Expanding the Markets for Environmental Protection

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Recent Initiatives on Certification, Voluntary Carbon Offsets, Protected Area Certificates, and Emission Trading

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Referentin: Prof. Dr. Ulrike Grote

Institut für Umweltökonomik und Welthandel

Wirtschaftswissenschaftliche Fakultät

der Gottfried Wilhelm Leibniz Universität Hannover

Korreferent: Prof. Dr. Klaus-Peter Wiedmann

Institut für Marketing und Management

Wirtschaftswissenschaftliche Fakultät

der Gottfried Wilhelm Leibniz Universität Hannover

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Abstract

A number of innovative, market-based instruments (MBIs) have emerged over the last years; certification schemes, emission trading, protected area certificates, and conservation banking are just a few of them. In many cases such MBIs have been initiated as climate policies but have transformed into more comprehensive instruments over time. They focus not only on greenhouse gases, but also on carbon stocks, biodiversity and social issues. At the same time the complexity makes these instruments challenging. How should they be implemented? Are they efficient in reaching their goals? And what potential do they have to attract consumers? This doctoral thesis addresses those questions while considering four MBIs more closely: a) biofuel certification, b) voluntary carbon offsets, c) protected area certificates, and d) emission trading.

Biofuel production increased very rapidly after the turn of the millennium. Drivers of this development include energy security motives, assistance to domestic farmers, and raised climate awareness. Those objectives may not always aim at the same direction. For example, domestic biofuels often receive preferential treatment by the governments although they have a comparatively low greenhouse gas savings potential. Furthermore, it is difficult – if not impossible – to isolate climate and economic strategies from other environmental and social targets. This became very clear when the supposedly climate friendly biofuels were blamed to cause deforestation and food price inflation in 2008. In direct response to this, a number of certification schemes were developed; one of these became mandatory in the European Union (EU).

Chapter 2 considers sustainability aspects and certification of biofuels in detail. It finds that a major difficulty consists in breaking down very complex issues into measurable criteria. Moreover, it highlights the risk that sustainability standards are used to favor domestic producers and thus translate into trade barriers. Chapter 3 continues evaluating obstacles and promises related to biofuels trade with a special focus on Africa. It concludes that African countries have a high unsatisfied demand for energy but that it will take time to develop the necessary infrastructure and knowhow for biofuels production. The risk of certification becoming an impediment to trade is also highlighted in this context.

These results are to some extent reinforced by the empirical analysis in Chapter 4. It analyzes the potential of certifying large-scale *Jatropha Curcas* (from now on Jatropha) oil production in Tanzania through an economic land evaluation approach. A major outcome is that high levels

of inputs are needed to obtain reasonable yields. With current technologies and given prices, large-scale production is not feasible, neither for domestic use nor for exports. Consequently certification is not an issue yet, although it might become one in the future. Findings reveal that costs for meeting sustainability standards are fairly low for feedstock produced on good soils where water is abundant. In contrast, it is projected to become an obstacle for feedstock produced on less suitable soils or in highly biodiverse "no-go" areas.

Also Chapter 5 uses an interdisciplinary approach to explore sustainability issues related to biofuels. This time, however, a country and feedstock with a very long experience is considered – sugarcane ethanol from Brazil. Brazil exports substantial amounts of it to the United States (US) and the EU. The question is if production meets the most important sustainability requirements discussed on a global level. Results show that production is in fact largely sustainable. In particular the greenhouse gas savings potential is well above the mandatory requirement of the EU. The impact on welfare and human development is favorable as well, even though this is likely due to the more intense economic activity in general and not necessarily a result of producing ethanol per se.

Up to this point the thesis has only considered the supply side. In Chapter 6, the focus is turned to the demand side. While doing so it examines another MBI, namely emission trading through voluntary carbon offsets (VCOs). VCOs have existed on the market for about a decade, but adoption rates have been low. The question is how to increase them. Findings reveal that the typical purchasers are young and active people who prefer to eat little meat and make their own travel arrangements. Findings also show that a rather large share of the respondents has heard about VCOs before but not taken the step to buy one yet (47%). As most people in this group are interested in environmental issues, a conclusion is to target this group specifically. This should be done both by increasing the credibility of VCO schemes and facilitating the purchasing process.

Chapter 7 continues analyzing demand among tourists for a specific MBI, this time for protected area certificates (PACs). PACs aim to certify bundles of ecosystem services. Ideally, the instrument should achieve synergy effects between scientific and socio-economic aspects. As the instrument is new and very little is known about its market potential, a choice experiment is conducted. Results indicate that biodiversity, poverty reduction, and water protection are the three factors that the respondents appreciate most. In contrast, the interest in carbon sequestration is lower. Hence, a recommendation is to move away the emphasis from carbon to other sustainability aspects in the communication with consumers.

The last chapter aims to compare the effectiveness of different MBIs when production is connected with high externalities. To do so, the chapter takes the example of a wetland where agriculture and aquaculture systems coexist. To reduce the negative impacts of production, three MBIs are considered: conventional certification; emission trading; and PACs. The effects are then compared in a comparative statics framework. Results suggest that all the instruments have the possibility to increase welfare. Nevertheless, product certification does not incorporate the strong linkages between different ecosystem services. As a result, this instrument might not reach its full potential and could under certain circumstances even have negative impacts. In contrast, emission trading and PACs are first-best MBIs. However, the complexity of these instruments also creates new challenges.

Keywords: Bioenergy, protected areas, certification

Zusammenfassung

In den letzten Jahren sind eine Reihe von innovativen, marktbasierten Instrumenten (MBIs) wie zum Beispiel Zertifizierungssysteme, Emissionshandel, Schutzzonen-Zertifikate und Habitat-Banking-Systeme entstanden. Solche MBIs wurden häufig als Klimaschutz-maßnahmen eingeführt, haben sich aber im Laufe der Zeit zu umfassenderen Instrumenten entwickelt. Sie betonen nicht nur Treibhausgase, sondern auch Kohlenstoffbindung, Biodiversität und soziale Fragen. Gleichzeitig stellt die Komplexität dieser Instrumente eine große Herausforderung dar und wirft einige Fragen auf. Wie sollten sie umgesetzt werden? Sind sie effizient in der Zielerreichung? Und welches Potenzial haben sie, Kunden anzuziehen? Die vorliegende Dissertation befasst sich mit diesen Fragen, wobei vier MBIs näher untersucht werden: a) Zertifizierung von Biokraftstoffen, b) freiwillige Klimakompensationszahlungen c) Schutzzonen-Zertifikate und d) Emissionshandel.

Die Produktion von Biokraftstoffen ist seit dem Anfang des Millenniums stark angestiegen. Zu den treibenden Kräften dieser Entwicklung zählen beispielsweise ein erhöhter Bedarf an Energiesicherheit, der Wunsch, die heimische Landwirtschaft zu unterstützen, sowie ein stärkeres Klimabewusstsein. Diese Ziele sind nicht immer miteinander vereinbar. Einheimische Biokraftstoffe werden beispielsweise häufig vom Staat subventioniert, obwohl sie mit einer vergleichsweise geringen Einsparung von Treibhausgasen verknüpft sind. Darüber hinaus ist es schwierig - wenn nicht unmöglich – die durch Klimaschutz begründeten Strategien von anderen ökologischen und sozialen Zielen zu isolieren. Dies wurde sehr deutlich, als im Jahr 2008 die vermeintlich klimafreundlichen Biokraftstoffe dafür verantwortlich gemacht wurden, die Waldabholzung zu beschleunigen und den Preisanstieg für Lebensmittel anzutreiben. Als direkte Antwort darauf wurden verschiedene Zertifizierungsinitiativen ins Leben gerufen, von denen eine in der EU heute verpflichtend ist.

Im Kapitel 2 werden Nachhaltigkeitsaspekte und Zertifizierung von Biokraftstoffen näher untersucht. Es wird gezeigt, dass eine der größten Schwierigkeiten darin besteht, sehr komplexe Abläufe in messbare Kriterien herunterzubrechen. Die Analyse weist auch auf das Risiko hin, dass Nachhaltigkeitsstandards primär dazu verwendet werden, inländische Hersteller zu begünstigen und sich so in Handelsbarrieren verwandeln.
Kapitel 3 setzt die Analyse von Hindernissen und Möglichkeiten des globalen Biokraftstoffhandels fort. Ein besonderer Fokus wird dabei auf Afrika gelegt. Die Analyse stellt fest, dass viele afrikanische Länder eine hohe unbefriedigte Nachfrage nach Energie haben. Allerdings mangelt es mittelfristig an notwendiger Infrastruktur und Know-How zur

Produktion von Biokraftstoffen. Die Gefahr, dass Zertifizierung sich in ein Handelshemmnis umwandelt, wird auch in diesem Kontext hervorgehoben.

Zu ähnlichen Schlussfolgerungen kommt auch die empirische Analyse im Kapitel 4. Hier ist der Schwerpunkt auf das Potenzial von zertifizierter, großflächiger Ölproduktion auf der Basis von *Jatropha Curcas* (von nun an Jatropha) in Tansania. Den Berechnungen zufolge würden die Zertifizierungskosten für den Anbau auf guten Böden und mit reichlicher Wasserzufuhr relativ niedrig sein. Dahingegen könnten die Nachhaltigkeitsstandards zu einem Hindernis werden, wenn die Böden arm und wenig geeignet sind oder wenn die biologische Vielfalt im Anbaugebiet hoch ist. Unabhängig von der Zertifizierung zeigen die Ergebnisse, dass erhebliche Inputmengen notwendig sind, um die Erträge zu steigern. Mit vorhandenen Technologien und gegebenen Preisen ist die Produktion nicht rentabel, und zwar weder für den einheimischen Markt noch für den Export.

Kapitel 5 verwendet ebenfalls eine interdisziplinäre Herangehensweise, um die Frage der Nachhaltigkeit von Biokraftstoffen zu untersuchen. Dieses Mal wird jedoch der Schwerpunkt auf ein Land mit sehr langer Erfahrung in der Biokraftstoffherstellung gelegt - Brasilien. Brasilien exportiert erhebliche Mengen Ethanol aus Zuckerrohr in die Vereinigten Staaten (USA) und die Europäische Union (EU). Die Frage ist, ob die Produktion die wichtigsten Nachhaltigkeitsstandards, die auf globaler Ebene diskutiert werden, erfüllt. Die Ergebnisse deuten darauf hin, dass die Produktion in der Tat weitestgehend nachhaltig ist. Insbesondere das Einsparpotenzial an Treibhausgasen liegt deutlich über dem Niveau, das von der EU als Minimum gefordert wird. Die Auswirkungen auf Wohlfahrt und Entwicklung sind ebenso positiv, auch wenn dies wahrscheinlich auf die intensivere wirtschaftliche Aktivität im Allgemeinen und nicht unbedingt auf die Herstellung von Ethanol als solche zurückzuführen ist.

Bis jetzt hat die Arbeit ausschließlich die Angebotsseite behandelt. In Kapitel 6 verschiebt sich das Fokus auf die Nachfrageseite. Dabei wird ein anderes MBI untersucht, und zwar freiwillige Klimakompensationszahlungen im Flugverkehr. Die Möglichkeit, an ein Klimakompensationsprogramm teilzunehmen, existiert schon seit etwa einem Jahrzehnt, die Verkaufszahlen waren allerdings bisher bescheiden. Die Frage ist, wie sie erhöht werden können. Die ökonometrischen Auswertungen lassen erkennen, dass die typischen Käufer junge und aktive Menschen sind, die wenig Fleisch essen und ihre Reisen selbst organisieren. Die Auswertung zeigt auch, dass ein relativ großer Anteil der Befragten von freiwilliger Klimakompensation gehört hat, aber dass sie noch nicht den Schritt gemacht haben, eine

Kompensationszahlung zu leisten. Da die meisten Leute, die dieser Gruppe angehören, an Umweltfragen Interesse haben, ist eine Schlussfolgerung, dass diese Gruppe gezielt angesprochen werden sollte.

Kapitel 7 setzt die Analyse der Nachfrage von Touristen fort, dieses Mal mit einem Fokus auf Schutzzonenzertifikate. Die Idee von Schutzzonenzertifikaten besteht darin, Ökosystemleistungen gebündelt zu zertifizieren. Idealerweise sollte es dazu führen, dass Synergie-Effekte zwischen naturwissenschaftlichen und sozio-ökonomischen Systemen entstehen. Da das Instrument neu ist und sehr wenig über das Marktpotenzial bekannt ist, wird ein sogenanntes Choice Experiment durchgeführt. Die Ergebnisse zeigen, dass biologische Vielfalt, Armutsbekämpfung und Wasserschutz zu den drei Faktoren gehören, die die Befragten am höchsten schätzen. Das Interesse an Kohlenstoffbindung ist wiederum geringer. Eine Empfehlung ist daher, in der Kommunikation mit den potenziellen Käufern andere Nachhaltigkeitsaspekte als Kohlenstoffbindung zu betonen.

Das letzte Kapitel zielt darauf ab, die Effektivität der verschiedenen MBIs zu vergleichen, wenn die Produktionssysteme viele Externalitäten verursachen. Um dies zu tun, wird das Beispiel von einem Feuchtgebiet herangezogen, wo sowohl Landwirtschaft als auch Aquakultur betrieben wird. Um die negativen Auswirkungen der Produktion zu mindern, werden drei MBIs betrachtet: konventionelle Produktzertifizierung; Emissionshandel; und Schutzzonenzertifikate. Die Auswirkungen werden anhand von komparativer Statik untersucht. Dabei weisen die Resultate darauf hin, dass alle Instrumente das Potenzial haben, die Wohlfahrt zu erhöhen. Die Produkt-Zertifizierung beachtet allerdings nicht die starken Interaktionen zwischen den verschiedenen Ökosystemleistungen. Deshalb erreicht dieses Instrument nicht immer sein volles Potenzial und kann unter bestimmten Umständen sogar negative Wirkungen haben. Im Gegensatz dazu sind Emissionshandel und Schutzzonenzertifikate effektiver. Sie führen aber aufgrund ihrer Komplexität zu neuen Herausforderungen.

Schlagwörter: Bioenergie, Schutzgebiete, Zertifizierung

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List of Abbreviations

CDM	Clean Development Mechanism
CO_2	Carbon dioxide
ESS	Ecosystem services
EU	European Union
FAO	Food and Agriculture Organisation
FSNC	Full-service network carrier
ICAO	International Civil Aviation Organization
KMO	Kaiser-Meyer-Olkin
MBI	Market-based instrument
$MtCO_2e$	Million metric tons of carbon dioxide equivalent
PAC	Protected area certificate
PCA	Principal components analysis
REDD	Reduced Emissions from Deforestation and Forest Degradation
SE	Standard error
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VCA	Verified Conservation Areas
VCO	Voluntary carbon offset

1 Introduction

1.1 Background and Problem Statement

In 2007 and 2008, photographs showing the charred remains of forests and wetlands started to circulate the news. Media talked about soaring deforestation in the Amazon, irreversible loss of biodiversity, and an "orangutan genocide" in Indonesia (Bassett, 2010; BBC News, 2008; Knudson, 2009). It seemed that some of the most diverse hotspots in the world were rapidly transformed into industrial farm land. At the same time, violent demonstrations against increasing food prices had spread over the continents. Only within a few months, basic staple prices had reached levels not seen since the oil price crisis in the 70s (FAO, 2014).

Both food price volatility and land use change are dynamic processes with strong linkages to many sectors. Underlying causes may include e.g. oil price fluctuation, changing consumption patterns, increased urbanization and bad weather conditions. However, the explanation attracting most attention in 2007/2008 was not these traditional drivers but a new one: the growing demand for biofuels. This was in many ways controversial, not least because one of the most prominent arguments to support biofuels had been to combat climate change. When the debate on the negative impacts of biofuels heated up, the advocates faced a dilemma. How could carbon emissions targets be met without compromising other environmental and social objectives? Many stakeholders – policy makers and environmentalists alike – started to discuss biofuel certification as possible remedy.

This thesis set off in the aftermath of the biofuels dispute. Development of innovative, market-based instruments (MBIs) had begun a few years back and new markets were slowly taking form. Comprehensive certification schemes such as those for biofuels were one instrument. Other examples included transferable permit schemes for e.g. carbon emissions and effluents, biodiversity banking, and payments for ecosystem services. The case of biofuels had shown that good intentions could easily backfire if important sustainability aspects were ignored. Accordingly, in the discussions that followed on how to make progress with the MBIs, greenhouse gases, carbon stocks, biodiversity and social issues were all highlighted as important. The focus of this research is on four such MBIs that were set up primarily to protect the climate but have developed into more far-reaching instruments over time: biofuel certification, voluntary carbon offsets, protected area certificates, and emission trading.

