It's a free-for-all

Who owns soil ecosystem services on agricultural land?

Dennis Roitsch

Master Thesis Series in Environmental Studies and Sustainability Science,
No 2016:035

A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science (30hp/credits)

LUCSUS
Lund University Centre for Sustainability Studies

It's a free-for-all

Who owns soil ecosystem services on agricultural land?

Dennis Roitsch

A thesis submitted in partial fulfilment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science

Submitted October 3rd, 2016

Supervisor: Torsten Krause, LUCSUS, Lund University

Abstract

Soils provide the foundation for human well-being but are increasingly degrading from land use change or types of intensive land use like agriculture. In Europe, soil natural capital is degrading over time and space because of compaction, erosion, and the loss of organic matter. This trend diminishes the soil's ability to sustain a flow of ecosystem services, which are valuable to human well-being. To understand the reasons for soil degradation and therefore soil ecosystem services degradation is important because soils are a finite natural resource. Some reasons for soil ecosystem services degradation can be attributed to their status as both private and public good, insufficient quantification and their undefined economic value. Hence, some soil ecosystem services have not entered markets and are prone to overexploitation. Research has been conducted on the interrelation between ecosystem services and property rights in social-ecological settings, but little is known of how different property rights regimes can influence ecosystem services conservation.

I investigate property rights for soil ecosystem services under European and German policy. Data is collected from interviews and a literature review and the qualitative data is analysed with QDA Miner Coding Software. The coded data is studied through the lens of John Locke's theory of property and using ecosystem services as theoretical framework. First I investigate to what extent farmers have the right to appropriate ecosystem services from their agricultural land. I found that farmers cannot justify the appropriation of soil ecosystem services to full extent based on Lockean theory of property. Especially, a justification for regulating and cultural services is not possible.

Next, I examine drivers that impact soil ecosystem services in Saxony. I found that farmers in Saxony are influenced by European legislation, hereby mainly Greening, Nitrates Directive and Cross-compliance. This results from their substantial dependence on direct payments for environmental and climate friendly measures under the Common Agricultural Policy. Consequently, farmers concede incisions in their property rights by accepting support payments under the Common Agricultural Policy. Public money is transferred to farmers in exchange for a contribution to meet the environmental and climate goals of the European Union. An appropriate property rights allocation in the future will depend on what society deems as acceptable in soil ecosystem services conservation.

Keywords: Property rights, Sustainability Science, Common Agricultural Policy, Saxony, Soil Natural Capital, Payments for Ecosystem Services

Word count: 13,998

Acknowledgements

This thesis took me on a journey from vineyards in Sussex, to libraries in Lund and the fields of Saxony. There are many people who contributed to this thesis along the way.

First, I want to thank my grandparents Bernhard and Renate for their support throughout my time in Sweden. Thanks for taking the time and going on an adventurous field trip with me!

Thanks to mum and Kevin who have always supported and believed in me. Without the backing of my family, writing this thesis would not have been possible.

Thanks to Ellen for being an inspiration and reminding me to stay disciplined and focused.

Thanks to Shoni for listening to my confused arguments and thanks to Tim for telling me to keep things simple. You two kept up a good spirit around the house.

Thank you Torsten for introducing me to the topic, your helpful comments day and night have really saved the day on a number of occasions. Thank you for your scientific supervision, ideas and support throughout and beyond!

A million thanks to all the anonymous reviewers for your insightful and critical comments.

I would also like to thank all the farmers that took part in the interviews.

Table of Contents

List of Abbreviations

Common Agricultural Policy – CAP

Ecosystem Service - ES

European Union – EU

Payments for Ecosystem Services - PES

List of Figures

List of Tables

1 Introduction

Ecosystems have been changed by human activity at unprecedented rates to meet the demand for food, fresh water and timber during the latest epoch, the Anthropocene (Crutzen, 2002; MEA, 2005). In particular, land cover changes for agriculture have had impacts on the Earth's ecosystems beyond any previous scale in history (MEA, 2005). Today, agriculture covers between 28 to 37 percent of the land area globally (MEA, 2005; Plieninger et al., 2012). Human well-being depends on agriculture and terrestrial ecosystems to sustain a baseline for life on Earth (Daily et al., 1997).

Agriculture faces the challenge of ensuring food security for a global population that is estimated to increase by 50 percent by 2050 (Donaldson et al., 2014; Orgiazzi et al., 2016; Power, 2010). Functioning agriculture requires two parts: 1) human labour in the form of ploughing and harvesting and 2) soil-based natural system (e.g. nutrient cycling and soil structure) (Bennett et al., 2015). The Green Revolution and intensive agricultural techniques have enabled humans to produce more food but at the expense of soil ecosystem goods and services such as biodiversity, storage of atmospheric gases and retention of nutrients (Orgiazzi et al., 2016; SOILSERVICE, 2012). Greenhouse gas emissions from agriculture are expected to further increase (IPCC, 2014). Hence, an improved soil management is important because it allows soils to store soil carbon and therefore potentially contribute to climate change mitigation (SOILSERVICE, 2012).

Soils are key for agricultural production and therefore to the challenge of achieving food security (Schulte et al., 2014). They provide underlying services to the benefit of humans, some of which we are not always aware of, such as nutrient cycling, carbon transformation and biodiversity conservation (Dominati et al., 2010; Kibblewhite et al., 2008; MEA, 2005). As more soils in Europe degrade over time and space, soil ecosystem services (ES) cannot provide the same regulatory and supporting functions to benefit human well-being, thus causing potential threats to society (European Commission, 2015a; Prager et al., 2012).

1.1 Problem area

Soil ES are the benefits that humans receive from soil (Dominati et al., 2010). Their somewhat unclear property rights regime, lacking quantification and undefined economic value has been a contributing factor to the negative trend of exhausting soil natural capital, which is needed to create soil ES (Farley, 2012; Kosoy and Corbera, 2010; Lant et al., 2008; SOILSERVICE, 2012). In economic terms, most soil ES are public goods and some are private goods (Boyd and Banzhaf, 2007; Lant et al., 2008). Soil ES that are private goods (private ES) can be marketable such as crops and reared animals. These are usually sufficiently provided because it is possible to exclude others from using them and they are rival. Once used they are not accessible for others (Haines-Young and Potschin, 2009a; Lant et al., 2008). Most cultural and regulatory soil ES are public goods or open-access goods (public ES) and also contribute to human well-being. It is not possible to exclude others from using them and public ES are non-rival, which makes them prone to degradation (Haines-Young and Potschin, 2009a; Lant et al., 2008).

Agricultural profits come from the provision of marketable soil ES, but in the process of production they degrade soil natural capital and undermine public soil ES (Dominati et al., 2010; Lant et al., 2008). In the process of agricultural production, a variety of negative externalities like the eutrophication of water bodies or air pollution from dust occur. The absence of clearly defined property rights for public goods like some soil ES, and the fact that they are not considered by conventional markets leads to the degradation and overuse of soil ES (Boyd and Banzhaf, 2007; Costanza and Folke, 1996; Lant et al., 2008; Meyer et al., 2014; Ruhl and Salzman, 2007).

A lack of well-defined property rights of soil ES is the research problem that I examine in my thesis. I investigate the property rights of soil ES on the example of Saxony because while property rights of land are well defined under EU and German legislation, some soil ES remain without a clear property rights regime. Agriculture has a significant impact on soil ES and represents the most dominant form of land use at 54 percent in Saxony (Statistisches Landesamt des Freistaates Sachsen, 2015). Furthermore, farmers are directly involved in crop production and have a reciprocal relationship with soil ES. The unclear property rights regime of some soil ES creates a situation where farmers reap private gains from certain soil ES and at the same time degrade other public soil ES.

1.2 Research aim and research questions

The aim of this thesis is to test if principles of Lockean theory of property are still valid in the given political, cultural and societal setting of Saxony. Based on these principles, I examine the extent to which farmers can claim property rights to soil ES connected to their land. I also look at various drivers that impact soil ES. To address my aim, I focus on farmers in Saxony as they represent the owners of agricultural land and their actions have a direct impact on soil ES. This leads me to develop two main research questions broken down into sub-questions that allow me to fulfil the above overall aim.

Research questions:

My first research question seeks to investigate the extent to which farmers own soil ES. To delineate the extent, I initially identify which soil ES are present in Saxony (section 5.1). Subsequently, I examine property rights in Saxony and how they are linked to soil ES (section 5.2). Consequently, I discuss whether farmers can appropriate soil ES.

1. To what extent can farmers claim property rights and appropriate ecosystem services provided by their lands?
    a. Which soil ecosystem services are provided in Saxony?
    b. What property rights currently exist in the district of Bautzen, Saxony?

My second research question explores factors that farmers consider in using soil natural capital. As a result, I link these factors to soil ES (Robinson et al., 2013; SOILSERVICE, 2012). This could inform future improved soil-related policy design.

2. Which natural, economic and legislative factors do farmers in Saxony consider in using their soil for crop production?
    a. How do these factors impact soil ecosystem services?

1.3 Sustainability science, ecosystem services, and property rights

Sustainability science seeks to understand the complex interactions and bridge the knowledge gap between the natural systems and human well-being using participatory and transdisciplinary approaches (Clark and Dickson, 2003; Jerneck et al., 2011; Kates et al., 2001; Polk, 2014; Wu, 2013). The vision of sustainability science is to find solutions or transitions for societal and environmental problems by involving both scientific and societal knowledge (Lang et al., 2012). Doing so requires the understanding of complex systems on various scales and levels because of global challenges, like climate change, occur across system boundaries and can have implications for livelihoods of people on a local level (Jerneck et al., 2011; Kates et al., 2001).

Guided by Kates et al. (2001), my contribution to sustainability science is to explore how regulations, markets, scientific knowledge and norms can improve human-nature relationships and contribute to distributive justice. Distributive justice is concerned with an equal distribution of natural resources, in my case the right of individuals and society to equally benefit from soil natural capital and the underlying ES (Farley, 2012). To answer my research questions I decided to work with stakeholders from outside academia to generate robust knowledge. Therefore, I approach the sustainability challenge in my thesis by adopting a transdisciplinary approach (Polk, 2014).

Property rights as we know them today in western society have historically grown from the theory of property set out by John Locke (Locke, 1980). In this regard, we face a structural lock-in that is unquestionably problematic because it defends property rights over environmental policies and therefore measures to protect ES flow which is vital for human well-being (Haddad, 2003). Using Locke's philosophy can help understand this lock-in and ways to overcome it.

I use the ES concept to be able to bridge and connect trade-offs in social-ecological systems, for example between crop production (provisioning service) by humans and their consequences for nature such as the degradation of water quality (regulating service) and loss of landscapes (cultural service) (Haines-Young and Potschin, 2010). In my study, I investigate a case from Saxony, where property rights and agricultural activity are highly regulated (section 3.2). Despite the high level of environmental regulation in agriculture in the EU, the environment still suffers from degradation (SOILSERVICE, 2012). Hence the ES concept could help to address this problem.

2 Theoretical background

In this section, I explain the theory and concepts that structure, support and inform my arguments. First, I present the concept of ES with a specific focus on soil ES. Secondly, I demonstrate John Locke's theory of property. Thirdly, I present links between our current understanding of property rights and the concept of ES.

2.1 Ecosystem services

To understand and discuss the property rights status of soil ES, I first elaborate on the development of the ecosystem framework and its current use. In my thesis, I apply it because it can clarify trade-offs between gains and losses ES provide to human well-being, which can enable planning and decision-making (Burkhard et al., 2012).

2.1.1 The ecosystem services concept

The concept of ES assists our understanding of the intermediary and final benefits that we receive from nature (Birkhofer et al., 2015). Various definitions can be found in the literature, but the overall consensus is that ES directly and indirectly provide benefits to people's well-being (Daily et al., 1997; MEA, 2005).

Early frameworks from Daily (2000) and classifications from De Groot et al. (2002) helped to gain a better scientific understanding of the concept and have fuelled research related to ES over the last decade (Birkhofer et al., 2015). This work resulted in the commonly used Millennium Ecosystem Assessment (2005), which categorises ES into four categories: provisioning, regulating, cultural and supporting services. The Millennium Ecosystem Assessment (2005) defines provisioning services as goods such as food, fibre and water obtained from ecosystems. Regulating services are defined as the benefits humans obtain from the regulation of ecosystem processes like soil erosion control, pollination and water purification (MEA, 2005). Cultural services are non-material benefits and supporting services represent the underlying processes of all other ES such as habitat provision and soil formation (MEA, 2005; Schwilch et al., 2016). Soils supply services across the board of these categories from plant production, climate regulation, and biodiversity conservation to recreation (Fig. 1, p. 14).

As my thesis is placed in a European setting, I apply the Common International Classification of Ecosystem Services (CICES), which was developed by Haines-Young and Potschin (2013) for the European Environment Agency. It categorises ES into provisioning, regulation & maintenance and cultural services (Haines-Young and Potschin, 2013).

Here I will give a short overview of how the ES concept is applied to soil-based ecosystems and differentiate between the terms ES and ecosystem functions (Orgiazzi et al., 2016). Soil ecosystem functions are the biological, geochemical and physical soil-based delivery processes that occur in soil ecosystems and together they deliver soil ES (Fig. 1, p. 14) (Kibblewhite et al., 2008). The smallest building block of soil, which I consider in my thesis, is soil biota and some of its components are shown in column 3 of figure 1, p. 14. These biotic (macro fauna, bacteria, earthworms) and abiotic (soil structure, organic matter, nutrients) elements of soil create the ecosystem structure. The ecosystem structure facilitates natural processes in the soil, which are referred to as ecosystem functions like nutrient cycling, biological population regulation and carbon cycling. Hence, ecosystem functions provide useful services and goods to people.

Figure 1 shows the four categories of ES and the corresponding ecosystem functions and soil biota.

