Environmental issues from sugarcane plantations in Brazil and how to handle them with market-based instruments

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Environmental issues from sugarcane plantations in Brazil and how to handle them with market-based instruments

An overview of market-based tools for land management including Environmental Offsets, Payments for Ecosystem Services and Certification

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2019

LUNDS UNIVERSITET

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Abstract

This study is a literature review of three market-based instruments used for land management; environmental offsets, payments for ecosystem services (PES) and certification, and how they could be used to mitigate environmental impacts from sugarcane cultivation in Brazil when purchasing biopolymers. The study showed that certification is the most common market-based instrument in Brazil. Offset and PES are yet not common tools but are important for the future.

The effectiveness of the certifications depends on the certification standard. Many available standards lead to confusion and inefficiency. Certifications biggest strength is that it lies close to the company and it is therefore easy to incorporate it in the company's strategies and to communicate with the customers.

The biggest strength with environmental offset is that it allowed exploitation of sensitive areas if its compensated and no net loss is achieved. The biggest challenges with this tool are to reduce the uncertainties and achieve a no net loss in value.

PES efficiency depends on the design of the scheme. If the provider of the ecosystem service benefits from managing the ecosystem service, it usually becomes more successful. The biggest drawback with PES is that it is often carried out in areas where the price for land is lower and under less threat. The monitoring of the PES is often insufficient and long-running projects are missing which makes it hard to evaluate the effectiveness of PES.

When it comes to impact on nature, it is crucial what land management has occurred on the spot earlier. If sugarcane expands on native vegetation it will have an irreversible effect on carbon stock and soil quality, biodiversity, and ecosystem services. If sugarcane expands on degraded pasture or annual crops it will slightly increase the soil quality, carbon stock and lead to less greenhouse gas emission.

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1.Introduction

There has never been a bigger interest within society to find alternative material from renewable sources to mitigate their negative impact on global warming and CO_2 emissions than today (Zuurbier and Vooren, 2008). Plastics are often made from fossil feedstocks, but it is becoming more common to make plastics from biological feedstocks. One common feedstock used to produce bioplastics is sugarcane (Zuurbier and Vooren, 2008). The production of sugarcane has increased globally over the past years (Kiezebrink et Al., 2015) and the shift to biopolymers will depend on the availability and reliability of large quantities of feedstock from sugarcane (Eggleston and Lima, 2015).

The sugarcane industry is complex, and it is part of a highly competitive environment (Eggleston and Lima, 2015). Bioplastics are produced from biopolymers which are made from bioethanol which in turn is produced by fermentation of sugarcane. During the fermentation, the sugarcane is transformed by yeast and microbes into alcohol (Azadi et al., 2012; Zuurbier and Vooren, 2008).

Feedstock to produce bioplastics occupies 0,02% of the global agricultural land (European bioplastics, 2017). Sugarcane is in comparison to other feedstocks cheap and easy to process and is a highly productive crop. It can produce approximately 7000 liters bioethanol/ha in comparison to corn, which only produces 4000 liters bioethanol/ha (Zuurbier and Vooren, 2008).

Brazil is one of the world's most important agricultural land, while also maintaining one of the world's highest biodiversity (Pegas and Castley, 2016). 40% of the remaining rainforest is located in Brazil with global biodiversity hotspots such as Cerrado and Atlantic forest (Bordonal et al., 2018; Pegas and Castley, 2016). During the last decade, Brazil's production of sugarcane has more than doubled to meet the growing global demand for bioethanol (Bordonal et al., 2018; Smeets et al., 2008). In 2016/2017, Brazil had 9,1 million hectares cultivated area of sugarcane (Bordonal et al., 2018) which corresponds to 1% of Brazils arable area, 4,6 million hectares (0,5%) were used to produce bioethanol (Sugarcane, n.d.a). Sugarcane is mainly grown in the south-central parts of the country with 90% of the harvest (Bordonal et al., 2018). The remaining sugarcane production occurs in northeastern Brazil (Sugarcane, n.d.a). When the production of sugarcane expands, it mainly occurs on degraded pasture or arable land (Zuurbier and Vooren, 2008).

As a consequence of the increasing demand for renewable resources (biopolymers) for bioplastics, the assessing of the environmental impact of land use and land use change become increasingly important (Klöppfer and Curran, 2014). In this study, land use will be defined as the occupation of land where humans use and manage the land within a given boundary (Klöppfer and Curran, 2014; Koellner et al., 2013). Land use change is defined as the human transformation of an area within a given boundary (Klöppfer and Curran, 2014; Koellner et al., 2013). Land use changes are for example; when the forest is transformed into agriculture land.

Supply chains of biopolymers are long, complicated and it is hard to keep track of all their impacts and risks (social and environmental) (Eggleston and Lima, 2015). The first step of the bioplastics supply chain is to produce a feedstock, in this case cultivating and harvest sugarcane, this step will be in focus in this study. However, an important effect is adverse effects due to land use changes caused by sugarcane production, these effects are important for buyers of biopolymers to keep track of as for example cutting down of rainforest or pollution of waters are issues that may attract negative publicities for packaging companies. There are many strategies to handle the adverse effects of land use changes. Environmental legislation but also different kinds of market-based solutions could be used.

The mitigation hierarchy aims to limit the negative impact and to obtain no net loss in ecological value (Arlidge et al., 2018; Bull et al., 2013). The first step in the hierarchy is avoidance, second is to minimize, third is to restore and fourth is to offset the impact, see figure 1 (Villarroya et al., 2017; Filoche, 2017; Arlidge et al., 2018).

Figure 1: The mitigation hierarchy
The preference decreases further up in the pyramid.

1.1 Aim

The aim of this study is to study how different types of market-based solutions (environmental offsets, payments for ecosystem services and certification) could ensure the protection against adverse effects from land use and land use changes when producing sugarcane. The study looks closer to the supply chain when purchasing biopolymers produced from sugarcane harvested in Brazil and is delimited to the first step in the supply chain.

No author has, as far as I know, tried to compare different market-based instruments and how they are able to manage different environmental impacts from sugarcane. Therefore, I will try to describe how different market-based instruments handle negative environmental impacts in general and what effects it has on the nearby area based on the mitigation hierarchy when cultivating sugarcane. Market-based instruments can be a helpful tool for companies to ensure that they have effective work against mitigating their environmental impact. In this report the point of departure will be; to look closer to how market-based instruments collaborate with stakeholders like companies and governments.

1.2 Questions to address

- How do environmental offsets, payments for ecosystem services and certification work? How effective are they and what strength and challenges are connected to them?

- What central environmental impacts from land use and land use change can be identified when cultivating sugarcane in Brazil?

- How are the environmental impacts of sugarcane affected when land use change occurs?

- How well do the market-based instruments (environmental offsets, payments for ecosystem services and certification) work in Brazil when cultivating sugarcane?

1.3 Delimitations

This study will only look at the first step of the supply chain of biobased polymers produced from sugarcane,1:st generation biomaterial, grown in Brazil. The study also focuses on the environmental impact from the cultivation of sugarcane until it is harvested. Indirect land use change and social impacts will be outside the scope and therefore not addressed. This report does not take the cost of different tools into considerations.

1.4 Definitions

Environmental offsets - Environmental offset are voluntary or mandatory agreements where companies, industries or governments compensate for an unavoidable environmental impact/damages their activity causes the environment (Hayes and Morrison Saunders, 2007). The compensation occurs at a new location. Example of environmental offsets is biodiversity offsets and carbon offsets.

Payments for environmental services (PES) - Payments for environmental services, is about paying providers of ecosystem services to conduct more environmentally friendly or/and give up destructive working methods to benefit ecosystem services. PES is a voluntary transaction where a well-defined ecosystem service is bought by an ecosystem service buyer (often the user or someone that benefits from the ecosystem services) from an ecosystem service provider. The provider must then secure and deliver the provision of the ecosystem services (Engel et al., 2008).

Certification - Certification is a voluntary market-based instrument, attesting to a status or level of achievement (Nkonya et al., 2012; Huertas et al., 2010).

2 Method

This method has been processed based method and has been developed step-wise along with the research process. Below a simplified description of the process will be described. Many studies have been carried out covering a different part of the topic of this report and therefore this study has handled a large number of articles and information.

This study consists of four steps, see figure 3. The first, second and third step was literature studies. The fourth step was a validation of the result with help from researchers from Lund’s University. In the first step, three marked based instruments for land use management was selected and selected market-based instruments effectiveness, strengths, and challenges where investigated. The second step identified potential environmental impacts from land use and land use change connected with sugarcane cultivation. Step three where an investigation of how well the selected market-based instruments work in practice in Brazil and how the chosen market-based instruments can be used to mitigate negative environmental impact. Finally, five validation interviews were held with researchers at Lund’s University at the institution Centre for environmental and climate research.

