1991 until 2002 and completely destroyed the country. The poverty rate is estimated at 70.2% and its average life expectancy is 57.8 years for a population of almost 6 million (Central Intelligence Agency, 2016).

Figure 3: Location of the Makeni project



Source: Google Maps

The country started to rebuild itself after the war, and Addax's project is said to help Sierra Leone in its development plans. The project is President Ernest Bai Koroma's flagship and it is, as he said, *«the biggest agricultural project ever in the history of Sierra Leone»* (State House, 2010). Three Chiefdoms near Makeni are providing the lands required for the project. Bombali Sebora, Malal

Mara and Makari Gbanti, a total of 14,000 people and 53 villages, are affected by the ethanol estate (English & Sandström, 2014). The area is about 57,000 ha[15], with 10,000 ha that will actually be used to grow sugarcane for ethanol. Annex 3 is an aerial photograph of the project that shows the circular pivot structure of the crops, which minimizes deforestation. These lands are being leasing by Addax for a period of 50 years. About 4,000 workers will be needed on the fields. The capacity of the ethanol factory is 90 million liters per annum of 220 business days. The additional power plant is to be generating 32 MW of bioelectricity through burning of bagasse (Manley, Lonsway, & Aron, 2010a). The project is a consequence of the European Union's new objectives regarding the climate change (Directive 2009/28/CE). On one hand, the ethanol produced will be exported to Europe, and on the other hand, 17 MW will be used to power the factory and the remaining 15 MW will be sold and put on the national grid. If the target output is reached Addax will provide 1.71%[16] of Europe's ethanol fuel supply and meet 20% of the power needs of Sierra Leone. One third of the electricity produced in the country comes from fossil fuel. A biofuel project like the one in Makeni can therefore significantly decrease the use of fossil fuel.

The project has a total cost of EUR 400 million. This investment has been financed by several European and African development banks, which ambition is sustainable investing. Six of them joined a debt pool, while the Swedfund and the FMO became equity partners with the AOG:

Table 1: Addax Bioenergy's investment pool organized by Cordiant

African Development Bank (AfDB)	EUR 25 million
Emerging Africa Infrastructure Fund (EAIF)	EUR 20 million
Netherlands Development Finance Company (FMO)	EUR 25 million
German Development Finance Institution (DEG)	EUR 20 million
South African Industrial Development Corporation (IDC)	EUR 22 million
Belgian Investment Bank for Developing Countries (BIO)	EUR 10 million
Debt pool manager: Cordiant Capital	EUR 11 million
Debt Pool	**EUR 133 million**

[15] 19 km x 30 km, or three times Brussels

[16] 90,000,000L / (1,387 millions of gallons * 3.785 L/gallon) = 0.0171

The Swedish Development Fund (Swedfund)	EUR 83 million
Netherlands Development Finance Company (FMO)	EUR 83 million
Addax & Oryx Group (AOG)	EUR 100 million
Equity partners	**EUR 267 million**

Source: (Bio-Invest, 2011), (Addax Bioenergy, 2013)

The development partners confirmed the sustainability standards of the World Bank's International Finance Corporation (IFC) were part of the loan covenants. The IFC focuses on six areas, for which transparency is key: availability of land and water, climate change mitigation, sustainable financial market, gender equality, management of natural resources and infrastructure to stimulate economic growth. In 2008 the AfDB therefore contracted a team of researchers to perform an Environmental, Social and Health Impact Assessment and a Resettlement Action Plan in Sierra Leone (Manley, Lonsway, & Aron, 2010a), (Manley, Lonsway, & Aron, 2010b). Their main conclusions were that first, the project complies with all the sustainability criteria of the Roundtable on Sustainable Biomaterials (RSB) (Annex 2: Indicators of Compliance for the RSB EU RED Principles & Criteria), second, almost no displacement of people will be required, and finally, the environmental, social and health impact will be seen as acceptable to society and the environment.

This innovative project is a first of a kind in the region because of its focus on sustainability. The good relationships with all stakeholders is a priority for the company. Addax wanted to make sure their project was not considered as the conventional land grabbing. Therefore; they rented the lands, instead purchasing them, they established a public and fully transparent negotiation process, and they provided the people with a law firm of their choosing to assist them during the negotiations. More than a fair compensation is paid for the lands compared to the standards in the region. The promise of job creation and poverty reduction made the negotiation process much easier.

Less than 1% of the households has access to electricity and more than half of the people are illiterate (Fielding, et al., 2015). Economic development would bring food security in a country where 'hunger months' still exist. The development of infrastructure contributes as well to the development of the whole surroundings. Roads are being built, modern irrigation systems are installed and the power

grid is extended to retrieve the excess power of the new power plant. Not only can local farmers benefit from using the irrigation system and the electricity, but Addax also created a Farmer Development Programme (FDP) to teach communities to farm more efficiently. The environment is being preserved as well because the whole project uses at most 2% of the nearby Rokel River. The fauna and flora have been carefully displaced to minimize the impact on their habitat. On top of the many benefits, the ethanol produced has 71% less carbon emissions than fossil fuel, which is well above the 50% required for exportation to Europe.

In March 2013, Addax Bioenergy was rewarded, as the first biofuel entity in Africa, with an RSB certificate. Quoting Peter Ryus, CEO of RSB Services, *«Addax Bioenergy has become a model for sustainable projects in Africa»* and *«While they are just beginning their ethanol production this year, they have set up their business to meet RSB's very strict sustainability standards that encompass not just the environment, but more importantly people. We applaud them for leading the way in sustainable biofuels in Africa and introducing innovative social solutions to the local communities.»* (RSB, 2013).

These words are very reassuring and promising for the future of the biofuel industry in Africa. *«This proves that one can create a successful investment in Africa and also comply with world class sustainability standards»*, Simon Cleasby, CEO of Addax Biofuels (RSB, 2013).

The downscale

On June 25th, 2015, only one year after having officially started the production of bioethanol and bioelectricity for commercial use, Addax announced on their website that they would downscale the operations due to unforeseeable events. One year later, the factory is still not producing any ethanol. Unfortunately they are not the first ones in Africa to have had some serious trouble meeting their output targets (see page 17, Actual employment). Besides the Ebola outbreak, The Company has not, publically, given all the reasons behind the downscale, but unofficial opinions from various

stakeholders[17] have been gathered. The Ebola outbreak of May 2014 has had a massive impact on the project. As of March 2016, the World Health Organization brings the total lives lost to Ebola at 3,590 in Sierra Leone alone (WHO, 2016). This epidemic spread fast, and expatriates on site had no other choice than to leave the country at the peak of ethanol production. These foreigners were responsible for all the technical tasks, and when they left, claiming force majeure, the factory was shut down. Another possible explanation that contributed to the problem is the crash of oil prices. In June 2015, one barrel of crude oil had lost 31% compared to one year earlier[18]. The price kept falling until February 2016 when it had lost 57%[19]. The next month Addax announced it would extend the downscale for at least another six months. Low energy prices are bad for the biofuel industry because cheap oil makes expensive biofuels less attractive. NGO Sierra Leone Network on the Right to Food (SiLNoRF) also mentioned a cost overrun and the inability of the Company to keep supporting financially the operations in Sierra Leone. The development banks partially confirmed this theory, as EAIF stated: *«Addax & Oryx group as owners of Addax Bioenergy are seeking to attract co-investors to co-fund further investment that is required to further develop the project. This does not impact the lenders, as Addax and Oryx group repaid all outstanding loans in December 2015».* People and NGOs feared for a complete shutdown, however, this means the Company is looking for additional investors to keep the project alive. Finally, low yields on a biofuel project have brought more than one company down, and Addax is no exception. For unknown reasons, companies are often unable to reach their target output. Logistics, low soil quality and low seed quality as well as thievery of equipment are possible causes that have been mentioned, but those should not be that overwhelming for a multi-million dollar company. Unofficial numbers between 7 and 10 million liters of ethanol have been produced and sold to the European Union in May 2015, one month before the downscale.

[17] SiLNoRF, De Smet Engineers and Contractors (DSEC), Development Finance Institutions (DFI) aka Development Banks, (Fielding, et al., 2015) and Addax employee

[18] Marketwatch.com: June 2014, USD 90.94 - June 2015, USD 62.17

[19] Marketwatch.com: June 2014, USD 90.94 - February 2016, USD 39.10

Analysis of the positive externalities

Energy security: independence

Addax Bioenergy has built a 32 MW power plant, which can produce as much bioelectricity as 10 wind turbines of 3 MW. At an average of 20% capacity[20], this power station can produce 56 million kWh[21]. 17 MW is used to power the ethanol factory and 15 MW is destined to be sold and put on the national grid. The latest available data of 2012 estimates the power consumption of Sierra Leone to be 135 million kWh, from which one third is from fossil fuel and two thirds from hydroelectric plants (Central Intelligence Agency, 2016). This means that Addax could provide enough bioelectricity to power 19.47%[22] of the country. Although this is a lot for a country where not everybody has access to electricity, this would only supply 0.03%[23] of the power needs of a country like Belgium.

According to the latest measured data of 2012, Sierra Leone does not import any electricity from their neighbors, nor do they export any (Central Intelligence Agency, 2016). This means the country is already independent on a power level. Sierra Leone, just like most of the other Sub Saharan countries, has the ambition to expand the access to energy to more communities. With a 15 MW power facility the country can develop its power grid by at least 20% before importing energy resources and having to rely on trading partners. This means that Sierra Leone will stay independent from other countries for the next few years and they will not have to worry about the volatility of international prices of electricity.

Unfortunately the ethanol produced in Makeni will not be destined for the local market, but instead it will be sold on the European markets. This means that 1.6 million barrels or 255 million liters of petroleum imported each year in Sierra Leone will not decrease with Addax' project.

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[20] (220 days * 8 hours/day) / (365 days * 24 hours) = 20%
[21] 20% * 365 days * 24 hours * 32,000 kW = 56,064,000 kWh
[22] 56,064,000 * (15 MW / 32 MW) / 135,000,000 = 19.47%
[23] 56,064,000 * (15 MW / 32 MW) / 81,890,000,000 kWh = 0.03%

As mentioned before, the US has a break-even price for their ethanol of around USD 40 (EUR 35) per barrel, Brazil USD 30 (EUR 27) and Europe USD 100 (EUR 89). The project was set to process 4,800 tonnes of sugarcane per day, which will produce an annual output of 90 million liters of ethanol (Manley, Lonsway, & Aron, 2010b). Because the production cost is USD 20 per tonne of sugarcane, the break-even price of the bioethanol from Sierra Leone is USD 37 (EUR 33) per barrel[24].

Energy security: supply diversification

According to the Law of Supply and Demand, the day Addax is going to connect its power plant to the national power grid, electricity prices are going to plummet. The different suppliers also help to keep prices more stable, due to the first rule in finance for risk hedging when investing: diversification. Sierra Leone will have access to homemade electricity from hydroelectric plants, hard coal and biomass.