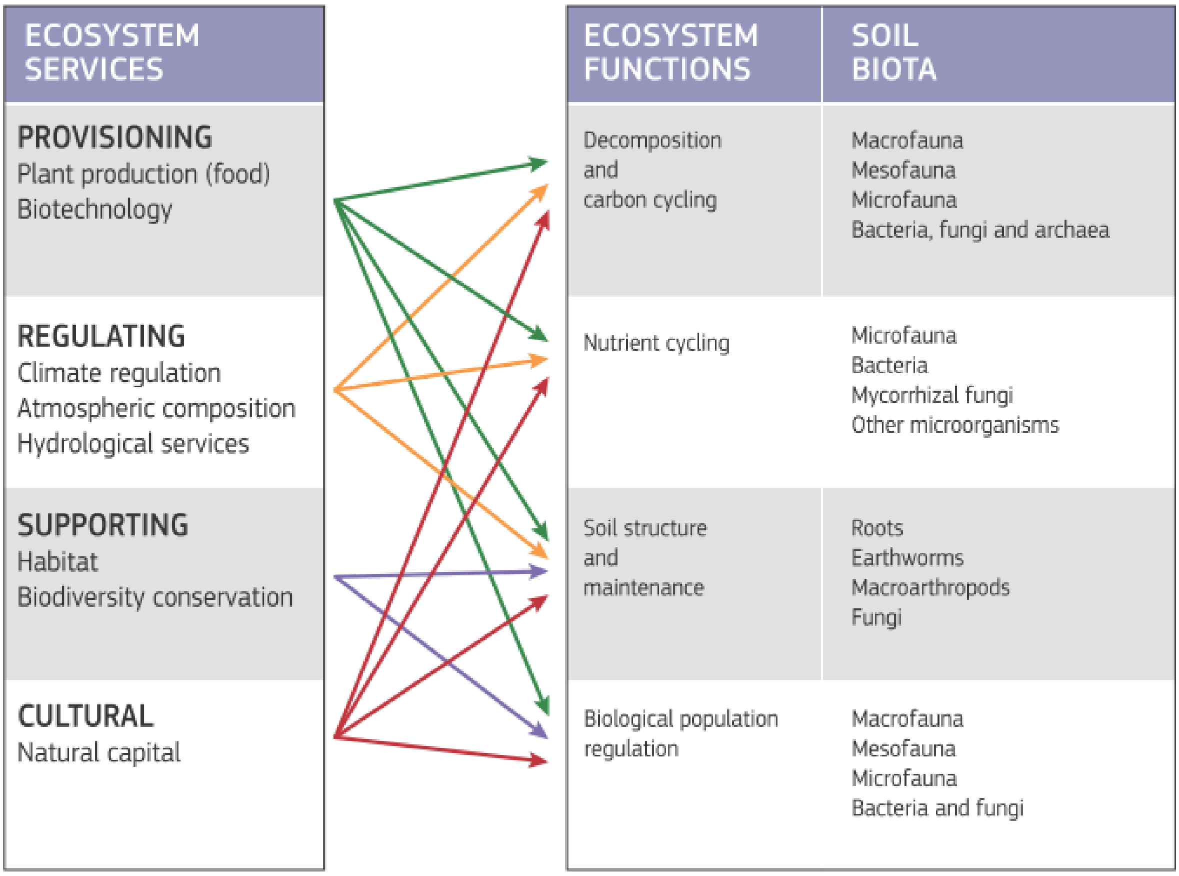

Fig. 1: The link between ecosystem services, ecosystem functions and soil biota (Orgiazzi et al., 2016)

Agricultural activity influences all soil-based delivery processes (organic matter input decomposition, nutrient cycling, soil structure, biological population regulation) illustrated in column two of figure 1 (Kibblewhite et al., 2008; Orgiazzi et al., 2016). Examples of negative impacts from land use change and on-going agricultural activities are biodiversity loss, the overuse of fertilisers which leads to a nutrient overload and conventional (intensive) tillage that damages soil structure (Orgiazzi et al., 2016).

2.1.2 Natural capital and ecosystem services

For the discussion about soil ES, it is important to recognise that these services arise from soil natural capital (Dominati et al., 2010). Robinson et al. (2013) argue that it is vital to focus on natural capital instead of ES because natural capital is more tangible and easier to measure, i.e. more data is available for informed decision-making. For my thesis, I use the ES framework because I do not investigate property rights of soils, but property rights of the services that soils provide to humans. Figure 2 (p.15) shows an overview of natural capital and soil ES concept. Natural capital can be regarded as stocks of natural assets such as soils, water bodies and forests (Costanza et al., 1997; Dominati et al., 2010). The term flocculation describes the soil ecosystem functions (e.g. nutrient and carbon cycling) which result in forming soil structure. It is vital to understand these interactions because natural capital provides a flow of goods and services such as atmospheric gas regulation, which has a final influence on human well-being (see figure 2) (Dominati et al., 2010).

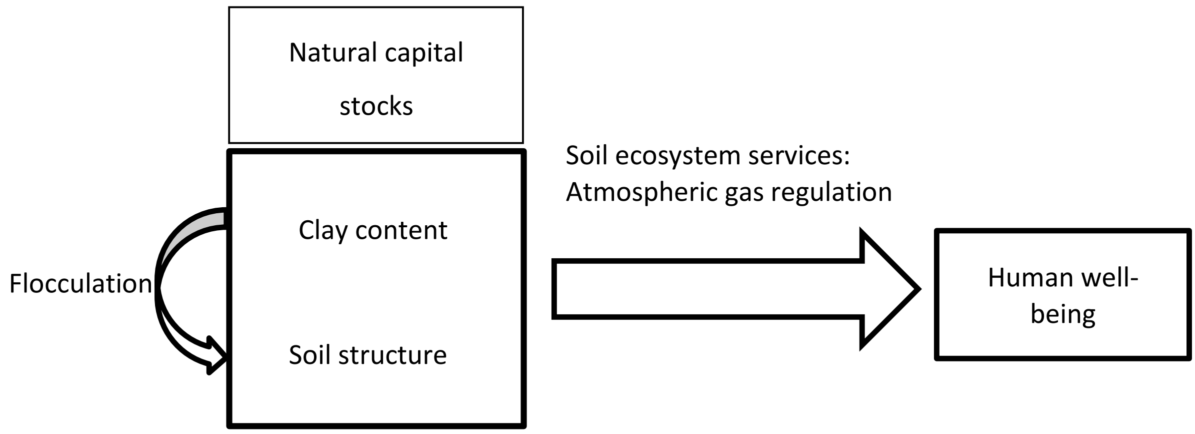

Fig. 2: Natural capital and ecosystem services concept (Adapted from Dominati et al., 2010)

Figure 3 shows the interactions between built, social, human and natural capital. Human well-being depends on the interactions between all of them. Natural capital does not contribute directly to human well-being but indirectly through ES (Costanza et al., 2014).

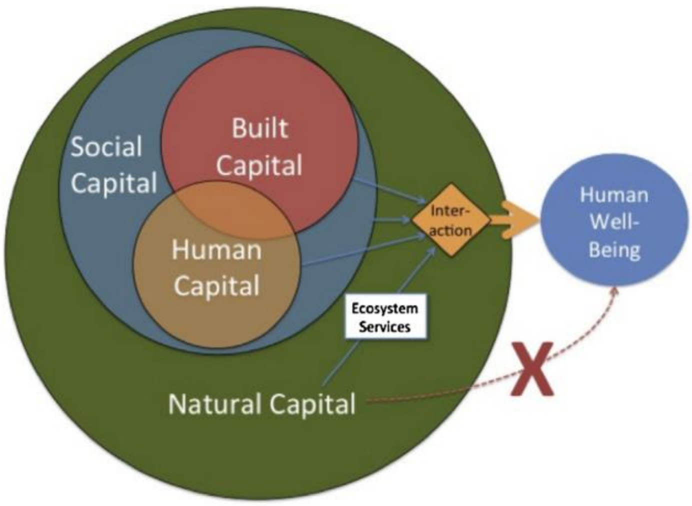

Fig. 3: Interaction between natural, social, built and human capital (Costanza et al., 2014)

2.2 John Locke - theory of property

I use John Locke's theory of property in my thesis because I consider it important to understand the contemporary liberal thinking, the role of governments in environmental policy design and the origins of strong individual property rights. The current economic and political system embraces liberal ideas and individual rights, although the system can only function as long as people respect these rights in a responsible and careful manner, including the rights of others (Mossoff, 2012; Taylor, 1997). The *Second Treatise of Government* (Locke, 1980) is useful to investigate property rights because it gives a cunning explanation of private goods, public goods, and transaction costs (Stevens, 1996).

Locke laid the groundwork of how we understand property today (Haddad, 2003). In the time after the English Civil War from 1642 to 1651 and during the English Enlightenment (Judge, 2002) the English economic system changed from a guild to an early capitalistic system (Henry, 1999; Polanyi, 2001). Villains became free people and former serfs became landowners, which leads to developments that shape society today. Former commonly cultivated land was enclosed and converted into private land (Helfrich, 2009). Locke approached individual's property claims in a new way and explained the developments in the social system with respect to property.

According to Locke (1980), the world, in its natural state, is owned by all human beings. In fact, an individual's fundamental possession is one's body and one's labour. It follows then that by carrying out labour with one's own body on goods provided by nature, one has the liberty to acquire natural goods that are freely accessible as one's property. To put it simply, everyone has the right to sustain themselves and acquire property that is not already the property of others (Locke, 1980). As a result, an individual can claim formerly common goods and resources as private property, and exclude others from this natural resource in the process (Davidson, 2012; Judge, 2002; Locke, 1980). Accordingly, individuals have the right to property in the form of land. By performing labour, one can claim a property right to this land (Haddad, 2003).

When applying the Lockean theory of property to my thesis, I use the following core points: first, when work is applied to natural goods and resources, one can acquire property rights (Locke, 1980). Second, Locke (1980) introduces boundaries to consumption: humans are not allowed to harvest more natural goods than they can consume before goods decay (Henry, 1999; Trachtenberg, 2014). Third, there should be enough common resources for others to be able to sustain themselves (Locke, 1980). Hence equitable distribution is in principle desirable. This fine line separates Locke from Hobbes' state of war where men have no obligation to take into account the rights of others (Stevens, 1996; Taylor, 1997).

These principles apply to natural goods and land; overall, they justify a fair and limited adoption of property rights in a Lockean sense (Trachtenberg, 2014).

The first principle of mixing labour with land became obsolete with the introduction of money because it allows an exchange of goods and land. In case that land is exhausted, individuals are only left with their labour to sell (Locke, 1980). Locke puts it this way: if one decides to sell his or her fundamental property right, which is one's body then there has to be a form of compensation in the form of money (Henry, 1999). Therefore, some individuals can accumulate value and reinforce their workforce through the labour market.

The second principle also became obsolete with the introduction of money (Henry, 1999). Money does not perish and therefore cannot infringe on the idea of not wasting goods. It makes an accumulation of value possible because one can own more goods than one needs to sustain one's livelihood (Henry, 1999; Locke, 1980; Trachtenberg, 2014).

This inevitably leads to equity issues, as some individuals are in the position to accumulate more than they can consume. According to Locke (1980), wealth accumulation is inherent in human nature. The accumulation of wealth in the form of land, money and goods is central to Locke's ideas and money serves as a mechanism to achieve this central objective (Helfrich, 2009). Once an individual owns a resource or land, they can then exclude others from using it. This is contrary to one of the basic ideas set out at the beginning of this chapter, to leave enough for others (Wolford, 2007). Trachtenberg (2014) critiques Locke's theory for that because it "provide[s] a natural-law justification for substantial inequality in the most significant form of property: agricultural land." (p. 102). Even though, Locke said that institutions such as governments are needed when the distribution of property becomes unbalanced (Locke, 1980).

From Lockean theory, Krueckeberg (1995) introduces "The Taking Issue" (p. 304); a "conflict between private and public interests in the use of a piece of land." In Locke's natural state, property rights are not secure, a civil authority such as the government must ensure property ownership, while respecting the natural right described by Locke (Trachtenberg, 2014). This issue has prevented environmental regulations in the United States and the EU (Trachtenberg, 2014) because property owners are subject to compensation if the government negatively influences land conditions or regulates the use of property (Haddad, 2003; Krueckeberg, 1995; Naskali, 2003; Trachtenberg, 2014).

2.3 Ecosystem services and property rights

Locke's theory is the foundation of our modern democracies and establishes private property rights for formerly common-pool resources. A private good or private land can be rival, excludable, and trading in markets becomes possible (see Appendix C) (Kosoy and Corbera, 2010). For some ES it is possible to enclose them but for others it is near impossible. Hence they can be rival and in other cases non-rival (see table 1) (Vatn, 2014).

Table 1: Classification of ecosystem services *(Haines-Young and Potschin, 2009a)*

	Excludable	Non-excludable
Rival	Rival Market goods and services (most provisioning services)	Open access resources (some provisioning services)
Non-rival	Non-rival Club goods (some recreation services)	Public goods and services (most regulatory and cultural services)

The status quo for policy solutions to ES conservation includes taxation, regulation and property rights (Bromley and Hodge, 1990; Farley, 2012). Property rights are defined as a subgroup of institutions in a formal or informal setting (Hagedorn, 2008). I differentiate between private property, common property (group of people), public (state) property and open-access non-property as described by Meyer et al. (2014) and Guerin (2003) (see Appendix C). Property rights evolve when they represent the cheapest option to deal with natural resource struggles; this process is also referred to as internalising externalities (Guerin, 2003).

A way to incorporate public ES into markets, in particular non-excludable ES, is by defining property rights (Farley, 2012). One method to nature commodification is the idea of exchangeable property rights by using the Coase Theorem (Farley, 2012). It states that it does not matter who holds property rights initially; as long as transaction costs are absent, the market will find an optimal solution (Lai et al., 2015). During crop production, farmers cause negative externalities in the form of nutrient runoff and soil erosion that can affect their neighbours. In the case of well-defined property rights and low transaction costs, a voluntary exchange will take place and the externality can be overcome (Farley, 2012). A governmental intervention in the form of taxation or regulation is not necessary (Farley, 2012). As a result of the property rights allocation, either the farmer or his or her neighbour has an incentive to negotiate an improved outcome, as property rights are defined and both know the cost of the externality. By negotiating they would find the optimal solution, without having the outcome of one being better off than the other (Groot et al., 2010).

A common market instrument in the EU is Payments for Ecosystem Services (PES), which also requires well-defined property rights regimes (Farley and Costanza, 2010). The assumption in PES schemes is that the beneficiary pays the farmer to change to business practices that reduce the degradation of ES (Farley, 2012). For ES that are excludable, either through present property rights or evolving property rights regimes, the PES is applicable (Farley and Costanza, 2010). Scholars like Costanza (2015) and Farley and Costanza (2010) argue for non-excludable ES to be "propertized" (Costanza, 2015, p. 14), hence to find a property rights regime without making them private goods. In Saxony, PES are part of rural development schemes and usually target agriculture, forestry and fisheries (Schleyer and Plieninger, 2011). Cross-compliance can also be regarded as PES (Meyer et al., 2014). Shifting property rights and new concepts like carbon rights, have created debates whether the owner of a forest is also the owner of the carbon rights of that forest (Meyer, 2004). Similar to the question about soil ES in my thesis.

To sum up, I presented the ES concept which serves as a framework for my thesis; I set out the conditions that facilitate Lockean theory of property and I offered one option to integrate public soil ES into markets via the Coase Theorem and PES schemes.

3 Case selection

The Free State of Saxony in Eastern Germany is a relevant case for my thesis because of four distinct challenges to the health of soils (natural capital): climate change, soil sealing, soil compaction and soil erosion. Property rights and soil-related regulations are clearly defined by European and German laws and policies.

3.1 Saxony

Agriculture takes up about half of the state's total land area of 1,841,582 ha (Statistisches Landesamt des Freistaates Sachsen, 2016). About 900,000 ha are used for agricultural production and the sector is the main land user in the state (SMUL, 2015). Wheat production covers 400,000 ha and represents the most important crop in the state (SMUL, 2015). Also, nature protection is high on the political agenda and strict environmental policies are in place and enforced by local authorities (SMLU, 2010).

The ownership status of farms in Saxony is structured as following: there are 206 privately owned businesses, 56 cooperatives (common property), and 199 agricultural corporations (common property) (SMUL, 2015). Agriculture went through structural changes since the reunification in 1990 and is now a modern and an efficient sector based on agricultural productivity (SMLU, 2010).

3.2 Threats to soils in Saxony

Several challenges threaten soils from outside and within the agricultural sector and I want to briefly outline the dominant ones.

3.2.1 Soil erosion

I conducted my field work in the administrative district of Bautzen, which represents a smaller administrative unit in Saxony. The district is located in the centre of figure 4 which also maps soil erosion from water for the study area.