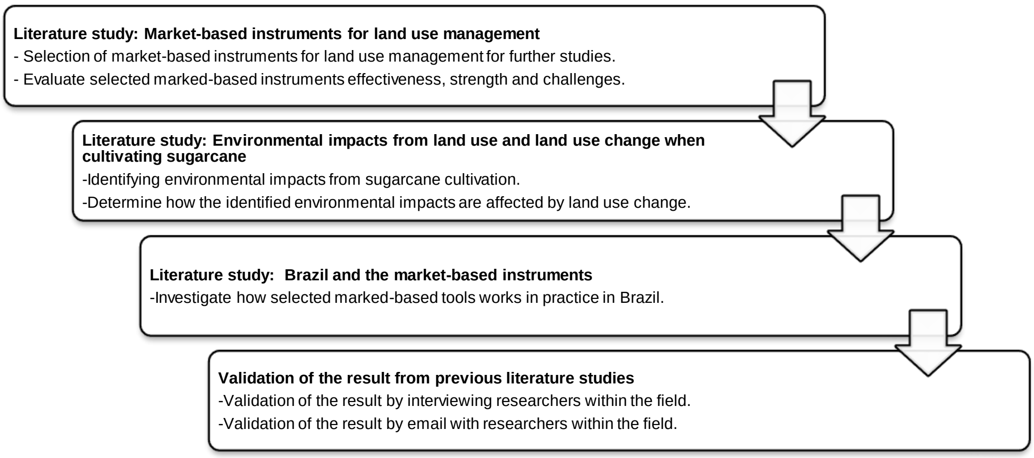

Figure 3 Work process
The figure describes the different step which was included in the study.

This study is more qualitative than quantitative study. All three steps used the same method for collecting articles. The method used was the snowball sampling method and the saturated data samplings method. The snowball sampling method was used to identify the most relevant articles by collecting the articles which possessed the most information and worked through the literature from most relevant information towards less relevant information (Walliman, 2006). The saturated sampling method decided when it was time to stop collecting articles (Saunders et al., 2017). Articles were collected and added to the study until no new information was found when analyzing new articles and a saturation point, was reached (Saunders et al., 2017).

2.1 Step 1: Market-based instruments for land use management

This step aims to investigate how market-based instrument for land use management works in general and to evaluate the market-based instruments effective, strength challenges. There are many different market-based instruments which aiming to handle negative environmental impacts (Filoche, 2017). This report looks closer to the market-based instrument which is used to improve land management. Tools for land management and for mitigating the environmental impact were defined in United Nations Department of Economic and Social Affairs report, *Sustainable land use for the 21st century* written by Nkonya et al., (2012). Following marked based tools were mentioned in the report and therefore investigated in this paper; offsets, payments for environmental services and certification and ecolabeling. The report also mentions conservation easements as a tool but because this tool is more government-orientated then company-orientated it was left out. This report also discussed certification and ecolabeling as one tool, but only certification will be handled in this report due to that ecolabeling is not used in the bioethanol sector.

These three tools are of interest to look closer into because they are in many cases voluntary and is located on different steps in the mitigation hierarchy. Offsets are the last option in the mitigation hierarchy, payments for ecosystem services are somewhere in the middle restoring/minimize damages and certifications working proactively with avoiding the negative impact (Arlidge et al., 2018). This part of the study looks at how the tools work in general, how they are packetized and what is included in the tools. Collected articles were analyzed after the tool's effectiveness, strength and challenges.

Articles were collected from LubSearch, and each search gave a large number of hits, the articles used in this study where selected by title and abstract. Selected articles looked at the different tools in general and described how the tools worked and included arguments about the tool's effectiveness, strength, and challenges. From selected articles reference list more articles, reports, and webpages were collected. References to this step are presented in Annex 1.

2.2 Step 2: Environmental impacts from land use and land use change when cultivating sugarcane

This step aims to identify the central direct environmental impacts from land use and land use change when cultivating sugarcane and how they are affected when land use change occurs. Step two consists of two parts; First part to identify the environmental impact and second part how they are affected by land use change. To identify the major environmental issues from land use and land use change, a literature study was carried out. Impacts which were found in the literature but mainly had social or indirect environmental effects was not chosen for further studies. This delimitation where made because the market-based instrument presented in step 1 mainly focus on handling and mitigating direct impacts and are not designed to handle indirect effects. Impacts which were delimited away were: land grabbing, extensive water use, food security, deforestation of Amazon, and gen modified organisms (GMO).

The studies started with an open search to identify and collect broad articles and review-articles from LubSearch by using the search words: *environmental impact AND sugarcane AND Brazil AND land use*. Because there are much written within this topic the search words gave many hits. The articles collected were selected by relevance in title and abstract. Relevant articles were review-articles and articles which presented different aspects and a broader perspective on land use/land use change and its environmental issues connected to sugarcane cultivation. The articles collected tried to describe the entirety of the problems with sugarcane cultivation. Articles which were in a different language than English, where to specific; just focused at one geographical area or issue, or other steps than sugarcane cultivation in the bioethanol production chain where downgraded

From the selected broad and review articles the major and central environmental impact was identified. More profound information; articles, reports, webpages, was then composed of the selected articles references lists. When the information in the selected articles was saturated, no new articles were collected and added to the study (Saunders et al., 2017).

The impacts found in the literature were categorized after environmental topic. Three categories where made; climate, biodiversity and ecosystem services and pollution of soil and water. After this, a table was made which presented how the different environmental impacts were affected when three different types of vegetation were converted into sugarcane. The vegetation was native vegetation, degraded pasture, and annual crops. These three vegetation types where chosen because they are the most common vegetation types which sugarcane in Brazil expands on (Bordonal et al., 2018). The impacts were categorized into four categories, irreversible impact, negative impact, no impact, and positive impact. These categories were chosen because they are described as the main outcome when land use change occurs (Koellner et al., 2013). Each impact was given a sign to describe the outcome on the impact when land use change occurs, the division and explanation of the different signs are described in table 1. References used to perform this step is presented in Annex 2.

Table 1: Description of sign used to categorize the impact when land use change occurs

Description of sign used in table 7.	Sign
Irreversible impact	--
Negative impact	-
No impact	0
Positive impact	+

2.3 Step 3: Brazil and market-based instruments

This step aims to look closer to how selected tools work in practice in Brazil. The study collected articles from the search engine LubSearch. The study started with an open search at LubSearch by using the following search words; *market-based instruments AND Brazil*. This search aimed to get a deeper knowledge of market-based instruments in Brazil, how common they were and how they coped with stakeholders and politicians. These articles were collected through relevance in title and abstract. Only literature in English where selected. Articles which were to specific to one geographical area or handled other steps in the supply chain based on the abstract was not chosen.

After this, a more specific search at LubSearch was done. Search words used in this step, the number of hits and number of selected articles are presented in table 3. All relevant articles based on the abstract and title there used in the study. Articles which were not selected were as mentioned above; to specific to one geographical area, handle other steps in the supply chain or not written in English. From selected articles reference list more profound information; reports, webpages, articles where collected. References used in this step is presented in Annex 3.

Environmental offsetting seems not to be a common tool when cultivating sugarcane, therefore the search word *"sugarcane"* was excluded, and the search aimed to look at the offset as an entirety in Brazil. The theory behind offsets is the same independent of what impact is aiming to compensate (Hayes and Morrison Saunders, 2007), therefore the search was concentrated to offsets which aimed to compensate biodiversity to minimize the number of hits.

Table 2 Search words for the literature study, step 2.
Used search words, search engine and number of hits and the number of selected articles.

Used search words	Search Engines	Number of hits	Number of selected
Biodiversity offsets and Brazil	LubSearch	43	4
payments for ecosystem services and Brazil and sugarcane	LubSearch	4	1
certification and Brazil and sugarcane	LubSearch	21	4

2.4 Validation

After step 1, 2 and 3 were done, three validation interviews were held with researchers at the institution of "Centre for environmental and climate" at Lund's University. Two researchers did not have time for an interview but answered the questions by email. The interviews were about 30 minutes and structured. All researchers were asked to answer the same questions (Bryman, 2016). The researchers were asked to validate the result from previous steps. The answers from the interviews and emails were then used to improve the result from the literature study. Participants and in which form they answered the questions is presented in table 3.

Table 3 Researchers interviewed for validation of the result.

Name	Interview/email
Helena Hanson	Interview 190513
Johan Ekroos	By email 190509
Johanna Alkan Olsson	By email 190514
Maria von Post	Interview 190513
Mark Brady	Interview 190510

3 Market-based instruments for land use management systems

Market-based instruments contribute to making environmental work more efficient and enabling environmental goals to be more easily reached (Nkonya et al., 2012). Market-based instruments are good complements to laws and regulations (Nkonya et al., 2012) and allow flexible implementation which can be adapted to any actor and situation (Filoche, 2017). These tools often create a win-win situation where protected areas are created, and economic development is benefited (Filoche, 2017). A green global market starts to take form but there are a lot of different ways and tools for companies to manage their negative environmental impact (Filoche, 2017). Below three different tools will be presented, and their effectiveness, strength, and challenges will be investigated.

3.1 Environmental Offsets

Environmental offset is voluntary or mandatory agreements where companies, industries or governments compensate for an unavoidable environmental impact/damage their activity causes nature (Hayes and Morrison-Saunders, 2007). The goal with environmental offset is to achieve no net loss (Doswald et al., 2012; Hayes and Morrison-Saunders, 2007). Environmental offsets have been used in the western world for a long time and for it to work well, a requirement is clearly defined land ownership rights, which not always is the case in developing countries (Nkonya et al., 2012).