Again, because the ethanol from this project will not be sold in Sierra Leone, there is no fuel diversification. People will still rely on international market prices, the currency exchange rate and its volatility. However, having a biofuel production facility that has the capacity of supplying 35%[25] of the liquid fuel needs can be helpful in times of crisis or conflict. Most of the fuel is for transportation, and the fuel used is exclusively diesel. Therefore, because of a lack of demand for Addax' ethanol, it would not have contributed to the fuel diversification of Sierra Leone. Fielding, et al. (2015) have a different perspective. 99% of households are cooking with firewood or charcoal. Using ethanol would be healthier because it creates less polluting fumes. If 10,000 households, living close to the project area, would switch to ethanol, Fielding, et al. (2015) estimate they would need between 3 and 5 million liters of fuel every year. This is only 3 to 6% of Addax' annual output, which means the Company could provide fuel to much more Sierra Leoneans beyond the local

[24] (((4,800 tonnes/day * 220 day) * USD 20) / 90,000,000 liters/year) * 158.99 liters/barrel = USD 37.31/barrel

[25] 90,000,000L (Ethanol) / 255,000,000L (Fossil fuel) = 35.29%

communities. By looking at it that way Addax could possibly contribute to the diversification of cooking fuel.

Energy security: enhanced infrastructure

The development of Sierra Leone's infrastructure is essential if the country wants to pull itself out of poverty. Economic progress can only be achieved if roads are being built for transportation of goods and people, and if a decent power grid supplies most of the country. Energy infrastructure is still non-existent in the project area (Fielding, et al., 2015). If the government does not expand its power grid, they will not be able to benefit from Addax' power plant. The local authorities often lack good management in African counties. Roads are a public good that should be implemented by the relevant authority. However, as the project area was not covered by proper roads, over 440 km had to be built by Addax itself to be able to transport the equipment to the site and its ethanol from the refinery to the main road (Addax Bioenergy, 2015). A medical station has also been built next to the factory. It was mainly meant for the employees, but it is now often used to treat locals as well. Now is the time for the government to start building schools, roads, public hospitals and expand the power grid to the power plant. This way foreign investors stimulate the development of, or develop themselves, the country's infrastructure.

Reduced GHG emissions

The biofuels produced in Sierra Leone are meant primarily for the European market, and this involves the compliance with certain sustainability criteria. First of all, to be considered sustainable, biofuels need to save at least 35% GHG emissions compared to fossil fuel. In 2017 this saving will have to be at least 50%, and 60% in 2018 (Directive 2009/28/EC). Secondly, biofuels made on converted lands, with high carbon stocks, like forests, will not be accepted on the European market. The third, and last, criterion is that the converted lands cannot have held a high level of biodiversity that will be lost due to the biofuel production. An external audit is mandatory to ensure an objective

observation of the three requirements. These criteria are established by the European Union in order to decrease its footprint and limit climate change.

In May 2015 Addax Bioenergy successfully sold ethanol to Europe, meaning they comply with the directive 2009/28/EC and its requirements. The amount sold is not known as they did not want to share that information. However, it is estimated that between 7 and 10 million liters have been exported (SiLNoRF, 2016). According to an external audit's calculations the ethanol produced in Makeni will be releasing 71.48% less greenhouse gasses than regular fuel over the entire lifecycle: cultivation, processing, transport and the use of the ethanol (Manley, Lonsway, & Aron, 2010b). The UK Biomass Energy Centre estimates the CO_2 emissions of oil to be 87 kg/GJ or 87 grams per MJ. Addax' ethanol has a 23.90 grams of CO_2 emission per MJ, which is indeed 72.53%[26] less than oil. Not only does it comply with today's regulations, but it will also still be authorized for import after 2018. The lands chosen for growing sugarcane have been carefully selected in order to avoid as much clearance of vegetation and trees as possible. When bushes or trees did get removed, to free some space for the crops, seeds were planted elsewhere in order not to decrease the absorption capacity of the planet. In 2012, 89,000 seeds of various types of fruit vegetation and 27,000 different sorts of forest trees have been potted. In 2013, 56,308 of these plants germinated and were transplanted (Bisset & Driver, 2014).

Fertilizers are known to be a major player in the GHG emissions because of the nitrous oxide (N_2O), which can trap 300 times more heat than CO_2 (Mole, 2014). Another by-product from the ethanol industry is a nutrient rich product called vinasse. This can be resprayed on the fields in order to replace industrial fertilizers. Unfortunately, Addax has not used this by-product yet, but it is one of their objectives for the future.

As mentioned before, Sierra Leone uses coal to generate 33% of its electricity needs, or 45 million kWh. According to the UK Biomass Energy Centre, a typical European house consumes 20,000 kWh per year in heating power. If hard coal is used to heat that house, 8,280 kg of CO_2 is released

[26] 1 - (23.90 grams/87 grams) = 72.53%

each year. The electricity production in Sierra Leone therefore has 18,630 tonnes of CO_2 emissions each year. Addax' substituted bioelectricity can therefore save 10,882 tonnes[27] of CO_2. To put this into perspective, according to the World Bank the average Belgian is responsible for 10 tonnes of CO_2 emissions a year, taking into account all different types of energy consumed.

Poverty alleviation

The benefit people of Sierra Leone most care about is the poverty alleviation and the promise of a better life if they agree to let Addax come. People got their hopes up to the idea of more employment in the Chiefdoms. This meant their income would increase, as well as the food security. 7 years later it has been observed that people were indeed generally better off since the arrival of Addax Bioenergy (SiLNoRF, 2014). Their income has risen through jobs, land lease and compensation of assets. Even the local authorities have seen a significant increase in revenues with the land leases. This has led to new homes being built, more children being sent to school, schools being improved and roads being built to access more lands for cultivation (Addax Bioenergy, 2015).

Local NGOs, Bread For All and SiLNoRF, have confirmed that long-term employment contracts have increased and that the issues regarding the lack of written contracts have been resolved, resulting in increased job security. People working for the company are paid much more than the minimum wage in Sierra Leone (SiLNoRF, 2012). An average worker receives between SLL 325,000 (EUR 71.5 [28]) and SLL 400,000 (EUR 88) per month (Baxter & Schäfter, 2013), whereas the minimum wage has not changed since The Minimum Wage Act of 1997 and is at an alarming SLL 21,000 (EUR 4.62) per month (Kabbah, 1997). As of March 2015, 1,604 permanent jobs have been created and 2,243 casual workers are contracted by Addax in a region where 14,000 people live. The area currently used by Addax is about 24,656 ha, and the project has therefore an average of 0.14 employees per hectare. The number of employees has been steadily increasing over the last few years

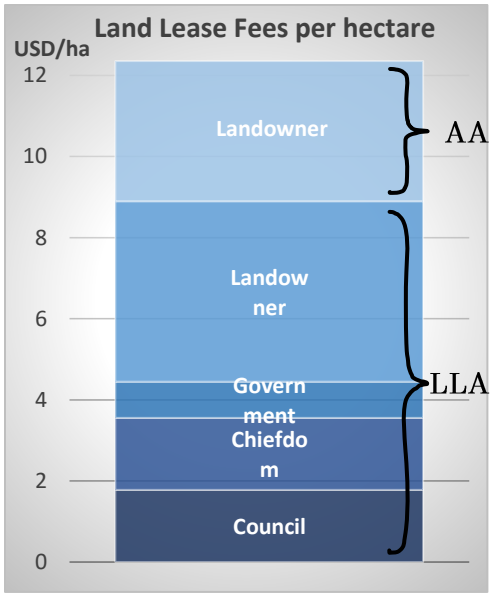
[27] (19.47% * 135,000,000 kWh) * 0.414 kg CO_2/kWh = 10,881,783 kg CO_2

[28] Average rate SLL to EUR in June 2016 is 0.00022

as shown in Annex 4: Number of fixed and seasonal contracts at Addax (2012-2015). Unfortunately, the impact of the downscale on jobs is also clearly visible.

The Chief of one of the villages testified: *«We are thankful to Addax. They came with money. Before, we were all poor.»* (SiLNoRF, 2016)

Besides revenues from employment, communities have been receiving regular compensations for the lands they have lost. Addax has kept its promise and paid USD 3.60 (EUR 3.19) per acre[29] of land as agreed upon in the Land Lease Agreement (LLA), article 1.1 [30]. The fees paid are distributed among the District Council, 20%, the Chiefdom Administrator, 20%, the National Government, 10%, and the Landowners, 50%. Addax went further and added an Acknowledgment Agreements (AA), which pays an annual fee of USD 1.40 (EUR 1.24) per acre directly to Landowners, even though it is not customary in Sierra Leone to compensate landowners directly (English & Sandström, 2014). Whereas LLA are signed by Chiefs, AA are signed by Landowners. A community of 500 hectares, or 1,236 acres, will consequently receive USD 3,955[31] (EUR 3,507) per year, whereas the District Council and the Chiefdom Administrator will receive each USD 890 (EUR 789) and the National Government USD 445 (EUR 395). In 2015, the District Office had already received accordingly a total of SLL 996,618,000 million (EUR 219,256), from which half is due to Landowners. Another SLL 387,534,000 (EUR 85,257) was paid on top of that under the Acknowledgement Agreement. SiLNoRF (2016) has witnessed people using the money from the lands leased to renovate or rebuild their house.



[29] 1 acre is about 64m x 64m; 1 hectare is 100m x 100m

[30] Article 1.1 of the Land Lease Agreement: … therefore during the said term from the commencement of the Lease the yearly rent of US$3.60 per acre of the Demised Premises from the commencement of the Lease unless and until such acre is surrendered in accordance with this Lease.

[31] (50% * USD 3.60 + USD 1.40) * 1,236 acres = USD 3,955

A last source of cash for the communities is the one-off payment as compensation for destroyed assets. The LLA covers only the lands and therefore an Asset Compensation Programme has been put in place to make up for the loss of assets. The assets were mainly crops and economic trees, which have been defined as *«trees, shrubs or plants that are grown for their intrinsic value»* (English & Sandström, 2014). These trees are compensated at a price that is seen as fair by both parties and with the approval of the Ministry of Agriculture, due to a lack of official rates. Even though the Ministry has a list of values for economic trees (Baxter & Schäfter, 2013, p. 79), it is not used as an official minimum compensation rate. The vast majority of economic trees are palms, that are used to make palm oil (Fielding, et al., 2015). Addax is paying SLL 35,000 (EUR 7.70) for each palm tree destroyed (SiLNoRF, 2014), which is more than the SLL 25,000 (EUR 5.5) price tag from the Ministry. These are one-time payments and have cumulated to SLL 63,656,316 (EUR 14,004) during the pilot phase (Manley, Lonsway, & Aron, 2010a) and up to SLL 7.3 billion (EUR 1.6 million) in February 2014 (English & Sandström, 2014).