1.1.1 Biofuel certification

Biofuel certification schemes started to appear in direct response to the criticism of biofuels. They ranged from concrete feedstock schemes (e.g. Roundtable on Sustainable Palm Oil and the Roundtable on Responsible Soy) to schemes embracing all kinds of feedstock at all stages in the value chain (e.g. Roundtable on Sustainable Biofuels). Many initiatives covered aspects of environmental and social sustainability similar to other agricultural certification schemes, yet the biofuel initiatives tended to go further. For example, most of them included also criteria on greenhouse gases, land use, and food impact assessments. A major difference was also that they did not refer to a niche product. This became very obvious when the EU decided to introduce sustainability criteria tied to the EU Renewable Energy Directive. According to these, the biofuels eligible for the mandatory biofuel targets had to meet requirements on greenhouse gas emissions savings. Further, they could not be produced on land with high biodiversity value (European Parliament, 2009). Given that the objective was to achieve a share of 10% renewable fuels in the total transport energy mix by 2020, the EU constituted a large market.

The biofuel certification initiatives raised many questions. On the one hand, they initiated a long discussion on the sustainability of biofuels. What criteria should they contain and how should complex processes like food security be transferred into manageable criteria and indicators? Chapter 2 revises the sustainability concept and outlines different certification schemes in more detail. On the other hand, the certification initiatives also triggered a debate on costs and indirect trade barriers. In particular the mandatory criteria of the EU provoked heated discussion. Some of the issues related to trade flows and certification of biofuels are examined in Chapter 3 with a special focus on African countries. Chapter 4 continues exploring the sustainability and economic incentives of biofuels producers in an African country, namely producers of the potential feedstock Jatropha in Tanzania. Using data from an experimental plantation, the option of export under different certification regimes are compared with the option to produce for the local market. Chapter 5 provides a more comprehensive analysis of sugarcane ethanol in Brazil. As opposed to Tanzania, Brazil has a long tradition of ethanol production and the sector is very competitive. Focus is therefore not on the potential of single producers but on the sustainability impacts on the macro level. More specifically, the chapter considers main issues discussed on a global level like greenhouse gas emissions savings, carbon stocks, land use change and socio-economic development.

1.1.2 Voluntary Carbon Offsets, Emission Trading, and Protected Area Certificates

The second MBI included in the thesis is voluntary carbon offsets (VCOs). VCOs started to develop in the end of the 1980s but became familiar to the broader audience only around 2006/2007 (Hamilton et al., 2007). The idea was to give purchasers the possibility to compensate for the carbon emissions that they could not (or were not willing to) avoid by reducing an equivalent amount of emissions elsewhere. Potential customers were for example companies that wanted to improve their corporate social responsibility, conscious air travelers, or climate aware consumes in general. On the supply side, most mitigation projects supported through VCOs were – and still are – related to renewable energy investments, forestry or land use (Hamilton et al., 2007; Peters-Stanley and Yin, 2013).

Much hope was pinned to the VCOs, but recent data shows that the VCO market has remained small compared to the regulated market governed by the Kyoto mechanism.[1] This may not come as a surprise as both theory and empirical evidence tell us that financing public good through voluntary participations is difficult (Ledyard, 1994). Even so, stated preferences studies indicate that e.g. tourists would be willing to contribute to a larger extent than they do today (Araña and León, 2013; Lu and Shon, 2012; MacKerron et al., 2009). There are also a number of studies indicating that many people do not know about the possibility to offset (Gössling et al., 2009; Hooper et al., 2008; Lütters and Strasdas, 2012; Nakamura and Nishida, 2009). Chapter 6 examines the determinants behind knowledge and purchases of VCOs. It does so by taking the example of long-haul air travelers from Germany. Apart from socio-economic characteristics, determinants related to travel habits and other pro-environmental behavior are considered.

An additional issue related to VCO is co-benefits. Over time, VCO schemes have become more and more inclusive. For example, many of the suppliers of VCOs are now certified both to a scheme accrediting the carbon emission reduction and a scheme tied to criteria on additional social and environmental benefits (Peters-Stanley and Yin, 2013). One mitigation instrument that covers many different sustainability aspects already from the start is protected area certificates (PACs). PAC schemes certify that a land area meet certain criteria related to the provision of a *bundle* of ecosystem services (carbon sequestration, biodiversity, water protection, etc.). The UN-program Reduced Emissions from Deforestation and Forest Degradation is a prominent example of a PAC. It has come to attract much attention within the

[1] In 2012 VCO markets moved 42 $MtCO_2e$ equivalents while the transacted volume within the Clean Development Mechanism (CDM) under the Kyoto Protocol reached 2025 $MtCO_2e$ (Peters-Stanley and Yin, 2013).

United Nations Framework Convention on Climate Change (UNFCCC) and can be seen as an extension to carbon offsetting through forestry. Verified Conservation Areas is another PAC scheme, which puts the main emphasis on biodiversity. In Chapter 7, the potential of PACs is analyzed from the point of view of German tourists traveling to developing countries. While doing so, the willingness to pay for different attributes of the PACs is analyzed. Subsequently, Chapter 8 closes the thesis by comparing the three MBIs product certification, emission trading, and PACs with respect to an ecosystem where ecosystem services are strongly interlinked. Some general conclusions on when the different instruments can be used to reach the most efficient outcome are discussed.

1.2 Research Objectives

The overall aim of this thesis is to examine the impacts of four innovative MBIs with respect to potential supply, potential demand, and effectiveness.

More specifically, the objectives are:

1) To review recent developments related to production, trade flows and certification of biofuels (Chapter 2 and 3)

2) To investigate the potential role of developing countries in production and export of sustainable biofuels by taking the example of a) Jatropha in Tanzania and b) sugar cane in Brazil (Chapter 4 and 5)

3) To examine determinants of knowledge and purchases of VCOs among German air travelers (Chapter 6),

4) To explore preferences of German tourists for PACs created in developing countries (Chapter 7)

5) To compare the effectiveness of the three MBIs product certification, emissions trading, and PACs when ecosystem services are strongly interlinked (Chapter 8).

1.3 Methods

Various methods are used in the thesis depending on the research objective. Chapters 2 and 3 aim to give an introduction to biofuel sustainability, trade, and certification by reviewing existing literature.

In Chapter 4, an interdisciplinary economic land use assessment is applied to analyze more in depth the viability of producing and certifying Jatropha oil in Tanzania. The model connects land and input conditions with economic variables, which makes it possible to simulate the outcome for different scenarios. One advantage with this kind of approach is that it allows us to account for uncertainty in the parameters. This is helpful since data for the analysis was obtained from an experimental farm and will be subject to fluctuations under up-scaled conditions. Furthermore, economic variables are inherently volatile and change over time. By defining distributions for the unknown parameters instead of just point estimates, we obtain an approximation of the risk involved in the process.

Also Chapter 5 uses an interdisciplinary approach, which includes a combination of methods such as models to calculate changes in carbon stocks, greenhouse gases, land use change, and socio-economic impacts. Considering the socio-economic impacts, t-tests are used to compare municipalities where the main production source is sugarcane (>90% of total production) with municipalities where little or no sugarcane production takes place.

Chapter 6 considers determinants of knowledge and purchases of VCOs. A non-linear principal components analysis is first used to reduce the number of variables. In a second step a binomial logit model is used.

Chapter 7 analyzes how consumers assess different aspects of PACs. Willingness to pay for different sustainability targets is derived from a discrete choice experiment. To maximize the efficiency of the information gathered, a nearly-optimal main effects design is applied in line with the work of Street and Burgess (2007). A conditional logit as well as a random parameter logit model (Train, 2003) are then estimated. The random parameter logit accounts for unobserved heterogeneity and does not rely on the independency of irrelevant alternatives property. A direct result is that we are able to examine explicitly the drivers of preference variation between the respondents.

Finally, Chapter 8 uses a theoretical optimization model to describe the behavior of a land holder under different policy options. It shows how the private production decision of a land holder differs from the social optimum in the presence of negative externalities. Using comparative statics three different types of MBIs are then introduced to compare to what extent they are able to internalize the externalities.

1.4 Results

The aim of Chapter 2 is to give an introduction to sustainability of biofuels and provide an overview of different biofuel certification schemes. With respect to the economic sustainability, the analysis shows that biofuels will only be interesting for private stakeholders if production costs are below the fossil fuel price equivalent and opportunity costs remain low (i.e. the price of other feedstock uses). Most biofuel producers are not able to meet these criteria but still rely on subsidies, tariffs, and other measures aiming to protect the domestic industry. In view of the environmental aspects (greenhouse gases, energy balance, water etc.), sustainability impacts depend on agricultural practices, the choice of feedstock and site specific conditions. Among the first generation biofuels, sugarcane ethanol and palm oil biodiesel are identified to have the highest potential. Yet, the review also emphasizes the risk that they replace forests, wetlands, and other sensitive ecosystems resulting in a high carbon debt and biodiversity losses. Finally, considering the social aspects, issues related to land ownership, labor and employment are discussed. Against this background, a number of national and private certification schemes are reviewed. Findings show that many of the certification initiatives have taken place in Europe and North America with the aim to strengthen climate policies, respond to consumer groups and environmental organizations, but also to protect domestic producers. Other countries with a high export potential such as Brazil, Malaysia, and Indonesia have also shown interest in sustainability standards in order to obtain access to the large markets in Europe and the North America.

Chapter 3 continues to explore recent development in trade with biofuels. The literature review finds that trade with biodiesel is still negligible and trade with ethanol is small and concentrated to few regions (in particular Brazil, the US, and the EU). Various trade policies and barriers are identified. For example, in the case of the US trade is facilitated through various free trade initiatives (e.g. the Caribbean Basin Initiative and the Central America Free Trade Agreement). Even so, access to the US market remains limited as import tariffs and tax credits distort the relative competitiveness of exporting countries. Also the EU imposes duties on denatured alcohol. However, European producers are on average less competitive and there is high unsatisfied demand. Consequently, the access to the European market for non-member countries is easier than to the US. A special focus is placed on the potential of African countries. Factors such as trade agreements, price volatility and technical standards are identified as possible constraints for large-scale development. Also the access to roads and other infrastructure could become a bottleneck, given that many liquid biofuels require fast processing. Producers who aim for the export market should pay attention to international

sustainability standards, e.g. with regard to greenhouse gases and land use change since they are, or are likely to become, imperative for entering the big consumer markets (the EU and the US). In the first place, African countries are recommended to start production on a small scale for blending at the regional level.

Chapter 4 investigates the potential of large-scale Jatropha oil production from Tanzania empirically. A main question is if certification could become an indirect trade barrier. Results from the economic land evaluation assessment show that high yields are necessary to make production profitable. However, high yields demand substantial inputs. Especially fertilizer costs are a major bottleneck. Thus, under current conditions the probability to break even on the domestic market is virtually zero. Export is estimated to be somewhat more favorable due to the high prices of competing feedstock. How much certification would add to the total costs, depends on the scheme and the region where production takes place. As for the mandatory EU certification standards, most of the costs are connected with the accreditation process and fixed. Accordingly, they are not likely to become a large constraint as long as the land used for production is not of high biodiversity value (a prerequisite for most sales in the EU). Voluntary certification in turn could be related to higher costs if land is not suitable or more irrigation water is needed. Even so, the chapter concludes that the major problem is not certification criteria but rather the low efficiency of the production system. More experimental research is needed before any further investments are made.

Chapter 5 continues to look at another biofuel feedstock – Brazilian sugarcane ethanol – and the possibilities it has to comply with sustainability criteria. The findings indicate that the ethanol production is sustainable both from the point of view of greenhouse gas savings and land use change. In a life cycle assessment, greenhouse gas savings are calculated to be 78% compared to conventional gasoline. If the ethanol is exported to the EU, the equivalent number would fall to 70% but would still be higher than what is demanded in the mandatory EU certification criteria. Regarding the land use change, satellite images show that production has primarily taken place on previous crop and pasture land. Consequently, the commonly voiced criticism that sugarcane is a driver of deforestation is not supported in this study. Indirect land use change where sugarcane displaces pasture and pasture displaces forests does not seem to be a problem in São Paolo, yet it could be for some part of Mato Grosso. More research is needed to verify this result. Considering the socio-economic sustainability, paired t-tests are used to compare municipalities with high and low sugarcane production. Findings show that the sugarcane municipalities score significantly higher on the human development index, have

higher per capita incomes and more equally distributed incomes than the municipalities with no or little sugarcane production. Overall, the ethanol production in the considered regions is therefore considered to be sustainable.

In Chapter 6 the potential of voluntary carbon offsetting is evaluated and focus is changed from the producer side to demand. The diffusion theory of Rogers (1995) is used to identify drivers of knowledge and purchases of VCOs among German air travelers. Results show that quite a few of the respondents know about the possibility to offset (55%). However, only 8% have bought VCOs before. Drivers of knowledge include sport and adventure activities, making own travel arrangements, high ticket price, environmental interest, regular donations, as well as an academic degree. Factors that influence if a person who knows about VCOs actually buys a VCO include sport and adventure activities, making own travel arrangements, being young and following a diet with low climate impact. When considering how the respondents perceive climate protection measures, those who do not know about VCOs before are most negative towards the idea of voluntary offsetting. If they could choose, most of them would prefer to do nothing or reduce their carbon footprint at home. In general they are less interested in environmental issues. By contrast, those who know about VCOs but have not bought any yet are more interested and many of them are positive towards the VCO instrument. A recommendation is therefore to put most effort in convincing people belonging to this group. This could be done by strengthening the credibility of VCO schemes and facilitating the purchasing process.

One possibility to increase adoption rates of VCOs could also be to focus more on co-benefits. In Chapter 7 focus is on demand for PACs and what characteristics of PACs tourists travelling to developing countries value highest. Results from the choice experiment show that respondents are willing to pay most for biodiversity, poverty reduction, and water protection. In comparison willingness to pay for carbon sequestration is lower. The reason for this is likely that many of the respondents feel personally attached to the natural environment and the people at their destination. Carbon sequestration in contrast is abstract and it is difficult to see how the personal contribution makes a difference. The results are of practical relevance since carbon sequestration has been the perhaps most important characteristic of PACs. Accordingly, PACs are often thought of as a “carbon offset plus”. The study suggests that more emphasis should be put on other aspects. Even though carbon sequestration remains an important outcome, biodiversity and poverty reduction are more likely to attract the broader audience.

The estimation of potential supply and demand for different MBIs is an important exercise to see if the instruments will be able to reach their targets. In the same way, it is also important to compare the MBIs to see if they are *efficient* in reaching those goals. The last part of this thesis, Chapter 8, considers how product certification, emission trading and PACs perform within the context of a wetland. To do so the focus is on agriculture and aquaculture. It is assumed that both production systems will have a negative impact on other ecosystem services. In addition to this we assume that agriculture will reduce the productivity of aquaculture, for example due to runoff and pesticide pollution. Results show that the strong linkages between the two production systems and the other ecosystem services create different challenges for the MBIs. Product certification does on the one hand reduce the direct negative impacts on the ecosystem. On the other hand, the positive impact on aquaculture might have unwanted indirect effects. This is due to the negative externalities connected with aquaculture. To what extent these indirect effects counteract the desired impact of product certification is an empirical question, which is not investigated further at this place. Even so, the analysis demonstrates that policy makers and other stakeholders have to be careful when implementing an MBI in ecosystems where production systems are heavily entangled. In contrast to this, emission trading reduces the externalities without defining how producers should do this. As a result, participating producers have an incentive to reduce their emissions both with respect to agriculture and aquaculture. Yet it requires that the most crucial externalities can be isolated and measured, which is a difficult task in itself. PACs in turn are based on maintaining a pre-defined level of ecosystem services. The instrument therefore internalizes the externalities and increases overall welfare. However, just as emission trading schemes, it demands much as producers would have to predict how their actions affect the ecosystem. This is a great challenge in particular for small-scale land holders in developing countries.