Soil degradation is a persistent problem in Saxony, in total 450,000 ha are under threat from soil erosion (SMLU, 2010). Wind erosion (450,000 ha) and water erosion (150,000 ha) both affect over half of the entire agricultural land of 900,000 ha (SMLU, 2010; SMUL, 2015). Water erosion can partly be attributed to climate change (Frank et al., 2014) and wind erosion can be attributed to naturally occurring sandy soils (Bastian et al., 2013). Figure 4 shows, on a scale from 1 to 7 potential threats for soil erosion from water.

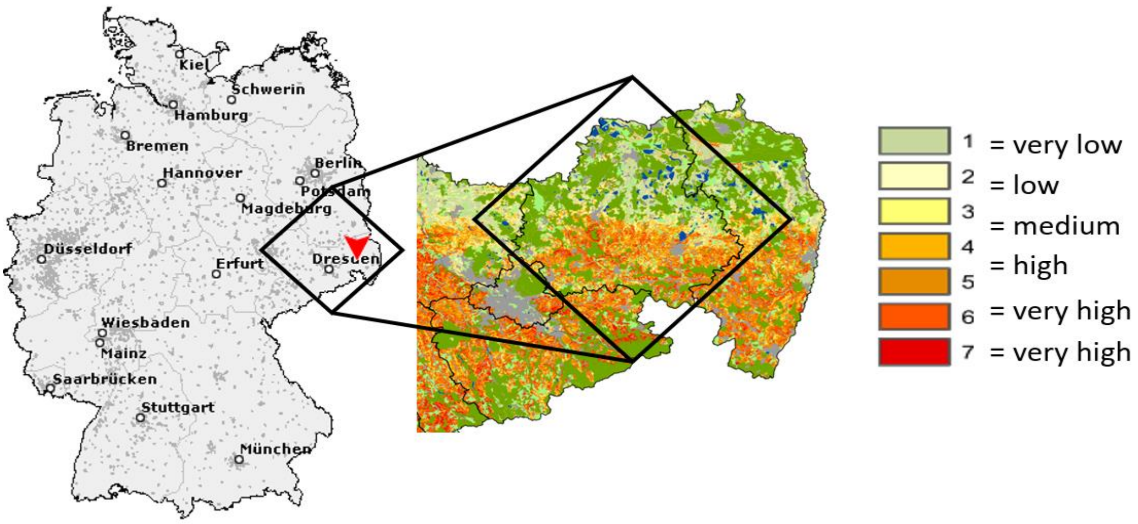

Fig. 4: Map of Germany (left) and the study area (centre). The centre maps also shows soil erosion from water on a scale from 1=very low to 7=very high (Adapted from Baum, 2016; D-Maps, 2016; SMUL, 2013)

The scale in figure 4 is based on soil type, slope gradient and pluvial erosion and these factors determine how prone the soil is to water erosion in the respective region (SMUL, 2013). Figure 4 shows a clear North-South divide in the level of erosion threats, which can be attributed to the flat topography in the Northern part of the region and the hilly topography in the Southern part. In total, about 25 percent of the land area is threatened by water erosion (Petzold et al., 2014).

The average soil value[1] for the administrative district of Bautzen is 43; the average price of one point of soil value is 254 EUR which translates to a price of 10,907 EUR/ha (SMUL, 2015). In 2014 the price of land was 5,075 EUR/ha, within one year the price of land more than doubled (SMUL, 2015).

3.2.2 Soil sealing

Soil sealing continues across Saxony; in particular agricultural land is consumed for urban, infrastructure and recreational projects. This creates a loss of soil ES such as crop production, natural water retention capacity, water filtration, and a change in the landscape which is currently not addressed by EU policies (Glæsner et al., 2014; SMUL, 2016a).

3.2.3 Soil compaction

In Saxony, soil compaction is a common problem, it is caused by intensive agricultural activity and leads to the loss of soil fertility (Bastian et al., 2013). The degree of soil compaction depends on local characteristics of the soil but it is dominantly caused by heavy agricultural machinery (SMUL, 2016b). Soil biota which influences soil fertility is crucial as ES provider on a local scale (Haines-Young and Potschin, 2009b).

3.2.4 Climate change

The agricultural profitability in Saxony is influenced by extreme weather events like the floods in 2002 and like the drought in 2003 (SMLU, 2010). Climate change will affect Saxony in the long run and yield losses can be expected. The northern part of the study area is worse affected because less precipitation can be expected and the sandy soils have less water storage ability than the loess soils in the southern part (Lorenz et al., 2013; Lupp et al., 2015; SMUL, 2015).

3.3 Policy background

The policy background informs how agricultural production is currently regulated within the EU. There is currently no specific regulation for soil protection in the European Union (EU). Instead soil protection is indirectly covered by regulations in areas such as agriculture, waste, and water (European Commission, 2015a; Glæsner et al., 2014).

[1]Assessment rating of agricultural soils during the Imperial Soil Assessment based on the Soil Assessment Law from 1934 (Wolff, 1939). Soil ranking from least fertile to most fertile on a scale from 0 to 100 based on crop yield potentials (Mueller et al., 2012).

In Germany, the protection and treatment of soils is regulated by 32 European directives and 53 German standards; the central directive in Germany is the Federal Soil Protection Act (BBodSchG) (Pingen and Huesmann, 2015).

3.3.1 European Agricultural Policy

The EU Common Agricultural Policy (CAP) regulates what farmers cultivate and thus influences soil management. The ES concept is not explicitly used by the CAP but the provision of environmental goods and services from agriculture is recognised (Plieninger et al., 2012). The latest CAP reform in 2013 is now valid from 2014 to 2020 and demands more attention to environmental friendly agriculture (BMEL, 2015). In my thesis, I mainly refer to two CAP policy instruments: direct payments (including Greening) and Cross-compliance.

Cross-compliance and Greening apply to my thesis because they cover direct and indirect protection of soils and soil ES. Their implementation is carried out by the member states; it is their responsibility how to design compulsory and voluntary schemes (European Comission, 2015). The latest CAP reform pairs direct payments with the compliance of environmentally beneficial actions, which are further regulated under Cross-compliance and Greening (BMEL, 2015).

Cross-compliance regulates direct payments under the condition of compliance with rules on the environment, public and animal health, and animal welfare (European Commission, 2015). It is a policy that adjusts monetary payments to farmers in exchange for the provision of common ES such as soil formation, water quality and nutrient cycling (Henriksen et al., 2011; Meyer et al., 2014; Posthumus et al., 2011).

Greening was added in the 2013 reform to meet environmental and climate goals (European Commission, 2011). It is a consequence of the implementation of the EU biodiversity policy which has among others, the objective to maintain ES (Maes et al., 2013). Greening covers the following measures: crop diversification, protection of permanent grassland, and ecological focus areas. A reduction in payments takes place if farmers do not comply with the rules (European Commission, 2011; Plieninger et al., 2012).

Other policies with a strict environmental focus and indirectly targeting soils include: first, the EU Water Framework Directive, which aims at the protection and restoration of European water bodies (European Commission, 2000; Schulte et al., 2014). Second, the EU Nitrates Directive which regulates organic and inorganic fertiliser applications (European Commission, 1991).

3.3.2 German policies

On property, the German Constitution article 14 secures private property which comes with obligations defined in Article 14 paragraph 2 GG: ownership has responsibilities and it should serve public welfare (BMJV, 2016a). Article 14 entails social and environmental responsibility which means that individual use can be limited (Meyer et al., 2014). Meyer et al. (2014) generalise that compliance with regulations is a must and no reimbursements may be received by the individual. The German Code of Federal Regulations states that the ownership of property extents to the terrestrial body of earth beneath the property and into the atmosphere above the property, though there can be restrictions (BMJV, 2016b).

Agricultural production and soils are covered by the Federal Soil Protection Act (BBodSchG). It defines best practise[2] guidelines by a precautionary principle to avoid detrimental soil changes. Furthermore, it is used to protect and start a restoration process of previously damaged soils. The main focal points of the best practise guidelines involve a focus on issues like soil compaction, soil erosion, and the preservation of soil fertility (Brandhuber et al., 2015). Soil protection is furthermore part of the Water Directive, Nature Protection Directive, and the Nitrates Directive; additionally, there is a range of local agri-environmental schemes that cover soil protection (Hagemann and Prager, 2002; Pingen and Huesmann, 2015).

4. Methodology

4.1 Research design

For my thesis I primarily collect qualitative data in the setting of a case study; hence my thesis is a cross-section in time. I structured my research based on a case-study to achieve a comprehensive and thorough analysis of a general problem in a specific setting. Particularly, I use purposeful sampling of data from farmers who represent my unit of analysis (Yin, 2011). I decide that farmers are the optimal choice because they work at the intersection of the natural and social sphere. Farmers in my study area are bound to strong and comprehensive European and German soil-related policies. The latest EU CAP integrates environmental aspects into agricultural activities, a farmer's position between nature and society gives him or her decision-making power, and hence he or she could act as a facilitator for change which is another reason why farmers in Saxony are targeted in my thesis.

[2] Gute fachliche Praxis (Brandhuber et al., 2015)

I take a mixed approach, starting from the literature and the concept of ES to generating data in the field and vice versa. To increase the validity of my thesis, I apply data triangulation as a strategy, which involves a rich pool of literature from various sources (Yin, 2011). The literature I use is mainly from primary and secondary sources. However this is complemented by grey literature collected during the International Green Week in Berlin in January 2016. Such an approach helps to verify descriptions and explanations given by the farmers.

When designing interview questions, I use open-ended questions (see Appendix A) as they fit within my constructivist view. This allowed farmers to explain topics in more detail that they hailed as important rather than me paving them into a direction that I hailed as important. I acknowledge that my personal values and political views influence my research questions; the way I analyse and interpret my data is subjective (Alvesson and Sköldberg, 2009).

4.2 Data collection

The study area for the interviews is limited to the administrative district of Bautzen in Saxony. This allows me to limit travel time and costs; in some cases the travel time to meetings takes up to two hours. The rural character of the region does not make public transport a feasible option. The decision to limit to one study region was also done for practical reasons, i.e. in so doing I kept my analysis within one political and cultural context. For the literature review, I extended the scope of my search to the state of Saxony due to the low availability of data for the study region of Bautzen.

4.2.1 Literature review

In preparation and to lay the groundwork for my thesis I conducted a literature review using secondary and tertiary sources. Secondary literature in the form of journal articles is collected from LUBsearch, Google Scholar, and Scopus. Several books were collected from the library in Lund. I conducted a purposive literature review to identify papers that investigate ES in Saxony. That revealed 40 scientific papers in total, of which I used 32 because they investigate soil ES in Saxony. Tertiary literature in the form of governmental and non-governmental reports and handbooks were collected during the International Green Week in Berlin in January 2016. They include guideline reports and assessments from agencies such as the Federal Ministry of Food and Agriculture and the German Farmers Union. These resources assisted my understanding of soils in a political, policy, and societal context and provided me with expert knowledge specifically for Germany.

4.2.2 Interviews

As a primary source of information for my paper I conducted interviews in Germany. Before conducting interviews in the field, I developed a list of possible interviewees using online resources. To find the addresses of farms in the administrative district of Bautzen, I downloaded a list of companies from the agricultural sector from the Department of the Environment and Agriculture of the State of Saxony. This search was deliberately limited to companies and farms that train people to become a crop cultivator or a farmer to increase the likelihood of responses. The webpage provided me with a list of 40 companies. Also, I only contacted farms that have crop production because the primary concern of my thesis is in relation to soils and crop production, not animal husbandry.

Out of 40 companies on the list, I identified 32 to be in my target group of meeting the two criteria: crop production and offering apprenticeships. I emailed these 32 farms a short introductory paragraph about myself and my research as well as the interview questions. I then followed up with individual phone calls to organise the highest possible number of interviews. In total, nine farms agreed to take part in an expert interview. Eight out of nine farms in my thesis are mixed businesses with crop and milk production. Only one farm is a business with a sole focus on cash crop production (see table 2).

Table 2: Type of ownership, farm size and main crops at nine farms in Saxony

Farm	**Ownership**	**Farm size [in ha]**	**Main crops**
F1	Private	307	Winter oilseed rape, winter barley, winter wheat
F2	Limited partnership with a limited liability company	1,491	Silage maize, winter wheat, winter oilseed rape
F3	Limited partnership	2,723	Winter oilseed rape, winter wheat, silage maize
F4	Civil law association	1,495	Winter wheat, winter barley, winter oilseed rape
F5	Civil law association	2,294	Silage maize, winter oilseed rape, winter wheat
F6	Limited liability company	1,400	Grain maize, autumn-sown rye, winter wheat
F7	Civil law association	1,000	Winter barley, autumn-sown rye, silage maize
F8	Limited partnership with a limited liability company	2,400	Silage maize, winter wheat, winter oilseed rape

F9	Limited liability company	1,400	Winter wheat, silage maize, winter barley

The sample size of my research is nine interviews. A tenth interview took place over the phone for one hour and a half but the data turned out insufficient for analysis and I did not receive the farmer's consent to use the data. For personal reasons, the tenth interviewee declined to meet me in person.

From March 3rd to March 23rd 2016, I conducted my field work in the study area using open-ended questions. The interview language is German and the translation was solely conducted by myself.

I noted the demographic data of all the participants in the form of education, age, and their employment status at the farm. The interviewees may be in different positions in their respective companies, but all are involved in crop production and therefore possess decision-making powers in crop production.

During the interviews I used proxy questions (see Appendix A) to identify major drivers that impact soil natural capital. First, the interviewees were approached with a brief introduction to my research. Semi-structured interviews were recorded using a voice recorder and accompanied by extensive notes regarding the tone of responses to certain questions. Open-ended questions generated a relaxed atmosphere whereby the flow of the conversation developed depending on the main interests and concerns of the farmer. If topics and explanations remained unclear to me then I would ask follow-up questions. The length of interviews varies from 35 minutes to 90 minutes; some farmers were better prepared and had given more thought to answer the questions than others. These audio recordings are supplemented by data from the literature.

4.3 Data analysis

The data is mostly qualitative (see Appendix B). For my thesis, I gathered close to 9 hours of audio recordings from the nine interviews and transcribed these word for word into 90 pages of text. This allowed me to investigate data in detail and in the context of the interview, rather than in isolation. For example, I included descriptions of how interviewees reacted to particularly interesting topics that raised emotions. I used Express Scribe Transcription Software to transcribe these audio recordings to a word document. The transcribed records were then analysed with the help of QDA Miner coding software.

Coding was performed with the help of the coding manuals by Saldaña (2013) and Ryan and Bernard (2003). As a first step, I read the transcribed interviews and highlighted paragraphs and words that seemed of importance to me and that reoccurred throughout the document. I used deductive and inductive approaches to coding, as some topics were not represented in the literature but remained important for my thesis. Several phases followed this initial step, which allowed codes to become more refined and new codes to emerge. This process is referred to as focused coding (Saldaña, 2013), where codes are refined based on regularity and significance. From the literature I previously explored key themes such as *Greening* which could be expected as answers to my interview questions; these themes were then tailored based on answers given in interviews to focus on the most important aspects. From this process I created keywords and key themes that are presented in the Results and Analysis section.