Not only do the additional sources of revenue contribute to the poverty alleviation, but increased productivity on the small-scale farming fields can help as well. Low productivity means low yields, which results in low income and hunger. The region still had the so called “hunger months” in August and September, proof of the extreme poverty in Sierra Leone. In order to have a sustainable development Addax had to eradicate these hunger months and create food security. The aim was at first to ensure people still had enough food even though they lost part of their land. With this purpose a Farmer Development Programme (FDP) was created in various villages to improve the farmers’ farming techniques in the communities affected by the project. 2,000 hectares have been made available for the three year programme. Participating villages can, free of charge, cultivate rice with machines and storage facilities provided by Addax. Annex 5 shows it got to a slow start due to the late preparation of the fields, low quality soils and weather conditions (SiLNoRF, 2014). In 2014, 22 villages left the programme for the first time after completion of their three year training. By 2015, only 17 villages were remaining, of which one village enrolled as the last one in that same year, meaning the FDP will end in 2017. During the programme farmers are encouraged to apply

at the Farmer Field and Life School (FFLS) where they are thought how to improve their agricultural practices, but also other social topics like savings, loans, sanitation, reading and mathematics (Bisset & Driver, 2012). They graduate after 30 weeks of training and are told to share what they learned with their community. Addax' FDP had a minimum yield target of 104 kg of rice per person because this is the amount estimated to feed one person for a whole year. Villages in Bombali Sebora and Makari Gbanti failed to the reach the target in 2013 with hunger as a potential consequence (Annex 5: Farmer Development Programme's annual rice yields (2012-2015)). Bisset & Driver (2013) explained the sudden drop in yields by a low participation in the harvest weighting and extensive leakages where people harvested their rice before the due date. The price tag of the FDP went up to USD 2.2 million (EUR 1.95 million) in February 2014 and is running at a cost of USD 0.7 million (EUR 0.62 million) per year. This means the programme has a current price tag of USD 3.95 million[32] (EUR 3.5 million) as of August 2016. Even though the FDP has not always been perfect, it indisputably contributes to improved productivity, and therefore to more food security for the surrounding communities. Addax even claims hunger months have disappeared for the first time in many years (English & Sandström, 2014).

A field study conducted by the Stockholm Environment Institute was conducted in 6 villages affected by the project (Fielding, et al., 2015, p. 21). This sample was chosen to portray a fair image of the 53 villages in the project area. The amount of land leased to Addax varies from 20% to 52% of the community lands which shows that people did not lose their entire property. This inference has been corroborated by Addax, because displacement of people is almost nonexistent in this project. Half of their lands, or more, can still be cultivated for food, with an improved productivity after completion of the Farmer Development Programme. In 2012, Bisset & Driver (2013) surveyed all households in the area affected by the project in an independent monitoring report for Addax. Some results have been copied in Annex 6: Selected Human Development Outcome Indicators: Comparison between 2012 and Baseline (2010). The average monthly income per household has significantly increased from SLL 32,000 (EUR 7.10) in 2010 to SLL 98,000 (EUR 21.62) in 2012.

[32] 2.2 million + (30 months/12 months) * USD 700,000 = USD 3.95 million

The World Bank set the poverty line at less than USD 1.90 (EUR 1.68) per day PPP, which is about SLL 4,035. According to those numbers the average household went from being extremely poor with SLL 1,066 a day, to being poor with SLL 3,272. People have also increased their lifestyle during the 2010-2012 period. Whereas the average livestock (chickens, goats and cows) decreased by more than half, probably due to land loss, the average number of people with 'luxury goods' (bike, metal roof, mobile phone, motor bike and radio) has significantly increased. Especially mobile phones have expanded a lot, with 1 out of 10 owning a phone in 2010, and 4 out of 10 in 2012. Addax' SLL 400,000 monthly wage, or SLL 13,333 daily, should therefore help its employees to get out of poverty.

Available technology

Addax Bioenergy is part of the Addax & Oryx holding, which is a Swiss based entity specialized in supplying oil and gas in Africa. Through the Addax Company they bring the advanced knowledge of the energy industry into one of the poorest and underdeveloped regions in the world. A Belgian company called De Smet Engineers and Contractors helped building the estate in Sierra Leone, bringing their expertise in sugar refining and ethanol extraction. The technology to produce first generation biofuels from sugarcane is simple and has been used in Brazil for decades, where there is an overproduction of sugar. The approach is exactly the same and there is no need for research and development because first generation biofuel technologies have already reached high levels of efficiency. Investments are now more useful in second generation biofuels, that are still expensive to produce, but they have a high potential in mitigating the downsides of first generation biofuels. There is no limitation in the lands available that would force Addax to invest in second generation technology either. Therefore, because the technology is widely available, cheap and efficient the Company chose to produce a target of 90 million liters of first generation sugarcane ethanol in Sierra Leone.

As mentioned before, 99% of all households interviewed by Fielding, et al. (2015) use firewood to cook. An alternative, to relieve some stress on the trees, could be to use some of the ethanol produced by Addax as cooking fuel. Unfortunately people do not have the proper equipment to switch, neither do they have the money to buy cooking fuel, something they currently collect for free. Even the trucks, tractors or power generators in Africa cannot benefit from the biofuels because they all require diesel, not gasoline. Hence, the biofuels produced will not flood the local market. In Europe however gasoline engines are common. Addax' ethanol will therefore target the European market, where the appropriate technology is already in place in the automotive industry, as mentioned in the literature (Pradhan & Mbohwa, 2014). The current technology is therefore, even for a project in Africa, a driver and not a brake, for a biofuel expansion.

Waste management

Addax' waste management tries to extract as much as possible from the by-products. From the sugarcane, they are able to extract the molasses, which is a sugar-rich paste. From the molasses they can produce the ethanol and the by-product called vinasse, which can be used as a fertilizer due to its high nutrients content. In the end they are left with dry cane residues that will be burned in the 32 MW power plant to generate bioelectricity. Their waste management is highly environmentally friendly as they use waste instead of fossil fuels to power their facilities, and they are to be using renewable fertilizers in the future. As a result, the ethanol produced could have been carbon-neutral if not for the fossil fuel used for the tractors and the transport trucks. The CO_2 emissions saved through a proper waste management can be estimated by calculating the CO_2 that would have been emitted if hard coal was used to power the facilities. The CO_2 emission from hard coal has already been calculated in a previous section (Reduced GHG emissions, page 30). If the substitution of hard coal electricity with Addax' 15 MW power plant saves 10,882 tonnes of CO_2, then a 17 MW power plant would have saved 12,333 tonnes of CO_2. Therefore, Addax' the waste management saves 12,333 tonnes of CO_2 per year from going into the atmosphere.

Sustainable development

In order to have sustainable development, there needs to be a development that benefits the investor, the local people and the government without jeopardizing any natural resources that might harm future generations. Once the sugarcane yields are high enough to reach a target processing quantities of 4,800 tonnes of cane, the ethanol sale is expected to earn Addax USD 53 million (EUR 47 million) per year (Bread For All, 2011). People will benefit through the enhanced infrastructure around the project area. Addax is also pumping each year almost EUR 3 million[33] into the local economy via employment and over EUR 300,000 [34] in LLA and AA. Additionally, EUR 1.6 million in asset compensation and EUR 3.5 million through the FDP and the FFLS have already been invested to improve people's welfare. It is safe to say that most people's needs have been met, as they are not hungry anymore and they have money to buy more luxurious goods. Because the lands are rent and nothing is extracted from it, unlike goldmines, people will get their lands back, unchanged. Therefore future generations will not be deprived of their ability to meet their needs.

Deforestation has been minimized as much as possible through circular pivots, and more than 50,000 seeds have been planted to have no impact on the environment.

Finally, the transparency of the project is exemplary. Land negotiations were public and lawyers were provided to make sure landowners understood the agreements they signed. A lot of information and studies have been available publically since the start of the project and NGOs and other stakeholders have been involved right from the beginning. Addax listens, and they try to find solutions to all complains through a grievance mechanism they have put in place. If they want to keep their RSB certificate and keep selling their bioethanol to Europe, they have to keep the sustainability of the project as one of their priorities.

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[33] [1,604 employees (permanent) * EUR 88/month * 12 months]
+ [2,243 employees (casual) * EUR 88/month * 6 months] = EUR 2,878,128

[34] Land Lease Agreements 2015: EUR 219,256
Acknowledgement Agreements 2015: EUR 85,257

Analysis of the negative externalities

Even though the Makeni project has many benefits on an economic, social and environmental level, some downsides, mostly industry-related, cannot be ignored.

Land grabbing

Land grabbing is seen as a very negative consequence of the global biofuel expansion, but it is dangerous only if not managed properly. Land Matrix has recorded 30 transnational land deals in Sierra Leone, piling up to a staggering 2.4 million hectares (Annex 7: International Land Deals in Sierra Leone (2000-2015)). This means that more than one third[35] of Sierra Leone is in the hands of foreign investors. The surface suitable for cultivation in Sierra Leone is estimated to be 5.36 million hectares (SiLNoRF, 2012), and the land deals therefore affect 45% of all the arable lands. People around the world often link large scale investments in Africa to corruption, lack of transparency, violation of human rights, displacement of local people and food insecurity due to the loss of crops (English & Sandström, 2014). Addax Bioenergy was well aware of these problems and they have put a lot of effort in trying to avoid the negative connotations land grabbing has. Nonetheless, NGOs on site still mentioned some issues regarding the dispossession of farmers' lands.

A closer look at the Land Lease Agreement written by Addax, available on the Food and Agriculture Organization website of the United Nation (fao.org), shows some concerns with the clauses. According to article 4, subparagraph 4[36], Addax Bioenergy has the right to remove any building,

[35] 2,408,247 ha / 7,075,641 ha = 34.04%

[36] Article 4.4 of the Land Lease Agreement: The Company is entitled to:
(a) erect or remove any buildings, fixtures or structures;
(b) install or alter any roads, conduits or other services;
(c) alter the level of the land;
(d) carry out earthworks;
(d) stop up or alter the course of any watercourse;
(e) reduce or remove vegetation,
in each case on, under or over the Demised Premises at any time during the lease period.

watercourse and vegetation at any point in time during the lease period. Even though it is understandable alteration or removal can sometimes be unavoidable, Addax has written this clause in such a way that they can do almost anything they want, regardless of the environment and the local people. This can have serious consequences for women who will be forced to walk further to collect water, firewood or medicinal herbs (SiLNoRF, 2012). Addax responded to this issue by mentioning article 4.4[37] as well, which forces the Company to compensate for any involuntary displacement. However it does not refer to any compensation for any displacement of water or vegetation, which could have the same consequences. Article 5.2.a[38] requires all disputes to be settled in London. This will discourage people to sue Addax, as they do not have enough money to finance such lawsuits. Addax mentioned however that they now do provide legal representation from a legal firm in Freetown, paid for by the Company (English & Sandström, 2014). The final, and probably most concerning, issue with the Land Lease Agreement is right from the start in Article 1.1[39]. The lands may not be bought but a 50 year lease does look like an actual sale, especially in a country that has a life expectancy of 57.8 years (Central Intelligence Agency, 2016). Nevertheless, Addax keeps denying any type of land grabbing since there is *«no violation of human rights»*, *«based on free prior and informed consent of affected land users»*, *«based on a thorough assessment of social, economic and environmental impacts»* and *«based on transparent contracts that specify clear and binding commitments about activities, employment and benefit sharing»,* which is all true according

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[37] Article 4.4 of the Land Lease Agreement: … the Company shall not be entitled to require a Permitted Third Party to cease to reside on any part of the Demised Premises except in exceptional circumstances and then it shall not be done without agreeing to pay to the affected party compensation agreed by the Chiefdom Council, the affected person and the Company each acting reasonably…

[38] Article 5.2 (a) of the Land Lease Agreement: All Disputes shall be referred to and finally resolved by arbitration in [London] before [three] arbitrators under the [Rules of Arbitration of the International Chamber of Commerce] from time to time in force.