1.5 Structure of Dissertation

Chapter	Authors	Title	Published in/Submitted to/Presented at
2	Elbehri, A., Segerstedt, A., Liu, P. (2013)	Biomass and biofuel sustainability: An overview of issues, methods, and initiatives	Published in: Elbehri, A., Segerstedt, A., Liu, P. (2013): Biofuels and the Sustainability Challenge: A Global Assessment of Sustainability Issues, Trends and Policies for Biofuels and Related Feedstocks. Food and Agriculture Organization (FAO), 2013, Rome (Italy). Trade and Markets Div., pp. 53-111. ISBN 978-92-5-107414-5. The other 2 chapters of this book serve as background papers: http://www.fao.org/docrep/017/i3126e/i3126e.pdf
3	Walter, A., Segerstedt, A. (2012)	International Trade of Biofuels: Current Trends and the Potential Role of Africa	Published in: Janssen, R., Rutz, D. (Eds.), Bioenergy for Sustainable Development in Africa. Springer Netherlands, Dordrecht (Netherlands), pp. 147-162. ISBN 978-94-007-2181-4.
4	Segerstedt, A., Bobert, J. (2013)	Revising the potential of large-scale Jatropha oil production in Tanzania: An economic land evaluation assessment	Published in: *Energy Policy*, Vol. 57, pp. 491-505. doi:10.1016/j.enpol.2013.02.023. Earlier versions were presented as follows: Segerstedt, A., Bobert, J. (2010): Potential of Sustainable Jatropha Oil Production in Tanzania: an Economic Land Evaluation Approach. Presented at the 117th European Association of Agricultural Economists (EAAE) Seminar: Climate change, food security and resilience of food and agricultural systems in developing countries: Mitigation and adaptation options. November 25-27, University of Hohenheim, Germany. Segerstedt, A., Bobert, J., Faße, A., Grote, U., Hoffmann, H., Kabir, H., Sieber, S., Uckert, G. (2010): A Land Suitability Appraisal Based Costs-Benefit Analysis of Sustainable Jatropha in Tanzania: Will Certification get a viable option? Presented at Tropentag 2010, September 14-16, Zürich, Switzerland.
5	Walter, A., Dolzan, P., Quilodrán, O., de Oliveira, J., da Silva, C., Piacente, F., Segerstedt, A. (2011)	Sustainability assessment of bio-ethanol production in Brazil considering land use change, GHG emissions and socio-economic aspects	Published in *Energy Policy*, 39(10), 5703-5716. doi:10.1016/j.enpol.2010.07.043. An earlier version was published as an independent report "Brazilian Bio-Ethanol: A Sustainability Analysis. Report", developed with support from the Department for Environment, Food and Rural Affairs (Defra) and the British Embassy in Brasília, 2008.
6	Segerstedt, A., Grote, U. (2014)	Increasing Adoption of Voluntary Carbon Offsets among Tourists	Under review in: *Journal of Sustainable Tourism.*
7	Segerstedt, A., Grote, U. (2015)	Protected area certificates – gaining ground for better ecosystem protection?	Published in *Environmental Management*, 55(6), 1418-1432. doi:10.1007/s00267-015-0476-2.

8	Segerstedt, A., Röttgers, D. (2014)	Effectiveness of Market Based Instruments for Protecting Wetlands	Versions of this paper were presented as follows: Segerstedt, A., Röttgers, D. (2011): Efficiency of Market Based Instruments for Protecting Ecosystems: The Example of Wetlands. Presented at the 18th Ulvön Conference on Environmental Economics, June 21-23, 2011, Ulvön, Sweden. Segerstedt, A., Röttgers, D., Winter, E., Grote, U. (2011): Efficiency of Market Based Instruments for Protecting Wetlands. Presented at Tropentag 2011: Development on the margin. October 5-7, University of Bonn, Germany. Grote, U., Röttgers, D., Segerstedt, A., Stellmacher, T., Winter, E. (2011): The Economics of Ecosystems: An Integrated Institutional Approach. Presented at the Conference ICCAFFE 2011, May 20-22, 2011, Agadir, Morocco.

Note: Co-Authors contributed to the chapters in the following way. Chapter 2 was primarily written by Anna Segerstedt under supervision of Aziz Elbehri and Pascal Liu from the Food and Agriculture Organisation (FAO). Authorship of Chapter 3 was divided equally between Arnaldo Walter and Anna Segerstedt. In Chapter 4, Anna Segerstedt was responsible for writing and estimating the economic model including the simulations in the sensibility analysis, while Jans Bobert was responsible for the land suitability, yield and irrigation simulations. Both authors contributed to the data collection. In Chapter 5, Anna Segerstedt was primarily involved with the socio-economic evaluation (Section 5), general editing and paper structuring. In Chapter 6 and 7, Anna Segerstedt was in charge of data collection, model estimations and writing. Ulrike Grote was supervising and advising with respect to the paper structure and content. In Chapter 8, Anna Segerstedt and Dirk Röttgers divided the task of writing and modeling equally.

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Knudson, T., 2009. The cost of the biofuel boom on Indonesia's forests. Yale Environment 360. Guard. Environ. Netw., The Guardian.

2 Biomass and biofuel sustainability: An overview of issues, methods, and initiatives

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3 International Trade of Biofuels: Current Trends and the Potential Role of Africa

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4 Revising the Potential of Large-Scale Jatropha Oil Production in Tanzania: An economic land evaluation assessment

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5 Sustainability assessment of bio-ethanol production in Brazil considering land use change, GHG emissions and socio-economic aspects

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Downloadable: http://www.sciencedirect.com/science/article/pii/S0301421510005732

6 Increasing Adoption of Voluntary Carbon Offsets among Tourists

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Submitted paper to *Journal of Sustainable Tourism*

ABSTRACT – Air travelers have had the possibility to buy voluntary carbon offsets (VCOs) for almost a decade, yet adoption rates have remained rather low. We use the diffusion theory from Rogers (1995) as framework to explore how adoption rates may increase in the future. Based on a survey of about 450 German long-haul tourists, we apply econometric models to analyze their knowledge of VCOs and their probability of purchasing them. Our findings reveal that tourists are more likely to buy VCOs if they are young, adventurous, and follow a diet with low climate impact. Factors such as a high ticket price, environmental interest, regular donations, and an academic degree increase the probability of knowing the concept of VCOs but do not affect the decision to purchase them. There is a large share of tourists who are aware of VCOs but have not offset until now. These are considered as potential clients, as they are positive towards the idea and have a high interest in environmental issues. For the future development of VCO markets one important task will be to persuade the travelers belonging to this group, both by strengthening the credibility of VCO schemes and facilitating the purchasing process. In contrast, those who have not heard about VCOs until now are also less interested in environmental issues and less willing to take voluntary action. Targeting those tourists will likely be associated with higher costs.

Keywords: voluntary carbon offsets; climate change; innovation process; adoption; tourism

6.1 Introduction

Voluntary carbon offsets (VCOs) have received a lot of attention over the last decade. From a theoretical point of view, the concept is straightforward: a person buys a VCO and the provider guarantees that the money is invested in a project that helps to reduce emissions by an equivalent amount elsewhere. Such project could aim to increase renewable energy sources, sequester carbon through reforestation or improve energy efficiency (Peters-Stanley and Yin, 2013).

VCOs have been available on the German market for about a decade. One of the sectors where the instrument has attracted most interest is the aviation sector (Kind et al., 2010). There is little doubt that air travel plays an increasingly important role in climate change (Becken, 2013; Gössling and Upham, 2012; Owen et al., 2010). Many long-haul tourists emit more greenhouse gases on their holidays than they do in traffic at home during a whole year (Aamaas et al., 2013). In view of this, proponents of VCOs refer to it as a "quick and cost effective way to balance a carbon footprint whilst waiting for the fruition of internal abatement measures" (The Gold Standard Foundation, 2011).

At the same time, there is also a lot of controversy surrounding the VCO market. Major criticism refers to the additionality aspect and the lack of transparency.[2] Another key problem concerns the voluntary nature of the offset itself. As previous research has shown, financing public goods through voluntary contributions is difficult because the temptation to free ride is large (Ledyard, 1994). Consequently, most experts agree that mandatory instruments such as global cap and trade systems in combination with changed travel habits would be the first-best alternative (Eijgelaar, 2011; Gössling et al., 2007; Hooper et al., 2008). However, the development of

[2] Additionality refers to the condition that carbon projects should not be able to survive without the external finance enabled through carbon offsets. Common criticism is that it is very difficult to prove additionality since the project holder will always be better informed than the investor. Another criticism refers to the difficulty in comparing different offset providers as they are widely unregulated and it is hard to identify the quality of the offset (for more information, see e.g. (Dhanda and Hartman, 2011).

intergovernmental strategies has been slow and is not undisputed (Lewis and Volcovici, 2013).[3] Furthermore, behavioral change among tourists seems to be difficult - even among the most devoted ones (Barr et al., 2010; Holden and Linnerud, 2011; Kroesen, 2013). As argued by Kotchen (2009), in the short run VCOs may be the best available option.

Table 6-1 shows that about half of the most important airlines in Germany offer their customers the option to buy VCOs online. Some of these airlines give the possibility to consent the VCO purchase directly upon reservation by checking a box. Yet, for the majority a second transaction is necessary and the client has to search for the airlines' offsetting homepages. As a result, the purchase option is limited to those who already know about the possibility and are interested enough to search for it. In 2012, the VCO market transacted 101 million tonnes of carbon dioxide equivalents out of which only 9% were related to tourism and transportation (Peters-Stanley and Yin, 2013).

Table 6-1 The 15 largest carriers in Germany and their possibilities to buy VCOs in order of flight volume

Airline	Airline type	Possibility to buy VCOs on homepage	Direct possibility to buy VCO upon reservation
Lufthansa	FSNC	√	x
Air Berlin	Low cost	x	x
German wings	Low cost	x	x
Ryanair	Low cost	x	x
Condor Flugdienst	Charter	x	x
easyjet	Low cost	x	x
TUIfly	Charter	√	√
Air France	FSNC	√	x
KLM-Royal Dutch Airlines	FSNC	√	√
Swiss	FSNC	√	x
British Airways	FSNC	√	√
Turkish Airlines	FSNC	x	x
Austrian Airlines AG	FSNC	√	x
NIKI	Low cost/ FSNC	x	x
SAS Scandinavian Airlines	FSNC	√	x

Note: FSCN refers to a full-service network carrier, which is characterized by a wider range of services on-board and before/after the flight. Source: Own compilation. Information on VCOs was collected the airlines' homepages. Information on the largest airlines and airline classification was collected from Berster et al. (2012)

[3] The UN agency International Civil Aviation Organization (ICAO) is currently working on a proposal for a global marked-based mechanism, but it first has to pass through the General Assembly and could come into force earliest by 2020 (European Commission, 2014).

Some researchers have put forward that adoption rates are lower than they would be if air travelers would receive more information about VCOs (Gössling et al., 2009). Furthermore, as suggested by Hooper et al. (2008), participation rates might increase if those tourists who are most interested would be targeted directly (compare also Brouwer et al., 2008; MacKerron et al., 2009).

Recent studies have focused on the design of and willingness to pay for VCOs and they primarily used stated preferences data. In this paper we aim to investigate the profile of buyers to develop strategies on how to increase adoption rates of VCOs. The econometric analysis is based on primary survey data.

The structure of the paper is as follows: in the next section we review previous literature on demand for VCOs. In the subsequent sections we outline the research questions and conceptual framework. We then present the survey, the data collection process and the representativeness of the sample, as well as the methodology. Finally we reveal our findings and discuss strategies for the future development of VCO markets.

6.2 Previous literature

First insights in VCO demand can be obtained by estimating knowledge of VCOs. There are various studies that have provided rather different estimates of knowledge among air travelers (see Table 6-2). MacKerron et al. (2009) for example found that 91% had heard about VCOs before. Their respondents were all higher educated citizens in the United Kingdom (UK) aged between 18-34 years. In contrast Barr et al. (2010), who also conducted their analysis in the UK but with no specific target group, found that 45% were familiar with the concept and Gössling et al. (2009), who considered a Swedish sample, found an equivalent share of only 24%. Clearly factors such as nationality, age and education seem to make a difference, although knowledge itself has seldom been the focus of the analyses.

A number of qualitative studies suggest that some people will be easier to convince about the advantages of VCOs than others. Hares, Dickinson, and Wilkes (2010) interviewed some people who expressed guilt about their impact on climate change. As they could not imagine cancelling their trips, VCOs were perceived as a way to reduce some of that guilt (compare also Barr et al., 2010; Cohen et al., 2011). Many focus group studies have also identified participants who are sceptical towards the instrument and see it as a way to "green-wash" themselves (Cohen et al., 2011; Hares et al., 2010; Higham and Cohen, 2011). A study by Gössling et al. (2009) indicated that the aversion against participating in VCO schemes might be larger among those

who know of VCOs than those who do not. One explanation for this could be that frequent travelers tend to be better informed, but are less willing to change their standard procedures. As a consequence, the authors reckoned, it is not only important to increase trust in offsetting schemes but also to put more effort in informing the unaware travelers.

Table 6-2 Number of offsetters found in previous studies

Author	Country of data collection	Survey description	Offset target	Number of respondents	Awareness of VCO	Number of off-setters
Gössling et al. (2009)	Sweden	Face to face interviews with air travelers	Air travel	300	24%	2%
Kroesen (2013)	Netherlands	Online survey on traveling distributed through student network	Air travel	491	NA	6%
Barr, Shaw, Coles, and Prillwitz, (2010)	UK	On street survey	Air travel	201	55%	15%
Araghi et al. (2014)	Netherlands	Randomly selected people at airports in Netherlands	Air travel	261	NA	6.5%
Mair (2011)	UK and Australia	Online panel with people who had visited at least one domestic conference in the last year	Air travel	470	NA	10%
McKercher et al. (2010)	Hong Kong	Telephone interviews with randomly selected residents	Air travel	174	NA	0.4%
MacKerron et al. (2009)	UK	Online survey limited to UK adults aged 18–34 with a higher education	Air travel	321	90.7%	22.1%
Hares (2013)	UK	Drop and collect survey in randomly selected households	Air travel	647	NA	6.4%
Nakamura and Kato (2013)	Japan	Randomly selected mail interviews	Various	1106	<50%	1%
Blasch and Farsi (2014)	Switzerland	Online survey	Various	1010	62.8%	22.7%
Lütters and Strasdas (2012)	Germany	Representative survey	Various	1001	33%	7.5%
Hooper, Daley, Preston, and Thomas (2008)	UK	Cross-section of business and leisure travelers at Manchester Airport	Air travel	487	44.9%	7%
Peterson et al., 2013)	USA	Registrants in 4 trail running races	Sport event	1526	-	57%

There are also various quantitative studies aiming to identify how the VCO sceptics differ from those with a more positive attitude. For example van Birgelen et al. (2011) identified the following four factors that significantly increased the willingness to pay for VCOs in a stated preferences study: (i) perception that CO_2 emissions from flying constitute a serious problem; (ii) perception that pro-environmental behavior is good for society; (iii) habit to behave environmentally friendly in general; as well as (iv) the willingness to make sacrifices for the

environment. A study by Chen (2013) focused on how personal norms influence the intention to participate in a VCO program. The author found that information campaigns should address beliefs and emotions to increase participation rates. Similarly, Araghi et al. (2014) and Blasch and Farsi (2014) identified social norms to be influential and important. Mair (2011) used the New Ecological Paradigm instrument to group respondents according to their environmental awareness. She then applied Chi-square tests to analyze if some of the groups had been more active in buying VCOs in the past. Her results indicated that offset purchasers might be more environmentally aware (ecocentric), but most of the results were not significant.

Apart from pro-environmental attitudes, socio-economic characteristics are likely to have an impact on the willingness to pay for VCOs as well. As can be seen in Table 6-3 results have been quite mixed. For example, many authors have tested the correlation between VCOs and household income. While some of them have indicated that higher incomes increase the willingness to compensate (Blasch and Farsi, 2014; Brouwer et al., 2008; Nakamura and Kato, 2013), others have not found any significant evidence for this (Hooper et al., 2008; Lütters and Strasdas, 2012; MacKerron et al., 2009; Peterson et al., 2013). As for age, most analyses have observed that young age is positively correlated with the willingness to offset (Blasch and Farsi, 2014; Hooper et al., 2008; Lu and Shon, 2012; Lütters and Strasdas, 2012), although one study did not find a significant link (Mair, 2011) and two other studies observed the opposite relationship (Nakamura and Kato, 2013; Peterson et al., 2013). Further variables that have been included in previous studies are e.g. high traveling frequency, high education, and being female.