Offsets can be mandatory and required by the authorities if there is a development which leads to environmental impact (May et al., 2017). The offset could also be voluntary and is then often made by companies, who want to avoid or prevent an obligated offset. I could also be because offsets are a natural way for a company and its businesses due to its social and environmental policies, their good practice and commitments (Doswald et al., 2012). Voluntary offsets are often undertaken by a company with support or partnership from a conservation organization or through help from consultants (Doswald et al., 2012).

Through quantitative measurements, the amount, type and quality of an impact/damage can be determined. When the extent of the impact has been determined a new location (receptor site) is selected, where the value that has been destroyed can be compensated to obtain no net loss in ecological values (Doswald et al., 2012; Hayes and Morrison-Saunders, 2007). The names of offsets vary with what value it aims to compensate, it could, for example, be called environmental offsets, carbon offsets, biodiversity offsets or ecological offset/compensation (Nkonya et al., 2012; Hayes and Morrison-Saunders, 2007). Offsets could be divided into the following categories; environmental management, reservation of land, restoration of ecosystem, research or contribution to founds to achieve less negative environmental impact (May et al., 2017).

Offsets are becoming a popular but controversial tool. Popular because economic development and conservation of nature could work together. Controversial because it gives permission to destroy ecological value if it is compensated somewhere else and no net loss can be achieved (May et al., 2017).

3.1.1 Effectiveness

Little is known about the effectiveness of the environmental offsets (May et al., 2017). Most evaluation regarding environmental offsets refers to ecosystem function or wetland mitigation project to offset carbon. There is no unambiguous way how to evaluate and measure the offsets, an explanation for this could be that there are a lot of different offset schemes, which are measured in different ways (May et al., 2017). A study by May et al. (2017), evaluates the effectiveness of environmental offsets in western Australia and concluded that maximum 39% of all offsets were effective and 30% where not or inadequately implemented.

One of the most crucial parts to obtain an effective offset is the design of the offset (Bull et al., 2013; Doswald et al., 2012). The offset should be carefully planned and considerate before carried out. The design of the offset must contain a defined time for which the offsets schemes should occur. The equivalence and no net loss between the offset site and the receptor site should be proven before the project is carried out (Doswald et al., 2012). It is also important to consider and define time lag and if there is a gap between destruction and recreation of a value (Bull et al., 2013; May et al., 2017; Villarroya et al., 2014).

The implementation of the offset does often not live up to the theoretical expectations and no net loss is often not achieved (Hayes and Morrison-Saunders, 2007). Reservation of land has been proven to be the most reliable way to offset an impact and has had the biggest positive outcome (May et al., 2017).

3.1.2 Challenges

Offsetting a value is the last option in the mitigation hierarchy. The compliance with the mitigation hierarchy is often low (Hayes and Morrison-Saunders, 2007) and not enough energy and resources have been put into the steps before in the mitigation hierarchy to avoid, minimize or restore the negative impact (Bull et al., 2013; Villarroya et al., 2014). It should not be possible for companies to skip steps in the mitigation hierarchy (UNDP, 2019a).

The uncertainties around the offset should be measured and estimated (Bull et al., 2013; Hayes and Morrison-Saunders, 2007). There could also be uncertainties when determining the replacement ratio for the impact and if enough value is being compensated (Villarroya et al., 2014). There are also uncertainties regarding if the offsets will persist and have a positive outcome (Bull et al., 2013; Doswald et al., 2012). Offsets are complex and hard to design because ecosystem services and climate change are hard to account for (Doswald et al., 2012). Offsets could be a risky tool where the development causes a negative impact in exchange for uncertain gains (LES, 2014).

Offsets should be able to calculate the value and consider indirect effects as well as direct effects to be effective. If indirect values not are considered, the value that needs to be compensated will probably be underestimated (Reid et al., 2015). The offset must in many cases be long-term due to the impacts that in many cases are irreversible and the highest values often need a long time to be fully developed (Reid et al., 2015).

Another weakness is that not enough research has been carried out regarding the receptor site and that the receptor site is not the most preferable site or cannot fully compensate for the lost values (Villarroya et al., 2014). Location of the offset site is crucial and should lie close to the developed site, otherwise, the benefits (ecosystem services) from the offset site will favor another community. On the other hand, a location far from the development site could be benefited and as a result gain greater ecological value (Bull et al., 2013). It is also important to make sure that the offset site would not have been an object for protection and conservation if not the project had been carried out (Doswald et al., 2012).

3.1.3 Strength

The biggest strength with offsets which also is one of the most important criticisms to the tools is that it gives the companies and governments a chance to develop in sensitive areas while assuring no net loss and still have an economic benefit (May et al., 2017). Offsets could lead to new market shares and make it easier to reach a new target group (Doswald et al., 2012). Strength and challenges connected to offsets are presented in table 4.

Table 4: Strength and challenges with environmental offsets.

Strength	**Challenges**
Improved business and reputation -if the offset is voluntary it gives the company a license to operate by improving the business and reputation of the company. If the company works preventive, it will lower the cost for compliance with regulations (Doswald et al., 2012).	*No net loss*- clear requirements for how to obtain and demonstrate that there has been no net loss (Bull et al., 2013; Doswald et al., 2012).
No net loss- Governments can accept developments in sensitive environments while assuring no net loss and still achieve economic benefits from the development (UNDP, 2019a).	*Design of the offset*- the design of the offset needs to consider; duration, equivalence, time lag, uncertainties, location (Bull et al., 2013; Doswald et al., 2012; Villarroya et al., 2014).
Opportunities- New market opportunity and new target group. Economical benefits (Doswald et al., 2012).	*Threshold and compliance with the mitigation hierarchy- Define threshold for a value which beyond is it okay to offsets instead of mitigating the impact (Bull et al., 2013; Doswald et al., 2012). And assuring compliance with the mitigation hierarchy (Hayes and Morrison-Saunders, 2007).*
Competitive advantage (Doswald et al., 2012).	*Additionality*- Ensure that the offset site would not have been an object for protection if not the offset project were absence (Doswald, 2012).
Employees- Employee approval and easier to retention employees (Doswald et al., 2012).	*Indirect effects*- indirect effects are often not considered when calculating the offset ratio (Reid et al., 2015).
	Measuring outcomes- not a uniformed way to measure the outcome, a different way to measure means different outcome, short measuring period, not monitored over time or not monitored at all (Bull et al., 2013; Doswald et al., 2012).
	Uncertainty- uncertainties in measuring of value, in the development's impact, and the uncertainties for a failed or not persisting offsets (Bull et al., 2013; Doswald et al., 2012).
	Implementation- Offset is often bad implemented (Villarroya et al., 2014).

3.2 Payments for environmental services

The interest in payments for ecosystem services, (PES) has increased over time and today there are more than 300 programs worldwide. PES could be compared to the polluter's pay principle but rather beneficiary pays, the one that benefits from an ecosystem service should also pay for it (Engel et al., 2008). PES is voluntary, were well-defined ecosystem services can be evaluated, priced and converted into a product which then is bought by an ecosystem service buyer (often user of the ecosystem services). The one (ecosystem service provider) who manages the ecosystem services are paid to conduct more environmentally friendly land management or/and abandon destructive working methods to be able to secure and deliver the purchased ecosystem services (Filoche, 2017; Engel et al., 2008).

PES aims to make it easier to share the burden with better-adjusted rules and distribution of obligations with a transaction between the one who benefits from the ecosystem services and the one who provides an ecosystem service. In many cases, PES provides compensation in exchanges for some restriction on land use (Filoche, 2017; Nkonya et al., 2012). PES is often a transaction to a landowner who is willing to protect a larger area than the law prescripts. The sellers of ecosystem services are often private landholders but, in some cases, it could be public land, owned by the government (Engel et al., 2008).

PES often occurs in situations where;

1. Land, land use or resource management activities could increase a certain ecosystem service or services (Smith et al., 2013).
2. There is a demand for the ecosystem services and the service has financial value for the buyers of the services (Smith et al., 2013).
3. It is clear who has the ability to increase the value of the services (Smith et al., 2013).

PES programs differ in type and scale in regard to which ecosystem services the program aims to protect, what activities which entail payments, the mode and amount of payments. PES also differ in measuring methods and monitoring of the performance (Engel et al., 2008). It could, for example, be aiming to protect land beauty, watershed services, to address biodiversity or carbon sequestration and climate change (Nkonya et al., 2012; Engel et al., 2008).

3.2.1 Effectiveness

PES has been successful in medium and low-income countries (Nkonya et al., 2012) and its effectiveness is depending on the design of the program (Engel et al., 2008). Watershed services tend to be the most effective PES because the provider benefits from managing the ecosystem service (Nkonya et al., 2012). Biodiversity and carbon PES have been less successful due to the provider not gain any added values by preserving the ecosystem services (Nkonya et al., 2012).