[39] Article 1.1 of the Land Lease Agreement: … any such matters belonging to Permitted Third Parties together with the rights set out in Schedule 2 over the adjoining and neighbouring land of the Chiefdom Council (the "Adjoining Land") TO HOLD the same unto the Company for a term of Fifty (50) years from the …… day of ……. 2009 …

to the field researches that have been made over the years: (Manley, Lonsway, & Aron, 2010b) (Baxter & Schäfter, 2013) (Bisset & Driver, 2014) (English & Sandström, 2014) (SiLNoRF, 2014) (Fielding, et al., 2015). And because the project is under continuous observation they are limited in their actions that impact the environment or the communities' well-being.

Food security: food versus fuel

Sierra Leone has a poverty rate of 70.2% and a 45% food insecurity (Central Intelligence Agency, 2016), (Fielding, et al., 2015). When rich foreign investors come to one of the poorest regions in the world to produce biofuels it might raise some questions. How acceptable is it to transform food into fuel? Or to put in a cruel way, is it ethical to take food from starving people's lands so that rich people could use it to drive around? Unfortunately, the first research studies in the region started in 2010 and therefore no actual data of the food crisis of 2008 is available. However, in 2008, Sierra Leone ranked 84 out of 88 in the Global Hunger Index and the World Food Programme had to consequently feed 473,800 starving people that same year (WFP, 2008). This is understandable as an average of 63% of their income is spent on food, and in 2008 the food inflation rate hit 23% (Trading Economics, 2016). The rate of revenue spent on food is an average, meaning a lot of Sierra Leoneans spend more than that. A 23% inflation meant 77% of their revenues had to be saved just for food. However, even after the food crisis people have still been going through hunger months. Because of the hot weather from June through August there is a lack of water. As a consequence, food and drinking water becomes scarce during that period.

The thought of using food to make fuel in a region with such levels of food insecurity seems mad. Still, in order to have a higher and more stable food production, agricultural development is essential. The ultimate goal is economic growth and poverty reduction. The benefits of a biofuel project on an economic, social and environmental level have already been discussed, but it is appropriate to repeat that Addax has claimed to have eradicated the hunger months in the area of its activities. All studies agree that generally people have been better off since the arrival of Addax.

Therefore food security and biofuels are not always exclusive, but sustainability is always mandatory.

Nonetheless, two issues regarding food security have been identified. Firstly, according to some testimonies gathered by SiLNoRF, Addax promised the bolilands were not going to be part of the project, and people could therefore keep cultivating them (SiLNoRF, 2014). Bolilands comes from boli, which is a word used by Sierra Leoneans for lands that flood during the rainy season. These lands are highly fertile and are ideal for rice cultures. Despite the promise made not to use the bolilands, Addax did include the fertile lands of many village into its plans, claiming they never made any promises. This can be a serious threat to the food security of the local people relying on the high yields of their lands. In 2015, Addax started to give some of the bolilands back to the communities, but many of them are still used for sugarcane plantations. The second issue is about the Farmer Development Programme (FDP) and the yields during the pilot phase. Annex 5: Farmer Development Programme's annual rice yields (2012-2015) shows the average output since the start of the programme. During the first three years yields have been low, sometimes even under the minimum target of 104 kg of rice. Since then, rice harvests have increased drastically, resulting in more than eight times the target yield per person. This can be explained by the experience with the programme, more supervision and less villages still enrolled, therefore more land per person.

Actual employment

According to the literature, the main issues regarding jobs in the African biofuel industry are: the seasonal jobs, the impact on workers when the project fails, child labour, low wages, and health and safety of workers on the fields.

On the Makeni project there have been no complaints regarding child labour. This would be in direct violation of Principle 4[40], Human and Labor Rights, of the Roundtable on Sustainable Biofuels

[40] Criterion 4.c: No child labor shall occur, except on family farms and then only when work does not interfere with the child's schooling and does not put his or her health at risk.

(Annex 2: Indicators of Compliance for the RSB EU RED Principles & Criteria). If cases of child labour were to be confirmed, they would lose their RSB certificate. And because their financial help, from development banks, is linked to the sustainability of the project, a revocation of their certificate could put an end to their financial support.

In 2012, strikes about Addax' low wages have been reported (SiLNoRF, 2014). Employees currently earn SLL 400,000 (EUR 88) per month, which is much higher than the minimum wage of 21,000 (EUR 4.62) per month. The average wage in Sierra Leone at similar companies is between SLL 161,182 (EUR 35) and SLL 241,818 (EUR 53) per month[41], which is far below what Addax is paying (Baxter & Schäfter, 2013). Nonetheless, Baxter & Schäfter (2013) estimated the monthly expenses of an average household to be SLL 633,292 (EUR 139), which is still too high to be supported by one job at Addax. The estimation is solely based on a household of seven, with one meal per day, firewood and school supplies. Transportation, clothing, healthcare and other costs have not even been included. Therefore it is understandable that people feel one Addax wage is not enough to provide for their family. No other strikes regarding wages have been reported, even though there has not been any significant raise of employees' wages.

Every company active in the agriculture business has the same issue regarding the duration of contracts. Because the same workforce is not required all year long on the fields, part of the jobs created are seasonal, i.e. between 3 and 6 months. This means some people are hired only when crops have to be planted and when they have to be harvested. But at the exact same moment more workforce is also needed on the community fields. As a result, Addax creates a shortage of man power during the high seasons, and a surplus during the low seasons when there is less work. This creates a lot of uncertainty, inter alia about food insecurity (Anane & Abiwu, 2011). In March 2015, more than 63% of the employees were on a short-term contract, a number that has been increasing since 2013 (Annex 4: Number of fixed and seasonal contracts at Addax (2012-2015)).

[41] The numbers used in the study are USD 2 and USD 3 per day

The downscale of the last two years has had a massive impact on the people in the area. A study stated that 38% of households in the surrounding villages are relying on at least one wage paid by Addax (Fielding, et al., 2015). In other words, the actions taken by the Company has a substantial impact on all communities. 52% of its employees have been laid off between March and December 2015 (Annex 4: Number of fixed and seasonal contracts at Addax (2012-2015)). Only 642 people still receive a regular salary for their full-time job, whereas 1,128 obsolete employees have seen their paychecks reduced by 55% (SiLNoRF, 2016). Huge disappointment is felt in the communities as not only did Addax take a part of their lands, but the Company also fails to provide the money people are now relying on. A previous testimony cited in the Poverty Alleviation chapter on page 32, continues with *«we are thankful to Addax. They came with money. Before, we were all poor. Then people got used to the money from the company. Now we have no land and no employment. We never experienced this sort of poverty before.»*

A last concern in many biofuel projects is the health and safety management of the employees working on the fields. With the exception of minor cases, Addax does care about the health and the safety of its employees. Workers are trained by the Company to use the machines properly and safely. They are also equipped with safety gears like coats and boots, especially when using fertilizers. Various health centers and hand-washing stations have also been installed throughout the area. Finally, people enrolling at Addax' FFLS are given courses on health issues and how to prevent diseases.

Environmental impacts: Land use change

Sustainability is one of the most important aspects of this project. Therefore, no deforestation was allowed and if some trees or vegetation did get removed it was essential to replant new trees elsewhere. High carbon stock trees like palms were avoided as much as possible during the pilot phase when clearing and preparing the lands for sugarcane plantation. Over the years only 77 households have been displaced (Fielding, et al., 2015). The environmental impact of the Direct Land Use Change is therefore minimized. A Life Cycle Assessment (LCA) estimated the carbon

emissions of Addax' bioethanol to be 23.90 grams of CO_2 per MJ against 87 grams of CO_2 per MJ for regular gasoline. Unfortunately, the Indirect Land Use Change (ILUC) is not considered in the LCA, and real GHG emissions are therefore always higher than first thought. In an effort to estimate the impact of the ILUC, Bread For All (2011) compared biofuels in Brazil with the same level of carbon emissions for which ILUC had been calculated. Brazilian ethanol with a 71% CO_2 saving compared to fossil fuel, saves only 51% when including ILUC into the assessment. However, this should not be taken over as is because the forest density in much higher in Brazil than in Sierra Leone and trees have also been planted in order to decrease the ILUC impact.

Environmental impacts: heavy water use

Not only does an agricultural project consume a lot of water in a country where clean water is already scarce, but on top of that Addax can change the course of a river or even remove the water source (Article 4.4 of the Land Lease Agreement). A water use assessment was made in order to evaluate the impact of the irrigation system on the Rokel River, which is the largest river in the area (Manley, Lonsway, & Aron, 2010b). The project is said to use only 2% of the annual water flow. The following calculation confirms this claim. At most $7m^3$ of water per second will be pumped out of the Rokel Rivel, which has an annual flow of 3.8 billion m^3 (Annex 8: Monthly water flow at the Bumbuna dam). The project, only running on business days, therefore 220 days/year, will irrigate crops during the dry season of November-May. As a result, only 2.22%[42] of the Rokel River will be used by Addax. However, a serious concern has not been taken into account in this calculation. The project will require the highest levels of water, which is $7m^3/s$, during the driest months of February, March and April. At that time the Rokel River will be at its minimum water flow. The river may be flowing at an annual average of $121m^3/s$, but from during the dry season its natural flow is only $2m^3/s$ (Akiwumi, 1997). In 2009 a new dam for hydroelectric power has been built upstream in Bumbuna. The dam can control the outflow to create a more consistent water

[42] Project's consumption of water: $7m^3/s$ * 60s * 60min * 24h * 20 days * 7 months = 84,672,000 m^3
84,672,000 m^3 / 3,840,000,000 m^3 = 0.0222

flow. At its lowest level 27m^3/s pass through the dam, meaning the irrigation system does not endanger people's water security.

70% of households in project area reported that during the dry season they compete for water and women have to walk between 15 minutes and an hour to access a water source (Fielding, et al., 2015). New arrivals of households looking for a job at Addax increase the competition for water.

As expected from the start, Addax has changed several water courses for its sugarcane plantations. This affects the people relying on those streams, and Addax always promised to build wells to provide people with clean water. Several examples of altered water sources are to be found in Romaro, Woreh Yeamah, Madrisa and Makama Bana, where Addax has built wells to replace the streams. Unfortunately those wells sometimes took two years or more to be completed like in Romaro and Madrisa.

The pollution of the Rokel River with fertilizers and herbicides prevented people from collecting water in the river. Although there was no threat for human health Addax did warn people not to drink the water. A study revealed levels of pollution that are not life threatening, but they are considered as not suited for human consumption in Europe (SiLNoRF, 2014). Because of the pollution Addax installed 500 liter tanks in the nearby villages and is refilling them with clean water about twice a week (SiLNoRF, 2016). Even the wells in Romaro, Rotonka, Tonka, Mabilafu, and others were not safe to use because the chemicals used on the fields could erode back to the river and pollute their ground water.