Table 6-3 Variables used in earlier studies to determine willingness to offset and/or previous offsetting behavior

Variable	Level	Number of studies	Studies with significant results	Studies with insignificant results
Income	High	7	e,f,g	a,d,h,i
Age	Young	5	a,c,d,e	b
	Old	2	f,i	-
Frequency of international/ continental traveling	Often	4	a,c,g	d
Education	High	4	a,e,i	b
Awareness of climate change	High	3	d,g	f
Perceived responsibility for climate change	High	3	d,e,g	-
Gender	Female	4	h,i	e,f
	Male	1	-	b
Ticket price	High	3	c,g	d
Business traveler	Yes	2	c,d	-
Having children	Yes	1	-	e
Being married	Yes	1	-	e
Number of people in household	More	1	-	a
Employed	Yes	1	a	-
Vegetarian	Yes	1	-	a
Membership in environmental organization	Yes	1	h	-
Concern about international development	High	1	f	-
Package trip	No	1	d	-

[a] Lütters and Strasdas (2012), [b] Mair (2011), [c] Lu and Shon (2012), [d] Hooper et al. (2008), [e] Blasch and Farsi (2014), [f] Nakamura and Kato (2013), [g] Brouwer et al. (2008) [h] MacKerron et al. (2009), [i] Peterson et al. (2013)

Note: Letter written in brackets indicates that the result was not significant. a, c, d, g, h refer to studies considering the willingness to buy carbon offsets; c refer to a study where the respondents had the possibility to choose a voluntary carbon offset instead of receiving gift certificate; b, e, i refer to studies that are (also) considering previous carbon offset purchases.

Most of the previous quantitative studies have focused on stated preferences. Accordingly, the emphasis has been on characteristics that influence the disposition to participate rather than actual participation. Furthermore, many of these studies have focused on how design (e.g. different payment modes, the inclusion of co-benefits, etc.) and pricing of VCOs affect the decision to participate. Hence, individual characteristics of the respondents have played a minor role (although, as shown in Table 6-3, most of them have included some control variables such as income or education). Studies that do have a stronger focus on personal characteristics usually have not gone further than descriptive analysis. Two exceptions are Blasch and Farsi

(2014), who considered both stated and revealed preferences for VCOs among Swiss citizens, as well as Peterson et al. (2013), who considered revealed preferences for VCOs among trail runner participants in the USA. Both studies used econometric techniques to explain earlier purchase behavior. However, as their focus was not exclusively on tourists they did not study travel-specific factors more in detail.

6.3 Research Questions and Conceptual Framework

We use econometric models to explore the relationship between demand for VCOs and a broad range of socio-economic and travel-related factors. In particular we want to answer three questions:

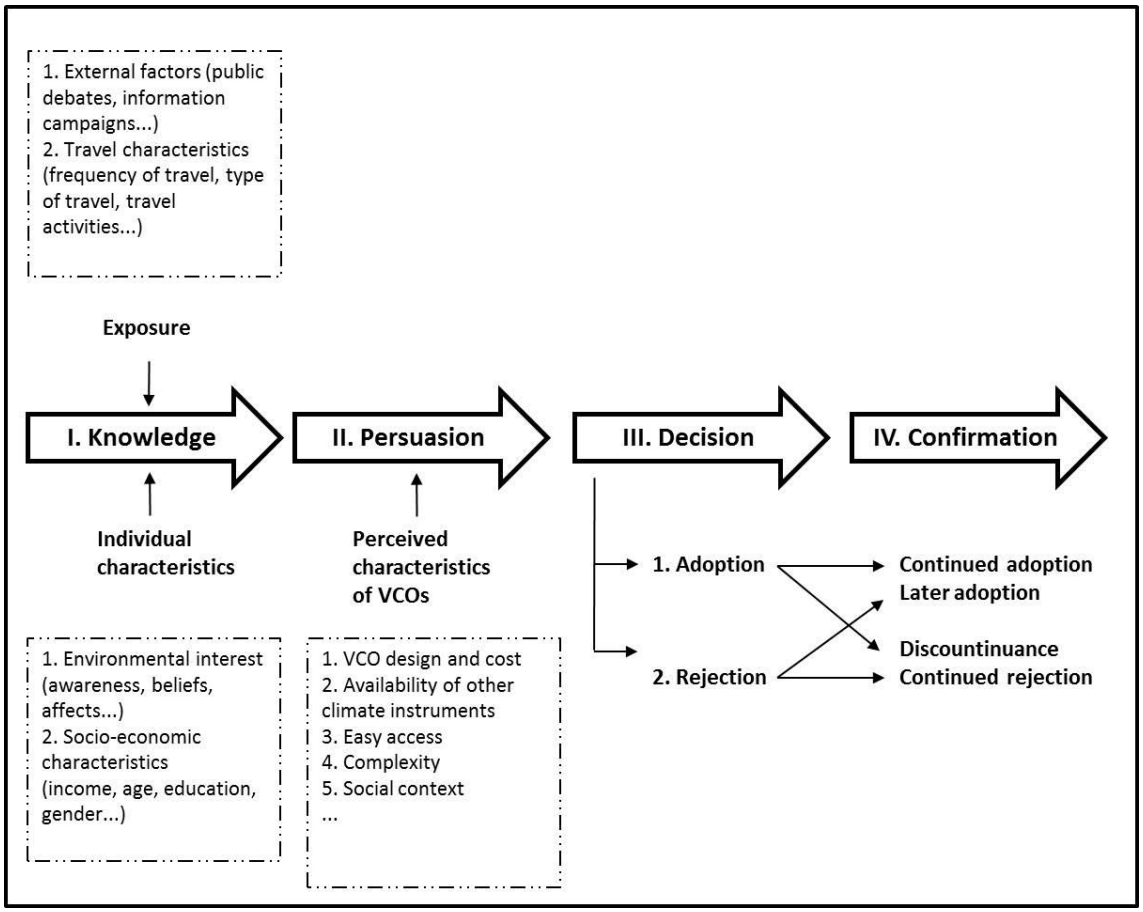
(1) what factors increase the probability of a traveler knowing about the possibility to buy VCOs?

(2) If a person knows about the possibility to offset, what factors increase the probability that this person will actually buy a VCO? And on the basis of this,

(3) what strategy should VCO providers follow to increase participation rates?

Figure 6-1 presents the conceptual framework used to analyze the determinants of knowing and purchasing VCOs. It is adapted from the innovation-decision framework proposed in the diffusion theory by Rogers (1995). According to this, the process of buying a VCO begins with *knowledge*. Information campaigns or simply frequent traveling increase the exposure and thus the knowledge about VCOs. In addition, individual characteristics affect whether and to what extent information about VCOs will be digested by the tourists. They also determine if the potential purchasers will get persuaded in the next stage. *Persuasion* takes place when the potential purchaser develops a positive or negative attitude towards the VCO scheme based on factors such as cost, the VCO design (what organization is responsible, if there are co-benefits, etc.), if someone in the social network has talked positively about VCOs, and so on. As mentioned in the previous section, a number of researchers have looked into these questions in stated preferences studies. In the third stage the individual decides to purchase a VCO or not. A rejection can be an active decision not to adopt, or passive, if the person is not really considering the purchase of a VCO. A rejection may also be transformed into adoption in a later occasion.

Figure 6-1 Conceptual framework



Source: Own compilation based on the innovation-decision framework of (Rogers, 1995)

6.4 Survey Data

6.4.1 Data Collection

Data collection took place in four German airports between February and May 2012. Prior to the official data collection, a pilot survey was conducted with 30 respondents to rule out misunderstandings and make necessary adjustments. The enumerators approached people randomly and those who agreed to participate filled out the questionnaire on their own. As part of a larger project, we wanted to analyze long-distance tourists who had made at least one leisure trip to Asia, Africa and/or Latin America within the last 10 years. This period corresponds approximately to the time tourists have had the possibility to buy VCOs in Germany.

Data collection took place in Berlin, Hamburg, Hanover and Munich with most data being collected in Hanover out of logistical reasons (see Table 6-4). Later testing did not reveal any significant differences among the airports. If possible, we selected the days and daytime of data

collection randomly. In addition to the airports-interviews, we also invited people to participate in the survey online. After data cleaning 428 questionnaires remained of the original 470 ones.

Table 6-4 Traveler data

Distribution	Berlin	Hamburg	Hanover	Munich	Online	Total	Total after cleaning
Number of travelers per year (including transits) in 2011	17 Million	14 Million	5 Million	38 Million	-	-	-
Respondents	65	46	223	67	70	470	428
Share in total respondents	14%	10%	47%	14%	15%	100%	

Note: [a]Hannover Airport (2013), [b]Hamburg Airport (2013), [c]Berlin Brandenburg Airport (2013) [d]Flughafen München GmbH (2012)

6.4.2 Sample Description

On average the respondents had been in Africa, Latin America and/or Asia 4 times in the last 10 years, even though there was a rather large spread (SE 5.61). The median trip lasted for 16 days. Most favored destinations were Turkey followed by Thailand, Egypt and China. 28% had booked a package trip while the rest had made their own travel arrangements. Regarding the main attractions of the holiday, the majority found that cultural diversity, museums and heritage sites belonged to the most important factors when choosing their travel destination. This was followed by beautiful beaches and sunny weather. About 7% had stayed in an accommodation with a sustainability label. As for carbon offsets, roughly half of the respondents had heard about VCOs before (55%), and 8% had bought a VCO at least once. Although there are no official data entries on carbon offsetting in Germany, Lütters and Strasdas (2012) mentioned a share of 7% in a representative German study, and TUIFly (one of the largest German airlines) has declared a share of 8% (TUIfly, 2008).

With respect to the socio-demographic variables, 52% of the respondents were men and 48% women. Most of them lived in one or two person households (27% and 43% respectively) and were between 25 and 49 years old (59%). The majority of the respondents had a relatively high household net income of over €4000 a month (26%) while the second most frequent income category ranged between €2001 and €3000 (24%). 60% held a university degree.

Considering the representativeness of the sample, no public records exist on long-haul tourists from Germany, but a general idea can be obtained from Reinhardt (2014), who presented travel data from a sample representative for the German population (Table 6-5). The comparison suggests that our sample is representative with respect to the trip length and the gender

distribution. However, for the age group between 50 and 64 as well as for the lowest income percentile (those with a net household income of €1000 or below), our sample is somewhat overrepresented. Having said that, the focus of Reinhardt (2014) was on tourists in general and a relatively small percentage had travelled to long-haul destinations (11.7% out of 4000 respondents).

Table 6-5 Descriptive data and sample representativeness

Variable	Sample	German travelers to non-European destinations[a]
Average number of long-haul trips in the last 10 years	4 (5.61)	
Average trip length	16 days	16 days
Booked package trip	28%	
Accommodation had sustainability label	7%	
Gender		
Female	48%	49%
Male	52%	51%
Income		
€1000 or below	13%	6.6%
€1001-€2000	17%	20%
€2001-€4000	43%	38%[b]
€4001 or above	26%	36%[c]
Age		
18-24	14%	13%
25-49	61%	71%
50-64	18%	11%
65-	8%	7%
With academic degree	59%	-
Knowledge of VCOs	55%	-
Bought VCOs once	4%	-
Bought VCOs more than one time	4%	-

[a] Data was obtained from (Reinhardt, 2014), who based the descriptive data on a representative sample of about 470 German long-haul travelers

[b] The number corresponds to the range €2000-€3499

[c] The number corresponds to the range €3500 or above

6.5 Methodology

6.5.1 Regression Model

We use a binomial logistic analysis to estimate (1) what factors determine if a tourist knows about VCOs or not, and (2) what factors determine if a person has bought a VCO or not. The logistic approach is suitable for problems where the dependent variable is dichotomous, i.e. where it can take on two values. Following Maddala (1992), the general logistic model specification is

$$P_i = \frac{e^{\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}}}{1 - e^{\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}}} \quad (1)$$

with P_i representing the probability that an event will occur, β_0 the intercept, β_j slope parameters, and x_{ij} explanatory variables. The regression coefficients are estimated using maximum likelihood estimation.

The explanatory variables included in the models can be seen in Table 6-6. Overall, we consider four groups of variables: (1) general travel characteristics, (2) travel activities on the last trip, (3) environmental awareness and other pro-environmental behavior related to travel, as well as (4) socioeconomic characteristics. When necessary, we refer to the last long-haul trip as reference. The number of travel activities is reduced using the non-linear principal components analysis (PCA) approach described below.

Table 6-6 Explanatory variables used in the analysis

Variable	Description	Expected sign	Type of variable
General travel characteristics			
Travel frequency	Number of long-distance travels in the last 10 years	+	Continuous
Ticket price	Ticket price of the last trip	+	Ordinal
Package trip	If the last trip was a package trip (1=yes)	-	Binary
Travel activities on last trip[a]			
Sports and adventure	Includes the variables deep-sea fishing, air activities, hunting, golf, and motor sports	+/-	Continuous
Beach activities	Includes the variables beach visit, diving, and other water activities	+/-	Continuous
Cultural activities	Includes the variables visits of heritage/historical sites, and cultural exchange	+/-	Continuous
Spa and health activities	Includes the variable spa and health activities	+/-	Continuous
Nature activities	Includes the variable excursions to parks/hiking	+/-	Continuous
Environmental awareness and other pro-environmental behavior related to travel			
Environmental interest	Index related to environmental interest and awareness[b]	+	Ordinal
Eco-label	If they usually choose eco-labelled accommodations	+	Ordinal
Low food impact	If they ate food with a low climate impact on their last trip[c]	+	Ordinal
Socio-economic characteristics			
Regular donations	Regular donations to environmental or human rights organizations (1=yes)	+	Binary
Female	If the respondent was female	+	Binary
Income	Net household income per month	+	Ordinal
Age	Age	+/-	Binary
Academic degree	Academic degree	+	Binary

[a] The travel activities refer to results from the non-linear principal components analysis

[b] The index is constructed by adding up the scores of four categorical variables: (i) I am well informed about environmental issues, (ii) I think it is important to protect the environment, (iii) I behave in an environmentally conscious way, and (iv) When I'm on holidays, I prefer not to think about environmental issues. All variables contain three levels with *1=Don't agree, 2=Agree to some extent, 3=Agree*, except for (iv) where the categories have the scores in the reverse order.

[c] The variable is measured on a three-item scale with *1= Meat, primarily beef, 2=Meat, primarily other, 3=No meat*

6.5.2 Non-linear Principal Components Analysis

The non-linear PCA aims at finding combinations of variables that reflect as much as possible the variation contained in the original variables. To increase the interpretability, it is important that the variables load on few components. This is obtained by orthogonal rotation of the dimensions (so-called varimax rotation) (Linting et al. 2007). The appropriateness of the

method is confirmed by the Kaiser-Meyer-Olkin (KMO) statistic (0.77) and the Bartlett's Test of Sphericity ($p<0.001$). According to the latent root criterion and the scree plot, the appropriate number of dimensions is 5, which is enough to explain 69% of the variance. The components and component loadings are depicted in Table 6-7. All variables contribute to variance by >10% and the communalities (the shared variance) are >50% for all components. To confirm the generalizability of the data we split the sample into two equal sets and re-estimate the model. As component loadings and communalities are approximately the same for both groups, we conclude that results are stable within the sample.

Table 6-7 Results of non-linear principal components analysis

Item	Component loading	Eigenvalue	Variance explained (%)
Sports and adventure		3.163	22.593
Deep-sea fishing	0.783		
Air activities (helicopter trips, heliskiing, hang gliding etc.)	0.670		
Hunting	0.807		
Golf	0.638		
Motor sports	0.751		
Water activities		1.815	12.961
Beach visit	0.709		
Diving	0.786		
Other water activities (surfing, rafting, sailing, boat etc.)	0.687		
Cultural activities		1.715	12.248
Visits of heritage/historical sites	0.864		
Cultural exchange	0.860		
Spa and health activities		1.232	8.797
Visits of health/wellness spa	0.828		
Nature activities		1.181	8.437
Excursions to parks/hiking	0.887		

6.6 Findings

6.6.1 Drivers of VCO Knowledge and Purchases

Results from the econometric estimations of drivers of VCO knowledge (Model 1) and purchases (Model 2) are provided in

Table 6-8. With respect to the knowledge about VCOs, we find the following: The first variables relate to general travel characteristics. We assumed that they might have an impact on exposure

to VCO campaigns and therefore indirectly on knowledge about VCOs. *Travel frequency* for example, reflects how often the respondent goes abroad for more than a week per year. We expected it to be positive as people traveling more frequently have a larger probability to come across a VCO campaign, but it is insignificant.