When choosing PES programs, it is important to ensure that money adds more value. For example, there could be a financial inefficacy if the ecosystem services paid for would be adapted either way. This leads to fewer ecosystem services per invested capital. The effectiveness of PES and the benefit from the ecosystem services could be overestimated if the geographical zoon outside the PES area is environmentally damaged. Few PES-projects has been carefully documented which means that they are hard to follow up and evaluate (Engel et al., 2008). Börner et al., (2017) concluded in their study that the effectiveness of PES often is lower than expected. It is important that PES is transparent if high effectiveness should be obtained (Engel et al., 2008).

The effectiveness of the PES is partly connected with the monitoring which in turn is dependent on data of the land property which is known to be a challenge in developing countries (Nkonya et al., 2012; UNDP, 2019b).

PES programs can be financed by two types of buyers. User-financed, where they who use the ecosystem services is financing it, and government-financed programs which are financed by the government or NGO (Engel et al., 2008). If government finances PES, the government act as a third part of the ecosystem services users behalf. Programs that are user-financed are often more efficient since the buyer knows the value of the product. Government financed projects are often more cost effective but often fails to ensure that the project is working effectively (Engel et al., 2008).

3.2.2 Challenges

One of the biggest challenges is to make an economic evaluation of the ecosystem services (Börner et al., 2017; UNDP, 2019b). The price to preserve an area with PES where the soil is used for agriculture with high yield crop are high due to the high value of the soil (Nkonya et al., 2012; UNDP, 2019b). Several PES-projects uses fixed prices and often pays a certain price/hectare for a given activity (Engel et al., 2008; UNDP, 2019b). This leads to agriculture fronts in hot spot areas are in danger due to the high price to establish a PES scheme (Nkonya et al., 2012; UNDP, 2019b). PES often focus on areas where the price for the land and ecosystem services are lower but also where the land is under less threat. There is a risk that the "opportunity cost" in high-risk areas are higher than the financial resources and therefore the PES schemes cannot be carried out in this area. There is also a risk that investor pays for land and ecosystem services in areas which are not in danger (UNDP, 2019b). External changes could lead to that PES becomes less desirable for the farmers for example if the market price on agricultural land rises (Engel et al., 2008). When PES is voluntary, both seller and buyer can cancel the project if the condition changes (Engel et al., 2008).

Monitoring of PES is divided into two categories, the first monitors the compliance with the contract for the specific land use and the second monitors if the payment helps to preserve the ecosystem services then certain land use occurs. Unfortunately, in most cases, only the first step is done (Engel et al., 2008). There is also a lack of long-running project due to that many projects are time-limited (Engel et al., 2008).

3.2.3 Strength

Encouraging a behavior change with positive incitements is more likely to lead to a long-term behavior change. By pricing conservation efforts and making it possible to earn money on conservation it could correct market failures (Filoche, 2017). When the applicants for participating in a PES program extends the buyer and financial aid, the buyer can maximize financial efficiency. The choice of a PES-seller can be based on benefit- and cost consideration or both (Engel et al., 2008).

Preventive work is often more cost-effective than handling and restoring of an environmental impact (Richards and Jenkins, 2007). For example, investments in watershed management are more cost-effective than treatment or creating a new water supply. It is estimated that each dollar invested in watershed protection saves 7-200 dollars in new filtration and water treatment facilities (Richards and Jenkins, 2007).

Table 5 Strength and challenges with payments for ecosystem services.

Strength	Challenges
Maintaining native vegetation- by paying the landowners to protect a certain value, nature can be protected (Engel et al., 2008).	*Pricing ecosystem services* - economic challenges in pricing an ecosystem service (UNEP, 2019b).
Cost effective- when used as a preventive tool (Richards and Jenkins, 2007).	*Monitoring and follow up*- None or insufficient monitoring of the PES performance. No uniformed way to measure the outcome and/or short measuring periods of the result (Engel et al., 2008)
Win-win situation- Both the provider and user of an ecosystem services benefits from protecting and conservation of ecosystem services (Nkonya et al., 2012).	*Duration*- Define the running time of the PES schemes (Engel et al., 2008).
	External changes- Changes in land price can lead to that the landowner becomes more interesting in using their land in another more harmful way (Engel et al., 2008).
	Additionality- Ensure that the PES scheme would not have been happening if not the project were absence (Engel et al., 2008; UNEP, 2012).

3.3 Certification

Forest certification and ecolabeling have been the most successful market-based instrument over the last decade with the most positive outcome, enhanced land management and harvesting (Nkonya et al., 2012). Certification is a voluntary market-based instrument, attesting to a status or level of achievement (Nkonya et al., 2012; Huertas et al., 2010). The standard is the core of the certification and describes what environmental and social criteria the certification will consider (Huertas et al., 2010). Different certification has different shall-requirements which are different hard to accomplish. If the companies, industries or governments fulfill all the shall-requirements given in the certifications standard concerning environmental, social and economic criteria they/their product can become certified (Nkonya et al., 2012; Huertas et al., 2010). Certification is often certified by a third part which examines the organization and can often be a form of a quality seal.

There are in general four areas where the standard differs from each other, listed below;

- The issue in focus – Different standard focus on different issues (Huertas et al., 2010).
- Issue of content - aiming to describe how and what the standard is aiming to achieve. It could be by practice-based sustainability criteria or a criterion describing the outcome (Huertas et al., 2010).
- Verification of certification - some certification requires a third-party verification and other allows self-verification (Huertas et al., 2010).
- Fees - standards with more strictness to verifying compliance have in general higher fee to access the certification and is often seen as more trustworthy (Huertas et al., 2010).

3.3.1 Effectiveness

If the certification and its standards are well defined it is an effective instrument to achieve a more environmentally friendly industry (Huertas et al., 2010). The effectiveness of certification mainly depends on the standard and it can have between low and high-performance levels (Schlamann et al., 2013). The performance level directly affects the result of preventing and mitigating the environmental impacts (Yenipazarli, 2015).

There is a large number of certifications for certified bioethanol from sugarcane (van Dam et al., 2008; Sugarcane, n.d; Huertas et al., 2010). Only in the EU, there are 17 different voluntary certification schemes which fulfill the EU: s sustainability criteria of biofuel and bioliquid (European Commission, 2019). The certifications all follow different standards with different scope and content but also in strictness of verifying compliance and therefore aiming to achieves different benefits, cost, credibility and legitimacy and sustainability goals (Huertas et al., 2010).

Certifications are sensitive against economic recession if the economic cyclically falls this tool will be less efficient (Nkonya et al., 2012). If customers demand certification of the product or if certification is the easiest way to reach a certain target group or market, the market will drive the development towards more sustainable production of bioethanol (Yenipazarli, 2015).

Certifications lie closer to the company and can be handled and incorporated into the company’s strategies. This close link between the company and the certification makes the certification efficient.

3.3.2 Challenges

A large number of different certifications which aims to certify the bioethanol from sugarcane creates uncertainty for producers and companies (van Dam et al., 2008). Certifications are being reported to be confusing and fragmented due to the variability in the standards (van Dam et al., 2008). Only the criteria that fit inside the standard of the certification will be considered when handling and mitigating the impact on the environment and impacts.

The price to become certified is high compared to the extra income a company can gain from the certified products (Nkonya et al., 2012). Many certifications demand an effective production which often includes mechanized production, which leads to a lot of people who earlier worked in the sugarcane plantation getting dismissed (Huertas et al., 2010). There is also a cost for the producers to change agriculture to meet the standard, and this could be costly, especially for small producers.

A certification should be trustworthy, independent and transparent (Nkonya et al., 2012). Customers care about different topics, and it is sometimes hard for a company to meet all customers wishes and demands (Yenipazarli, 2015).

3.3.3 Strength

Certifications lie close to the company and it is therefore easy for the companies to work with the certification standard and incorporate it into the company's strategies (van Dam et al., 2008). Certifications are also easy to communicate with the customers (Yenipazarli, 2015) and it could also be the key to access new markets and reach new target groups.

Customers are more likely to pay extra for an environmentally friendly alternative which leads to an economic benefit for the company. The tool can also be used to ensure the quality and origin of the raw material (van Dam et al., 2008). It also gives the company an effective tool which can be used in risk management and to gain control over the supply chain (van Dam et al., 2018).

Table 6 Strength and challenges with certifications.

Strength	Challenges
Easy to incorporate in the company's strategies- Certifications lies close to the company and is therefore easy to include in the strategies and easy with communicate to the customers. (Nkonya et al., 2012).	*A large number of certifications for bioethanol*- there is no unambiguous standard which leads to high uncertainties for producers and buyers of bioethanol (van Dam et al., 2008; Sugarcane, 2019; Huertas et al., 2010)
Risk management and quality tool- Certification standards can be used to manage risks and ensuring the quality of the raw material (van Dam et al., 2008).	*Sensitive against a recession*- The price to obtain a certification is high compared to the extra economic benefits the certification entails, this makes the certification sensitive against recession (Nkonya et al., 2012).
New markets and customers- Access to new markets and target groups and creates a more competitive product (Huertas et al., 2010).	*Content in the standard*- Only the environmental issues determined in the standard will be in focus and handled.