4.4 Ethical aspects

In the initial e-mails sent to farmers, I introduced myself, my research objective and the reason why I would like to talk to them and have their expertise. I later contacted farmers via the phone and during the calls explained my background in detail and that the data collected during interviews will be used for my Master Thesis. Before the interview took place, I asked the farmers if they would object to a recorded interview and if I can have their consent to use the data for my thesis. Every farmer gave his or her verbal consent to have the interview recorded, data analysed and used in my thesis. I made the farmers aware that they have the right to refuse to take part in the interview. Because of the fact that I rely on verbal permission to use the gathered data, I decided to refer to the nine farms as F1, F2, F3, F4, F5, F6, F7, F8, and F9 to protect the farmers' anonymity.

4.5 Limitations

My interview data is limited because I rely on the opinions of farmers; their answers to my questions have been influenced by their views and their actions. Hence, this data does not necessarily reflect their behaviour in everyday work life.

The opinions of politicians, policymakers and the public could be a very useful addition to my study but do not present a feasible option given the limited time. I also tried to target a balanced number of companies with respect to the ownership status. However, I only talked to one farmer with a privately owned business. The other farms have mixed ownership statuses in their businesses.

There a several other market-based instruments to include non-excludable soil ES into markets such as pollution taxes, cap-and-trade, labelling, and eco-certification (Farley, 2012). Though, I focused on PES on a European level because of my findings in section 5.3: Greening, Cross-compliance, and Nitrates Directive.

The number of my interviews is limited to nine because I could not get more farmers to agree to take part in an interview. Nine interviews can be considered low compared to my initial sample size; it only represents a response rate of 28 percent (9 out of 32). This could be due to the season because farmers started to prepare their fields and bring out the next crop during the time of the field work.

The character of the open-ended question allows farmers to answer freely and according to what they rate as an important topic depending on their beliefs and values. Conversely, this carried the danger that interviewees might drift off topic. The interviewed farmers answered instantly. Hence they never gave a complete picture even though they touched upon topics related to my research. The data is not exhaustive as two farmers for example ignored one of the interview questions about whether they would like to cultivate different crops to what they currently cultivate.

5 Results and Analysis

Within this chapter of my thesis, I present my results and analysis to investigate my aim set out at the beginning of my paper, which is to explore property rights to soil ES for the district of Bautzen in Saxony. Section 5.1 focuses on findings that were compiled from the literature to answer research question concerning the soil ES that are provided in Saxony. In section 5.2 I answer research question 1.b) regarding the property rights that currently exist in the district of Bautzen, Saxony. In both sections, findings from my qualitative data are analysed with respect to soil ES. Section 5.3 focuses to answer the second research question about natural, economic and legislative factors that farmers consider in using soils for crop production. Furthermore, the factors are linked to effects on soil ES to answer research question 2. a).

5.1 Ecosystem services in Saxony

The following table, which is adopted from the CICES framework (Haines-Young and Potschin, 2013), shows a list of soil ES in Saxony. From the literature and from my interviews I identified the relevant ones for my thesis. The CICES framework is split up into three parts: Provisioning, Regulation & Maintenance, and Cultural services.

Table 3: List of soil ecosystem services in Saxony

Section	Division	Group	Examples of soil ecosystem services in Saxony
Provisioning	Nutrition	Biomass	Crop, fruit and vegetable production F1 to F9 (see Appendix B); Livestock production: 504,315 cattle (SMUL, 2015) Wild animals and plants: Natura 2000 sites for Eurasian jay and Eurasian wildcat (Bastian, 2013)
		Water	N/A
	Materials	Biomass, Fibre	Fibres and other materials from plants, animals for direct use: Silage maize 79,220 ha (SMUL, 2015); Forests: 43,800 ha (Grunewald et al., 2014)
		Water	N/A
	Energy	Biomass-based energy sources	Fast growing timber for energy production: 243ha (SMUL, 2015);
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	N/A
		Mediation by ecosystems	2,500 km of tree lines are required along water body for improved water filtration (Grunewald et al., 2014)
	Mediation of flows	Mass flows	Potential soil loss reduction of 1,156 $t*a^{-1}$ through Greening II (Frank et al., 2014)
		Liquid flows	21,300 ha of arable land should be abandoned for flood protection (Grunewald et al., 2014)
		Gaseous / air flows	N/A
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance	Wild bees distance between agricultural land and potential nesting habitat increased since 1964 (Lautenbach et al., 2011)
		Pest control	Pest control through crop rotations in study area of 4,800 km^2 around Dresden (Lorenz et al., 2013)
		Soil formation and composition	N/A
		Water conditions	N/A
		Climate regulation	2.9 K decrease of temperature for vegetated soil as land cover in Leipzig (Haase et al., 2014)
Cultural	Physical and intellectual interactions with ecosystems	Physical and experiential interactions	Bird watching (agricultural land as breeding ground): Lark (Lerche), Northern Lapwing (Kiebitz) (F6)

		Intellectual and representational interactions	32 citations in Scopus database (own research)
	Spiritual, symbolic	Spiritual and/or emblematic	N/A
		Other	N/A

5.2 The property rights status of nine farms in the district of Bautzen, Saxony

In my case study, I identified the following ownership situations of nine farms: one farmer (F1) is a private landowner and the other eight interviewees (F2 to F9) hold land in a common property regime. That means that access control, withdrawal, management and exclusion rights to land lie with the private and joint owners respectively (Guerin, 2003).

Key topics identified in interviews. The following three key topics emerged from my qualitative analysis: leased land, soil sealing, and permanent grassland. These key topics were identified because they represent potential threats to soil ES and property rights. Eight out of nine farmers mentioned these topics. In one interview none of these topics emerged.

Leased land. This finding represents a special arrangement of property ownership where farmers own agricultural land for a limited time. There are implications for soil natural capital as F2 exemplified by stating "You want to farm on it, you cannot deteriorate [the soil]. Unless you know your lease contract is only valid for another three years, then you do not bring out lime anymore, then you actually do not do anything anymore." This statement suggests that the general intention of farmers is to maintain soil fertility, but when a lease contract approaches expiration, less efforts for soil maintenance are carried out.

During the lease, farmers have to ensure best practise guidelines, which are basic standards safeguarded by civil law in Germany (F1). "Experiences tell me that most landlords are not interested. They do not care." (F1). F1 indicates that there are few limiting factors in how farmers can use soils; regulations such as best practise guidelines exist but are rarely monitored or enforced. Even before a lease contract is signed no one checks the state of nutrients in the soil: "Not a bit! Not at all, nothing. Nothing! Nietschevo!" (F4). The only variable that counts is the price per ha (F4). As a result, there is no need to maintain the soil, perform drainage or keep a fertiliser balance (F4). Compliance with best practise guidelines is central to the maintenance and protection of soil ES because they dictate precautionary measurements towards soil compaction, soil erosion and the preservation of humus content (Brandhuber et al., 2015).

A farmer with secure property rights is more likely to keep short-term productivity and long lasting natural capital value in equilibrium; therefore reinforcing the soils ability to maintain a flow of ES (Foudi, 2012). F1 claims that a minimum level of soil fertility is maintained on leased land. It would be a different story if this land was privately owned; then, grandchildren would at least benefit [from investments in soil fertility]. F1 proceeded to say that alienation of land from private property resembles a massive problem in soil use. This was already a problem in the German Democratic Republic where the agricultural cooperatives did not care (direct quote: "did not give a crap") about soils because they were not the owner (F1).

Soil sealing. This was identified as a threat to soil ES in the event of agricultural land being bought for infrastructure projects or urban developments. The consequence of soil sealing is the diminished provision of soil ES. When on the topic of land ownership, interviewees identified the purchasing of agricultural land by external stakeholders as a major trend. Therefore, in these cases the purpose of agricultural land is changed to a non-agricultural use (F1, F6, F7, F8, and F9). This land use change includes road constructions, development of business parks, and the expansion of the national electricity grid (F7, F8, and F9), which leads to more agricultural land disappearing in Germany (F6, F9). Farmers cannot sell their land freely; they require permission and valuation from authorities before doing so (F1). Farmers that intend to buy land have priority but are restricted by high prices. F1 added that there are strict regulations related to land use change, for example changing agricultural land to land used for industry. Though, farmers could be outbid and lose land for agricultural production (Pingen and Huesmann, 2015). F7 describes leaseholds as "[…] a real fight", which is currently dominated by increasing prices. Prices are dictated by soil quality[3] and soil value (F7, F9).

Permanent grassland. Another emergent topic in the interviews relates to the banned conversion of permanent grassland under the EU's Greening regulations. It is important to mention this because it represents an intervention into property rights to force an environmental policy for which farmers are entitled to compensation (Bromley and Hodge, 1990; Haddad, 2003). F1 and F6 gave the following example; cropland that has been uncultivated for more than five years cannot be reconverted back to

[3] Soils ability to meet three components: crop and animal health, bio-production, environmental quality (Karlen et al., 1997).

cropland. According to F6 this is problematic because "These [fields for fodder production] are suddenly declared as permanent grassland and now they cannot be converted into arable fields even though it says that they are arable fields in the land register." For provisioning soil ES this represents a negative trend because no production of crops (expect fodder production) takes place despite that fact that it could be beneficial for some regulating ES.

5.3 Factors that influence interviewees (I=9)

The following results highlight the pressures that farmers face in the way they utilise soil natural capital. For further discussion, I will link key findings from my interviews to soil ES.

5.3.1 Natural factors

I found that there are four dominant natural factors that influence farmers in how they cultivate crops as shown in figure 5, mainly crop rotation, soil value, topography and climate.

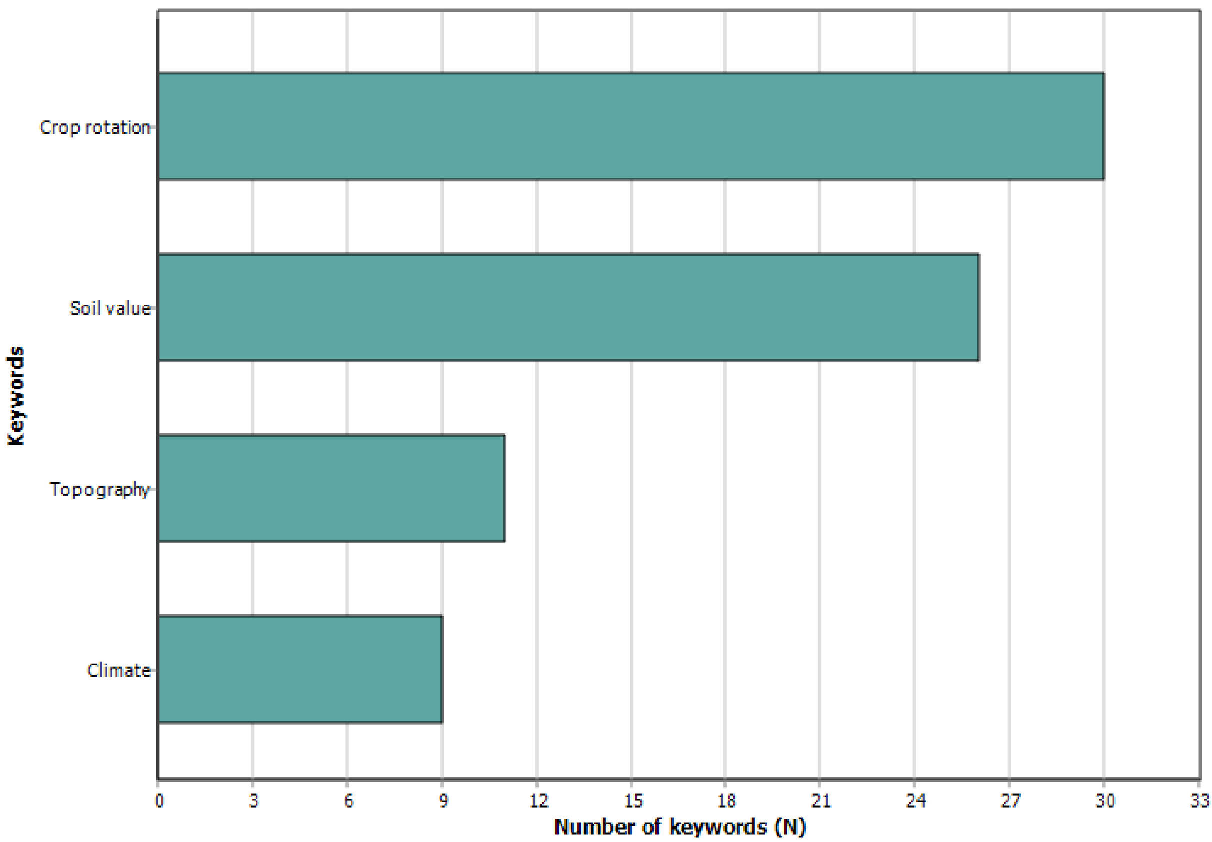

Fig. 5: Count of the four keywords for natural factors mentioned by interviewees (I=9)

Crop rotation. All interviewed farmers discussed crop rotation; six out of nine mentioned it with reference to natural considerations. F1 suggested that from a profitability point of view, "I should only cultivate those three crops [winter oilseed rape, winter barley, and winter wheat], what I also did over many years, but then I reached biophysical boundaries". These natural boundaries were not specified, but F3 mentioned fungi and excessive weed occurrence, F2 specified Fusarium fungi and "Schwarzbeinigkeit[4]" in cases where excessive crop rotations are used.

However, economic considerations were a dominant factor in how a farmer plans crop rotations as highlighted by this quote from F7: "The crop rotation is based on how I can sell, how I can market it. That also plays an important part in it." Similarly, "crop rotations have become one-sided, due to economic backgrounds" (F8). F1 emphasised "excesses" in maize monocultures for biogas plants. Regardless of the natural boundaries, it is possible to adapt crop rotations to a farmer's needs. F3 identified several modern crop protection products that can help to manage fungi and plant pests. He or she followed up with, "there are many nice crops that one can cultivate […] though as long as no one pays for these then they are not being cultivated." (F8). F8 demonstrated with the example of a nitrogen-fixing plant an economic consideration: "Phacelia fields look nice but no one in society pays for them." (F8). One interviewed farmer elaborated further by claiming that "one could do a lot differently in crop rotations, but it has to be economical in the end" (F9). This highlights trade-offs between economic returns for provisioning services and ecological measures to maintain soil ES.

Technological advances to surpass biophysical boundaries with the use of inorganic fertiliser and pest control. Earth worms for example, which serve as natural indicator for soil quality and soil pollution levels can be impacted (SOILSERVICE, 2012).

The mentioned monocultures affect cultural services like sense of place, and provisioning services like drinking water from groundwater sources because of their comparatively high inputs of fertiliser (Haines-Young and Potschin, 2013; Orgiazzi et al., 2016).

Soil value. Soil value refers to soil fertility which is based on nutrient cycling and soil organic matter; which are linked to regulation & maintenance and provisioning services (Haines-Young and Potschin, 2013). Soil values (I=8/9) for the farms that I visited ranged from 20 to 70. "One says that above a soil value of 30 wheat can be cultivated" (F3) and 48 is "the average value for Saxony" (F8). "Depending on the soil value a range of plants can be cultivated or cannot be cultivated." (F3, F6, F7) and "From the

[4] Pectobacterium carotovorum

natural location here, we are a weak location with a soil value of around 35; that means that rapeseed and wheat do not grow everywhere [on our fields].” (F6).