Table 6-8 Results of binomial logit regression for knowledge of VCOs (Model 1) and VCO purchasing (Model 2)

Determinants	Model 1: Knowledge of VCOs			Model 2: Purchase of VCOs		
	Coefficient	Robust standard errors	P>|z|	Coefficient	Robust standard errors	P>|z|
Travel frequency	-0.16	0.24	0.51	-0.04	0.50	0.94
Ticket price	0.16	0.08	0.06*	0.13	0.17	0.43
Package trip	-0.46	0.25	0.06*	-1.19	0.68	0.08*
Nature activities	0.17	0.11	0.12	-0.04	0.20	0.82
Beach activities	0.00	0.11	0.98	0.20	0.22	0.35
Cultural activities	0.06	0.10	0.58	-0.06	0.30	0.84
Spa and health activities	-0.17	0.11	0.12	0.31	0.25	0.22
Sports and adventure	0.21	0.11	0.05**	0.61	0.15	0.00***
Environmental interest	0.18	0.08	0.03**	0.16	0.18	0.38
Eco-label	-0.18	0.42	0.66	1.15	0.96	0.23
Low food impact	-0.14	0.18	0.42	0.79	0.42	0.06*
Regular donations	0.70	0.24	0.00***	0.74	0.51	0.15
Female	0.08	0.22	0.72	-0.21	0.52	0.69
Income	-0.01	0.08	0.87	-0.14	0.15	0.36
Age	0.08	0.10	0.42	-0.45	0.20	0.02**
Academic degree	0.54	0.23	0.02**	0.61	0.50	0.22
Constant	-3.38	1.07	0.00***	-4.07	2.33	0.08*
Number of observations	428			240		
Pseudo R2	9.26			22.12		
Wald Chi2	46.43			45.94		

With respect to the second variable *ticket price* however, the impact on knowledge is positive and significant. This is in line with the general picture provided by Table 6-1, which indicates that the traditional (and usually more expensive) carriers provide information on VCOs more often. Another explanation could be that price sensitive tourists pay less attention to add-ons such as VCOs that would increase the cost of their trip. The third travel-related variable, *package trip* is also significant but negative. Hence, those tourists who booked a package trip the last time are less likely to buy a VCO. Similar to the ticket price coefficient, the explanation for this is probably connected with how the reservation process looks like. Germany's largest

travel agency, TUI, for example gives customers the possibility to offset their emissions when making an individual booking but not when ordering a package trip (TUI, 2014).

As for the travel activities, most of them are insignificant. One exception is *sports and adventure activities,* which is significantly positive. As this kind of recreation is often outdoor and closely bound to nature, it seems reasonable that those who are interested in these activities might encounter environmental and climate related campaigns more often. With the same argument one would expect *nature activities* to be positive as well, but they do not reach the 10% significance level.

Apart from exposure, also individual characteristics play a fundamental role in how a person perceives e.g. communication messages on VCOs and if they lead to raised awareness. Here we consider an index of environmental interest, other pro-environmental behavior and socio-economic characteristics. Results suggest that *environmental interest* increases the probability that a person has heard about VCOs before. The variable is significant and the sign corresponds with what we assumed. Other pro-environmental behavior however – a low climate impact (*low food impact*) and the choice of an eco-labelled accommodation (*eco-label*) – are both insignificant. Considering the socio-economic variables, *regular donations* to social and/or environmental organizations as well as higher education (*academic degree*) have a significantly positive impact. Further socio-economic characteristics – being female, having high income, or age – are insignificant.

Knowledge is a precondition of an active decision to purchase VCOs. However, the factors affecting knowledge may not necessarily be the same as the ones leading to adoption. In Model 2 we examine the drivers of purchasing among the subset of respondents who knew about the possibility to offset (

Table 6-8). As is the case for knowledge, *package trip* is significant and negative. Accordingly, it seems like people making their own travel arrangements are not only better informed but also tend to purchase VCOs more often. Also *sports and Adventure* have a significant impact on purchasing. As mentioned above, one explanation could be the closeness to nature. In addition, the activities included here (e.g. air activities, motor sports, and golf) belong to some of the touristic activities with the highest environmental footprint (Becken et al., 2003). It is possible that the aware sport traveler may perceive VCOs as a way to reduce guilt over the own footprint without having to abstain from the activities. This would support the results of studies like the one of Brymer et al. (2009), which showed that many people pursuing adventure sports are well

aware of environmental issues and want to reduce their negative impact as far as possible (compare also Salome et al., 2013). Another explanation could be that travel providers offering these activities are more active in convincing their clients to buy VCOs. Further determinants that are significant for purchasing are a *low food impact* and *age*. Consequently, being young and eating more vegetarian food increases the likelihood of buying a VCO.

It is interesting to see that *environmental interest* is insignificant for purchasing. Thus it seems that it matters for raising the awareness among tourists but does not play a decisive role in the decision to adopt. Other variables that we would expect to be positive are *academic degree* and *income*. Many studies have identified these variables as important drivers for sustainable tourism (Dolnicar, 2010). Also studies on VCOs show in that direction, even though the results have been mixed (see Table 3). In the present analysis neither higher education nor higher household incomes are significant for adoption, although higher education has an indirect impact through knowledge. Instead, our survey provides evidence that more lifestyle related factors play the crucial role. It is difficult to say to what extent this is connected with the purchasing process. As mentioned in the introduction, most of the airlines offering VCOs demand a considerable level of initiative as the clients have to search for their offsetting homepages. It could be that young, adventurous vegetarians are more prone to be active in their booking routines. As discussed above, another explanation could be that travel suppliers targeting this specific audience are better at persuading their clients to offset. We did not control for it here but it is worth investigating in future analyses.

6.6.2 Most Favored Measures

To find out about the most favored measures, we asked the respondents if they believe that VCOs are a good instrument to combat climate change. Moreover, we were interested to identify the most preferred instrument or action to reduce carbon emissions from traveling. Results on how the various groups of consumers (aware/unaware; adopters/rejecters) answered are provided in Table 6-9.

Most of the carbon offsetters (71%) think that VCOs are a good instrument to combat climate change. In spite of this, if they could choose the majority would prefer to pay a mandatory carbon tax. Quite interestingly, reducing the number of trips is an equally popular measure as VCOs; almost a fifth of the purchasers had marked it as their most preferred action, which is the highest share in any segment. This indicates that most of the offsetters seem to be aware that VCOs are a second-best instrument.

Among those who have knowledge but have not participated in VCO schemes yet, substantially less people believe in the concept of offsetting (42%). Many of them make open comments where they express that legally binding instruments are necessary to have a real effect. Accordingly they would prefer a system with carbon taxes. A rather large share would also prefer the somewhat vague alternative of compensating by reducing the carbon emissions at home.

Finally, regarding those who have no previous knowledge of VCOs, only about a third believes in the idea of offsetting (34%). Moreover, the largest share of the respondents favors taking measures at home or doing nothing. Hence, our results do not support the suggestion of Gössling et al. (2009), that lacking knowledge could be a major bottleneck for adoption. Even though it may be possible to persuade also people in this group to participate, it will likely be connected with higher cost. Our data indicate that those who are most interested in environmental issues and most inclined to take action already have some knowledge of VCOs.

Table 6-9 Measures to combat climate change

Description	**Knowledge about VCOs**		**Knowledge and purchase**	
	No (N=193)	**Yes (N=236)**	**No (N=202)**	**Yes (N=34)**
Carbon offsetting is a good instrument to combat climate change?				
Yes	34%	46%	42%	71%
No	66%	54%	58%	29%
Most preferred measure to combat climate change				
Do nothing	14%	6%	6%	6%
Compensate by reducing my carbon emissions at home	26%	22%	24%	12%
Reduce the number of trips	10%	15%	14%	18%
Choose closer destinations and transport with low emissions (e.g. train)	18%	17%	18%	12%
Pay a voluntary carbon offset	11%	11%	10%	18%
Pay an obligatory carbon tax on top of the flight price	21%	28%	27%	35%

6.7 Summary and Conclusion

To find out about the future of voluntary carbon offset markets, we explore the knowledge and purchasing behavior of long-haul tourists from Germany. The results show that a bit more than half of the tourists (55%) know about VCOs but only a small share (8%) have ever invested in VCOs. The significant factors that increase the probability of both knowledge and adoption

include making individual travel arrangements, and sports and adventure activities. A high ticket price, nature activities, environmental interest, as well as an academic degree increase the probability that a person knows about VCOs but not that they will purchase one. The other way around, being young and following a diet with low climate impact influences the purchase decision but not if a person knows about the possibility to offset.

The findings presented above also suggest that those who do not have any knowledge of VCOs are less interested in taking action to reduce their carbon footprint. Therefore, we believe that the most efficient way to increase adoption rates is to persuade those who already know about offsetting schemes. This would probably involve two strategies: a) convince those who are skeptical about the instrument, and b) make it easier for those who are positive but not willing to invest a lot of time in making a purchase.

Regarding the first strategy, much effort would have to be invested in increasing the credibility of VCOs. As shown in Table 6-9, 58% of those who are aware of their existence do not believe that they make a significant contribution in combating climate change. At the same time, the econometric results suggest that this group is more interested in environmental issues. Therefore, as suggested by Chen (2013) one approach could be to appeal to emotions and beliefs and emphasize that there are currently few alternatives that do not involve refraining from long-haul trips. Furthermore, campaigns aiming to inform purchasers about the offset provider, how the money is invested and potential co-benefits could raise interest as well; sometimes, the actual carbon offset may not even be the selling argument but issues like increased biodiversity, human development etc. (Segerstedt and Grote, 2014; MacKerron et al., 2009). Some of the respondents stated that the responsibility also lies with the travel providers. Thus airlines that offer to participate in the offset payment may find it easier to persuade the clients. To what extent this would pay off, e.g. by strengthening the image of the airline, is worth looking closer at in future research.

The second strategy would be to facilitate the purchase for those who are generally positive but have not taken the step to purchase VCOs yet. Our results show that there is still over 40% in the aware group who believe in the concept. It is probable that some of them are passively rejecting to purchase rather than taking an active decision not to adopt. This is supported by our airline review, which shows that the access to VCOs on the homepages of the airlines is limited. Also here, the travel providers could be more active than they are today and look for creative solutions to increase participation rates. For instance, experiments by Araña and León (2013) and Araña et al. (2012) showed that setting the VCO purchase as default (i.e. the people booking

a trip had to actively opt out if they did not want to participate) increased the willingness to pay for VCOs. Also alternative payment possibilities should be considered. For example, Virgin America offers the possibility to buy the VCO on a touch screen at the seat (Virgin America, 2009). Quantitative studies following up how different payment modes have affected adoption are desirable.

The results presented here are based on a relatively small sample from only one country. In particular with regard to VCO purchasing there is need for more research targeting this group specifically. Our analysis provides practical guidance to stakeholders of the VCO market both regarding the profile of potential VCO purchasers and the profile of people who have bought VCOs in the past. We do not deny that the problem of free-riding makes it difficult to transform VCOs into a mainstream instrument. However, our results suggest that more people would be willing to participate if a larger effort is made to convince them.

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7 Protected area certificates – gaining ground for better ecosystem protection?

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8 Effectiveness of Market-Based Instruments for Protecting Wetlands

This chapter is a version of:

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ABSTRACT - Among the instruments proposed for the sustainable management of wetlands, product certification for wetland-based goods, wetland emission trading and ecosystem certification are some of the most recent. Based on a general model of wetland management, this paper analyzes the applicability of these three market-based instruments using a static optimization model. Taking the example of agriculture and aquaculture, findings suggest a potential to increase welfare for all three instruments. However, product certification suffers from drawbacks owing to strong interdependencies between the ecosystem services. Wetland emission trading and protected area certificates are first-best choices within this model as long as ecosystem services can be quantified properly and transaction costs are not prohibitive.

8.1 The State of Wetlands

Over the past years, awareness of wetlands and their importance for the biological cycle has been raised. Though cover of wetlands on earth as share of total land surface is relatively small (5-8 percent depending on the definition used, McCartney et al., 2010b; Mitsch and Gosselink, 2007), wetlands' impact in terms of ecosystem services (ESS) is far-reaching (Barbier, 2010; Costanza et al., 1997; Rebelo, McCartney, and Finlayson, 2009). On local and regional level, crucial functions include supplying and maintaining the quality of fresh-water, regulating disasters like floods, droughts, and disease, preserving the fertility of soils as well as providing intangible values such as leisure, space for religious activities and tourism (Falkenmark, 2007; Millennium Ecosystem Assessment, 2005). On a global level, wetlands play a decisive role in

carbon sequestration (Badiou et al., 2011; Bernal and Mitsch, 2012; Duan et al., 2008; Hansen, 2009; Xiaonan et al., 2008) and are home to some of the world's most precious biodiversity hotspots (Gopal and Junk, 2000; Keddy et al., 2009; Liu and Lü, 2011; Sukhdev and Kumar, 2008).

While some human activities may interact in a positive way with each other, many activities are competing for the same resources and are mutually exclusive. As a result, wetlands are continuously degraded and depleted. For example, the extensive use of fertilizers in crop production belongs to one of the primary threats for biodiversity of inland water and coastal areas (Malmqvist and Rundle, 2002; Skourtos, Kontogianni, and Harrison, 2010; Wood and van Halsema, 2008). Land use change (such as deforestation and drainage for agriculture), urban development, water extraction, overexploitation and the dissemination of invasive species are further drivers of degradation (Millennium Ecosystem Assessment, 2005). These interactions and their negative consequences are increasingly becoming a dilemma. Especially the rural poor in developing countries frequently find themselves in vicious circles; on the one hand, the ecosystem often provides the largest share of locals' means of subsistence, which means the rural poor are highly vulnerable to ecosystem deprivation and the direct effects of climate change (droughts, floods etc.). On the other hand, limited funds in combination with lacking property rights and other market failures render sustainable management of wetlands very difficult. To sustain themselves, locals slowly degrade the ecosystem which delivers their livelihood (Lee and Neves, 2010; Ratner, 2011).

8.2 Market-Based Instruments

Various policy options are available for dealing with the usual type of externality and many of them are efficient, market-based instruments. However, the particular interconnectedness of ESS with each other and their surrounding ecosystem demands consideration when implementing policies.

Classical MBIs for instance include taxes and subsidies, which optimally internalize the social costs and benefits by increasing or decreasing the market price. Typical examples are output or input taxes and conservation subsidies[4]. A number of articles have highlighted the possibilities

[4] See e.g. Bach & Gram (1996), as well as Claassen and Horan (2001) for examples of taxes on timber or fertilizers, Hoekman, Maskus, and Saggi (2005) for examples of financial and technical assistance programs, and Bastos and Lichtenberg (2001) as well as Hardie and Parks (1996) for cost-sharing programs for habitat expansion.

and limitations of these instruments also within the context of ESS, which are rival in their use (see e.g. Lankoski and Ollikainen, 2003; Havlík et al., 2005).

Apart from these measures there are various more recent market-based instruments (MBIs) driving the commodification of natural resources (Gómez-Baggethun, de Groot, Lomas, and Montes, 2010). In our analysis we will focus on three such instruments; (1) product certification, (2) capped emission trading, and (3) protected area certificates. As opposed to taxes and subsidies, these instruments are often governed across borders and may - but must not necessarily - be administered by a public authority. As a result, they may be appealing especially for developing countries as they provide the possibility to find finance abroad (Freireich and Fulton, 2009; Gunatilake and De Guzman, 2008; Mandel et al., 2009; Nahman et al., 2008, 2009).

The general approach of the first of those three, product certification, is to certify a specific ESS, e.g. an agricultural product. Many certification programs pursuing sustainable food products (coffee, sugar, fish and others) but also commodities and services like timber, flowers and tourism already exist (for an elaborate survey see Golden et al., 2010). Other approaches focus only on one part of the production process such as greenhouse gas emissions (e.g. the EU Biofuel Renewables Directive, European Parliament, Council, 2009).

The second of the three MBIs considered here, capped emission rading, uses the market to provide incentives to control the quantities of the externalities. It allows offsetting damage to a particular ecosystem by saving or rebuilding an ecosystem elsewhere, as practiced with emission certificates gained through Flexible Mechanism projects (ETS, 2003; UNFCCC, 1997) and in mitigation banking (Stein, Tabatabai, and Ambrose, 2000). Emission trading is criticized widely for unwanted side effects causing inefficiencies. This critique reaches from perverse incentives (Schneider, 2011; Winkler, 2004) over institutional misalignment and unintended financing side-effects (Castro, 2007; Axel Michaelowa and Michaelowa, 2007) to counterproductive outcomes (Kallbekken, 2007). However, least of this criticism is aimed at the core principle: Emission trading. This makes it worthwhile to discuss if it would be appropriate as alleviation mechanism for wetland externalities.

Third, a relatively new approach for ecosystem protection and management is the idea of a certificate for the whole ecosystem (Dargusch, 2010; Jie, 2008). Within such schemes the management or area of an ecosystem is evaluated according to fixed standards and the protected area certificates can be sold to finance the sustainable management of the ecosystem. Buyers

are companies participating in offset schemes or generally interested in fulfilling their corporate social responsibility as well as NGOs and private persons interested in nature conservation (Cohen, 2011; Hedden-Dunkhorst et al., 2011).