4 Environmental impacts from land use and land use change when cultivating sugarcane

Thought the literature study the central impacts from the land use and land use change then cultivating sugar cane was derived. Within the field, there seems to be a consensus about the central and most common problems within sugarcane production. Some authors also lift problem which they believe is central but other authors do not mention in their reports, this impact will not be handled in this report but is presented in the delimitations. Below central environmental issues found in the literature is displayed.

4.1 Climate

4.1.1 Soil quality and carbon stock

Bordonal et al., (2018) ranked soil quality and compaction of the soil as one of the biggest impacts from sugarcane cultivation in Brazil. The compaction comes from driving with heavy machines on the arable land which also increase the soil erosion (Hartemink, 2008; Azadi et al. 2012; Bordonal et al., 2018) and loss of soil structure (Hartemink, 2008; Walter et al., 2013). Smeets et al., (2008) reports that soil erosion from sugarcane is lower compared to annual crops. Sugarcane is a semi preanal crop and only needs to be replanted every fifth year and can during its growing period store a large amount of carbon in biomass. The low tilting rate which only occurs when replanting only contributes to a little lost in carbon storage (Zuurbier and Vooren, 2008). If the sugarcane is burned in the field before harvest the carbon stock in the soil are reduced (Azadi et al., 2012). Pasture has a lower soil erosion than sugarcane with a factor of 20. Soil erosion leads to a loss in carbon content in the soil (Smeets et al., 2008).

All carbon savings from using biopolymer/bioethanol can be neglected if the sugarcane has grown on former native forest, citrus or native grassland (Bordonal et al., 2018; Bordonal et al., 2015). It also leads to a large decrease in soil quality and decrease in soil structure and increase of erosion. (Cherubin et al., 2017). Carbon reservoir in soil and soil quality increases but leads to a slight loss in soil biodiversity if sugarcane expands on degraded pasture or arable land (Bordonal et al., 2015; Bordonal et al., 2018; Zuurbier and Vooren, 2008).

4.1.2 Greenhouse gas emissions

The production of the sugarcane is crucial for whether bioethanol/biopolymer reduces or contributes to emissions of greenhouse gases (Alkimim and Clarke, 2018). Bioethanol produced from sugarcane reduces the greenhouse gases emission by 86% if it is compared to gasoline (Zuurbier and Vooren, 2008). Compared to bioethanol from other feedstocks sugarcane have a leading performance (Zuurbier and Vooren, 2008).

A study made by Alkimim and Clarke (2018), argues that the land use changes due to the expansion of sugarcane on native vegetation are responsible for a significant amount of carbon emitted to the atmosphere. The amount of carbon could be equal or even greater then fossil fuel if the expanding of sugarcane takes place on native vegetation. Carbon debt from deforestation of Brazilian biomes has a payback time of 62 (Amazon forest) 15 (Cerrado) and 22 (Atlantic forest) years (Alkimim and Clarke, 2018).

Azadi et al. (2012) conclude that sugarcane contributes to air pollution by nitrogen fertilizers. Nitrogen fertilizer (NO2) emissions cause air pollution. NO2 is a more potent greenhouse gas than CO2 (Azadi et al. 2012). The use of fertilizers in Brazil is however still low due to the highly productive soils (Zuurbier and Vooren, 2008). The burning of sugarcane before harvest contributes to the soil, air and water pollution (Moraes et al., 2017; Azadi et al., 2012; Bordonal et al., 2018; Janssen and Rutz, 2011; Walter et al., 2013). The burning of sugarcane releases greenhouse gases, soot, and ashes (Walter et al., 2013). Burning the sugarcane before harvest is being phased out and therefore air pollution from burning the sugarcane will not be a problem in the future (Viana and Perez, 2013).

4.2 Biodiversity and ecosystem services

The main consequence of land use and land use change is the loss of biodiversity (Klöppfer and Curran, 2014). Land use will also lead to other negative impacts such as lowered ecosystem services, decreases in soil quality and lower biomass production (Klöppfer and Curran, 2014).

In south Brazil, protected areas are often surrounded by sugarcane cultivation and the buffer zoon has become more monocultural in recent years. The expansion of sugarcane has led to a big loss in biodiversity, ecosystem services and habitat destruction (Moraes et al., 2017; Kiesebrink et al., 2015) which now is suppressed by the agricultural land. The sugarcane plantation fragment the landscape and isolates conserved areas which lead to an over al loss in biodiversity and ecosystem service. In Brazil, it seems like there are lack of stepping stones end corridors even if the fragmented conserved areas could be used as stepping stones. Loss of biodiversity mostly happens when land use changes occur (Moraes et al., 2017). Janssen and Rutz (2011), report, that a biodiversity loss is expected if sugarcane expands into Cerrado, which is the most species-rich savannah on earth. There has been increased destruction of Cerrado the last year when sugarcane and cattle have expanded in that area (Janssen and Rutz, 2011).

Sugarcane mainly expands on degraded pasture and agricultural land (Smeets et al., 2008; Sparovek et al., 2008) which not leads to further biodiversity loss and therefore the direct and induced impact on biodiversity is limited (Smeets et al., 2008). The most threatened biotopes located in the sugarcane cultivation area is which could be converted into or affected by sugarcane is the Cerrado savannah and the Atlantic forest (Smeets et al., 2008).

The problem regarding illegal land occurs in sugarcane production areas, where sugarcane is cultivated on the ground reserved for the protection of native vegetation (Huertas et al., 2010).

4.3 Pollution

4.3.1 Pollution of groundwater, surface water, and eutrophication

Water pollution is a serious but often a regional problem that occurs when producing and processing sugarcane. The pollution is mainly organic or agricultural pollution (Smeets et al., 2008). Bordonal et al., (2018) raises the problem with finding god indicators to measure the impact on the water bodies quality. Agrochemical that is commonly used when cultivating sugarcane is following: herbicides, insecticides, biological and microbiocidal products, vegetable extracts, pheromones, adhesive spreading agents. The use of these chemicals and fertilizers can contribute to groundwater pollution, eutrophication and surface water pollution. Insecticides used on sugarcane are low compared to other crops (-40% for corn, -90% for coffee) (Smeets et al., 2008), and the use of herbicides is higher compared to other crops (Zuurbier and Vooren, 2008).

Herbicides have been found in rivers nearby sugarcane areas. Rivers in south Brazil have high levels of herbicides which strengthen the theory that sugarcane contributes to pollution of freshwater (Bordonal et al., 2018). The burning of sugarcane before harvest also contributes to the soil, air and water pollution (Moraes et al., 2017; Azadi et al., 2012; Bordonal et al., 2018; Janssen and Rutz, 2011; Walter et al., 2013). Researchers also conclude that sugar cane contributes to eutrophication by using fertilizers which then leaches from the fields into watercourses (Hartemink, 2008; Moraes et al., 2017; Kiesebrink et al., 2015).

4.3.2 Pollution of soil

The fertilizers used during production is lower compared to other crops (Zuurbier and Vooren, 2008; Walter et al., 2013), but higher compared to pasture (Bordonal et al 2018). The nitrogen is often applied by using nutrient-rich wastewater which increases the risk for salinization and nutrient leaching. Mineral fertilizers seem not to be used to a large extent in Brazil when cultivating sugarcane. It seems like the total impact of fertilizers is unknown because of the lack of studies (Smeets et al., 2008).

Azadi et al., (2012) believes that sugarcane contributes to soil pollution by using fertilizers. Other authors also conclude that agrochemicals and fertilizers used when producing sugarcane contributes to pollution and acidification of the soil (Hartemink, 2008; Moraes et al., 2017; Kiesebrink et al., 2015). Soil acidification is a common effect when nitrogen fertilizers are used (Hartemink, 2008).

The burning of sugarcane before harvest contributes to soil pollution (Moraes et al., 2017; Azadi et al., 2012; Bordonal et al., 2018; Janssen and Rutz, 2011; Walter et al., 2013).

4.4 Impact on climate, biodiversity and ecosystem services when land use change occurs

Impacts on climate, biodiversity and ecosystem and the risk for pollution of soil and water is affected in different ways when land use change occurs, and sugarcane expands over different types of vegetations. Koellner et al., (2013) categorized the most common outcome on land when land use changes occur as irreversible impact, negative impact, no impact, and positive impact. This categorization was used to describe the outcome of impacts from sugarcane cultivation in Brazil when land use change occurs. Table 7 present the outcome on climate, biodiversity and ecosystem services and pollution then sugarcane expands on different vegetation types. Land use change will have irreversible effects on biodiversity and ecosystem services, soil quality and carbon stock, greenhouse gas emissions and may have irreversible effects on water quality if sugarcane expands on native vegetation. Land use change will have a positive impact on soil quality and carbon stock and greenhouse emissions if sugarcane expands on degraded pasture or annual crops.

Table 7 How different impacts are affected when land use change occurs.

(NV=native vegetation, DP, degraded pasture, A=annual crops, SC= sugarcane.