Topography. The third most occurring theme is *Topography,* having been mentioned by seven out of nine farmers. There are clear local disparities with regards to topography; F4 has 80 percent of their farmland in an undulating landscape and some lands are completely flat (F2, F3, F6, and F9). Topography plays an important role in farming according to F8, whereas for F4 “It does not influence it [soil use].” The topography is an aspect for farms that are affected by erosion because it determines the suitable tillage practices that can be used (F6, F9). More details are given by Brandhuber et al. (2015), who exemplify that best practice guidelines comply with the German Soil Protection Act. This Act states that any damaging structural changes to soils are to be avoided, thus stressing the maintenance of physical biological conditions (Brandhuber et al., 2015).

Climate. Climate-related statements were mentioned by five out of nine farmers. For instance, F5 and F6 considered pre-summer droughts problematic as they occur during the main growth phase of winter wheat crops and rapeseed. Climate change is one of the most potent risks to farmers today, with severe impacts such as higher temperatures, droughts and infrequent rainfall (Cong et al., 2014). These risks affect provisioning and regulating ES because they can change soil nutrient dynamics and soil biodiversity (SOILSERVICE, 2012).

Erosion (I=6/9): Interviewees identified soil erosion and associated impacts as common problems. Six out of nine farmers mentioned erosion; a total count is presented in figure 6 (p. 35).

“It is in one’s interest that the soil stays where it is. Such an agricultural pit has a certain value.” (F8). F7, F8, and F9 described using farming practices (no-plough tillage) that reduce soil erosion. In fact, farmers “risk a part of their subsidies” (F6) when they do not comply with erosion regulations by the EU. The negative impact of erosion is compounded when fertilisers and other chemicals, together with the soil are washed into rivers and streams and cause water pollution (F3) (Orgiazzi et al., 2016).

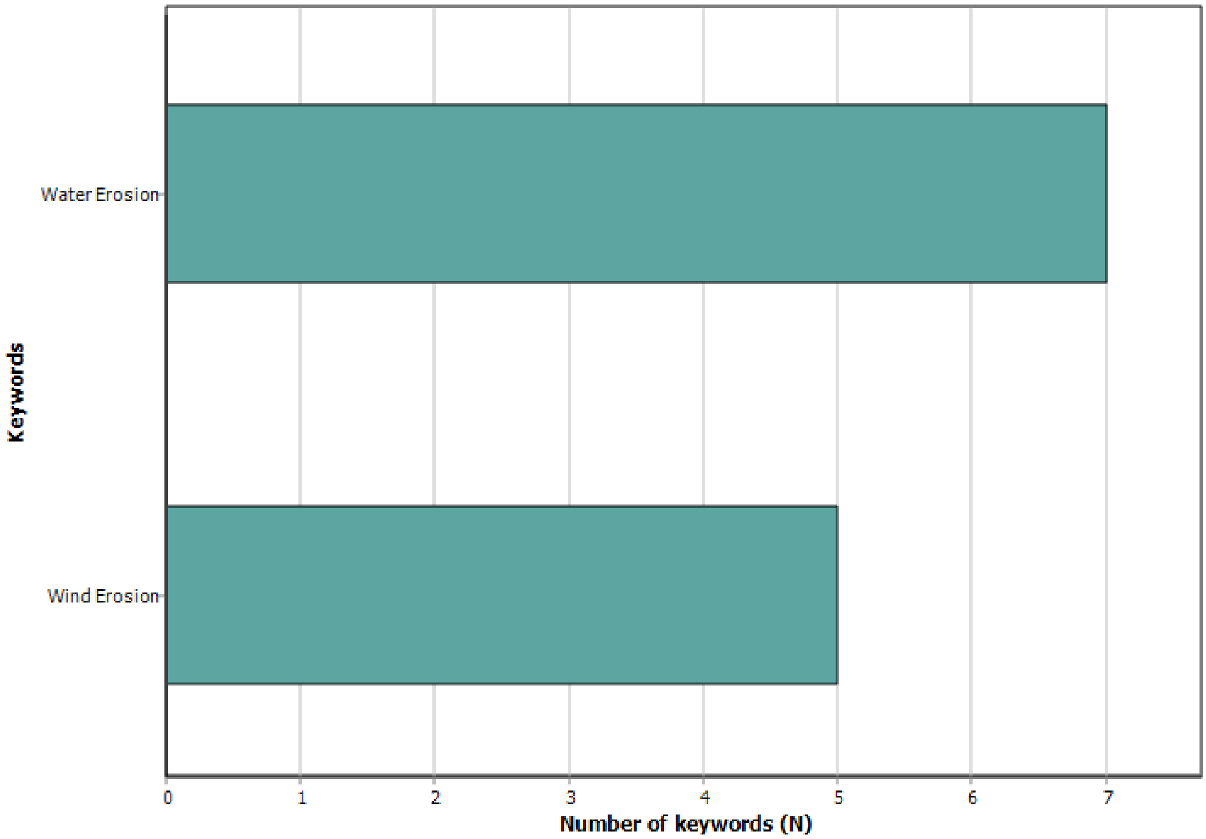

Fig. 6: Count of keywords for soil erosion mentioned by interviewees (I=9)

Alternative crop production (I=7/9): Seven out of nine farmers have considered alternative crop production. These findings give an interesting non-representative indication that farmers would prefer to cultivate crops that fit better with the natural conditions of their farmland. By doing so, impacts in soil natural capital would reduce in turn increasing the capacity to provide a flow of services (e.g. atmospheric gas regulation) and goods (cash crops). F6 stated “I would prefer to cultivate rye because it better fits the location compared to barley and wheat” but “[…] there is no big world market for rye.” and “rye prices are unattractive” (F6). Limiting factors to other crops are soil type, soil value, precipitation and resulting yield risks and risks to profitability (F5, F6, and F8).

5.3.2 Economic Factors

During the interview, economic factors were the major concern for interviewees; from my observations, these factors raised the tension during the interviews the most. My analysis revealed the following economic factors presented in figure 7. *Contribution margin*[5] was mentioned by all farmers; *profitability* by seven out of nine interviewees, and *Market access* by five out of nine interviewees.

According to F1, the contribution margin for different crops is “the crucial variable” (F 1). A specific return has to be achieved and “That is only possible with certain crops” (F 1); sugar beet is the crop with highest returns, next is rapeseed which “at best achieves a third of the profit of sugar beet[6]” (F 3). Rapeseed is still among the most profitable and widely traded crops in the area (F 8). Two farmers commented that the market price for peas and nitrogen-fixing crops like lupine is unattractive, making these crops useless for cultivation (F1, F3). Not all contribution margins reflect the actual situation of financial return for crops at the market, as the CAP financially rewards farmers that diversify their crops. One example is the previously mentioned catch crop Phacelia, which improves soil structure, reduces erosion and input at farms and therefore conserves biodiversity (Glæsner et al., 2014).

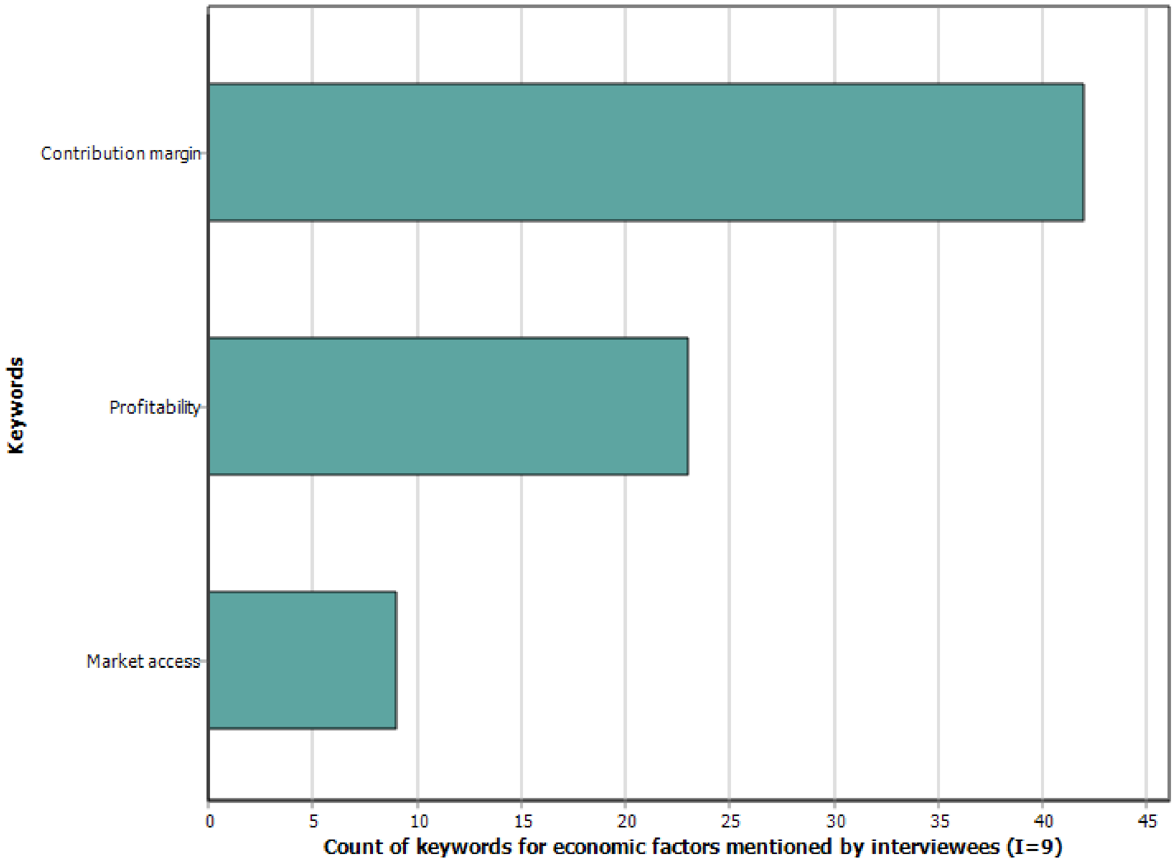

Fig. 7: Count of keywords for economic factors mentioned by interviewees (I=9)

[5] Contribution margin: revenue – variable costs (F1)
[6] The sugar beet quota runs until September 30th, 2017 (European Commission, 2015d)

Profitability. Profitability solely focuses on maximising provisioning soil ES and was expected as a result; similar to Robinson et al. (2013) findings, intermediate services are unnoticed because of the focus on final services like crop production. *Profitability* is the second most significant economic factor. Daily business operations are shaped by profitability, which "[It] is vital and decisive" (F1). About contribution margins and with profitability in mind, F1 and F4 said they would only grow three crops in an optimal crop rotation to achieve maximum profitability. Then, F3 specified that without EU direct payments, they would have to close their business and "There is not one year where we would have made a profit [without subsidies]." (F3). F9 acknowledged that an orientation solely on the profitability of crop production impacts soils; what drives soil management is "To be precise, with the situation in the market economy, one can almost say that compliance with best practise guidelines is left behind compared to the financial result" (F 9). "Nowadays, it is partly an overexploitation" (F 9) of soil resources.

Market access. The third most dominant theme *Market access* is influenced by some options for how farms can trade their produce. The trade of energy crops to biogas plants is common and impacts the supply of ES; Lupp et al. (2015) mention that a higher input of fertilisers for energy crops negatively affects groundwater because of the permeable surface layer of the sandy soils in the study area. The fertiliser input risks endangered species in the area (Lupp et al., 2015). Seven out of nine farms mentioned that they either: 1) have access to a biogas plant on-site, 2) markets for crop produce or 3) access to biogas plants close by where they can market manure produced by cows from their farms.

5.3.3 Legislative Factors

The most common key policies that were mentioned were *Greening*, *Nitrates Directive* and *Cross Compliance* (figure 8, p. 38); all interviewees mentioned these policies. Additionally, *Direct Payments* was mentioned by 7 out of 9 interviewees. For instance, F1 pointed to a high number of regulations regarding crop rotation and fertilising:

"It [the soil] is not very well protected from malpractices I would say. If a farmer does not have the capabilities or the interest to do it [properly] then he is not obliged to treat [soil] well. There are regulations for crop rotation, regulations for fertilising, but that does not guarantee in any way that he treats his soils correctly." (F1).

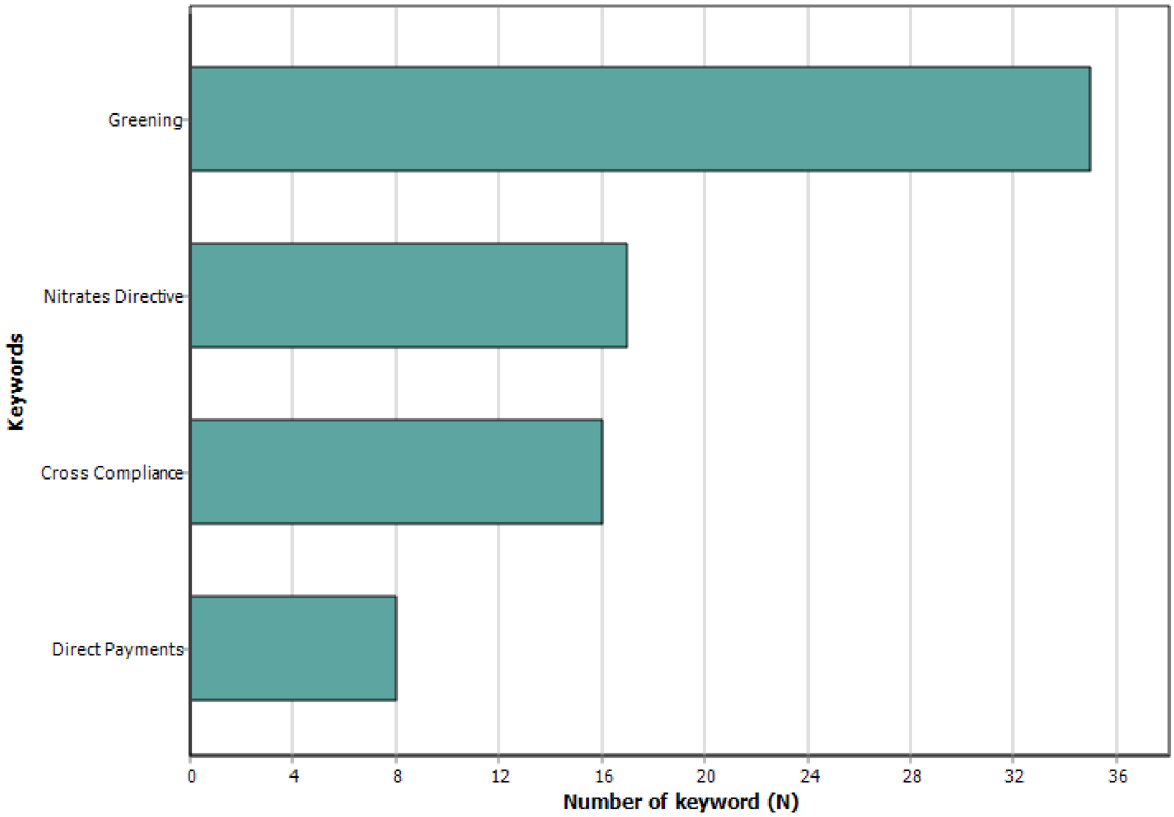

Fig. 8: Count of keywords for legislative factors mentioned by interviewees (I=9)

Greening[7] (I=8/9)**.** Greening has positive effects for soil ES: the establishment of ecological focus areas and permanent grassland are both beneficial to soil ES (SMUL, 2015). In Germany, permanent grassland is declared as Flora-Fauna-Habitat-Area[8], which are protected habitats for several species of wild animals. They serve as areas for the maintenance of biological conditions, and for bird watching (BMEL, 2015; Haines-Young and Potschin, 2013). Hence, they contribute to all three categories of soil-based ES.