Careful re-evaluation of political instruments is necessary in a context as interconnected as an ecosystem. In doing so, we will consider existing measures as well as potential initiatives aimed to target ecosystems directly (such as Reducing Emissions from Deforestation and Degradation (REDD) and the Verified Conservation Areas (VCA)), which center on a more holistic approach and to our best knowledge have not been included in similar analyses. Chapter 8.3.1 presents an ecosystem with only one stakeholder. Advancing from there, chapter 8.3.2 adds stakeholders who do not have an influence on ecosystem use and production decisions, but profit from its ESS, in order to demonstrate the welfare loss through externalities. These two models serve as baseline for the private and, respectively, public optimal maximization to compare the three selected instruments to. Chapter 8.4 presents three possible political instruments to set incentives for all stakeholders to achieve socially optimal production demonstrated in 8.3.2. To show the advantages and disadvantages as clearly as possible, the three existing and proposed environmental protection systems are stripped to their essential features to create a model of stylized environmental protection measures. This helps to sharpen the view on the workings of different mechanisms and allows for a more in depth theoretical analysis of them.

8.3 Basic Model

8.3.1 Production Optimum of a Private Wetland Holder

A wetland L provides a number of EES with positive utilities, some of which are treated as commodities exchanged at the market (q_i) (agricultural products, fish, hydro-power etc.) and some for which no market exists (x_i) (e.g. biodiversity or carbon storage capacity). To simplify analysis, we consider only one landholder, although we could also imagine the more realistic case of numerous landholders with a commons law and commons decision makers (e.g. a common village head). That landholder produces two goods: one from agriculture (q_1) and one from aquaculture (q_2). Both goods compete for the same land resources L, but agricultural activities also impose additional costs on aquaculture through runoff and pesticide pollution

(v_2)[5] (Carvalho et al., 2002; Sarrazin, Tocqueville, Guerin, and Vallod, 2011; Thiere and Schulz, 2004). The producer may choose to reduce the impact of the negative externality by introducing abatement measures (a). Hence, we define the functional relationship of q_1 and q_2 as

$$q_1 = f_1(l_1) \tag{1}$$

and

$$q_2 = f_2(l_2)[1 - v_2(f_1(l_1), a)] \tag{2}$$

with l_1 and l_2 representing the amount of land used for the production respectively, v_2 the negative externality of agriculture on aquaculture and a the abatement technology used in the production of q_1. Production of both goods increases in land but with diminishing returns so that $\frac{\partial f_i}{\partial l_i} > 0$, and $\frac{\partial^2 f_i}{\partial l_i^2} < 0$ for $i = 1,2$. We further assume that the value loss in aquaculture is a positive concave function of agriculture, where $\frac{\partial v_2}{\partial q_1} > 0$, $\frac{\partial^2 v_2}{\partial q_1^2} < 0$ and $0 \leq v_2 \leq 1$. The underlying assumption is that the first unit of damage inflicted on an otherwise unharmed ecosystem will cause a greater value loss than further units. While the point of marginal increase or decrease is debatable[6] and certainly depends on the interaction between specific ESS and production types, we assume diminishing marginal damage. Thus we assume that if production inflicts damage to a pristine part of the ecosystem, it has more environmental integrity to lose than an already damaged part of the ecosystem. Further, v_2 is a convex decreasing function of abatement with $\frac{\partial v_2}{\partial a} < 0, \frac{\partial^2 v_2}{\partial a^2} > 0$ and $\frac{\partial^2 v_2}{\partial q_1 \partial a} > 0$. The last term implies that the negative impact of agriculture on aquaculture products weakens when abatement is applied. For simplicity's sake we consider linear cost functions both for production (c_1 and c_2) and for abatement (c_a). Using this information we obtain the decision problem:

$$\max_{l_1, l_2, a_1} \pi = f_1(l_1) \cdot p_1 + f_2(l_2)[1 - v_2(f_1(l_1), a)] \cdot p_2 - c_1 \cdot l_1 - c_a \cdot a - c_2 \cdot l_2 \tag{3}$$

[5] Negative or positive impacts of aquaculture on agriculture may exist as well, but for now we will ignore such externalities, i.e. $v_1 = 0$. This assumption can be discarded in models with a higher number of ESS, but facilitates the presentation and is more realistic in context of the example ecosystem with agriculture and aquaculture.

[6] For example, Roughgarden and Schneider (1999) assume decreasing marginal damage while Kahn and Kemp, (1985) find evidence for an increasing marginal damage function. In the end it is an empirical question, which will depend on production technologies and the ecosystem functions.

subject to

$$l_1 + l_2 \leq L \tag{4}$$

$$l_1, l_2 \geq 0 \tag{5}$$

$$a \geq 0 \tag{6}$$

To simplify the analysis, we assume that production of both agriculture and aquaculture takes place and that all available land is used productively. Accordingly, strict equality in (4) applies and (5) cancels out, therefore the Lagrangian is

$$\mathcal{L} = f_1(l_1) \cdot p_1 + f_2(l_2) \cdot [1 - v_2(f_1(l_1), a)] \cdot p_2 - c_1 \cdot l_1 - c_a \cdot a - c_2 \cdot l_2 - \mu \cdot (l_1 + l_2 - L) - \lambda_1 \cdot a \tag{7}$$

Deriving (7) with respect to l_1 as well as l_2, results in the following optimal prices p_1 and p_2:

$$p_1 = \frac{f_2(l_2)\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1} \cdot p_2 + c_1 + \mu}{\frac{\partial f_1}{\partial l_1}} \tag{8}$$

$$p_2 = \frac{c_2 + \mu}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{9}$$

As would be expected, the price of agriculture p_1 increases in marginal costs of land c_1 as well as the shadow price of land μ and decreases in land productivity $\frac{\partial f_1}{\partial l_1}$. However, the producer also internalizes the marginal value loss caused by agriculture on aquaculture $f_2(l_2)\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1} \cdot p_2$ by demanding a higher price p_1 than he would in the case of $\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1} = 0$. Further, as can be seen in (9), the negative externality of agriculture also leads to a higher price of the aquaculture product, as the value loss lowers the land productivity term in the denominator. Finally, by deriving (7) with respect to a, we find that in the optimum

$$c_a = -f_2(l_2)\frac{\partial v_2}{\partial a} \cdot p_2 \tag{10}$$

The producer will abate to the point where the marginal value increase from abatement on aquaculture equals the marginal cost of abatement.

8.3.2 Production Optimum under Welfare Considerations

The previous profit function models the production rationale of an ecosystem holder. Hence maximizing it exclusively focuses on what is best from a producer's perspective. By contrast, members of society maximize their utility by consuming agriculture and aquaculture products but also through consumption of non-market ESS such as biodiversity, carbon sequestration and scenic beauty. We summarize the potential utility of these ESS in x. Land allocation to and production of q_1 and q_2 may have a positive impact on x when it implies a higher degree of conservation (for example, this could be the case of eco-tourism). Nevertheless, sticking to the example of conventional agriculture and aquaculture, at this point we assume that production of both goods will have a negative impact d on x**,** but to different extents (for further discussion of wetland interaction compare Wood and van Halsema, 2008). This damage may be mitigated by introducing abatement a_1 and a_2 so that

$$x = x_0 - d(\underbrace{q_1}_{(+)}, \underbrace{q_2}_{(+)}, \underbrace{a_1}_{(-)}, \underbrace{a_2}_{(-)}) \geq 0 \tag{11}$$

with d representing the damage on x, and x_0 the initial stock of x. Damage d behaves similar to the value loss in aquaculture, accordingly $\frac{\partial d}{\partial l_i} > 0$, $\frac{\partial d}{\partial l_i} < 0$ and $\frac{\partial d}{\partial a_i} < 0$, $\frac{\partial^2 d}{\partial a_i^2} > 0$. Accumulating the utility gained from production and utility from other ESS, the welfare function therefore takes the following shape

$$WF = \pi + x_0 - d(\cdot) \tag{12}$$

Deriving the welfare equation with respect to l_1 and l_2 under consideration of the constraints in (4)-(6), (13) and (14) yield the socially optimal prices:

$$p_1 = \frac{\left[p_2 + \frac{\partial d}{\partial v_2}\right]\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1} f_2(l_2) + c_1 + \mu + \frac{\partial d}{\partial f_1}\frac{\partial f_1}{\partial l_1}}{\frac{\partial f_1}{\partial l_1}} \tag{13}$$

$$p_2 = \frac{c_2 + \mu + \frac{\partial d}{\partial f_2}\frac{\partial f_2}{\partial l_2}}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{14}$$

In both (13) and (14), prices increase with the marginal damage caused by the production of both ESS, $\frac{\partial d}{\partial f_1}\frac{\partial f_1}{\partial l_1}$ and $\frac{\partial d}{\partial f_2}\frac{\partial f_2}{\partial l_2}$, as compared to a model that only considers the producer. This is in line with the general theory that social prices should be higher than private prices in presence

of negative externalities (compare e.g. Tietenberg, 2000). We find the welfare-maximizing abatement costs by deriving with respect to a_1 and a_2:

$$c_1^a = -f_2(l_2)\frac{\partial v_2}{\partial a_1} \cdot p_2 - \frac{\partial d}{\partial a_1} \tag{15}$$

$$c_2^a = -\frac{\partial d}{\partial a_2} \tag{16}$$

Comparing to (10), the social optimum would therefore require the producer to abate above the private level until marginal abatement costs equal the marginal damage reduction *in addition* to any marginal value loss reduction on other goods produced by the landholder.

To conclude, both, optimal prices and abatement, are higher in a model that considers overall welfare beyond producer profit. The first-best solution to this problem would be to introduce a pigouvian tax equal to the marginal damage caused by production on the non-market ESS (compare Pigou, 1952). Yet, as has been discussed extensively in the literature (e.g. Baumol, 1972 and Pearce and Turner, 1990), lack of information and information asymmetries restrict possible applications. Instead, policy makers often have to revert to alternatives which limit damage of production and stimulate more sustainable production methods. In the following section we will consider three such options that aim at increasing abatement of a single commodity (product certification), increase the cost of damaging production/benefit of conservation (emission trading) as well as compensating for provision of non-market ESS (protected area certificates).

8.4 Models for Market-Based Instruments

8.4.1 Product Certification

Targeted subsidies and sustainability certification may be useful instruments to increase abatement efforts of producers in the broader sense (including all kind of actions aiming at more sustainable production methods). In general such instruments would be tied to different kinds of abatement technologies. They could for example include a more sustainable nutrient management, better waste-water treatment and integrated pest management. In functional terms, we include this by distinguishing between conventional agriculture $f_1^{co}(l_1^{co})$ with conventional abatement $a_1^{co}$and certified agriculture $f_1^{cer}(l_1^{cer})$ with production methods according to the environmental certificate standards. To make it attractive for producers to increase the level of abatement above the private optimum, we consider a case where the

producer receives a price premium per unit. Subtracting additional expenses of compliance and direct certification costs yields the net premium p_{cer}^{net}. We assume that this abatement level would neutralize all negative externalities of production (i.e. both the impact of q_1 on q_2 and on x). Moreover, we employ the assumption that the abatement level of certified production reflects an abatement ceiling of the producer, i.e. the producer may choose to produce in a conventional way or certify (part of the) production but will not abate *above* the fixed level corresponding to certification. A possible impact of certified land area on the efficiency of abatement is ignored ($\frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}} = 0$), as are potential productivity losses in q_1 due to the sustainability standards. Finally, we suppose that the allocation of land to certified agriculture reduces the value loss in aquaculture $\frac{\partial v_2}{\partial l_1^{cer}} < 0$ with $\frac{\partial^2 v_2}{\partial l_1^{cer2}} > 0$ and a negative cross-elasticity $\frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}} < 0$. This assumption may apply for some farming system, e.g. when buffer zones are required, which might increase the carrying capacity of the wetland. However, as we will discuss later it may not always be the case. The new decision problem is given by:

$$\max_{l_1^{co}, l_1^{cer}, l_2, a_1^{co}} \pi = f_1^{co}(l_1^{co}) \cdot p_1 + f_1^{cer}(l_1^{cer}) \cdot (p_1 + p_{cer}^{net}) + f_2(l_2)\left[1 - v_2\left(f_1^{co}(l_1^{co}), a_1^{co}, l_1^{cer}\right)\right] \cdot p_2 \quad (17)$$
$$- l_1^{co} \cdot c_1 - c_a \cdot a_1^{co} - l_1^{cer} \cdot c_1 - c_2 \cdot l_2$$

with the extended land constraint $l_1^{co} + l_1^{cer} + l_2 \leq L$. To analyze how product certification affects the total damage level, it is necessary to analyze how it affects land allocation. In order to do so, we first hold land allocated to aquaculture l_2 fixed. This makes sense for two reasons. First, many new certification schemes considering agriculture in wetlands[7] rule out land with high carbon stock, such as peat, or high biodiversity, in which category many natural fishing grounds would fall. Second and perhaps most obvious, draining the fish ponds for agricultural land is related to costs and would generally not apply for the short term. Employing comparative statics, we find that an increase in p_{cer}^{net} in most circumstances would imply an expansions of land used for certified production at the cost of conventional farming (the mathematical derivation is provided in Annex 8A). We also find that the total amount of abatement outside of the certification program decreases, which is reasonable, since the area of conventional farming declines. The impact of these changes on damage depends on the aquaculture production on the one hand, and the damage function on the other hand. Looking first at

[7] Compare for example the standards of the Roundtable on Sustainable Palm Oil (RSPO, 2007) and the EU Biofuel Renewables Directive (European Parliament, Council, 2009).

aquaculture, v_2 decreases as $f_1^{co}(l_1^{co})$ decreases and l_1^{cer} increases. If this value loss is not completely compensated by the decrease in a_1^{co}, productivity of aquaculture increases and as a result q_2 turns out to be larger. As for the effect on non-market ESS x, we therefore obtain an ambiguous impact; the negative impact of farming falls whereas the negative impact of aquaculture increases

$$x = x_0 - d(q_1^{co}, q_2, a_1^{co}, a_2) \tag{18}$$

We may also consider the other case where the producer withdraws land from aquaculture for certified production or to replace the reduction in conventional farming (i.e. l_2 as variable). However, to be able to derive clear results from the analysis we would have to specify prices and the functional relationships more explicitly (for more details, see also Annex 8A). In general terms, the reduced damage in q_2 would have to be weighed against negative effects from land use change.

In conclusion, the use of certification to reduce negative externalities on non-market ESS x by means of increased abatement measures is likely to have impacts on the production of other (marketable) goods as well. With respect to our example, the aim of agricultural certification could be to improve biodiversity, soil and water quality etc. Nevertheless, as pesticide pollution and siltation decline, the certification standards may lead to a positive impact on aquaculture as well. If aquaculture has a positive impact on x, for example through higher food security and health, the beneficial effect of certification may be fortified. On the other hand, if - as assumed in 8.8.3.2 - the negative impact of aquaculture on x dominates (e.g. through feed pollution or other unsustainable methods; see FAO 2011), the positive impact of abatement on agriculture is countervailed by increased pollution from q_2. As a result, certification as stand-alone measure to reduce damage of one good may have unwanted side-effects.

8.4.2 Emission Trading

In most cases, product certification as discussed above is voluntary (Golden et al., 2010). More sustainable production methods (captured by the abatement function) are awarded, depending on the willingness of consumers to shoulder the additional cost or price premium p_{cer}^{net}. By contrast, so called emission trading systems focus on the maximum damage $\bar{d}$ that society is willing to accept. In emission trading systems the cost to keep damage below $\bar{d}$ (by producing less or increasing abatement) is shifted to producers (even though this generally affects prices paid by end-consumers). Prime examples for this method are some schemes under the Wetland

Mitigation Banking framework in the US (Morgan and Roberts, 1999; Sip, Leitch, and Meyer, 1998; Wilkinson and Thompson, 2006) and, on a global scale, the cap and trade system under the Kyoto protocol (UNFCCC, 1997), most prominently implemented in the EU emission trading scheme (ETS, 2003). These kinds of systems, within their particular frameworks, allow for only a certain overall amount of environmental degradation or pollution which can be offset elsewhere. The optimal amount of $\bar{d}$, the cap, could be taken from the results of the model in 8.3.2, but is of no further concern here. It matters only that such an amount is specified[8] and that it is smaller than x_0. To pollute and destroy parts of the ecosystem, a polluter has to hold a proportional amount of permits to do so. An authority gives out these permits, producers buy these permits and can attain more (and in turn sell) by creating and maintaining buffer areas or protected zones $f_{pt}(l_{pt})$ and so save a proportional amount of the ecosystem. Hence the total amount of pollution permits is described by

$$Allowed\ Emissions = \bar{d} + f_{pt}(l_{pt}) \tag{19}$$

In this equation $\bar{d}$ represents the previously determined optimal amount that society is willing to accept as pollution and $f_{pt}(l_{pt})$ is a function for the activity of converting land into protected areas or buffer zones. This protected area function is essentially a production function for permits. Externalities of the permit production are captured by including the production function as a factor of value loss v_2. Under an offset scheme the outcome of $f_{pt}(l_{pt})$ can be converted into offset certificates. It incurs costs caused by maintenance of the protected area c_{pt}. Including input costs for abatement in f_{pt}like for f_1 and f_2 is unnecessary, since permit creation by definition does not pollute or destroy the environment and therefore does not need to be abated. For simplicity we assume that each additional unit of land gives the same amount of additional permits. Damage caused by the production of products other than offset permits has to be accounted for through permits bought at price p_{pt}. We cannot assume that each type of production causes the same amount of damage and therefore needs the same amount of permits to cover this damage. Hence a conversion factor $w_i(a_i)$ is necessary, which describes the negative environmental impact of production depending on abatement efforts. This factor for production-to-pollution conversion will be smaller the larger a_1 gets, but decreasingly so. That is, $\frac{\partial w_i}{\partial a_i} < 0$ and $\frac{\partial^2 w_i}{\partial a_i^2} < 0$ for both $i = 1,2$.