Sign description: (--) irreversible impact, (-) negative impact, (0) no impact and (+) positive impact

Type of impact	**Subcategory of impact**	**NV-->SC**	**DP-->SC**	**A-->SC**	**Comment**
Climate	Soil quality and carbon stock (carbon storage in biomass and soil)	--	+	+	NV-->SC Large decrease in soil quality, decrease in soil structure increase of erosion (Cherubin et al., 2017). Carbon savings can be neglected and be even be positive (Bordonal et al., 2018; Bordonal et al., 2015). P-->SC= Slightly increase in soil quality, increase in soil erosion (Azadi et al., 2012; Kiesebrink et al, 2015). Carbon reservoir increases if sugarcane expands on degraded pasture and lead to positive carbon sequestration (Bordonal et al., 2015; Zuurbier and Vooren, 2008). A-->SC Slightly increases the soil quality, structure and erosion. Carbon reservoir increases if sugarcane expands on degraded pasture or arable land and lead to positive carbon sequestration (Bordonal et al., 2015; Zuurbier and Vooren, 2008).
	Greenhouse gas emissions	--	-	+	NV-->SC Expansion of sugarcane are responsible for a significant amount of carbon emitted to the atmosphere. The amount of carbon could be equal or even greater then fossil fuel if the expanding of sugarcane takes place on native vegetation (Alkimim and Clarke, 2018). P → SC Increase in use of fertilizers and emissions of NO2. A→ SC Decrease in use of fertilizers.
Biodiversity and ecosystem services		--	-	0	NV-->SC Big losses in biodiversity and ecosystem services (Moraes et al., 2017) P-->SC Small decrease in biodiversity and decreases in soil biodiversity (Bordonal et al., 2018). A-->SC Expansion on agricultural land does not lead to further biodiversity loss and therefore the direct and induced impact on biodiversity is limited (Smeets et al., 2008; Sparovek et al., 2008)
Pollution	Pollution of groundwater, surface water, and eutrophication	--	--	0	The more the soil is processed the more pollution will be released in forms of agrochemicals and fertilizers (Olsson[1]). A → SC Less tilting which leads to less leaching (Brady[2])
	Pollution of soil	--	-	0	The more the soil is processed the more pollution will be released in forms of agrochemicals and fertilizers. A → SC Less tilting which leads to less leaching (Brady[2])

[1] Johanna Alkan Olsson, Centre for Environmental and Climate research, interviewed 190510.

[2] Mark Brandy, Centre for Environmental and Climate research, interviewed 190510.

5 Brazil and market-based instruments

Sugarcane agriculture is one of Brazil's most important agricultural business (Viana and Perez, 2013). The industry is of international interest and therefore receives foreign investments for expansion (Viana and Perez, 2013). The sugarcane expansion has been subject for control and restriction related to sustainability issues by foreign institutions and government in more developed countries (Viana and Perez, 2013). Market-based instruments in Brazil environmental politics are still new and therefore not yet fully achieved and developed (Filoche, 2017) but still much debated in Brazil. They are considered by Brazilian stakeholders to be an innovative way of implementing environmental politics. Market-based instruments are often considered in national regulations (Filoche, 2017). Voluntary restoration projects made by business has grown in Brazil. Payments for ecosystem services and carbon-neutral projects are used as a restoration tool and have had both environmental and social benefits as well as benefits for the businesses (Ramalho et al., 2016).

5.1 Environmental Offsets

Offsets can be both voluntary and mandatory and the literature is often unclear of in which form offsets occur. The form depends partly on the context. The interest in environmental offsets has increased in Latina America over the last decade (Villarroya et al., 2014). Brazil's government has implemented a compensation program for ecological compensation (Reid et al., 2015). Brazilians government sometimes required offsets of the impact, accordantly to the forest code and from the "National Protected Areas Law when an activity causes a negative impact on the environment (Reid et al., 2015; Doswald et al., 2012; Villarroya et al., 2014). The law force developers to pay a fee equal to a percentage of the investment cost (maximum 0,5% of the initial investment costs) into the "Protected Areas System" through the "Environmental Compensation Fund". The fund is then used to protect and managing sensitive areas and ensures that there always are offsets available for purchasing since the fund is more general than specific when protecting areas and have no geographic boundaries (Reid et al., 2015). The fund focusses on already protected areas and its intention is not to form and create new protected areas (Reid et al., 2015). The fund is also used to monitoring the offsets (Reid et al., 2015).

As previously mentioned, an environmental impact assessment is sometimes required when there is an activity which can cause negative environmental impacts on protected areas (Villarroya et al., 2014; Doswald et al., 2012). The authorities can then based on the outcome from the environmental impact assessment decide that a certain value must be compensated. If the environmental impact assessment is weak and poorly executed, it could lead to an underestimation of the value that needs to be compensated. The environmental impact assessment does not need to consider the indirect effects from the environmental impact, which in many cases leads to an underestimation of value which needs to be compensated. The indirect effects of sugarcane plantation and expansion could be significant (Villarroya et al., 2014).

None of the Brazilian environmental offsetting programs incorporates ecosystem services on the receptor site or at the impact site when deciding how much value that should be compensated (Villarroya et al., 2014). Brazil strives for regulatory simplicity which mitigates the cost uncertainties and ecological uncertainties (Reid et al., 2015). There is likewise no clear reference to the mitigation hierarchy in the environmental impact assessment regulations (Reid et al., 2015; Villarroya et al., 2014). During the time when it has been possible to offset the negative impact through biodiversity offsetting, it has generated over 200 million US$ to conservation and investments in protected areas (Villarroya et al., 2014).

It does not seem like offsetting occurs when sugarcane expands, but environmental offsetting could be a useful tool to ensure no net loss when sugarcane expands in the future.

5.2 Payments for ecosystem services

The institution of largescale farming and cattle breeders, Confederation of Agriculture and livestock (Confederac¸ ão da Agricultura e Pecuária do Brasil, CNA) and the Rural workers, Confederation of Agricultural Workers (Confederac¸ ão Nacional dos Trabalhadores na Agricultura, Contag) all believe that PES is a useful tool (Filoche, 2017). PES is still just infancy in Brazil and so far, not a common policy or instrument in Brazil (Filoche, 2017). So far PES is mostly implemented in local scale in Latina America (Silva et al., 2016).

Farmers were asked to describe the biggest difficulties and obstacles to the implementation of PES projects in Brazil in a study made by Silvia et al., (2016). The framers then mentioned technical assistance from people or companies with the right competence, financial resources, and initiative from the government in the meaning of bringing the ecosystem services providers and users together. Another obstacle is the implementation and maintenance of the PES (Silva et al., 2016). Ecosystem services providers prefer cash payments when stepping into a PES project (Silva et al., 2016).

A study made by Alarcon et al., (2017), concluded that the PES program would be an ineffective tool to promote environmental conservation of the Atlantic forest in southern Brazil. The farmers were interested in receiving payments for conservation of the Atlantic forest but not to restore or conserve nature rather just to comply with the environmental regulations. The farmers did not want to set aside more land when prescribed in the conservation law. They also found that the farmer´s willingness to restore degraded forest was six times lower than to conserve forest areas (Alarcon et al., 2017).

5.3 Certification

The number of certified producers of sugarcane rises in Brazil (Huertas et al., 2010). One of the most common certifications in Brazil and especially south Brazil is Bonsucro (Sozinho et al., 2018) which certifies 8,9% of Brazilians total area of cultivated sugarcane (SugarCane, n.d.). Bonsucro is actively supported by The Brazilian Sugarcane Industry Association (UNICA) (SugarCane, n.d.). The applications for becoming certified is rising to meet the international markets demand and to ensure the international stakeholder that the sugarcane has been grown sustainable (Sozinho et al., 2018). The sustainability issues regarding the sugarcane ethanol have mostly been noticed by importing countries and to meet the international stakeholder's demand, a certification system has been developed in Brazil (Huertas et al., 2010).

Partly the European market which demands sustainable bioethanol drives the development. The producers know that they must comply with certain requirements to access the European market. EU ethanol market is expected to have some influence on the Brazilian market but is unlikely to lead to a total shift against more sustainable forms (Huertas et al., 2010). The interest for certifying bioethanol which is going to be used on the domestic market is in contrast low (Huertas et al., 2010). The certification of bioethanol is, therefore, more orientated to international products to avoid trade barriers.

6 Discussion

6.1 Market-based instruments

Market-based instruments are good at driving the development in a certain way by challenges old structures, contributes to change in the mindset and get away from business as usual (Freitas, 2017). By putting demands on the supplier when sourcing feedstocks, the development of more sustainable agriculture can be established (Brady[3]). In the future, the demands on companies from customers and governments will be considerably higher as the negative impact on climate and biodiversity reminds itself of its negative effects on human welfare (Ekroos[4]). This will affect companies which will have to adapt to the new market. If they work proactively they can be benefited by promoting themselves as environmentally friendly, and at the same time preparing for a changing market.