Environmental impacts: biodiversity loss

Minimizing the environmental impact of the project is one of the Company's priorities. They are well aware of the fact that their 10,000 ha monoculture plantation is a threat to biodiversity. For this reason 1,800 hectares of forest have been avoided during the mapping of the crops' location, and marked as ecological corridors (Bread For All, 2011). During the pilot phase of 2011, 3,500 trees had already been planted in an effort to preserve biodiversity. At the same time an estimated 600

hectares of trees and 4,000 hectares of bush would have to be cleared. In 2012, a tree nursery was created at the FFLS in order to manage the plantation and displacement of vegetation. In one year the nursery had already potted 116,000[43] fruit and forest seeds, of which 56,308 were transplanted after germination (Bisset & Driver, 2014). The fruit and forest seeds ratio in the plantation phase was respectively 23% and 77%. Therefore, if the ratio remained during the transplantation phase, about 43,202 fruit plants and 13,106 forest plants have been transplanted in 2013.

Addax' forest management might not have changed Sierra Leone's biodiversity, but it has impacted the local fauna and flora. People often relied on forest trees for charcoal or firewood and on fruit trees for food. As one woman testified to SiLNoRF (2016): *«We used to have trees, fruits and sticks and so on from the bush. Now it is all empty land»*. The section on poverty alleviation, page 33, explained how people were compensated for the loss of economic trees. But now people have to travel to the city of Makeni to get certain types of fruit, fruit they could simply collect from the trees before. And because the supply decreased, prices increased. According to Addax the money paid as compensation for the economic trees was supposed to be used to plant new trees for the community. Instead, people used it to renovate their house, not knowing it was a one off payment. People thought it was an annual compensation, like their land lease, because it was included in the Acknowledgement Agreement (Manley, Lonsway, & Aron, 2010b), which is an annual payment. Now the money is gone and so are the trees.

The use of natural resources like wood, medicinal plants and wild fruits as well as the practices of beekeeping, hunting and fishing are part of their livelihoods. Biodiversity is therefore essential for households. A study recorded 55 different species of fish in the three largest rivers nearby, of which the Rokel River is used for the irrigation of the sugarcane plantation (Manley, Lonsway, & Aron, 2010b). A regular monitoring of the quality of water and the biodiversity of animals is performed by Addax, but the data is not publically available. Because of the high water usage of the project, streams have disappeared in some villages. In others, near the Rokel River, fishing also became

[43] 89,000 fruit seeds and 27,000 forest seeds

impossible because of the pollution. No study on the current state of the animal biodiversity has been performed, but the impact of the pesticides used on the fields and the fertilizers polluting the river should be assessed.

Environmental impacts: choice of crop

Choosing the right crop has always been a real challenge for producers. In a tropical country only two types of feedstock can really be considered for lucrative ethanol production, sugarcane and cassava, aka manioc. According to The World Bank, Sierra Leone has an average temperature of 26.4°C with an average annual rainfall of 2,466 mm. Belgium and Brazil have respectively temperatures of 10.4 °C and 25.3°C and rainfalls of 847 mm and 1,761 mm. Sierra Leone is therefore considered as a tropical country and ideal for sugarcane and cassava plantations because they require a lot of water and high temperatures. Engineers in the biofuel industry explained why sugarcane is preferred for sustainable biofuels and why there are very few cassava plantations for ethanol. Both have the same production cost of around USD 20 (EUR 17.7) per tonne of input, but cassava requires more heat energy input to extract the ethanol. As a result, there is more carbon emission in the production of cassava ethanol. Sugarcane ethanol has also been produced for decades in Brazil and has proven to be profitable.

Gender issues

Sierra Leone is no exception to the status of women in the society. Their tasks mainly consist of working on the fields, collecting water and cooking for the household. Men, on the other hand, often have a job in the city to earn money for their family. The biggest concern for women when Addax came, was the loss of the lands they cultivated. Since they are not allowed to own lands, even though they are the ones relying on these lands, they do not get any compensation for their loss (SiLNoRF,

2014). This issue is especially of concern for single women with children and no husband to bring home money. Unfortunately, Addax did not compensate women for the lands they took.

During the pilot phase, Addax' FFLS counted 88 women and 92 men[44], which is very equally distributed (Manley, Lonsway, & Aron, 2010b). An explanation for the high female enrollment is the fact that women are the ones working on the fields, and therefore the ones who absolutely need the trainings. Addax employs on average between 8% and 12% of women, which was about 372 female employees before the downscale. The involvement in Addax' biofuel project can be considered as high because jobs in agriculture are hard and intensive, and they are therefore often restricted to men.

This analysis showed that most downsides of biofuels in Africa are also issues in the Makeni project. However, Addax tries hard to minimize the negative externalities on the environment and on the local communities. Ideally, if it wants to be more sustainable, Addax should address all of the issues listed above. Most of them are easy to fix; bolilands, water pollution and compensation for economic trees, others should be continuously monitored; ILUC, biodiversity and water usage. The biggest issues are the most recent ones. The water pollution is something that has to stop as soon as possible, before it has real consequences on the biodiversity. The downscale has a massive impact on people living in the area. The uncertainty of the future of Addax Bioenergy causes a lot of stress in the communities.

[44] The study stated that 49% of the FFLS were female.

4. True Price

The previous sections identified the various weaknesses and threats of a biofuel expansion in Africa. In Addax' case most of the negative externalities have been internalized. Deforestation has been avoided as much as possible, and a revegetation programme has been put in place in order to mitigate the biodiversity loss. They also tried to avoid land grabbing through a proper leasing instead of an acquisition of the lands. Addax has started to give some of the bolilands back as well. The Company continued to invest in the FDP, and people are finally harvesting large quantities of rice. The project employs a decent amount of workers, including women, and their wages are well above Sierra Leone's minimum wage. Lots of rainfall, combined with a substantial water flow of the Rokel River, are making the heavy water consumption acceptable. Wherever water sources have disappeared because of the project, wells have been built. Finally, in terms of GHG emissions, sugarcane is probably the best feedstock for bioethanol in Africa.

Unfortunately there are issues that have not been resolved, yet. Wages may be higher than the minimum allowed by law, but they do not keep an entire household above the poverty line. The pollution of the Rokel River is a huge concern for the people relying on the river for water and food. A last concern that has not been settled is the fair compensation for economic trees.

The following chapter will try to monetize the shortcomings of the project in order to assess the magnitude of the negative externalities. An adequate procedure has been found through a True Price analysis. One of the weaknesses in the current research studies is the lack of concrete numbers that can be quickly be understood by a reader. Different currencies are often mixed throughout the papers and issues are rarely being scaled to the whole project in order to have a better understanding of magnitude of each problem. The purposes of this thesis has been to identify the pros and contras, and to convert them into coherent money terms. The next objective is to obtain the true price of one liter of ethanol produced by Addax. This will be done through a quantification and aggregation of environmental and social impacts that have not been internalized by the Company.

What is True Price?

True Price is a social organization which purpose is to create an economy that creates value for all stakeholders (True Price, 2016). True price assists companies by evaluating their social costs, but also by helping them improve their impact on the environment and on society. A true price includes the retail price as well as social and environmental costs that have not been accounted for during the pricing decision. In other words, it is a fair price that values all negative externalities across the value chain. Deforestation is an example of a negative externality that can easily be monetized by estimating the costs of planting a similar forest elsewhere. This environmental damage is then added to all other material costs in order to reflect the true cost of a product, to ultimately obtain a true price.

Companies can also benefit from a Life Cycle Assessment, because by conducting such analysis they can get a better understanding of their environmental and social impact. The harmonization of costs, provided by True Price, quantifies all externalities in one easy to work with metric. A True Price analysis can then help a company decide whether or not to invest in a project. For a third party, it also helps to understand the magnitude of different issues. Only by first identifying the hidden costs across the value chain can an organization start improving its business processes in order to reduce the negative externalities.

More and more stakeholders are involved in a project. Nowadays, banks want to see impact assessments before financing a project. Corporate Social Responsibility and transparency are becoming key requirements in most industries. This is why companies are putting more and more efforts in reporting. True Price creates an impact assessment, and thus helps businesses communicate on critical sustainability issues.

Methodology

The methodology of the impact assessment of Addax' project will follow the same structure as the one from True Price. The reason why this approach has been chosen is because of the ease of understanding. It follows a simple procedure of quantifying each externality at every step of the supply chain. Valuing each impact is done in a single measure, to allow for aggregation at the final stage. The conversion to the same measure also has a comparison purpose. Two externalities like deforestation and water pollution would not be comparable if not monetized into one single currency.

True Price does not try to obtain perfectly accurate costs, but instead its purpose is to use the available data to make a first estimation of the true price and then to invite key stakeholders to join the discussion. With the same objective this research will make an attempt to list and to monetize material negative consequences of the Makeni project.

The recent downscale of the production has not been accounted for in this chapter. This paper assumes that Addax is going to find other investors, as stated by the development banks, and continue its activities. Other short-term issues like broken water wells, that took two years to be repaired, or the low yields during the pilot phase of the FDP, have not been considered in the true price assessment. Only material issues that are probably not going to be resolved by Addax will be covered in this chapter.

True price estimation of Addax' bioethanol

Retail price

Earlier, a break-even price of USD 37 (EUR 33) per barrel of bioethanol was estimated. This means the cost of producing one liter of ethanol is about USD 0.23 (EUR 0.21). Addax' retail price is determined by S&P Global Platts, which is an entity that provides information about energy and commodities. Addax Bioenergy sold, only once, 7 million liters of biofuel, in May 2015. At that time, according to Platts' weekly global ethanol report, the ethanol price was USD 605 for one cubic

meter, or USD 0.61 (EUR 0.54) per liter (Platts, 2015). The profit on the ethanol sold was USD 2.7 million[45] (EUR 2.4 million) in 2015.

The future price of ethanol is expected to fluctuate between USD 485 (EUR 430) and USD 514 (EUR 456) per cubic meter over the next five years (Annex 9: Nominal and Real Ethanol Prices (2004-2024)). A retail price of USD 500 (EUR 443) will be used to find the true price of one liter of bioethanol. The real price of ethanol will also be used instead of the nominal price because inflation has not been accounted for in this paper. The inflation rate in Sierra Leone has fluctuated between 6 and 18% over the last five years, making it hard to anticipate (Trading Economics, 2016). Even though only 7 million liters have been sold at USD 0.61 (EUR 0.54) per liter, the true price will be based on the target annual output of 90 million liters at an estimated retail price of USD 0.50 (EUR 0.44).