"Specifically with the Greening last year, I think that led to many changes in the cultivation structure." (F4, F6). Buffer strips were set up or catch crops and legumes were cultivated (F6). Further, F2 and F8 identified catch crops as a Greening measure at their farms; "then we had peas and lupine as catch crops." Buffer strips not only reduce runoff from fields and increase biodiversity in adjacent fields, but they also take land away from crop cultivation and therefore affect provisioning services (Posthumus et al., 2011). Legumes, like peas, fix nitrogen and reduce the need for mineral nitrogen fertilisers, which

[7] If Greening was not directly mentioned then I looked for proxies that are related to or are synonyms of Greening. These were ecological focus area, crop diversification and permanent grassland.
[8] Flora-Fauna-Habitat-Gebiete (FFH-Gebieten)

reduces the greenhouse gas output during fertiliser production; hence they provide climate regulation (Müller, 2015).

Greening measures are financially supported and checked by authorities on-site to ensure that farmers comply with Greening measures (F8). Greening and direct payments are linked; if a farmer applies for one, he or she will apply for the other. "I could say I only apply for direct payments and do without Greening. Unlikely, no one will do that. Most will take along the Greening." (F6). Statistically, in 2015, farms that applied for basic payments also applied for Greening compensation (BMEL, 2015)

Some trade-offs were mentioned during the interviews with respect to Greening. Nitrogen-fixing crops can pose a challenge when they have to be incorporated into crop rotations. "If we do catch crops with lupine and peas, then I cannot put peas as main crop because I cannot keep the 4 to 5 years cultivation break[9].

Fallow land under Greening means that no added value on agricultural land is created. "If I do not cultivate areas then I am not going to make a profit during that time, only subsidies. If I cultivate peas, that are a catastrophe for contribution margins point of view, then I could also cultivate wheat." (F8). Farms in the area of the Lommatzscher Pflege are not interested in leaving their land fallow. They lease land in areas with poor soil quality and allow that land to stay fallow and continue to produce on their good soils. "Greening has good intentions but then in some regions, no agricultural added value is created, this land is not cultivated but in the Lommatzscher Pflege even more is produced."; "This is a consequence of Greening" (F8).

Nitrates Directive (I=9/9). The Nitrates Directive and CAP are the only policies that refer to and aim to restrict water pollution caused by agricultural activity. The directive includes buffer strips that can mediate flows and relate to regulation and maintenance ES (Glæsner et al., 2014; Haines-Young and Potschin, 2013). There are restrictions for fertiliser application when fields are situated in drinking water protection areas (F2) For example, if one applies fertiliser too close to water bodies then they will incur fines and a reduction in subsidies (F6).

Cross-compliance (I=7/9). Cross-compliance represents a minimum standard for agricultural practices and is a policy tool where farmers receive payments if they comply with minimal environmental rules (Meyer et al., 2014). That can be valuable for soil ES such as soil formation and water conditions

[9] Cultivation break: Time in a crop rotation when a certain crop cannot be cultivated, because it could cause fungi or bacterial diseases in crops (F2).

because Cross-compliance prevents damage from unsuitable farming practices, limits fertilisation and protects biodiversity (European Commission, 2015c; Posthumus et al., 2011).

According to F1, no one can really translate the meaning of Cross-compliance and he goes on to say "I would call it a little bit of a token." (F1). F1 sums up by stating that farmers have to comply with environmental regulations to receive direct-payments; this is further supported by F3 "[we] are forced by EU directives to realise a decent cultivation." The standards for Cross-compliance are minimal because farmers can easily cover soils all year round. No one in politics has to financially support that but this [Cross-compliance] causes excesses [in paper work]." (F8).

6 Discussion

6.1 Property rights of soil ecosystem services

To address my first research question regarding the extent to which farmers can claim property rights and appropriate ES provided by their lands, I researched property rights in Saxony.

I argue that farmers cannot claim property rights to all soil ES under the current property rights regime. For the following discussion I use the theory of property (Locke, 1980) and my findings presented in table 3 (section 5.1). The three categories: provisioning, regulation & maintenance and cultural services from the CICES framework now form the basis of my discussion in this section.

I argue that based on the conditions set out in section 2.2: to mix labour with natural goods, no goods are allowed to decay and there should be enough left for others, that farmers cannot justify a full appropriation of soil ES from their lands (never mind the acquisition of land in the first place).

Consider the first condition. To mix one's labour with natural resources, Mossoff (2012) identified that Locke speaks of "concrete labour" (p. 290) in the Second Treatise of Government. Consequently, a justification to acquire property rights to soil ES is complicated because one would have to be able to quantify the amount of labour regarding ploughing and fertilising. Then one could calculate the share of labour relative to an overall value that is being produced at a farm and in the soil (Mossoff, 2012). A quantification of the relative application of labour might be possible with hours of work input or litres of fertilisers used, but a quantification of the total value of labour from soil natural capital is simply not feasible.

To be more precise, it is challenging to determine the extent to which property rights can be claimed because Locke's theory only slightly applies to ES because it is a relatively new concept (Haddad, 2003).

For Locke, nature was there for the taking and human labour presented the majority of the work to make nature's goods and services accessible to human well-being (Blanco and Razzaque, 2009; Haddad, 2003). Contemporary knowledge about the earth's systems contradicts Locke's view (Costanza, 2015). Essentially, human labour presents a minor share in the final energy flux of the production of goods and services such as nutrient cycling, pollination and the production of biomass (Haddad, 2003).

6.1.1 Property rights for provisioning services

I could argue in favour of farmers for a right to the appropriation of some provisioning services such as cultivated crops and reared animals. In doing so, I want to refer to Lockean conditions: a farmer can mix his or her labour with the natural good soil by seeding and ploughing the ground; he or she would not spoil anything because of modern techniques in storage and transport; there are still enough soil ES left for others, and if not then one is still free to sell his or her labour (Locke, 1980). All three conditions can be met and of course, farmers do own the crops, fruits and vegetables that they harvest (see Appendix B). In an economic sense, they are rival and excludable. The same conditions though are not true for wild plants because here, no labour is applied.

Though, the first condition is not necessarily met when farmers apply modern machinery for example. Alienation from nature has progressed to a level where we cannot justify the appropriation of provisioning ES based on Lockean theory of property (Dickens, 2002; Locke, 1980). This would especially apply to farms F2 to F9 because they use paid labour at their companies. Hence the property rights holders are further alienated from soil ES.

Intensive agriculture causes soil compaction, loss of soil biodiversity and nutrient runoff which threatens soils and the underlying processes that provide soil ES (SOILSERVICE, 2012). This is contrary to Locke (1980), who allows the harvest of natural goods as long as the processes providing the harvest are not degraded (Haddad, 2003). The farms in my case study are conventional agricultural companies (table 2, p. 25). Hence their impacts are higher compared to for example organic farms (e.g. less fertilisation) and therefore their claim to appropriate ES falls with their bigger impact on soil natural capital.

6.1.2 Property rights for regulation & maintenance soil ecosystem services

A focus on this category is very important because the MEA (2005) shows that some regulating soil ES, in particular nonmarketable ES provided by natural capital are degrading more than provisioning services that are marketable (Lant et al., 2008).

For regulating soil ES, little or no labour has been applied to generate for example nutrient or carbon cycling and biological population regulation. The sheer complexity of soil ecosystems represents a central obstacle in judging the application of labour. It is almost impossible to define systems boundaries of regulating services or to separate them without loss of functionality (Haddad, 2003; Kosoy and Corbera, 2010; Vatn, 2007).

To be able to justify rights to the appropriation of regulating soil ES, farmers would have to apply labour to three major ecosystem functions (see figure 1, p. 14). If we break this further down, they would need to mix labour with natural capital in the form of soil biota, which is responsible for the generation and maintenance of ecosystem functions (see figure 1, p. 14). It is not possible to measure and quantify ecosystem functions and as Kosoy and Corbera (2010) rightly point out, it is expensive, ambiguous and only guided by the interest of "market regulatory agents" (p. 1231). Hence, if soil ES enter the market then they do not necessarily fare better than non-excludable public ES.

Philosophically speaking, without the comprehensive application of labour to the required ecosystem functions, no claims to property can be made based on Lockean theory of property (Locke, 1980). Scholars like Farley (2012) further argue that an allocation of private or common property rights can create more problems because it is simply not possible to delineate property rights for some regulating services.

Writing in the journal Biological Conservation, Mathews (2016) suggests that by taking a bio centric view, one can argue based on the conditions set out by Locke in favour of the biosphere to have their right to property in the form of land and goods. Animals have long before mankind been mixing their labour with nature. Hence humans do not have the right to interfere with their environment (Mathews, 2016). Mathews (2016) refutes Locke's claim that God gave the earth to all people in common (Locke, 1980). Hence he excludes wildlife from the right to ownership.

There is an argument in favour of farmers claiming ownership to some regulatory services. Farmers could invest labour and money into some regulatory services as described by Grunewald et al. (2014), such as providing the 2,500 km of tree lines required along water bodies for improved water quality, or voluntarily abandoning parts of farmland to meet the need for 21,300 ha for flood protection (see table 3, p. 29). This would certainly strengthen their argument in favour of justifying the status quo of private property towards their crop production. Farmers already carry out measures like are a diversification of crop rotations under Greening which contributes to the reduction of erosion by 1,156 t*a-1 (Frank et al., 2014).

6.1.3 Property rights for cultural soil ecosystem services

Cultural services such as aesthetics, landscapes and symbolic interactions require built, human, and social capital (Costanza, 2015; Haines-Young and Potschin, 2013). To assign property rights to the different types of capital that provide cultural services is possible but it seems impossible to define property rights to cultural soil ES based on Locke (1980) because no labour is mixed in the process of the provision of these services.

As a result of my argumentation I want reiterate that Locke's theory (Locke, 1980) does not justify to change the property rights regime of all soil ES from public goods to private goods. Therefore, agriculture cannot be excluded from regulations by legal and political institutions. Even more so, we must question the status quo where farmers have the right to extract provisioning services to maximise their profits by placing environmental costs, so-called negative externalities on society. Farmers defend their right to private land ownership and the right to benefit from soil ES based on historical grounds (Helfrich, 2009), even though the current property rights regime does not support the sustainable use of soil ES in the long term (SOILSERVICE, 2012).

The current property rights regime does not support an equal distribution of natural resources. Individuals have already acquired land based on the historic grounds of the theory of labour (Locke, 1980). Hence it is not possible for later generations to mix their labour with private land or private resources because these resources are rival and excludable (Trachtenberg, 2014). Governmental institutions protect individual property rights of farmers and only slowly adjust these property rights based on environmental needs (Meyer et al., 2014).

6.2 Property rights of land leads to trade-offs in soil ecosystem services

The main findings of my qualitative analysis in the district of Bautzen (section 5.2) revealed three key topics with respect to the current property rights regime of agricultural land and soil ES: leased land, soil sealing and permanent grassland. Permanent grassland is discussed as part of Greening in section 6.3. My findings in section 5.2 about the ownership situation of the 9 farmers that I interviewed give little information to the property rights regime of their soil ES. Instead I identified deficiencies and threats in the property rights regime of land, which has implications for soil ES as discussed in the following. Leased land and soil sealing present a change to already existing property rights and do not establish new property rights of formerly public property (Lai et al., 2015).

6.2.1 Leased Land

The first deficiency occurs between an owner and a tenant of land. F2 told me that towards the end of a lease contract, he or she does not "do anything anymore". This exemplifies that farmers do not always have secure private property rights, which leads to less investments into soil maintenance. To set a minimum standard in soil cultivation and protection, the government sets out best practice guidelines but these are not monitored (F1). Hence, the incentive to maintain soil fertility in a good state is further reduced because it is not monitored. It is further reduced because the next leaseholder would reap benefits from for example fertilisation or a previous reduction of soil compaction when lease contracts come to an end. The farmers (F1 to F9) primary concern is a high return for their labour exemplified by economic factors contribution margin (I=9/9) and profitability (I=7/9) (section 5.3.2). During interviews, farmers only expressed concerns for economic factor which guide their actions but they did not express a deep understanding and concern for underlying soil ES. A recent study from Foudi (2012) found similar results. A farmer that leases land is more likely to overexploit soil natural capital and remain uninterested in the state of the land and therefore its value in the future. On the contrary, a farmer with private property has a vested interest in maintaining the value of the soil. Leased land causes a trade-off between a short-term maximisation of provisioning services and a long-term degradation of regulatory services. F1 supports that claim by suggesting that if land was privately owned then his or her grandchildren would benefit from investments into soil fertility. Hence, the question of land ownership is important for the protection of all soil ES (Foudi, 2012; Pingen and Huesmann, 2015).

Leased land also falls under the total area of a farm and is part of the subsidy calculations under the CAP (F8), but is somewhat of a grey area for land ownership, as farmers that lease do not represent the owner of that land. Problems arise when wealthy farmers (Lommatzscher Pflege) lease land, leave it fallow and instead overexploit their good soils thereby degrading regulating soil ES. This represents a loophole in the current policies, which has negative consequences for regulating soil ES even though some provisioning services are enhanced, usually in areas with high soil fertility and therefore high soil carbon content (SOILSERVICE, 2012). Thus, these actions contribute to greenhouse gas emissions and therefore accelerate climate change (SOILSERVICE, 2012).

6.2.2 Soil sealing

Soil sealing is a negative trend caused by agricultural land being converted into infrastructure and urban developments. Thus this land is essentially lost for agricultural production. It caused negative outlooks with interviewees who feared for their source of income (F1, F6, F7, F8, and F9). Agricultural soils are highly profitable assets that can be misused for property speculations (Helfrich, 2009), which drives the price of land up (Pingen and Huesmann, 2015). The right of farmers to speculate with the value of their agricultural land is controversial because it represents the most important form of property (Trachtenberg, 2014) because soils form the basis for food security (Orgiazzi et al., 2016; Schulte et al., 2014). According to Glæsner et al. (2014), soil sealing is among the main pressures that cause soil degradation and hinder the flow of ES; for Western Lusatia which is part of the study area, Bastian (2000) identified that groundwater recharge in particular is negatively affected by soil sealing. Essentially, it is urbanisation that causes the loss of all soil functions, which is currently not addressed by policies on an EU level (Glæsner et al., 2014). There are clearly negative implications for soil ES from soil sealing and a change of private ownership of land.

6.3 *The Taking Issue* – the status quo in EU agricultural policy

Based on my findings in section 5.3, I can show that: first, farmers are paid financial incentives to use soil in a socially and environmentally friendly manner (Greening) and second, governments impose regulations on farmers (Cross-compliance, Nitrates Directive, Water Directive, best practice guidelines). These findings reflect "The Taking Issue" (p. 304): a conflict of interest between private landowners and the public (Krueckeberg, 1995).