Companies often have a limited space to offer a higher payment to conduct a more environmentally friendly cultivation method due to that they compete with other companies at an international market. The development of agriculture is made by demanding the best practice to ensure that the supplier conducts a more environmentally friendly production of sugarcane (Bordonal et al., 2018). Best practice can for example be; total eradication of pre-burning before harvest, improved nitrogen fertilizer use efficiency, crop rotation and reduce the tilting rate (Bordonal et al., 2018). In this way, companies can have some influence over agriculture located far away and contributing to mitigate the negative impact. The problem with the market-based instruments which are aiming to benefit climate, biodiversity and ecosystem services and pollution is that it gives collective benefits (Dwyer et al., 2015). By improving the agriculture and benefit climate, biodiversity and ecosystem services and pollution the company does not get an added value and none/or small price increase to the company's products.

Many companies who want to work and improve their sustainability work, want to see a rise in the performance in laws and regulation. This would make the whole market more sustainable and set the same game rule for everyone who

[3] Mark Brandy, Centre for Environmental and Climate research, interviewed 190510.

[4] Johan Ekroos, Centre for Environmental and Climate research, by email 190510

operates in the country (Ekroos[4]). To make the Brazilian sugarcane cultivation more sustainable the Brazilian government must contribute by implementing laws and regulation which lifts the minimum requirements and raises the demands on all farmers and companies (Filoche, 2017).

Of the countries that produce sugarcane, Brazil is the country which has most actively reported its sustainability performance (Eggleston and Lima, 2015). A reason for this would be Brazils big export of bioethanol to other countries.

The most positive outcome of using voluntary tools is that it results in the protection and maintenance of the environment beyond what the environmental law requires, which would not have occurred if not the project were carried out. This is important in a country like Brazil, which has one of the worlds most conserved tropical vegetation, species-rich biodiversity and because Brazil is expected to increase the export of bioethanol to meet the growing global demand. (Freitas, 2017).

In developing countries, the land is used to lift people out of poverty. By putting a restriction on the land it hits on the poorest in the community who depends on the land. This could be the indigenous community who are displaced from their ancestral land which they are depending on for hunting (Kiezebrink et al., 2015). Therefore, it is important to include social responsibility when purchasing sugarcane to create a more sustainable production. Many market-based tools include social aspects, but their performance level is often low.

6.1.1 Environmental offsetting

Offsetting is more logical when it comes to compensation of carbon storage, which has a global effect and is easy to measure and define (LES, 2014). When it comes to recreating biodiversity, offsets are less efficient because the highest value of biodiversity and ecosystem quality can in many cases not be reconstructed when land use change has occurred (Koellner et al., 2013). Even if a long time passes, an ecosystem affected by human activities will never be the same again (Koellner et al., 2013). The strength of carbon offsets is that it provides a tool which could be used to mitigate global warming, protecting forests and improving livelihoods. Characteristic for carbon offsets is that the greenhouse gases may be produced locally but having a global effect and one ton offset carbon will have the same effect independent on where in the world it is compensated (Kumar et al., 2014). Despite this, there is doubt against the effectiveness of carbon offsets and in a commercial carbon market, it is difficult to assess the quality of the offset providers and projects.

It is impossible to define a consistent unit of biodiversity (Villarroya et al., 2014; LES, 2014). Therefore, it is highly problematic to trade biodiversity and receive no net loss (Bull et al., 2013). There is a need to define a unit of biodiversity and ecosystem services before offsets of biodiversity can become efficient and an important question is if this is possible at all. Biological units are complicated and the value of components like biodiversity patterns, population, species and vegetation, and ecosystem services are not fixed (Bull et al., 2013). Due to this, it is much more difficult to offset and receive a no net loss in relation to biodiversity protection than carbon offsets (Bull et al., 2013) and therefore, it is easier to create a global trading system for carbon than biodiversity (LES, 2014).

If another site can benefit and gain a higher biodiversity value it could be counted as a positive outcome (Doswald et al., 2012). Another problem with offsets is that there often is a time gap between when one value is destroyed until another has been recreated (Villarroya et al., 2014). During this time biodiversity and ecosystem services are suppressed and less efficient, this needs to be considered and handled during the design phase of the project. To design an effective offset, it must strive to find the most favorable offset site and be able to demonstrate equivalence between the two sites. The design should also consider the time lag for which the ecosystem services and the biodiversity will be suppressed. Calculations of how much of the impact which is reversible and the uncertainties with the project and how to demonstrate compliance with the mitigation hierarchy should also be carried out (Bull et al., 2013). To be able to do this knowledge, good communication and guidelines are needed.

If it becomes too cheap and easy to use, there is a risk that not enough effort is put into the higher prioritized steps before in the mitigation hierarchy, and areas being cleared because it seems easy to replace. If it is not ensured that there is no other way to preserve the nature than offsetting the impact, the offsets could be a toothless tool that just gives permission to destroy values (Doswald et al., 2012).

If the offset-system is not reliable and monitored, the offset can be used as a form of greenwashing by neutralizing the negative concern about the negative impact of the development (LES, 2014). The offset can then be used as an excuse to make a development which entails negative impact of the environment which would not have been approved otherwise and at the same time just gives a small actual environmental protection.

Offsets are a useful tool in developing countries to ensure that the development of the country does not occur at the expense of nature. Many countries have strong foundations from which policies for offsetting could be developed to become a powerful and useful tool (Villarroya et al., 2014). Brazil even has laws which entail implementation of the offset. Unfortunately, the offset policy in Brazil has no references to previous steps in the mitigation hierarchy (Villarroya et al., 2014). The frames to make offsets a powerful tool is already in place, what needs to be done to achieve efficiency is better guidance and follow up from the government or third party to ensure the offsets are efficient and lives up to the expectations in practice (Hayes and Morrison-Saunders, 2007).

6.1.2 Payments for ecosystem services

Payments for ecosystem services, (PES) is often used to improve the land management of already cultivated land. It does not secure long-term protection of biodiversity and ecosystem services but allows lands to remain productive and private owned, which often seen as desirable by the politicians (Fishburn et al., 2009). PES is not yet a common tool to use in Brazil and even if few PES services schemes are carried out, they are politically relevant (Filoche, 2017). PES could provoke controversies and challenges nature conservation to develop in new ways (Freitas, 2017). PES could be used as a complement to legislation and regulations and cause a positive synergetic effect together with the laws on the environment (Börner et al., 2017). In developing countries like Brazil, it could be hard to make the farmers follow and comply with environmental laws (Alarcon et al., 2017). The use of PES can stimulate the compliance with the environmental laws and regulations and compensate the farmers for the loss in income the environmental laws have entailed on their property (Alarcon et al., 2017). If they are compensated for protecting or changing land management, it increases the incitements to practice nature conservation and adopt best practice.

By lifting forward nature's contribution to society, PES can help increase the acknowledgment and the willingness to pay for conservation of nature and ecosystem services (Davidson and Gutman, 2007). When the awareness of ecosystem services arises, the buyers will have a better knowledge of what they are purchasing and therefore could demand improvement of the land management. This increases the efficiency of the invested money in conservation (Davidson and Gutman, 2007). If PES become more common it could work against poverty and at the same time contribute to sustainable rural development by offering an income in exchange for nature conservation (Davidson and Gutman, 2007). Most ecosystem services are undervalued and undersupplied (Davidson and Gutman, 2007). The toughest part with this tool is to make sure that the one which benefits from the ecosystem services realizes this and are willing to start contributing to the conservation of the ecosystem services.

6.1.3 Certification

By labeling the product with a certification-logo, customers can be ensured of the properties of the product and often be guaranteed a certain quality (Horvat and Kržan, 2012). The environmental and social performance level in the standard for bioethanol approved by EU varies greatly and is often low. Many certifications often fails to address crucial environmental and social issues and therefore it cannot ensure that imported bioethanol has been produced sustainably (Schlamann et al., 2013; van Dam et al., 2008) Bonsucro which is the most common certification in

Brazil and the mandatory "*environmental impact assessment"* which is used by the environmental authorities when approving a bioethanol project have almost the same requirements regarding the environmental issues (Sozinho et al., 2018). This means that the certification does not contribute to decreasing the environmental impacts more than prescribed by law.

The many bioethanol certifications lead to inefficiency (SugarCane, n.d.c), and the best would have been if the number of standards decreased or become more uniformed. It is hard for the customers to know the differences in performance between the different standards. The lack of a "global standard" for what sustainable bioethanol should be and how to achieve it, plays a central part in many certifications. Many certifications lead to counterproductivity, less efficiency and might contribute to less investment to accomplish a sustainable production (van Dam et al., 2008; SugarCane, n.d.c.). It also gives contradictory signals to the farmers and causes uncertainties for the producers of what the final standard will look like and what requirement it will contain. The many possibilities and different requirements foster trade barriers and are of concern in developing countries (SugarCane, n.d.c). The farmers need time to change their behavior and clear guideline to improve their agriculture to not suffer financial damaging.

Certification in Brazil will not result in a change towards a more sustainable bioethanol sector (Huertas et al., 2010). This could be due to that it is mostly exported bioethanol which is being certified and the main part is used within the country (Huertas et al., 2010) Bioethanol used within the country is usually not certified and the interest of becoming certified is low. In countries like Brazil which is highly corrupt (Transparency International, 2019), certification can contribute to ensuring compliance with laws. The certification organization could work as a control organ when the state is not strong enough to handle this. This means that certification contributes to certain protection and increased compliance with laws. Even if the standards are not perfect, they contribute to putting sustainable work in focus by working with the environmental and social aspect which would not have happened if not the standard would have been present (Hansson[5]).