Land Lease Fees

According to the Land Lease Agreement and the Acknowledgement Agreement, Addax compensates one hectare of land at EUR 10.95 per year in rent for the next 50 years, provided that Addax does not restitute this area during the period. Per hectare, EUR 1.58 is paid to the District Council, EUR 1.58 to the Chiefdom Administrator, EUR 0.79 to the National Government and EUR 3.94 to the landowners on top of the EUR 3.07 additional rent. This analysis is focused on people and the negative externalities they had to endure since the arrival of Addax. The benefit of leasing one hectare of land to Addax is EUR 7.01 per year for landowners. However, people do not think that the benefits they get from leasing their lands reflects the opportunity cost of growing rice. Addax made a promise from the start that no bolilands would be used for sugarcane plantation. This promise has not been kept in some regions, and people lost their most fertile lands. The rent was not negotiated, but rather imposed on them, and today they regret signing the Land Lease

[45] (USD 0.61 - USD 0.23) * 7,000,000 liters = USD 2,660,000

Agreement. In order for them to be properly compensated, ActionAid (2013) estimates, based on field research, the rent to be at least twice as high.

> *«Before we were eating up to 10 cups of rice [per family, per day] because of the produce we were getting from our farms. But since Addax came, we can no longer eat that amount of rice we used to eat. Now we are eating 5 cups we cannot even imagine to get 6 cups because our source of getting money is very slim. »* Zaria Conteh, female farmer with nine children (ActionAid, 2013)

In 2014 Addax was using 24,656 hectares. According to the local people the cost of not being able to cultivate rice anymore is then EUR 172,839 per year[46].

Wages

The minimum wage in Sierra Leone for government officials is SLL 500,000 (EUR 110) (Kamara, 2014). In March 2015, Addax employed 1,604 people with a fix contract and 2,243 with a seasonal contract (Annex 4: Number of fixed and seasonal contracts at Addax (2012-2015)). A worker's salary varies between SLL 325,000 (EUR 72) and SLL 400,000 (EUR 88), but the vast majority receive the maximum wage. Even though their wages are higher than outside the area, a single income is not enough to provide for an entire household. According to Baxter & Schäfter (2013) a Sierra Leonean family's expenses are about SLL 633,292 (EUR 139) per month, which is a lot more than the monthly wages Addax is currently paying. This issue has led to strikes and has to be resolved properly. A more ethical solution then would be to increase wages to the bare minimum living revenue. As a result, wages should increase to SLL 633,292 (EUR 139). This means the social cost of underpaying workers is SLL 7,630,048,152 [47] (EUR 1,678,611) per year.

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[46] EUR 7.01/ha * 24,656 ha = EUR 172,839

[47] (SLL 633,292 - SLL 400,000) * (1,604 fixed workers *12 months + 2,243 seasonal workers * 6 months) = SLL 7,630,048,152

Economic trees

When Addax Bioenergy started converting their leased lands into sugarcane crop fields they had to cut down and burn plenty of trees and bushes. As biofuels for the European market cannot result from deforestation, Addax had to replant trees elsewhere if it wanted to produce sustainable ethanol. This decision, however neutral for the environment, has an impact on the people living from some of those trees. Palm trees, for example, produce oil which can be sold at the local market. Those trees are called 'economic trees' due to the economic value of its fruits. Addax compensates the palm trees by paying SLL 35,000 (EUR 7.7) per unit to the families relying on them (ActionAid, 2013). However, people thought this compensation was an annual payment like the land lease rents. EUR 7.7 for one tree is far from enough considering the life span of a palm tree and the amount of oil it produces each year. A quick calculation tells us how much money is lost by selling the economic trees to Addax. Baxter & Schäfter (2013) estimated the value of a wild palm tree to be at least SLL 2,500,000[48] (€ 550), while an improved palm tree is valued at SLL 7,200,000[49] (EUR 1,584). This is based only on the production of oils alone during a life span of 30 years. This means, one can earn at least SLL 83,300 (EUR 18.3) per year with one wild palm tree, and SLL 240,000 (EUR 52.8) with an improved one. With no data available on how many economic trees were displaced, the next step is a guess based on aerial footage. On a random 70.8 [50] hectare pivot, Addax identified 247 [51] economic trees, or 3.49 trees per hectare (Figure 4: Aerial picture of pivot 11_002, with economic tree mapping, page 55). However, on one hectare with a higher density, there are as much as 33 trees.

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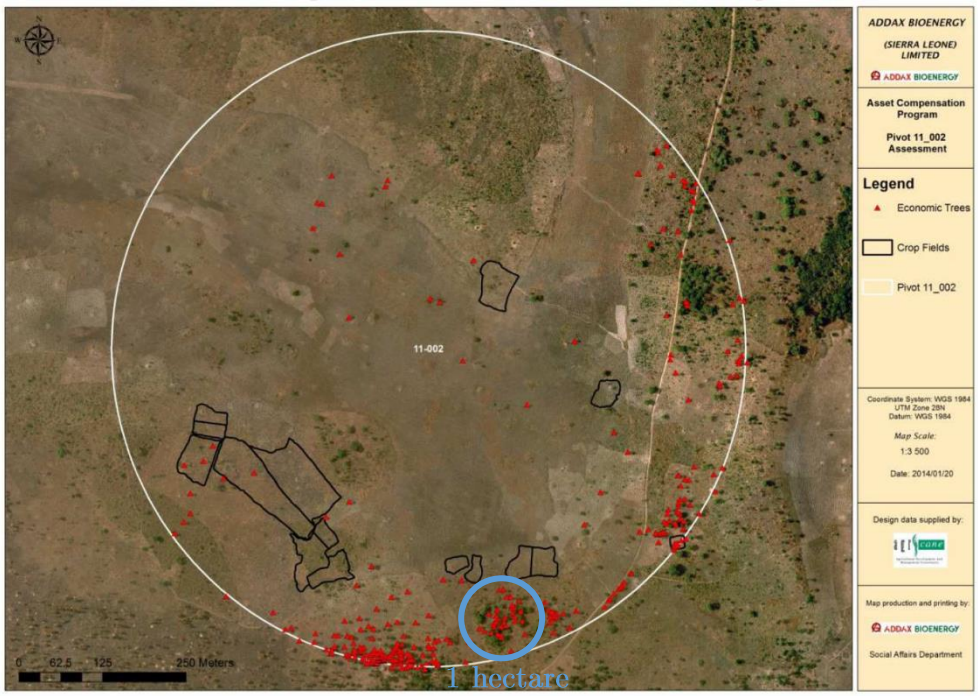
[48] 1 wild palm tree produces 20 fruits/year, which can produce 13.33L of red palm oil and 6.67L of kernel oil
1L of red palm oil sells for SLL 5,000 and 1L of kernel oil sells for SLL 2,500
[(13.33L * SLL 5,000/L) + (6.67L * SLL 2,500/L)] * 30 years = **SLL 2,500,000**

[49] 1 improved palm tree can produce 30 fruits/year, which can produce 40L of masanke (palm oil from improved tree, but less liked by people) and 40L of kernel oil
1L of masanke sells for SLL 3,500
[(40L * SLL 3,500/L) + (40L * SLL 2,500/L)] * 30 years = **SLL 7,200,000**

[50] Surface = $r^2 * \pi = (475m)^2 * \pi = 708{,}462m^2$ or 70.8ha

[51] According to personal own counting

Figure 4: Aerial picture of pivot 11_002, with economic tree mapping



Source: (English & Sandström, 2014, p. 25)

According to the Environmental, Social and Health Impact Assessment, the project required the removal of 122.3 hectares of wild palm trees and 104.7 hectares of improved trees, during the pilot phase (Manley, Lonsway, & Aron, 2010a). The total area converted into monocultures, 24,656 ha, is double the size of the pilot phase, 12,176 ha. If the number of trees removed increased proportionally with the expansion of the project, then 248 ha and 212 ha have been cleared. At a fair rate of 33 trees per hectare, 8,184 wild palms and 6,996 improved palms have been taken from the communities. Translated into money terms, the true cost of removing the economic trees is SLL 2,360,767,200 [52] (EUR 519,369) per year.

Water pollution

The water pollution is much harder to monetize than previous issues. Clean water is being provided to all the villages relying on the Rokel River. This means the cost of drinking water is internalized.

[52] (8,184 wild palms * SLL 83,300) + (6,996 improved palms * SLL 240,000) = SLL 2,360,767,200

However, people also used to go fishing in the river, something they cannot practice anymore. Even though the levels of pollution are not high enough as to threaten the biodiversity of the aquatic life, people now have to travel to Makeni to buy fish. Annex 10: Map of all the villages affected by the project) shows how many villages are near the Rokel River. At least one third of them are within less than an hour walking from the river and are therefore likely to rely on fishery to feed their household. A daily meal for a Sierra Leonean family consists of rice, greens and fish, valued at SLL 13,000 (EUR 2.86) (Baxter & Schäfter, 2013). People who have to buy their fish in Makeni are paying SLL 2,000 (EUR 0.44) per 4 or 5 fish (SiLNoRF, 2016). If assumed that the distance to Makeni decreases the amount of fish consumed to 4 units a week per person, then the cost is about SLL 2,000 (EUR 0.44) each week per household member. There are 13,617 people living in the project area, and an estimated one third of them has been deprived from fishery. Therefore, the true cost of polluting the river is not only the cost of providing 500 liters tanks of clean water twice a week, but also the cost of food for a total of SLL 472,056,000 (EUR 103,852) per year[53].

Results in context

The final step of calculating the true price is the aggregation of the invisible costs that have been monetized. The costs that have not been internalized by the Company are: a fair land lease, EUR 172,839, adequate wages, EUR 1,678,611, a proper compensation for economic trees, EUR 512,775 and the cost of depriving people of fishery, EUR 103,852. Hence, the social cost is EUR 0.027 [54] per liter of ethanol produced. The true cost of one liter of ethanol is then EUR 0.24, and the true price is EUR 0.47. This price increase does not seem like a lot, but this means each year a European car on gasoline is responsible for EUR 3.29 [55] social costs in Sierra Leone. EUR 3.29, or SLL 14,958, can

[53] 13,617 * (1/3) * SLL 2,000/week * 52 weeks = SLL 472,056,000
[54] (EUR 172,839 + EUR 1,678,611 + EUR 519,369 + EUR 103,852) / 90,000,000L = EUR 0.02749/L
[55] 24 tanks/year * 50 liters * E10% * EUR 0.0274 = EUR 3.29/year

feed ten Sierra Leoneans with rice and fish for a day[56]. Addax' sustainable ethanol will fuel 750,000 cars per year[57].

The annual revenue from ethanol export can be estimated at EUR 39.6 million[58]. Additional social costs will reduce the Company's net income by EUR 2.5 million.

Even though there are substantial externalities for the local population, Addax has tried very hard to minimize its impact. In addition, the Company has also contributed a lot to the well-being of the people around the factory. When comparing these results with the true price of cacao from Ivory Coast, the social costs only account for 6% of the retail price of ethanol, whereas the social and environmental costs of a chocolate bar add 33% to the price (True Price & IDH, 2016). The same story goes for tea from Kenya and coffee from Vietnam where True Price estimates these costs to increase the retail price by respectively 25% [59] and 35% [60].

Unfortunately, the insecurity about the future of the project since the downscale cannot be monetized, although it is probably the biggest issue right now for all the stakeholders.