Greening exemplifies policies on a European level that aim to reduce soil ES degradation and maintain agricultural production; thereby, it interferes with the property rights of farmers (Meyer et al., 2014). Based on the answers given in the interview, Greening is mentioned the most by interviewees (I=8/9). This could partially be explained by the fact that it was just recently added to the CAP and it represents a large contribution to their subsidies. If a farmer carries out Greening measure, he or she receives 87.34 EUR per ha in addition to the 188 EUR per ha they receive in basic payments (SMUL, 2015). These payments are important with respect to the need of farmers (I=9) to operate their farms profitably (section 5.3.2). F6 suggested that farmers who receive basic payments will also carry out Greening measures, in Saxony that applies to 7,397 farmers in 2015 (SMUL, 2015). Hence the cultivation structure at the farms (I=9) and the environmentally beneficial measures that they carry out are heavily influenced by their need for profits in the form of CAP subsidies. As a consequence, farmers do not have the freedom to cultivate what they think is right, given the natural conditions of their area: soil value (soil fertility), topography and climate (see section 5.3.1). This undermines their knowledge about environmental impacts that certain ways of cultivation may cause. Farmer's need the freedom to cultivate what they think is right, and governmental support should be there for environmentally friendly cultivation if needed (Helfrich, 2009). Helfrich (2009) and Powlson et al. (2011) also argue for transparent decision-making and communication, which is a big problem according to F6 and F8. The terminology in hand books from the Federal Ministry of Agriculture (BMEL, 2015) is foreign to the language used by a farmer. Hence, important information as to why a policy like Greening is implemented is lost.

Greening focuses on environmental improvements and this is evident by interviewees F4 and F6 who state that it changed the cultivation structures. Cong et al. (2014), Koschke et al. (2013), and Lorenz et al. (2013) argue in favour of a diverse cultivation structures because it improves pest control, regulates drought risks and soil organic carbon management, which reduces the risk of climate change and susceptibility to energy price shocks. Hence, the environmentally beneficial measures under the CAP (Greening and Cross-compliance), which are financially supported by the public contribute to a level of soil ES conservation.

My findings are case specific to Saxony but the policies apply to every farmer and cover soil ES on a European level because every country has to implement them. This can be beneficial because soil ES do not follow state boundaries (Birkhofer et al., 2015; Costanza, 2015). On a pan-European level the establishment of commonly managed trusts that are given property rights can also be an option to conserve soil ES (Birkhofer et al., 2015; Costanza, 2015). It also has the advantage that current property law would apply (Costanza, 2015). From there it would be possible to charge money for damages and use, it would even enable investments (Costanza, 2015).

6.4 Recommendation for further research

The study could be enhanced by focusing on specific soil ES to make it more tangible. I analysed based on the three categories used in CICES. A more narrow focus could also be beneficial because of the sheer complexity of ES. That way one could better link the effects that policies in my study have to soil ES. More questions regarding the concept of soil ES should be implemented into the questionnaire but that requires to make farmers aware of the concept in the first place. In my experience from the interviews, farmers were completely unaware of the concept.

7 Concluding Remarks

A lack of well-defined property rights of soil ES served as a starting point to my thesis. The argument of my thesis is structured using two research questions: first, to what extent can farmers claim property rights and appropriate soil ES provided by their lands? Second, which natural, economic and legislative factors do farmers in Saxony consider in using their soil for crop production?

Based on my study of farmers in Saxony, a Lockean theory to allocate property rights to soil ES, in particular regulating and cultural ES, does not seem justifiable. However, an appropriate property rights allocation always depends on individual cases. Ultimately, the optimal property rights situation for soil ES conservation will reflect what society deems as appropriate. The government, as facilitating institution, will further balance between the protection of private property rights of farmers and society's interest in soil ES conservation. My thesis is centred on Locke's considerations which are human-centric but the appreciation of existence, non-use, and bio centric values could enhance the debate by different perspectives (Haddad, 2003).

My thesis has shown the status quo in EU agricultural policy and its implications for soil ES and property rights. To achieve an enhanced conservation of soil ES, property rights will have to further evolve across various political and public levels and at various spatial scales.

8 References

Alvesson, M., Sköldberg, K., 2009. Reflexive methodology: new vistas for qualitative research. SAGE, Los Angeles; London.

Bastian, O., 2013. The role of biodiversity in supporting ecosystem services in Natura 2000 sites. Ecological Indicators 24, 12–22. doi:10.1016/j.ecolind.2012.05.016

Bastian, O., Syrbe, R.U., Rosenberg, M., Rahe, D., Grunewald, K., 2013. The five pillar EPPS framework for quantifying, mapping and managing ecosystem services. Ecosystem Services 4, 15–24. doi:10.1016/j.ecoser.2013.04.003

Baum, J., 2016. Bautzen [WWW Document]. URL http://www.postleitzahl.org/sachsen/bautzen/ (accessed 5.9.16).

Bennett, E.M., Cramer, W., Begossi, A., Cundill, G., Díaz, S., Egoh, B.N., Geijzendorffer, I.R., Krug, C.B., Lavorel, S., Lazos, E., Lebel, L., Martín-López, B., Meyfroidt, P., Mooney, H.A., Nel, J.L., Pascual, U., Payet, K., Harguindeguy, N.P., Peterson, G.D., Prieur-Richard, A.H., Reyers, B., Roebeling, P., Seppelt, R., Solan, M., Tschakert, P., Tscharntke, T., Turner, B.L., Verburg, P.H., Viglizzo, E.F., White, P.C.L., Woodward, G., 2015. Linking biodiversity, ecosystem services, and human well-being: three challenges for designing research for sustainability. Current Opinion in Environmental Sustainability 14, 76–85. doi:10.1016/j.cosust.2015.03.007

Birkhofer, K., Diehl, E., Andersson, J., Ekroos, J., Früh-Müller, A., Machnikowski, F., Mader, V.L., Nilsson, L., Sasaki, K., Rundlöf, M., Wolters, V., Smith, H.G., 2015. Ecosystem services - current challenges and opportunities for ecological research. Frontiers in Ecology and Evolution 2, 1–12. doi:10.3389/fevo.2014.00087

BMEL, 2015. Umsetzung der EU-Agrarreform in Deutschland. Berlin.

BMJV, 2016a. Grundgesetz für die Bundesrepublik Deutschland Art 14 [WWW Document]. Bundesministerium der Justiz und für Verbraucherschutz. URL https://www.gesetze-im-internet.de/gg/art_14.html (accessed 9.15.16).

BMJV, 2016b. § 905 Begrenzung des Eigentums [WWW Document]. Bürgerliches Gesetzbuch (BGB). URL http://www.gesetze-im-internet.de/bgb/__905.html (accessed 9.12.16).

Boyd, J., Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. Ecological Economics 63, 616–626. doi:10.1016/j.ecolecon.2007.01.002

Brandhuber, R., Breitschuh, T., Brunotte, J., Bug, J., Busch, M., Chappis, A., Fröba, N., Henke, W., Honecker, H., Höppner, F., List, M., Mosimann, T., Ortmeier, B., Schmidt, W., Schrader, S., Vorderbrügge, T., Weyer, T., 2015. Gute fachliche Praxis. Bodenbewirtschaftung und Bodenschutz. Bonn.

Bromley, D.W., Hodge, I.D., 1990. Private property rights and presumptive policy entitlements: reconsidering the premises of rural policy. European Review of Agricultural Economics 17, 197–214.

Burkhard, B., De Groot, R., Costanza, R., Seppelt, R., Jörgensen, S.E., Potschin, M., 2012. Solutions for sustaining natural capital and ecosystem services. Ecological Indicators 21, 1–6. doi:10.1016/j.ecolind.2012.03.008

Clark, W.C., Dickson, N.M., 2003. Sustainability science: the emerging research program. Proceedings of the National Academy of Sciences of the United States of America 100, 8059–8061. doi:10.1073/pnas.1231333100

Cong, R.G., Hedlund, K., Andersson, H., Brady, M., 2014. Managing soil natural capital: An effective strategy for mitigating future agricultural risks? Agricultural Systems 129, 30–39. doi:10.1016/j.agsy.2014.05.003

Costanza, R., 2015. Ecosystem services in theory and practice, in: Figgis, P., Mackey, B., Fitzsimons, J., Irving, J., Clarke, P. (Eds.), Valuing Nature. Protected Areas and Ecosystem Services. Australian

Committee for IUCN Inc., Sydney, pp. 6–15.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R. V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260. doi:10.1038/387253a0

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K., 2014. Changes in the global value of ecosystem services. Global Environmental Change 26, 152–158. doi:10.1016/j.gloenvcha.2014.04.002

Costanza, R., Folke, C., 1996. The Structure and Function of Ecological Systems in Relation to Property-Rights Regimes, in: Hanna, S., Folke, C., Mäler, K.-G. (Eds.), Rights to Nature. Ecological, Economic, Cultural, and Political Principles of Institutions for the Environment. Washington, DC.

Crutzen, P.J., 2002. Geology of mankind. Nature 415, 23. doi:10.1038/415023a

Daily, C.G., Alexander, S., Ehrlich, R.P., Goulder, L., Lubcheno, J., Matson, A.P., Mooney, A.H., Postel, S., Schneider, H.S., Tilman, D., Woodwell, M.G., 1997. Ecosystem Services: Benefits Supplied to Human Societies by Natural Ecosystems. Issues in Ecology 2, 1–16. doi:1092-8987

Daily, G.C., 2000. Management objectives for the protection of ecosystem services. Environmental Science & Policy 3, 333–339. doi:10.1016/S1462-9011(00)00102-7

Davidson, M.D., 2012. Distributive justice in the international regulation of global ecosystem services. Global Environmental Change 22, 852–861. doi:10.1016/j.gloenvcha.2012.06.004

De Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics 41, 393–408. doi:10.1016/S0921-8009(02)00089-7

Dickens, P., 2002. Reconstructing Nature. International Library of Sociology, New York.

D-Maps, 2016. Saxony/Sachsen [WWW Document]. URL http://d-maps.com/carte.php?num_car=6436&lang=en (accessed 5.9.16).

Dominati, E., Patterson, M., Mackay, A., 2010. A framework for classifying and quantifying the natural capital and ecosystem services of soils. Ecological Economics 69, 1858–1868. doi:10.1016/j.ecolecon.2010.05.002

Donaldson, J.S., Town, C., Africa, S., 2014. Pollination ecosystem services in South African agricultural systems 110, 1–9.

European Commission, 2015a. Soil [WWW Document]. URL http://ec.europa.eu/environment/soil/index_en.htm (accessed 5.6.16).

European Commission, 2015b. Direct aids schemes [WWW Document]. URL http://ec.europa.eu/agriculture/direct-support/direct-payments/docs/direct-payments-schemes_en.pdf

European Commission, 2015c. Cross-compliance [WWW Document]. URL http://ec.europa.eu/agriculture/direct-support/cross-compliance/index_en.htm (accessed 5.6.16).

European Commission, 2015d. Sugar [WWW Document]. URL http://ec.europa.eu/agriculture/sugar/index_en.htm (accessed 5.6.16).

European Commission, 2011. EU regulation COM(2011) 625 final [WWW Document]. URL http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011PC0625&from=EN (accessed 5.6.16).

European Commission, 2000. Council Directive 2000/60/EC [WWW Document]. URL http://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF (accessed 5.6.16).

European Commission, 1991. Council Directive 91/676/ECC [WWW Document]. URL http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31991L0676&from=EN (accessed 5.5.16).

Farley, J., 2012. Ecosystem services: The economics debate. Ecosystem Services 1, 40–49. doi:10.1016/j.ecoser.2012.07.002

Farley, J., Costanza, R., 2010. Payments for ecosystem services: From local to global. Ecological Economics 69, 2060–2068. doi:10.1016/j.ecolecon.2010.06.010

Foudi, S., 2012. The role of farmers' property rights in soil ecosystem services conservation. Ecological Economics 83, 90–96. doi:10.1016/j.ecolecon.2012.08.015

Frank, S., Fürst, C., Witt, A., Koschke, L., Makeschin, F., 2014. Making use of the ecosystem services concept in regional planning-trade-offs from reducing water erosion. Landscape Ecology 1–15. doi:10.1007/s10980-014-9992-3

Glæsner, N., Helming, K., de Vries, W., 2014. Do current European policies prevent soil threats and support soil functions? Sustainability 6, 9538–9563. doi:10.3390/su6129538

Groot, R. De, Fisher, B., Christie, M., Aronson, J., Braat, L., Gowdy, J., Haines-young, R., Maltby, E., Neuville, A., Polasky, S., Portela, R., Ring, I., 2010. Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. 1–40. doi:10.4324/9781849775489

Grunewald, K., Syrbe, R.U., Bastian, O., 2014. Landscape management accounting as a tool for indicating the need of action for ecosystem maintenance and restoration - Exemplified for Saxony. Ecological Indicators 37, 241–251. doi:10.1016/j.ecolind.2013.09.014

Guerin, K., 2003. Property Rights and Environmental Policy : A New Zealand Perspective. Wellington, NZ.

Haase, D., Haase, A., Rink, D., 2014. Conceptualizing the nexus between urban shrinkage and ecosystem services. Landscape and Urban Planning 132, 159–169. doi:10.1016/j.landurbplan.2014.09.003

Haddad, B.M., 2003. Property rights, ecosystem management, and John Locke's labor theory of ownership. Ecological Economics 46, 19–31. doi:10.1016/S0921-8009(03)00079-X

Hagemann, N., Prager, K., 2002. Politische Instrumente zum landwirtschaftlichen Bodenschutz – Defizite und Handlungsansätze.

Haines-Young, R., Potschin, M., 2013. CICES V4.3.

Haines-Young, R., Potschin, M., 2010. Proposal For A Common International Classification Of Ecosystem Goods And Services (CICES) For Integrated Environmental and Economic Accounting, Contract. Nottingham. doi:10.1038/nature10650

Haines-Young, R., Potschin, M., 2009a. Methodologies for defining and assessing ecosystem services. Centre for Environmental Management Report 1–84. doi:Project Code C08-0170-0062, 69 pp.

Haines-Young, R., Potschin, M., 2009b. The links between biodiversity, ecosystem services and human well-being., in: Raffaelli, D., Frid, C. (Eds.), Ecosystems Ecology: A New Synthesis. BES Ecological Reviews Series. Cambridge, pp. 1–31. doi:10.1017/CBO9780511750458

Helfrich, S., 2009. Wem gehört die Welt? Zur Wiederentdeckung der Gemeingüter, Heinrich-Böll-Stiftung. oekom verlag, Berlin, Germany. doi:10.1007/s00739-009-0111-1

Henriksen, C.B., Hussey, K., Holm, P.E., 2011. Exploiting soil-management strategies for climate mitigation in the European union: Maximizing “win-win” solutions across policy regimes. Ecology and Society 16. doi:http://dx.doi.org/10.5751/ES-04176-160422

Henry, J.F., 1999. John Locke, Property Rights, and Economic Theory. Journal of Economic Issues 33, 609–624. doi:10.1080/00213624.1999.11506188

IPCC, 2014. Summary for Policymakers. Ipcc Wgiii Ar5 1–33. doi:10.1017/CBO9781107415324

Jerneck, A., Olsson, L., Ness, B., Anderberg, S., Baier, M., Clark, E., Hickler, T., Hornborg, A., Kronsell, A., Lövbrand, E., Persson, J., 2011. Structuring sustainability science. Sustainability Science 6, 69–82. doi:10.1007/s11625-010-0117-x

Judge, R.P., 2002. Restoring the Commons : Toward a New Interpretation of Locke’s Theory of Property. University of Wisconsin Press 78, 331–338.