PES and offset could in the future be incorporated in the certification system to make companies take more responsibility for their negative impact and improve the performance of the certifications. Certification should also introduce different levels of performance for example; bronze, silver gold. Overall standards should have a higher performance and work with constant improvement, meaning that they update the standards and raises the performance level continually.

[5] Helena Hansson, Centre for Environmental and Climate research, interviewed 190513

6.1.4 Comparison between the market-based instruments

According to the mitigation hierarchy, offsetting is the least desirable option and certification which focuses on avoidance is the most desirable option if wishing to mitigate the negative environmental impact (Arlidge et al., 2018). Studies show that the compliance with the mitigation hierarchy in Brazil is low and better references to the mitigation hierarchy needs to establish in the laws (Reid et al., 2015; Villarroya et al., 2014). The mitigation hierarchy should also become better defined in Brazilian law. There should be a clear described in the law in what extent damages should be avoided and minimized, and when the damages are to extend and needs to be restored or offset. A control organ which ensures the performer's compliance with the mitigation hierarchy should also be established.

Offset is mainly used when land use change occurs and will probably mostly be used when sugarcane cultivation expands. PES and certifications are often used to improve the land management of already transformed land. Certification works proactive and focuses on making the farmers conduct a more environmentally friendly agriculture practice. Certification is also in many cases a tool to prevent deforestation and destruction of native vegetation due to the criteria (which is included in several standards) that sugarcane can't be certified if produce on former native vegetation. Certification can also be used when land is about to change the purpose or when selecting land suitable to produce certified sugarcane.

The use of PES and offset can be central in developing land management and to achieve sustainable production of sugarcane, but it is still a long way to go before they become common and mainstream tools. Hence, a conclusion that can be made is that to make offsets and PES more efficient and decrease the uncertainties around these tools, they need to be better monitored and followed up, there needs to be clear accountability and the system needs to become more transparent. There could also be a third party involved that has requirements for control of compliance, performance accountability and process transparency of the offsetting and PES (Silvia et al, 2016). Stakeholder inclusion should also occur which leads to better performance, compliance, and outcome (de Vargas Mores et al., 2018; Silvia et al., 2016). Clear rules should also exist about who is responsible and what happens if the environmental offset aiming to compensate and achieve no net loss fails or if PES fails to deliver the purchased ecosystem service. If PES and offset schemes are well designed, they can create added value. For example, when carbon sequestration is benefited by creating a wetland, biodiversity and water purification is often improved.

The uncertainties and risks for a failed or bad implemented project are highest for offset followed by PES. Certification tends to have most compliance, but studies show that compliance with certification varies. Third part certified standards have higher compliance with the standard and have fewer uncertainties (Schlamann et al., 2013).

A company which wants to be profiled as an environmentally friendly and have an environmental policy with the stance "*do no harm on society and environment*", should not use offsetting. Offsetting is not compatible with the stance *"do no harm on society and environment*". The offset will probably be used by subcontractors to the packaging companies when sugarcane expansion is about to occur.

Today many companies have an environmental policy with the stance "do no harm on society and environment", but in the future, the stance will probably be transformed into "leave with a good impact on society and environment" (Norris, 2019). If companies would like to go a step further with their environmental work and embrace the stance "leaving with a good impact on the society and environment" whey could start using payments for ecosystem services. By paying farmers for adopting a more environmentally friendly agriculture practice, the company could start to have a positive influence at the local area. Payments could be made to create and maintain artificial wetlands and riparian buffer zones, increase woodland and ecological corridors, avoid bare soil over not cultivating periods and applying fertilizers on high-risk areas and at high-risk times (Smith et al., 2013; Pechey et al., 2013). By doing this companies can create more job opportunity which benefits the local inhabitants, purchasing more sustainable feedstock and leaving a good impact behind. By having a good design payment for ecosystem services, it could even help people out of poverty by providing a cash income in a rural area where poverty might be concentrated (UNDP, 2019b). Local communities can benefit from the PES-schemes by gaining increased knowledge of sustainable agriculture practice from technical assistance and training.

6.2 Sugarcane and land use and environmental issues

When it comes to impact on nature it is crucial that land management which has occurred on the spot earlier. If sugarcane expands on native vegetation, climate benefits from producing polymers from bioethanol instead of fossil ethanol can be neglected (Bordonal et al., 2018; Smeets et al., 2008). Expansion of sugarcane at native vegetation will have irreversible effects on carbon storage, biodiversity and ecosystem services (Bordonal et al., 2018; Bordonal et al., 2015; Moraes et al., 2017). The impact of sugarcane cultivation comes both from land use and land use change (Bordonal et al., 2018). During the occupation and transformation of land, the ecosystem quality is kept on a different level and the characteristics of the ecosystem are changed to fulfill another purpose (Koellner et al., 2013). First, when the land is left outside human activities it starts to recover and go back to its natural state (Koellner et al., 2013). In many cases, land use change can be seen as a reversible impact. The expansion of sugarcane is not only bad but can have positive effects on soil quality, carbon stock, and greenhouse gas emissions if it expands on degraded pasture or annual crops. The sugarcane can store a large amount of carbon in its biomass and bind soil with its roots due to less tillage. This increases carbon storage and decreases soil erosion.

Another thing that needs to be considered is how long the current land management has been going on. In the beginning, all land has been native vegetation which at a certain point were converted into pasture or agriculture land. It is a philosophic question from when you should start counting the land use change and how big the carbon debt should be.

A difference between Sweden and Brazil is that Sweden already has turned over almost all forest a couple of times, meanwhile, Brazil still has a large amount of untouched vegetation. There are also differences in the amount of forest/vegetation which must be set aside if land use change shall occur. In Sweden there are no such numbers, no forest must be left by law, but if the wood shall be certified, 5% of the areal must be set aside (FSC, 2010). In Brazil, the forest code demands that 20-80% of the forest must be set aside if land use change should occur (Ramalho et al., 2016). This means that Brazil already has strong protection against land use change, but then again, the compliance with the environmental laws in Brazil is low. In the future sugarcane will expand on 60% on pasture and remaining 40% on cropland. (Zuurbier and Vooren, 2008) This means that none or a small part native vegetation in the future will be converted into sugarcane plantations. Indirect effects are not investigated in this study but the indirect effect from land use change when sugarcane expands could be significant since there is still a demand for the land to cultivate edible crops (Villarroya et al., 2014). Sugarcane plantation could, therefore, have indirect effects which lead to deforestation and destruction of native vegetation (Klöppfer and Curran, 2014). Agriculture politics are important to ensure food security and reduce the effects of indirect land use effects from sugarcane plantations (Ferreira Filho and Horridge, 2014). The sugarcane industry in Brazil has still a lot of potential for improvement. If the productivity of the sugarcane increases the direct and indirect effects of sugarcane cultivation will be smaller (Ferreira Filho and Horridge, 2014). The sugarcane production in Brazil has the ability to quadruple its capacity for bioethanol whiteout major implications to land use by using high yield technology (GMO, advanced hybrids, new biorefinery technologies, and new cultivation methods) (Bordonal et al., 2018).

Sugarcane could play an important role in the future by reducing the emissions from fossil fuel, both by producing biofuel and biopolymers which our society is dependent on. But there are still a lot of work left both within social and environmental areas before the first part of the biopolymer supply chain and the land use can be called environmentally friendly.

7 Conclusion

Market-based instruments could play a central role in the development of sustainable sugarcane production in the future. But to become efficient, many of the market-based instruments need to become more transparent, better monitored and followed up.

Offset is mainly used when land use change occurs and can contributing to achieving no net loss if carefully designed and implemented. Offset is not yet a common tool to use when sugarcane cultivation expands.

PES and certifications are used to improve land management. Certification can work proactively by avoiding expansion of sugarcane in sensitive areas. Certification is the most successful market-based instrument and is heavily used in Brazil´s bioethanol sector. But due to the standard’s low-performance level and the low interest for certifying bioethanol which should be used within the country, certification does not contribute to more sustainable sugarcane cultivation.

PES has the ability to become a powerful tool which could be used by companies when purchasing a feedstock to create a positive impact on society and the environment. By offering payments in exchange for nature conservation it works against poverty and could contribute to sustainable rural development.

When it comes to nature, it is crucial what land management that has occurred in the area before. If sugarcane expands on native vegetation, carbon savings from producing polymers from bioethanol instead of fossil ethanol can be neglected. It also leads to a large decrease in biodiversity and ecosystem services. If sugarcane instead expands over degraded pasture or annual crops it could have a small positive effect on soil quality, carbon stock, and greenhouse emissions.

7.1.1 Future work

For future studies, I recommend more research and comparisons between the different certification systems. There should be a study which sorts out and ranks their performance. More research is also needed regarding the sugarcanes indirect effect, to be able to calculate the actual environmental impact from sugarcane plantations. A standard/guideline for how to measure the performance and outcome from environmental offsets and PES should be established.

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