8 For example by setting maximum levels of phosphorous runoff (Stephenson, Norris, and Shabman, 1998) or CO2 emissions (Gayer and Horowitz, 2006).

Hence the additional cost paid by the producer for damage caused by agriculture and aquaculture, the allowance cost, equals:

$$Allowance\ cost_1 = f_1(l_1) \cdot w_1(a_1) \cdot p_{pt} \tag{20}$$

$$Allowance\ cost_2 = f_2(l_2) \cdot w_2(a_2) \cdot p_{pt} \tag{21}$$

Similar to product certification, apart from the reduction in d to $\bar{d}$, also the value loss of aquaculture might decrease due to positive external effects of the production of permits. Incorporating this interaction to accommodate an emission trading system thus changes the decision problem.

Since a third type of land use is introduced, the land constraint changes to $l_1 + l_2 + l_{pt} \leq L$. In addition, the Lagrangian contains a cap which constrains production $\bar{d}+f_{pt}(l_{pt}) = f_1(l_1) \cdot w_1(a_1) + f_2(l_2) \cdot w_2(a_2)$ with $l_{pt} \geq 0$. Accordingly the new Lagrangian is defined as:

$$\begin{aligned}\mathcal{L}_{pt} = {} & f_1(l_1) \cdot p_1 + f_2(l_2) \cdot \left(1 - v_2\left(f_1(l_1), f_{pt}(l_{pt}), a_1\right)\right) \cdot p_2 + f_{pt}(l_{pt}) \cdot p_{pt} \\ & - l_1 \cdot c_1 - c_a^1 \cdot a_1 - c_2 \cdot l_2 - c_a^2 \cdot a_2 - c_{pt} \cdot l_{pt} - f_1(l_1) \cdot w_1(a_1) \\ & \cdot p_{pt} - f_2(l_2) \cdot w_2(a_2) \cdot p_{pt} + \mu \cdot (l_1 + l_2 + l_{ct} - L) + \psi \\ & \cdot \left(\bar{d} + f_{pt} - w_1(a_1) \cdot f_1 - w_2(a_2) \cdot f_2\right) + \lambda_2 \\ & \cdot \left(1 - v_2\left(f_1(l_1), f_{pt}(l_{pt}), a_1\right)\right) + \lambda_3 \cdot l_1 + \lambda_4 \cdot l_2 + \lambda_5 \cdot a_1 + \lambda_6 \cdot a_2 \\ & + \lambda_7 \cdot l_{pt}\end{aligned} \tag{22}$$

Derivation yields (23) and (24) which show that the emission trading scheme accounts for damage caused by production independently of the product.

$$p_1 = \frac{f_2(l_2)\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1} \cdot p_2 + c_1 + \mu + \frac{\partial f_1}{\partial l_1} \cdot w_1(a_1)(p_{pt} + \psi)}{\frac{\partial f_1}{\partial l_1}} \tag{23}$$

$$p_2 = \frac{c_2 + \mu + \frac{\partial f_2}{\partial l_2} \cdot w_2(a_2)(p_{pt} + \psi)}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{24}$$

Accordingly, changing land allocation between the products is of minor importance. Comparing (23) and (24) to (13) and (14), respectively, shows that the marginal damage of production, $\frac{\partial d}{\partial f_1}\frac{\partial f_1}{\partial l_1}$, in the optimality calculation for welfare has been replaced. Instead the terms

show the marginal cost of land-use in terms of permit prices, $\frac{\partial f_i}{\partial l_i} w_i(a_i) \cdot p_{pt}$, and $\psi \frac{\partial f_i}{\partial l_i} \cdot w_i(a_i)$, the shadow costs of permits, using the shadow price ψ and weighing it with the marginal damage. Both these terms are price drivers since they make production more costly and therefore decrease production and consequently pollution.

The third price in the model, p_{pt}, behaves differently than the prices of agriculture and aquaculture products,

$$p_{ct} = \frac{f_2(l_2)\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1} \cdot p_2 + c_{pt} + \mu - \psi \frac{\partial f_{pt}}{\partial l_{pt}}}{\frac{\partial f_{pt}}{\partial l_{pt}}} \tag{25}$$

Though it also increases in marginal productivity of input use and marginal production costs, it decreases in $\psi \frac{\partial f_{pt}}{\partial l_{pt}}$. This term simply is a measure of efficiency for permit production. As (25) shows, such changes in efficiency are passed on to the price, providing correct signaling on the emission trading market.

Turning to the optimal abatement, equations (26) and (27) emerge.

$$c_a^1 = -f_2(l_2)\frac{\partial v_2}{\partial a_1} \cdot p_2 - f_1(l_1) \cdot \frac{\partial w_1}{\partial a_1} \cdot p_{pt} - \psi \frac{\partial w_1}{\partial a_1} \cdot f_1(l_1) \tag{26}$$

$$c_a^2 = -f_2(l_2)\frac{\partial w_2}{\partial a_2} \cdot p_{pt} - \overbrace{\psi \frac{\partial w_2}{\partial a_2}}^{<0} \cdot f_2(l_2) \tag{27}$$

In comparison to (10) (and the analog case for c_a^2), the cost functions in the emission trading model are extended with two terms. Producers will abate up to the point where marginal costs of abatement equal the marginal value increase in the other ESS plus the nominal and shadow decrease in production-to-pollution conversion. That means essentially two factors have been added to the cost rationale, gauging the potential of damage and potential of abatement of this damage. Thus emission trading gives an incentive to accept abatement costs not only due to gains through another ESS, but also due to cost savings in the production to the two considered goods. Higher acceptable costs for pollution and environmental destruction will lead to higher prices, which in turn will lead to less demand and therefore less production.

Comparing the private optimum of chapter 8.3.1 to the results of (26) and (27) shows that any cap on environmental degradation or pollution will increase welfare as long as that cap is based on the value for d suggested by a calculation similar to the one from 8.3.2. This, however, only

applies if homogenous units of environmental degradation are considered. With respect to emissions this might be realistic. When turning to biodiversity or scenic beauty, however, homogeneity or mathematical conversion is hard to achieve.

8.4.3 Protected Area Certificates

So-called protected area certificates (PACs) are a third marked-based instrument worth considering. Similar to emission trading, the idea is to create a market for global payments for environmental services. However, while the emission trading approach is based on a cap of the negative externalities in the tradable commodities, PACs put the focus on the positive externalities of a well-maintained wetland. The idea is relatively new and can be connected with initiatives like the Verified Conservation Areas (VCA)[9]. Here we assume that a PAC x_z can be sold to ESS users at a price p_z depending on how well a set of non-market ESS are maintained.

$$x_z(\underbrace{f_1(l_1)}_{(-)}, \underbrace{f_2(l_2)}_{(-)}, \underbrace{l_{ct}}_{(+)}\ \underbrace{a_1}_{(+)}, \underbrace{a_2}_{(+)}) \tag{28}$$

As can be seen in (28), x_z decreases when conventional production of agriculture and aquaculture increase, and grows with conservation. However, note also that the producer can achieve PACs by introducing more a_1 and a_2. Hence - as opposed to emission trading where abatement could reduce the *need* for permits but not create new ones - the producer does not have to stop production of q_1 and q_2 in order to obtain a PAC. The extended objective function translates into:

$$\begin{aligned}\max_{l_1,l_2,l_{ct},a_1,a_2} \pi = {} & f_1(l_1)\cdot p_1 + f_2(l_2)[1 - v_2(f_1(l_1), a_1, l_{ct})]\cdot p_2 \\ & + x_z(f_1(l_1), f_2(l_2), l_{ct}, a_1, a_2)\cdot p_z - c_1\cdot l_1 - c_a^1\cdot a_1 - c_2\cdot l_2 - c_a^2 \\ & \cdot l_2 - c_{ct}\cdot l_{ct}\end{aligned} \tag{29}$$

Deriving with respect to l_1 and l_2 under consideration of the necessary conditions now yields:

$$p_1 = \frac{f_2(l_2)\frac{\partial v_2}{\partial f_1}\frac{\partial f_1}{\partial l_1}\cdot p_2 + c_1 + \mu - \frac{\partial x_z}{\partial f_1}\frac{\partial f_1}{\partial l_1}\cdot p_z}{\frac{\partial f_1}{\partial l_1}} \tag{30}$$

$$p_2 = \frac{c_2 + \mu - \frac{\partial x_z}{\partial f_2}\frac{\partial f_2}{\partial l_2}\cdot p_z}{\frac{\partial f_2}{\partial l_2}(1 - v_2)} \tag{31}$$

[9] For more information on this initiative, see GDI (2011).

As can be seen in the last terms containing $\frac{\partial x_z}{\partial f_i}\frac{\partial f_i}{\partial l_i} \cdot p_z$, PACs increase the prices of agriculture and aquaculture products as we assume that l_i affects the vector of ESS in x_z negatively. The PAC price in turn can be established at a lower level if the impact of conservation on the value loss in $f_2(l_2)$ is large:

$$p_z = \frac{f_2(l_2)\frac{\partial v_2}{\partial l_{ct}} \cdot p_2 + c_{ct} + \mu}{\frac{\partial x_z}{\partial l_{ct}}} \tag{32}$$

Similarly, the more conservation affects the amount of PACs obtainable (i.e. the higher $\frac{\partial x_z}{\partial l_{ct}}$), the smaller can be the PAC price without losing its appeal to producers. By contrast, the additional costs connected with conservation would boost the price. In the break-even point where the reduced marginal value loss in aquaculture and the opportunity cost of land (as reflected in the land constraint parameter μ) are equal to the marginal costs of conservation, the producer would conserve without any PAC.

Marginal abatement costs are given by

$$c_a^1 = \frac{\partial x_z}{\partial a_1} \cdot p_z(l_2)\frac{\partial v_2}{\partial a_1} \cdot p_2 \tag{33}$$

$$c_a^2 = \frac{\partial x_z}{\partial a_2} \cdot p_z \tag{34}$$

As would be expected, c_a^1 increases in the reduced marginal value loss in aquaculture (as before) and both marginal costs increase in the impact on x_z.

8.5 Conclusion

Modeling the interdependencies between ecosystem services in a wetland, we showed how applicable economic instruments fit into this model and whether they are effective and efficient. As flexible instruments with long tradition, product certification may be attractive given the (relatively) low requirements in terms of system infrastructure, monitoring and information costs. However, similarly to Heberling, García, and Thurston (2010), we conclude that instruments targeting abatement of one product only may also lead to counterproductive effects; as the negative impact on other goods declines, production of these other goods becomes more appealing. In which way this will affect the overall welfare depends on the positive or negative impact of these goods on non-market ESS. Setting incentives right and applying this method to wetlands in an efficient manner demands close monitoring. Therefore, depending on the transaction costs and the complexity of the system, this kind of instrument may be rated as

second-best when compared to emission trading and PACs. The former would punish all polluting and destructive production and hence internalize the externalities where they occur. Accordingly, as the equations in 8.4.2 show, prices would increase without giving cause to an unintended reallocation. One possible drawback might be the measurement of externalities. While it may be easier to do for single pollutants as carbon dioxide or water contaminants[10], it is challenging with respect to biodiversity and other ESS, which tend to be very heterogeneous.

By contrast, the PACs as described here may be less demanding in terms of emission calculation, given that it is based on inventories of available ESS rather than ongoing emissions of production activities. They further allow the producer great latitude as conservation, production and abatement measures can be combined in the, for the producer, most efficient way. On the other hand, this advantage may also be a shortcoming of the system, as it demands a high degree of knowledge of the landholder how production and conservation affect biodiversity, carbon sequestration capacities, etc. Hence, depending on the circumstances, it will probably be easier – and less costly - to provide certificates for straight conservation or to compensate directly for the abatement measures taken.

A second concern relates to the payment vehicle. In the case of product certification, end-consumers generally pay price premiums directly, while for emission trading the polluters pay the cost (although ultimately consumers may do, too, through higher prices). An advantage of these systems in terms of efficiency is thus the possibility to make use of the market mechanism for price signaling. PACs as bundles of ESS cannot as easily be connected with specific products. Because of this, non-governmental organizations, governments or companies with an interest in increasing their social responsibility could be potential funders.

Having provided a framework to capture the interactions in a wetland ecosystem, there are still many open questions that need to be addressed. For example, the multiple producer structure present in many wetlands and how traditional institutional settings (e.g. with respect to property rights) may affect the outcome of policy measures are two of many issues that remain to be tackled successfully. Finally, empirical research to follow up new initiatives is crucial, especially for developing countries where the market potential is high, but little infrastructure is available.

[10] This is in fact already practiced within the EU ETS (ETS, 2003) and various water trading programs (Colby, 2000; Schary and Fisher-Vanden, 2004; Speed, 2009; Thompson et al., 2009).

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Annex 8A

Comparative Statics

To evaluate the impact of certified production for a fixed land area l_2, we take the first order conditions of (17) with respect to the optimization variables and derive again with respect to the net price premium p_{cer}^{net}.

$$\frac{\partial^2 \mathcal{L}}{\partial l_1^{cer} \partial p_{cer}^{net}} = \frac{\partial^2 f_1^{cer}}{\partial l_1^{cer^2}} \cdot (p_1 + p_{cer}^{net}) \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial^2 v_2}{\partial l_1^{cer^2}} \cdot p_2 \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}} \cdot p_2 \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}}$$
$$- f_2(l_2) \frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}} \cdot p_2 \cdot \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} + \frac{\partial f_1^{cer}}{\partial l_1^{cer}}$$

$$\frac{\partial^2 \mathcal{L}}{\partial l_1^{co} \partial p_{cer}^{net}} = -f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \left(\frac{\partial f_1^{co}}{\partial l_1^{co}}\right)^2 \frac{\partial^2 v_2}{\partial f_1^{co^2}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} + p_1 \frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}}$$
$$- f_2(l_2) \frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} \frac{\partial v_2}{\partial f_1^{co}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial a_1^{co}} \cdot p_2 \cdot \frac{\partial l_1^{co}}{\partial p_{cer}^{net}}$$

$$\frac{\partial^2 \mathcal{L}}{\partial a_1^{co} \partial p_{cer}^{net}} = -f_2(l_2) \frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}} \cdot p_2 \frac{\partial a_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial f_1^{co}}{\partial l_1^{co}} \frac{\partial^2 v_2}{\partial f_1^{co} \partial a_1^{co}} \cdot p_2 \frac{\partial a_1^{co}}{\partial p_{cer}^{net}} - f_2(l_2) \frac{\partial^2 v_2}{\partial a_1^{co^2}} \cdot p_2 \frac{\partial a_1^{co}}{\partial p_{cer}^{net}}$$

$$\frac{\partial^2 L^*}{\partial \mu \partial p_{cer}^{net}} = -\frac{\partial l_1^{co}}{\partial p_{cer}^{net}} - \frac{\partial l_1^{cer}}{\partial p_{cer}^{net}}$$

From the assumptions in 8.3.1 and 8.4.1, we know that:

Symbol	Function	Sign
a	$\frac{\partial^2 f_1^{cer}}{\partial l_1^{cer^2}}$	< 0
b	$\frac{\partial^2 v_2}{\partial l_1^{cer^2}}$	> 0
c	$\frac{\partial f_1^{co}}{\partial l_1^{co}}$	> 0
d	$\frac{\partial^2 v_2}{\partial f_1^{co} \partial l_1^{cer}}$	< 0
e	$\frac{\partial^2 v_2}{\partial a_1^{co} \partial l_1^{cer}}$	$= 0$
f	$\frac{\partial^2 v_2}{\partial f_1^{co^2}}$	< 0
g	$\frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} \frac{\partial v_2}{\partial f_1^{co}}$	< 0
h	$\frac{\partial^2 v_2}{\partial f_1^{co} \partial a_1^{co}}$	> 0
i	$\frac{\partial^2 v_2}{\partial a_1^{co^2}}$	> 0