[56] 10 cups of rice + 10 fish = SLL 10,000 + SLL 5,000 = SLL 15,000
[57] 90,000,000L / (24 tanks/year * 50 liters * E10%) = 750,000
[58] EUR 0.44/L * 90,000,000L = EUR 39,600,000
[59] Based on a cup of tea drank at home at a cost of EUR 0.09. When consumed in a bar at EUR 2 it only adds 1%
[60] Based on a cup of coffee drank at home at a cost of EUR 0.1. When consumed in a bar at EUR 2.5 it only adds 5%

5. Conclusion

Since 2002, year the civil war ended, Sierra Leone has been welcoming international investors in order to help rebuild and develop its country. This resulted in a third of its lands being in the hands of foreign companies. Renewable energy projects can offer some development, as they create employment, reduce the country's dependence on fossil energy, and fundamentally, they stimulate the agricultural development. However, governments have to be careful with land grabbing due to the potential negative externalities.

Research shows that the Makeni project has been a blessing for the communities around the monocultures. People's revenues increased and so did their productivity on the fields. With the money came a better lifestyle where mobile phones are common now. Extreme poverty and hunger also disappeared with the arrival of Addax Bioenergy. Unfortunately, the hope for more wealth is fading with the long-lasting downscale of production.

Sustainability has been one of the priorities set from the beginning. The objective is to create economic development without compromising the ability for future generations to meet their needs. For this reason vegetation has been replanted, limiting the biodiversity loss and the decrease in absorption capacity of the planet. Wages, clean energy, roads, and the Farmer Development Programme are examples of how sustainable investments can be catalysts for the economic growth, infrastructure development and social welfare in Africa.

Unfortunately, even sustainable projects seem to have negative impacts. The European Union, with its new mandates, has been accused of being responsible for the increased food prices, resulting in millions of people being pushed into poverty and famine. These allegations will keep on coming as long as first generation biofuels are used. Efforts have been made by Addax in order to mitigate the other industry-related issues. A revegetation programme will neutralize the CO_2 emissions caused by direct land use change. Indirect land use change is minimized as people's productivity has increased and only part of their lands is used for the sugarcane cultures. Water wells and roads have been built in order to make the Company's heavy water consumption acceptable. An attempt to

solve gender inequality in Africa has been made though a Farmer Development Programme and female employment at Addax. Finally, employment contracts have increased over the years, half of them being fixed. Further close monitoring and continuous impact assessments are essential in sustainable biofuel project.

A True Price analysis has showed that some material externalities have not been internalized by the Company. Social impacts were the main hidden costs of this project, accounting for 6% of the true retail price. Higher land lease fees, proper wages, a fair asset compensation and fish supply would decrease the annual profit by EUR 2.5 million, if the company is to mitigate these externalities. If the production can achieve its 90 million liter goal, it will generate EUR 40 million, which should be enough to absorb the additional costs. Only then will the Makeni project truly be the first benchmark for sustainable biofuel investments in Africa.

In line with the G7's Declaration on Climate Change, the ultimate objective for Addax is to help Europe achieve its biofuel targets, while contributing to *«accelerate access to renewable energy in Africa and developing countries in other regions»* (G7, 2015).

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7. Annexes

Annex 1: Examples of mandates worldwide

Country	Mandate
Angola	E10
Argentina	E5 - B10
Australia	E6 - B2
Belgium	E4 - B4
Brazil	E27.5 - B10
Canada	E5 - B2
China	E10 - B2 in nine provinces
Colombia	E8 - B10
Costa Rica	E7 - B20
Ecuador	E10 - B5
Ethiopia	E10
Guatemala	E5
India	E10
Indonesia	E3 - B5
Jamaica	E10
Korea	B2.5
Malawi	E10
Malaysia	E10 - B10
Mozambique	E15
Norway	B3.5
Panama	E7
Paraguay	E25 - B1
Peru	E7.8 - B2
Philippines	E10 - B5
South Africa	E2 - B5
Sudan	E5
Thailand	E5 - B7
Turkey	E2
Ukraine	E5
United States	Hawaii: E10, Louisiana: E2 - B2, Massachusetts: B5, Minnesota: E20 - B10, Missouri: E10, Montana: E10, New Mexico: B5, Oregon: E10 - B5, Pennsylvania: E10
Uruguay	E5 - B5
Vietnam	E5
Zimbabwe	E5

Source: (REN21, 2016, p. 183)

Annex 2: Indicators of Compliance for the RSB EU RED Principles & Criteria

Legality: *Biofuel operations shall follow all applicable laws and regulations.*

Planning, Monitoring and Continuous Improvement: *Sustainable biofuel operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative impact assessment and management process and an economic viability analysis.*

Greenhouse Gases: *Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels.*

Human and Labor Rights: *Biofuel operations shall not violate human rights or labor rights, and shall promote decent work and the well-being of workers.*

Rural and Local Development: *In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.*

Food Security: *Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions.*

Conservation: *Biofuel operations shall avoid negative impacts on biodiversity, ecosystems, and conservation values.*

Soil: *Biofuels operations shall implement practices that seek to reverse soil degradation and/or maintain soil health.*

Water: *Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights.*

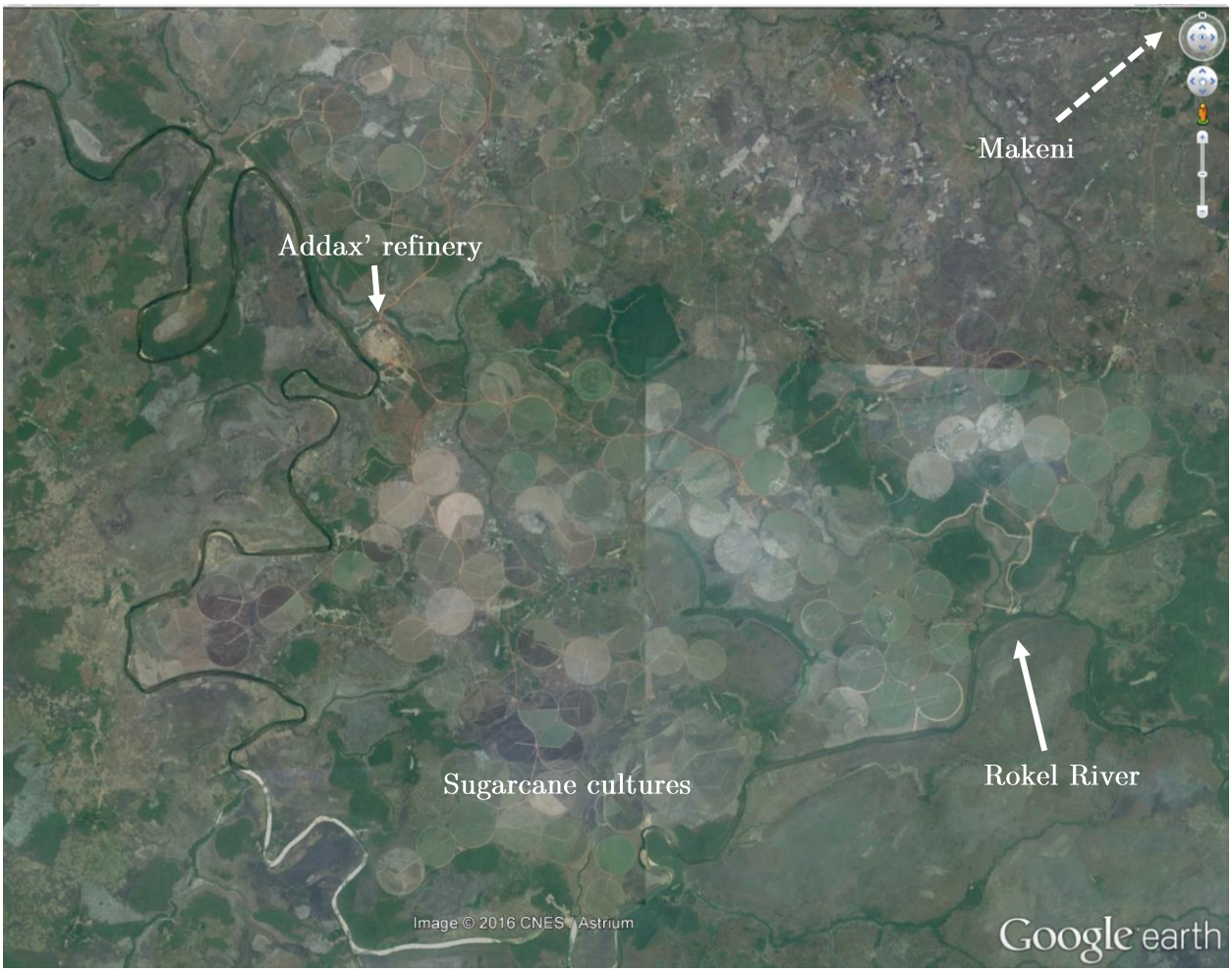
Air: *Air pollution from biofuel operations shall be minimized along the supply chain.*

Technology, Inputs, and Management of Waste: *The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.*

Land Rights: *Biofuel operations shall respect land rights and land use rights.*

Source: RSB.org/sustainability/rsb-sustainability-standards/

Annex 3: Google Earth's view of the Makeni project

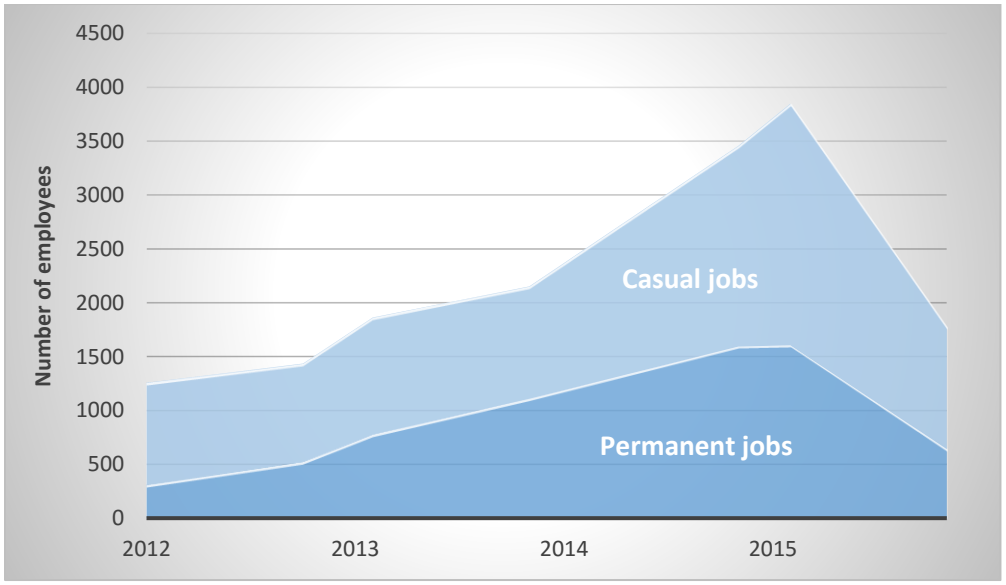


Source: Google Earth: 8°41'05"N-12°12'29" W, April 2016

Annex 4: Number of fixed and seasonal contracts at Addax (2012-2015)