Karlen, D., Mausbauch, M., Doran, J., Cline, R., Harris, R., Schuman, G., 1997. Soil Quality: A Concept, Definition, and Framework for Evaluation (A Guest Editorial). Soil Science Society of America 61, 4–10. doi:doi:10.2136/sssaj1997.03615995006100010001x

Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., Mccarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Calloprn, G.C., Grübler, A., Huntley, B., Jäger, J., Jodha, N.S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., Iii, B.M., Riordan, T.O., Svedin, U., 2001. Sustainability Science. Science 292, 641–642. doi:10.1126/science.1059386

Kibblewhite, M.G., Ritz, K., Swift, M.J., 2008. Soil health in agricultural systems. Philosophical transactions of the Royal Society of London. Series B, Biological sciences 363, 685–701. doi:10.1098/rstb.2007.2178

Koschke, L., Fürst, C., Lorenz, M., Witt, A., Frank, S., Makeschin, F., 2013. The integration of crop rotation and tillage practices in the assessment of ecosystem services provision at the regional scale. Ecological Indicators 32, 157–171. doi:10.1016/j.ecolind.2013.03.008

Kosoy, N., Corbera, E., 2010. Payments for ecosystem services as commodity fetishism. Ecological Economics 69, 1228–1236. doi:10.1016/j.ecolecon.2009.11.002

Krueckeberg, D., 1995. The Difficult Character of Property: To Whom Do Things Belong? Journal of the American Planning Association 61, 301–309. doi:10.1080/01944369508975644

Lai, L.W., Davies, S.N., Lorne, F., 2015. Creation of property rights in planning by contract and edict:

Beyond “Coasian bargaining” in private planning. Planning Theory. doi:10.1177/1473095215596546

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C.J., 2012. Transdisciplinary research in sustainability science: Practice, principles, and challenges. Sustainability Science 7, 25–43. doi:10.1007/s11625-011-0149-x

Lant, C.L., Ruhl, J.B., Kraft, S.E., 2008. The tragedy of ecosystem services. BioScience 58, 969–974. doi:10.1641/B581010

Lautenbach, S., Kugel, C., Lausch, A., Seppelt, R., 2011. Analysis of historic changes in regional ecosystem service provisioning using land use data. Ecological Indicators 11, 676–687. doi:10.1016/j.ecolind.2010.09.007

Locke, J., 1980. Second Treatise of Government. Hackett Publishing Company, Inc., Cambridge. doi:10.1017/CBO9781107415324.004

Lorenz, M., Fürst, C., Thiel, E., 2013. A methodological approach for deriving regional crop rotations as basis for the assessment of the impact of agricultural strategies using soil erosion as example. Journal of Environmental Management 127, S37–S47. doi:10.1016/j.jenvman.2013.04.050

Lupp, G., Steinhäußer, R., Bastian, O., Syrbe, R.U., 2015. Impacts of increasing bioenergy use on ecosystem services on nature and society exemplified in the German district of Görlitz. Biomass and Bioenergy 83, 131–140. doi:10.1016/j.biombioe.2015.09.006

Maes, J., Hauck, J., Paracchini, M.L., Hutchins, M., Termansen, M., Braat, L., Bidoglio, G., Furman, E., Pe, M., 2013. Mainstreaming ecosystem services into EU policy Outi Ratama. Current opinion in Environmental Sustainability 5, 1–7. doi:10.1016/j.cosust.2013.01.002

MEA, 2005. Millennium Ecosystem Assessment. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Meyer, A., 2004. The Verification Plan 165–181. doi:10.1016/B978-075067617-5/50008-0

Meyer, C., Matzdorf, B., Müller, K., Schleyer, C., 2014. Cross Compliance as payment for public goods? Understanding EU and US agricultural policies. Ecological Economics 107, 185–194. doi:10.1016/j.ecolecon.2014.08.010

Mossoff, A., 2012. Saving Locke From Marx: the Labor Theory of Value in Intellectual Property Theory. Social Philosophy and Policy 29, 283–317. doi:10.1017/S0265052511000288

Mueller, L., Schindler, U., Shepherd, T.G., Ball, B.C., Smolentseva, E., Hu, C., Hennings, V., Schad, P., Rogasik, J., Zeitz, J., Schlindwein, S.L., Behrendt, A., Helming, K., Eulenstein, F., 2012. A framework for assessing agricultural soil quality on a global scale. Archives of Agronomy and Soil Science 58, S76–S82. doi:10.1080/03650340.2012.692877

Müller, K., 2015. Annual Report 2014, ZALF. Müncheberg, Germany. doi:10.1017/CBO9781107415324.004

Naskali, A., 2003. Governing the Commons in private forests: incentive measures and multiscalar ecosystem management. Finnish Forest Research Institute 1–42.

Orgiazzi, A., Bardgett, R.D., Barrios, E., Behan-Pelletier, V., Briones, M.J.I., Chotte, J.-L., De Deyn, G.B., Eggleton, P., Fierer, N., Fraser, T., Hedlund, K., Jeffery, S., Johnson, N.C., Jones, A., Kandeler, E., Kaneko, N., Lavelle, P., Lemanceau, P., Miko, L., Montanarella, L., Moreira, F.M.S., Ramirez, K.S., Scheu, S., Singh, B.K., Six, J., van der Putten, W.H., Wall, D.H.Orgiazzi, A., Bardgett, D.H., 2016. Global Soil Biodiversity Atlas. Luxemburg.

Petzold, R., Butler-Manning, D., Feldwisch, N., Glaser, T., Schmidt, P.A., Denner, M., Feger, K.H., 2014. Linking biomass production in short rotation coppice with soil protection and nature conservation. IForest 7, 353–362. doi:10.3832/ifor1168-007

Pingen, S., Huesmann, C., 2015. Situationsbericht Boden. Berlin.

Plieninger, T., Schleyer, C., Schaich, H., Ohnesorge, B., Gerdes, H., Hernandez-Morcillo, M., Bieling, C., 2012. Mainstreaming ecosystem services through reformed European agricultural policies. Conservation Letters 5, 281–288. doi:10.1111/j.1755-263X.2012.00240.x

Polanyi, K., 2001. The Great Transformation. The Political and Economic Origins of Our Time. Boston.

Polk, M., 2014. Achieving the promise of transdisciplinarity: a critical exploration of the relationship between transdisciplinary research and societal problem solving. Sustainability Science 9, 439–451. doi:10.1007/s11625-014-0247-7

Posthumus, H., Deeks, L.K., Fenn, I., Rickson, R.J., 2011. Soil conservation in two English catchments: Linking soil management with policies. Land Degradation and Development 22, 97–110. doi:10.1002/ldr.987

Power, A.G., 2010. Ecosystem services and agriculture: tradeoffs and synergies. Philosophical transactions of the Royal Society of London. Series B, Biological sciences 365, 2959–2971.

doi:10.1098/rstb.2010.0143

Powlson, D.S., Gregory, P.J., Whalley, W.R., Quinton, J.N., Hopkins, D.W., Whitmore, A.P., Hirsch, P.R., Goulding, K.W.T., 2011. Soil management in relation to sustainable agriculture and ecosystem services. Food Policy 36, S72–S87. doi:10.1016/j.foodpol.2010.11.025

Robinson, D.A., Hockley, N., Cooper, D.M., Emmett, B.A., Keith, A.M., Lebron, I., Reynolds, B., Tipping, E., Tye, A.M., Watts, C.W., Whalley, W.R., Black, H.I.J., Warren, G.P., Robinson, J.S., 2013. Natural capital and ecosystem services, developing an appropriate soils framework as a basis for valuation. Soil Biology and Biochemistry 57, 1023–1033. doi:10.1016/j.soilbio.2012.09.008

Ruhl, J.B., Salzman, J., 2007. The Law And Policy Beginnings of Ecosystem Services. Land Use & Environmental Law 22, 157–172. doi:10.1525/sp.2007.54.1.23.

Ryan, G.W., Bernard, H.R., 2003. Techniques to Identify Themes. Field Methods 15, 85–109. doi:10.1177/1525822X02239569

Saldaña, J., 2013. The Coding Manual for Qualitative Researchers. Sage Publications, London.

Schleyer, C., Plieninger, T., 2011. Obstacles and options for the design and implementation of payment schemes for ecosystem services provided through farm trees in Saxony, Germany. Environmental Conservation 38, 454–463. doi:10.1017/S0376892911000361

Schulte, R.P.O., Creamer, R.E., Donnellan, T., Farrelly, N., Fealy, R., O’Donoghue, C., O’hUallachain, D., 2014. Functional land management: A framework for managing soil-based ecosystem services for the sustainable intensification of agriculture. Environmental Science and Policy 38, 45–58. doi:10.1016/j.envsci.2013.10.002

Schwilch, G., Bernet, L., Fleskens, L., Giannakis, E., Leventon, J., Mills, J., Short, C., Stolte, J., Delden, H. Van, Mara, T., Verzandvoort, S., 2016. Operationalizing ecosystem services for the mitigation of soil threats : A proposed framework. Ecological Indicators 67, 586–597. doi:10.1016/j.ecolind.2016.03.016

SMLU, 2010. Landwirtschaft in Sachsen. Dresden.

SMUL, 2016a. Bodenversiegelung und Flächeninanspruchnahme [WWW Document]. Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie. URL http://www.umwelt.sachsen.de/umwelt/boden/12210.htm (accessed 9.19.16).

SMUL, 2016b. Ursachen von Bodengefügeveränderungen [WWW Document]. Sächsisches Landesamt für Umwelt, Landwirtschaft und Geologie. URL http://www.umwelt.sachsen.de/umwelt/boden/12418.htm (accessed 9.23.16).

SMUL, 2015. Agrarbericht in Zahlen 2015. Dresden, Germany.

SMUL, 2013. Soil erosion from water - potential threats from erosion [WWW Document]. URL http://www.umwelt.sachsen.de/umwelt/download/boden/KSR_Sachsen.pdf

SOILSERVICE, 2012. Soil as natural capital. Lund.

Statistisches Landesamt des Freistaates Sachsen, 2016. Flächennutzung [WWW Document]. URL https://www.statistik.sachsen.de/html/506.htm (accessed 9.19.16).

Statistisches Landesamt des Freistaates Sachsen, 2015. Flächennutzung [WWW Document]. URL https://www.statistik.sachsen.de/download/050_W-Land-Forstwirt/Zeitreihe_bis2014.pdf (accessed 5.5.16).

Stevens, J.B., 1996. John Locke, Environmental Property, and Instream Water Rights. University of Wisconsin Press 72, 261–268.

Taylor, T.J., 1997. John Locke. Concise Encyclopedia of Philosophy of Language C, 209–24.

Trachtenberg, Z., 2014. John Locke: This Habitable Earth of Ours, in: Cannavo, P., Lane Jr., J.H. (Eds.), Engaging Nature. The MIT Press, Cambridge.

Vatn, A., 2014. Markets in environmental governance - From theory to practice. Ecological Economics 105, 97–105. doi:10.1016/j.ecolecon.2014.05.005

Wolff, W., 1939. Die bodenkundlichen Grundlagen der deutschen Reichs-Bodenschätzung. Die Naturwissenschaften 27, 374–376. doi:10.1007/BF01491648

Wolford, 2007. Land Reform in the Time of Neo-Liberalism: A Many Splendored Thing. Antipode 39, 550–570.

Wu, J., 2013. Landscape sustainability science: Ecosystem services and human well-being in changing landscapes. Landscape Ecology 28, 999–1023. doi:10.1007/s10980-013-9894-9

Yin, R.K., 2011. Qualitative Research from Start to Finish, Journal of Chemical Information and Modeling. The Guildford Press, New York. doi:10.1017/CBO9781107415324.004

Appendix

Appendix A: Interview questions

Questions for an open and voluntary interview for a Master Thesis

Dennis Roitsch
LUMES student, 2016 | http://www.lumes.lu.se/
Stora Tvärgatan 13 lgh 1101
SE-223 53 Lund
T: 0176-
T: 0355-
E: dennis.roitsch@hotmail.com

Interview questions:

Q1: What crops do you cultivate? How many hectares do you cultivate?

Q2: Why do you cultivate these crops?

Q3: Would you rather cultivate other crops? If yes, can you explain what prevents you from cultivating other crops?

Q4: Are there natural factors that influence your decision how to use the soil, can you tell me what they are?

Q5: Are there economic factors that influence your decision how to use the soil, can you tell me what they are?

Q6: Are there legislative factors that influence your decision how to use the soil, can you tell me what they are?

Appendix B: Type of crops per ha for 9 farms in Saxony

Table 1: Farmers interview answers about crops that they grow (per ha) (F indicates farmer; I=9)

TYPE OF CROP	F1	F2	F3	F4	F5	F6	F7	F8	F9
WINTER OILSEED RAPE	75	180	409	300	370	200	0	400	130
SPRING BARLEY	0	50	0	0	0	0	0	0	0
WINTER BARLEY	77	139	220	200	0	100	192.5	0	180
WINTER WHEAT	83	205	430	350	250	200	0	700	400
PEAS	20	20	0	160	68	0	0	50	0

LUPIN	20	1	66	0	17	0	0	0	0
BLOOMER	12	0	0	0	0	0	0	0	0
GRASS	5	129	34	30	17	0	0	20	0
AUTUMN-SOWN RYE	0	36	222	125	208	200	192.5	89	0
OAT	0	2	114	110	20	20	0	0	0
SILAGE MAIZE	0	345	400	145	430		192.5	350	330
GRAIN MAIZE	0	0	0	0	0	200	0	35	0
TRITICALE	0	32	274	0	160	0	192.5	80	0
RED CLOVER	0	0	0	30	0	0	0	0	0
LUCERNE	0	0	0	50	0	0	0	0	0
MEADOWS	0	330	515	150	356	350	330	550	230
SOY BEAN	0	0	0	0	4	0	0	0	0
CARROTS	0	0	0	0	0.6	0	0	0	0
SUGAR BEET	0	0	28	0	20	0	0	44	0
SUNFLOWERS	0	0	0	0	18	20	0	0	0
OIL FLAX	0	0	0	0	4	0	0	0	0
STRAWBERRY	0	0	0.6	0	0	3	0	0	0
POTATOES	0	0	7.5	0	0	0	0	0	0
ASPARAGUS	0	0	2	0	0	0	0	0	0
HOPS	0	0	0	0	0	0	0	0	52
FALLOW LAND	0	0	0	0	12	107	0	0	0
TOTAL	307	1491	2723	1495	2294	1400	1000	2400	1400

Appendix C: Withdrawal, management and exclusion for different types of property

Table 2: Types of property (Guerin, 2003)

	Owner	Example	Access	Withdrawal	Management	Exclusion
Private	Private	Fee simple title to land.	Controlled by owner.	By owner.	By owner.	By owner.
Common	Group	Common land.	Controlled by joint owners.	By joint owners.	By joint owners.	By joint owners.
Public	State	National park.	Controlled by state.	None.	By state.	By state.
Open access	No one	Ocean fishery.	Uncontrolled.	Uncontrolled.	None.	None.