We may use this information to calculate the determinant Δ:

$$\Delta = \begin{vmatrix} 0 & -1 & -1 & 0 \\ -1 & a \cdot (p_1 + p_{cer}^{net}) - f_2(l_2) b \cdot p_2 & -f_2(l_2) cd \cdot p_2 & -f_2(l_2) e \cdot p_2 \\ -1 & -f_2(l_2) cd \cdot p_2 & -f_2(l_2) cf \cdot p_2 + p_1 \frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} - f_2(l_2) g \cdot p_2 & -f_2(l_2) ch \cdot p_2 \\ 0 & -f_2(l_2) e \cdot p_2 & -f_2(l_2) ch \cdot p_2 & -f_2(l_2) i \cdot p_2 \end{vmatrix}$$

$$< 0$$

Then by Cramer's Rule

$$\frac{\partial l_1^{cer}}{\partial p_{cer}^{net}} = \frac{\begin{vmatrix} 0 & 0 & -1 & 0 \\ -1 & -\frac{\partial f_1^{cer}}{\partial l_1^{cer}} & -f_2(l_2) cd \cdot p_2 & -f_2(l_2) e \cdot p_2 \\ -1 & 0 & -f_2(l_2) cf \cdot p_2 + p_1 \frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} - f_2(l_2) g \cdot p_2 & -f_2(l_2) ch \cdot p_2 \\ 0 & 0 & -f_2(l_2) ch \cdot p_2 & -f_2(l_2) i \cdot p_2 \end{vmatrix}}{\Delta} > 0$$

$$\frac{\partial l_1^{co}}{\partial p_{cer}^{net}} = \frac{\begin{vmatrix} 0 & -1 & 0 & 0 \\ -1 & a\cdot(p_1+p_{ab}) - f_2(l_2)b\cdot p_2 & -\frac{\partial f_1^{cer}}{\partial l_1^{cer}} & -f_2(l_2)e\cdot p_2 \\ -1 & -f_2(l_2)cd\cdot p_2 & 0 & -f_2(l_2)ch\cdot p_2 \\ 0 & -f_2(l_2)e\cdot p_2 & 0 & -f_2(l_2)i\cdot p_2 \end{vmatrix}}{\Delta} < 0$$

$$\frac{\partial a_1^{co}}{\partial p_{cer}^{net}} = \frac{\begin{vmatrix} 0 & -1 & -1 & 0 \\ -1 & a\cdot(p_1+p_{ab}) - f_2(l_2)b\cdot p_2 & -f_2(l_2)cd\cdot p_2 & -\frac{\partial f_1^{cer}}{\partial l_1^{cer}} \\ -1 & -f_2(l_2)cd\cdot p_2 & -f_2(l_2)cf\cdot p_2 + p_1\frac{\partial^2 f_1^{co}}{\partial l_1^{co^2}} - f_2(l_2)g\cdot p_2 & 0 \\ 0 & -f_2(l_2)e\cdot p_2 & -f_2(l_2)ch\cdot p_2 & 0 \end{vmatrix}}{\Delta} = ?$$

A price premium increase would clearly have a positive impact on land allocation to certified production l_1^{cer} and a negative impact on land for conventional production l_1^{co}. By contrast, the system does not provide a straight answer for the impact on a_1^{co}. In general, a small impact of agricultural production on the value loss in aquaculture increases the probability of a reduction in abatement for conventional farming (reflected in the diagonal element in the third row).

If we assume that land for aquaculture is variable as well, we would do the same exercise but include the first and second order conditions with respect to l_2 and p_{cer}^{net}. However, the complexity of such a system does not allow a straight reply but would have to be checked in a numerical context.

Dissertation Appendix

Additional information sheet provided in the questionnaire

Remarks

	Helps to reduce our greenhouse gas emissions with 2 tons; the same amount an average person emits when heating his/her home during one year
	Helps to reduce our greenhouse gas emissions with 2.5 tons; the same amount an average European emits in **traffic during one year**
	Helps to reduce our greenhouse gas emissions with 3 tons; the same amount that is emitted during **a long distance flight trip** (such as from Germany to Thailand)
	Aims to adapt the production in the area and make it more sustainable in order to prevent further reductions in plants and animals
	Aims to increase the number of plants and animals by creating a protected area with minimal human interference
	A special emphasis is placed on actions that aim to protect scarce water resources
	A special emphasis is placed on actions that also lead to better living conditions of the people living in the vicinity of the area
	In cooperation with the United Nations
-	Unknown impact

Questionnaire

Except for the choice sets, the questions are the same in all versions. Thus, only version 1 and the choice sets from version 2, 3, and 4 are included here.

International travelling has literally exploded in the last decades and there is no reason to believe that this trend will change. Not least remote destinations such as Africa, Latin America or Asia are becoming increasingly popular. In order to find out more about tourists' preferences for **travel and sustainability** in these regions, the I**nstitute for Environmental Economics and World Trade at the Leibniz University of Hannover**, is currently carrying out a survey.

All respondents who have made a leisure trip within the last ten years to **Africa, Latin America or Asia** are very welcome to participate. The survey can be completed in **15 min.** This is a **research project** with no commercial interest involved.

Remeber that there are no right or wrong answers.

Your participation is greatly appreciated!

The data and information collected during this survey is anonymous and individual data will not be given to third parties.

For further information, please do not hesitate to contact us: Anna Segerstedt, segerstedt@iuw.uni-hannover.de

How often do you go on holidays for longer than a week per year?

☐ 0-1 times

☐ 2-3 times

☐ 4 times or more

How many times did you go on a leisure trip to Africa, Latin America or Asia in the last 10 years?

Please indicate the number of trips.

Africa _____.

Latinamerica _____.

Asia _____.

What are the three most important factors when you choose where to go on your holidays to Africa, Latin America and Asia?

1. Beautiful beaches
2. Peacefulness and silence
3. Great nightlife
4. Wildlife parks and forests
5. Good hunting possibilities
6. Cultural diversity, museums and heritage sites
7. Sunny wheather
8. Good shopping possibilities
9. Family-friendly theme parks and experience centers
10. Sports

Please indicate the respective number.

The most important factor for me is: ----------

The second most important factor for me is: ----------

The third most important factor for me is: ----------

For the following questions, please think of the last time you did a leisure trip to Africa/Latin America/Asia.

To what country did you travel the last time you went to Africa/Latin America/Asia?

How long was your trip?

---------- months, ----------weeks, and -------- days.

Did you travel on your own or did someone else go with you?

You may tick more than one box.

☐ On my own
☐ Partner
☐ Children
☐ Parents
☐ Friends
☐ Organized group
☐ Other: ----------

Was it a package trip or independent travel?

☐ Package trip
☐ Independent travel

How much did the return flight tickets cost per person ?

In case of a package trip, please indicate the price of the whole package.

☐ €0-€500
☐ €501-€1000
☐ €1001-€1500
☐ €1501-€2000
☐ €2001-€3000
☐ €3001-€4000
☐ €4001-€5000
☐ More than €5000

In what kind of accomodation did you stay most of the time?

Please check only <u>one box.</u>

☐ 5-Star hotel
☐ 3/4-Star hotel
☐ 1/2-Star hotel
☐ Hostel/Youth hostel
☐ Private accommodation (own or of relatives/friends)
☐ Camping site/Caravan site
☐ Other: ----------

Was the hotel eco-certified?

☐ Yes ☐ No ☐ Don‘t know

Please indicate to what extent the following activities were important for your satisfaction with the trip.

	Not important	Somewhat important	Important
Beach visit	☐	☐	☐
Diving	☐	☐	☐
Deep-sea fishing	☐	☐	☐
Other water activities (surfing, rafting, sailing, boat etc)	☐	☐	☐
Air activities (helicopter trips, heliskiing, hang gliding etc)	☐	☐	☐
Motor sports	☐	☐	☐
Hunting	☐	☐	☐
Visits of heritage/historical sites	☐	☐	☐
Cultural exchange	☐	☐	☐
Horseriding	☐	☐	☐
Excursions to parks/hiking	☐	☐	☐
Visits of theme parks/experience centers	☐	☐	☐
Visits of health/wellnes spa	☐	☐	☐
Golf	☐	☐	☐

Please indicate what kind of food you preferred to eat.

☐ No meat

☐ Sometimes meat

☐ Much meat

If you ate <u>much</u> meat, please indicate what kind of meat.

☐ Beef ☐ Other meat

Please indicate how you normally behave on your trip to Africa, Latin America or Asia.

	Seldom/ Never	Sometimes	Always/ Often	I don‘t know
I buy primarily locally produced products	☐	☐	☐	☐
I inform myself before travelling to avoid buying souvenirs from species nearing extinction	☐	☐	☐	☐
I choose "green" accommodations with an eco-label	☐	☐	☐	☐
I reuse towels	☐	☐	☐	☐
I use public tranports	☐	☐	☐	☐
I turn off the light when leaving the room	☐	☐	☐	☐
I turn off the air conditioner when leaving the room	☐	☐	☐	☐

Many airlines offer the possibility to offset the greenhouse gases you cause when flying at a certain cost. They are then obliged to reduce the equivalent amount of greenhouse gases elsewhere.

Have you already heard of carbon offsetting programs?

☐ Yes ☐ No ☐ I don‘t know

If you answered yes to the above question, did you ever participate in a carbon offset program?

☐ Yes, one time ☐ No

Do you think that carbon offsetting programs may be a good possibility to combat climate change?

☐ Yes ☐ No ☐ I don‘t know

Imagine that you would book a trip again to the same destination as the last time. Upon payment, you have the possibility to buy a **"green certificate"** from an independent environmental organization:

· When you buy a certificate, the organization guarantees to **protect or restore an area** the size of a football pitch in your **country of destination (f**or example, if you go to Thailand, you would buy a certificate to protect an area in Thailand.)

· The area always consists in a sensitive ecosystem such as a **rainforest, savannah or wetland**.

However, different certificates have different focus and prices. We will ask yo to repeat the choice between the purchase of two different certificates or not to buy any certificate **four times**.

A few things to note before making your decisions:

Experiences from similar studies have found that people frequently declare that they are willing to pay more than they are willing to do in reality. Imagine that you are making the contributions out of your own pocket.

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only one box.

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 3 tons 	Reduction of 2.5 tons 
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	Positive impact 	-
Poverty reduction	Positive impact 	-
UN cooperation partners	-	Yes 
Price	45€	35€

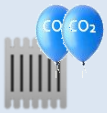
I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2 tons 	-
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	Positive impact 	-
Poverty reduction	Positive impact 	-
UN cooperation partners	Yes 	-
Price	55€	45€

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	-	Reduction of 3 tons 
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	-	Positive impact 
Poverty reduction	-	Positive impact 
UN cooperation partners	-	Yes 
Price	25€	55€

I choose

Certificate 1 Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2.5 tons 	Reduction of 2 tons 
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	-	Positive impact 
Poverty reduction	-	Positive impact 
UN cooperation partners	Yes 	-
Price	35€	25€

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you think back on the last trip you made, *in general* would you or would you not be willing to change your travel agency if you knew that another travel agency would be environmentally certified?

Please check only <u>one box.</u>

☐ No

☐ Yes, but only if the trip would cost the same

☐ Yes, to an additional cost up to: _____€

Motivation (optional): _____

_____

Please indicate to what extent you personally agree with the following statements.

	Disagree	Tend to agree	Agree	I don‘t know
I am well informed about environmental issues	☐	☐	☐	☐
I think it is important to protect the environment	☐	☐	☐	☐
I behave in an environmentally conscious way	☐	☐	☐	☐
Tourism is important for the sustainable environmental protection in developing countries	☐	☐	☐	☐
Tourism is important for the economic development of developing countries	☐	☐	☐	☐
Environmental certification delivers what it promises	☐	☐	☐	☐
Ecotourism is too expensive	☐	☐	☐	☐
Ecotourism comes at the cost of the luxury of the accommodation	☐	☐	☐	☐
Ecotourism is mainly for backpackers/adventure travellers	☐	☐	☐	☐
When I‘m on holidays, I prefer not to think about environmental issues	☐	☐	☐	☐

In your opinion, what action would you prefer to reduce your carbon emissions, or would you do nothing?

Please check only one box

☐ Do nothing

☐ Reduce the number of trips

☐ Pay an obligatory carbon tax on top of the flight price

☐ Pay a voluntary carbon offset

☐ Choose closer destinations and transport with low emissions (e.g. train)

☐ Compensate by reducing my carbon emissions at home

Explanation (optional): _____

_____

In your opinion, what action would you prefer to improve the environment in the country of destination, or would you do nothing?

Please check only one box

☐ Do nothing

☐ Support local charities and projects through voluntary donations

☐ Pay an obligatory tax to the country of destination earmarked for natural protection

☐ Pay higher fees to enter protected parks or other sensitive areas

☐ Choose eco-labeled accommodation and excursions

Explanation (optional): _____

_____

Do you donate money to an environmental and/or human rights organization regularly?

☐ No ☐ Yes, to _____

Age

☐ Below 18

☐ 18 - 25

☐ 25 - 35

☐ 35 - 50

☐ 50 - 65

☐ above 65

Gender

☐ Female ☐ Male

Country of residence _____

Nationality _____

Please indicate the highest level of education you have completed.

☐ Primary school

☐ Secondary school

☐ Vocational qualification

☐ Academic degree

☐ Other: _____

Occupation

☐ Student ☐ Retired

☐ Employee ☐ Unemployed

☐ Freelance ☐ Other: _____

If applicable

Sector: _____

Household size (including yourself)

A household is here defined as people who live together and have common expenses

Adults ---------- Children under 18 ----------

Net household income per month

☐ €500 or less ☐ €2001 to €3000

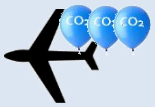
☐ €501 to €1000 ☐ €3001 to €4000

☐ €1001 to €2000 ☐ €4001 or more

Thank you very much for your participation!

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	-	Reduction of 3 tons 
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	Positive impact 	-
Poverty reduction	-	Positive impact 
UN cooperation partners	Yes 	-
Price	€45	€35

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2.5 tons 	Reduction of 2 tons 
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	Positive impact 	-
Poverty reduction	-	Positive impact 
UN cooperation partners	-	Yes 
Price	€55	€45

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2 tons 	-
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	-	Positive impact 
Poverty reduction	Positive impact 	-
UN cooperation partners	-	Yes 
Price	€35	€25

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 3 tons 	Reduction of 2.5 tons 
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	-	Positive impact 
Poverty reduction	Positive impact 	-
UN cooperation partners	Yes 	-
Price	€25	€55

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2.5 tons 	Reduction of 2 tons 
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	-	Positive impact 
Poverty reduction	Positive impact 	-
UN cooperation partners	-	Yes 
Price	€45	€35

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 3 tons 	Reduction of 2.5 tons 
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	Positive impact 	-
Poverty reduction	-	Positive impact 
UN cooperation partners	Yes 	-
Price	€35	€25

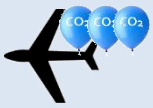
I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	-	Reduction of 3 tons 
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	-	Positive impact 
Poverty reduction	Positive impact 	-
UN cooperation partners	Yes 	-
Price	€55	€45

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2 tons 	-
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	Positive impact 	-
Poverty reduction	-	Positive impact 
UN cooperation partners	-	Yes 
Price	€25	€55

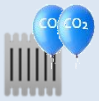
I choose

Certificate 1 Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2 tons 	-
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	-	Positive impact 
Poverty reduction	-	Positive impact 
UN cooperation partners	Yes 	-
Price	€45	€35

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	-	Reduction of 3 tons 
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	Positive impact 	-
Poverty reduction	Positive impact 	-
UN cooperation partners	-	Yes 
Price	€35	€25

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 2.5 tons 	Reduction of 2 tons 
Plants and animals	Stops the loss of species 	Increases the number of species 
Water resources	Positive impact 	-
Poverty reduction	Positive impact 	-
UN cooperation partners	Yes 	-
Price	€25	€55

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these

If you could only choose from the following two choices, which one would you choose, or wouldn‘t you buy any of these?

Please check only <u>one box.</u>

Sustainability targets	Certificate 1	Certificate 2
Greenhouse gases	Reduction of 3 tons 	Reduction of 2.5 tons 
Plants and animals	Increases the number of species 	Stops the loss of species 
Water resources	-	Positive impact 
Poverty reduction	-	Positive impact 
UN cooperation partners	-	Yes 
Price	€55	€45

I choose

☐ Certificate 1 ☐ Certificate 2

☐ I wouldn‘t buy any of these