	February 2012	November 2012	December 2013	December 2014	March 2015	December 2015
Permanent jobs	312	523	1,108	1,594	1,604	642
Casual jobs	946	911	1,044	1,861	2,243	1,128
Total	**1258**	**1434**	**2152**	**3455**	**3847**	**1770**
% Permanent jobs	24.80%	36.47%	51.49%	46.14%	41.69%	36.27%
% Casual jobs	75.20%	63.53%	48.51%	53.86%	58.31%	63.73%

Source: Based on (Bisset & Driver, 2013, p. 11; 2014, p. 14), (Fielding, et al., 2015, p. 18) & (SiLNoRF, 2016, p. 29)



Annex 5: Farmer Development Programme's annual rice yields (2012-2015)

Bombali Sebora

	2012	2013	2014	2015
Avg Yield (kg/ha)	1,242	1,180	1,152	0
Per Capita (kg)	181	93	154	**0**

Malal Mara

	2012	2013	2014	2015
Avg Yield (kg/ha)	1,168	1,263	1,255	8,029
Per Capita (kg)	180	148	329	**835**

Makari Gbanti

	2012	2013	2014	2015
Avg Yield (kg/ha)	1,105	705	1,042	9,328
Per Capita (kg)	159	63	206	**970**

Source: Based on (English & Sandström, 2014, p. 35) & (SiLNoRF, 2016, p. 15)

Annex 6: Selected Human Development Outcome Indicators: Comparison between 2012 and Baseline (2010)

	Human Development Outcome Indicators	Baseline (2010)	2012
Income			
	Average monthly income per household (USD)	8.01	24.39
	No. of individuals (households) reporting regular wage income	304	571
	No. of woman (households) reporting regular wage income	212	299
	% of individuals with bikes	17.6%	19%
	% of houses with corrugated metal roof	23%	59%
	% of individuals with mobile phones	7.8%	38%
	% of individuals with motor bikes	0.5%	4%
	% of households with radios	13.8%	44%
	% of households with tractor	0.2%	0.12%
	Average no. of livestock per household	1.27	0.5
	Average no. of chickens per household	9	0.6
	Average no. of goats per household	0.55	0.25
	Average no. of cattle per household	0.07	0.02
Health			
	No. households with improved sanitation facilities	24.30%	58%

Source: (Bisset & Driver, 2013, p. 18)

Annex 7: International Land Deals in Sierra Leone (2000-2015)

Investor	Country	Purpose	Year	Size
Addax Bioenergy	Switzerland	Agriculture & Renewable Energy	2010	54,000
Drie Wilgen Development	Netherlands	Agriculture	Unknown	450
Unknown	China	Agriculture	Unknown	1,500
Unknown	China	Agriculture	Unknown	2,000
Unknown	China	Agriculture	Unknown	2,000
Lion Mountains Agrico	UK	Agriculture	Unknown	14,000
Ecotech Timber	USA	Forestry	Unknown	120,000
SLGreen Oil	UK	Agriculture & Forestry	Unknown	121,406
Biopalm Energy	Singapore	Agriculture	Unknown	220,000
Complant Magbass Sugar	China	Agriculture & Renewable Energy	2003	3,000
Sepahan Afrique	Iran	Agriculture	2007	10,117
Vedico Mange Bureh	Viet Nam & Germany	Agriculture	2008	50,000
Sierra Gold	Canada	Agriculture & Forestry	2009	46,255
Quifel Agribusiness	Portugal	Agriculture	2010	126,000
Whitestone	UK	Agriculture & Renewable Energy	2010	525,000
Agricapital	UK	Agriculture	2011	1,250
Tropical Farms	UK	Agriculture	2011	4,750
Goldtree	Mauritius & Finland	Agriculture	2011	5,058
Farm Lands of Guinea	UK	Agriculture	2011	11,900
Win-Agri	UK	Agriculture	2011	20,000
Miro Forestry	Arab Emirates	Agriculture	2011	21,000
Socfin	Luxembourg	Agriculture	2011	30,000
African Palm Oil	India	Agriculture	2011	39,321
Red Bunch Ventures	UK	Agriculture	2011	45,000
Geoff Palm	India	Agriculture	2011	46,000
Long Van 28	Viet Nam	Agriculture	2011	200,000
Sierra Leone & China Agriculture Development	China & Sierra Leone	Agriculture	2012	135,000
Africa Lion Agricultural	UK	Agriculture	2013	2,500
Golden Veroleum	Singapore	Agriculture	2013	500,000
Natural Habitats	Netherlands	Agriculture	2015	50,740
Total				**2,408,247**

Source: Land Matrix

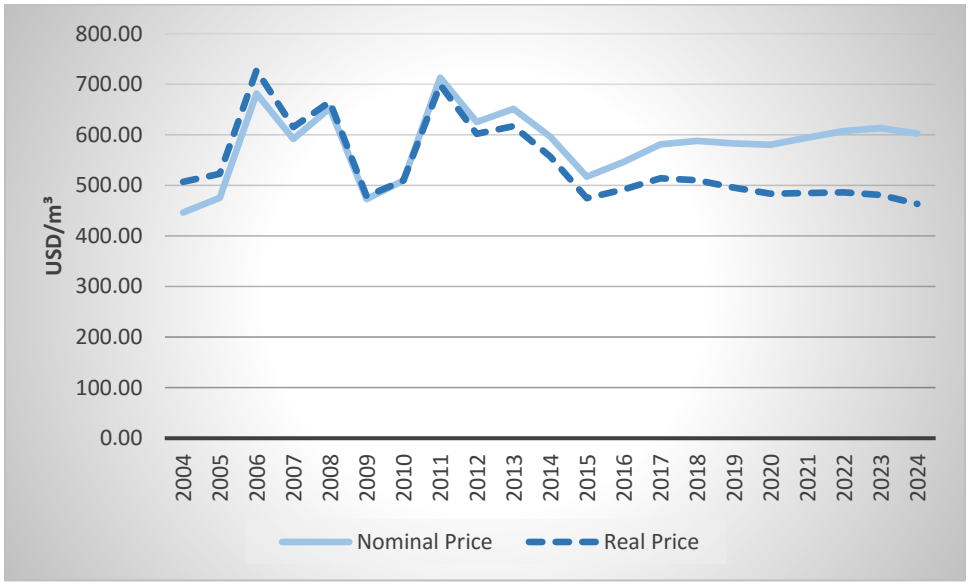
Annex 8: Monthly water flow at the Bumbuna dam

m^3/s	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Days/month	31	28	31	30	31	30	31	31	30	31	30	31
Outflow	33	27	28	27	39	73	128	255	338	302	138	67
Outflow/day	2.9E+06	2.3E+06	2.4E+06	2.3E+06	3.4E+06	6.3E+06	1.1E+07	2.2E+07	2.9E+07	2.6E+07	1.2E+07	5.8E+06
Outflow/month	8.8E+07	6.5E+07	7.5E+07	7.0E+07	1.0E+08	1.9E+08	3.4E+08	6.8E+08	8.8E+08	8.1E+08	3.6E+08	1.8E+08

Annual outflow 3.84E+09

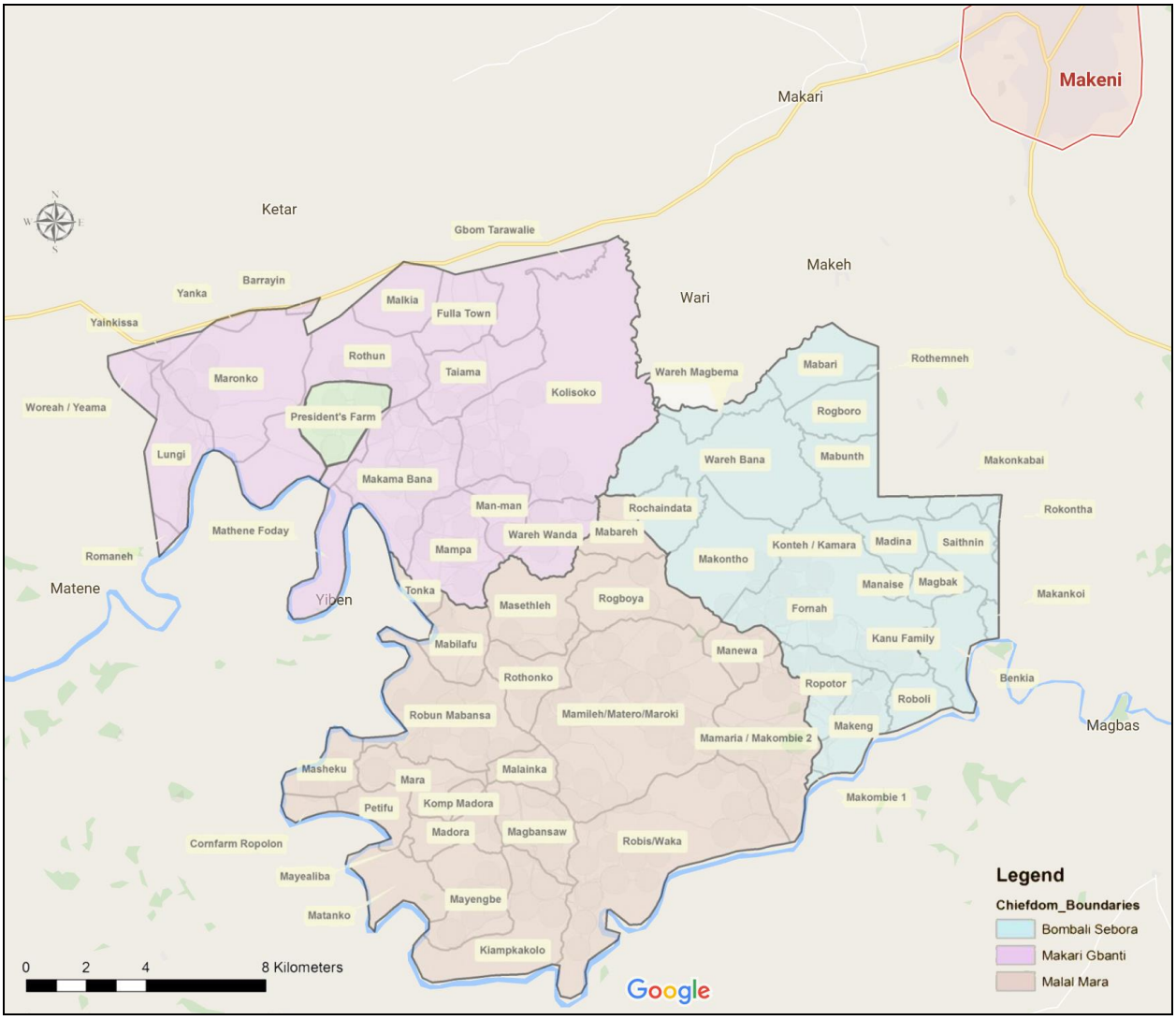
Source: Based on (WaterLex & Bread For All, 2011, p. 6)

Annex 9: Nominal and Real Ethanol Prices (2004-2024)



Source: (OECD/FAO, 2015, p. 127)

Annex 10: Map of all the villages affected by the project



Source: Google Maps & (English & Sandström, 2014, p. 21)