Payments for Forest Ecosystem Services: Global and Local Assessments of Costs and Benefits

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CHAPTER 1 ■ Introduction

1.1 BACKGROUND

Over the past three centuries humankind has cleared roughly 1.200 million hectares of the world's forests and woodlands (Bryant *et al.,* 1997; Ramankutty and Foley, 1999). Although the rate of global deforestation has decreased from an estimated 16 million hectares per year in the 1990s to around 13 million hectares per year in the last decade, the current rate of global deforestation is still alarmingly high in many parts of the world (FAO, 2010). While population and global economic growth are often regarded as the main underlying causes of deforestation and forest degradation, land conversion and timber extraction are widely viewed as key drivers (Lambin *et al*., 2001; Geist and Lambin, 2002; Eliasch, 2008). More specifically, land-use activities for agricultural production, infrastructure, urban expansion, and mining are *identified* to be responsible for the immense loss of forests (Hosonuma *et al.*, 2012).

Deforestation and forest degradation have substantial long-term consequences for the world's ecosystems, economies, and societies. Major environmental impacts consist of biodiversity loss due to the destruction and fragmentation of habitats, declining provision of ecosystem services such as disturbed water cycles and soil erosion, and anthropogenic global warming (Sodhi *et al.*, 2004; Fearnside, 2005; Fitzherbert *et al.*, 2008). The latter impact is explained by the fact that once forests are felled the carbon originally held in forests (in biomass and soil) is released into the atmosphere, either immediately if the trees are burned, or more slowly as unburned organic matter decays (Houghton, 2005). Deforestation is estimated to account for a quarter of all anthropogenic greenhouse gas (GHG) emissions and is thereby ranked as the third largest source after energy supply and industrial activities, and greater than the global transport sector (Houghton, 2005; IPCC, 2007; Nabuurs *et al.*, 2007). Major economic impacts of deforestation are a reduction in agricultural productivity due to soil erosion, nutrient depletion and soil compaction, and diminishing forest based energy sources such as firewood (Fearnside, 2005). Societal impacts include increased natural disasters such as floods, accelerated hill slope erosion, and sediment delivery to river

channels, loss of forest dependent livelihoods, and food insecurity caused by long-term decreasing productivity (Shackleton, 1996, 2007; Fearnside, 2005).

To effectively halt deforestation on both global and local levels, various policy instruments have been introduced (Muradian and Rival, 2012; Ring and Barton, 2015). Command-and-control instruments rely heavily on regulations and bans (e.g. protected areas), and environmental standards to prevent activities that cause deforestation. Market-based instruments use economic incentives to encourage forests protection like subsidies for sustainable timber logging or paying farmers for their supply of environmental services. Since the Kyoto protocol, market mechanisms for carbon services have been most actively promoted under the development of an internationally regulated Clean Development Mechanism (CDM) market, in parallel with the Reducing Emissions from Deforestation and forest Degradation (REDD) program. Examples of other enabling instruments are environmental education, awareness raising, capacity building, spatial planning, certification and eco-labelling.

Amongst these instruments, interest in Payments for Ecosystem Services (PES) in general and payments for carbon services in particular has grown considerably in recent years within both governmental and private sectors, from global to local level (Engle *et al.*, 2008; Pattanayak *et al.*, 2010). Although there exists a wide variety of such payment schemes in practice (Wunder ***et al.***, 2008; Vatn, 2010; Ring and Barton, 2015), PES have been generally defined as a voluntary arrangement where a well-defined environmental service is bought from a service provider by a service buyer, if and only if the service provider continuously secures the provision of that service (Wunder, 2005). PES are expected to enhance the cost-effectiveness of global climate change mitigation in the forestry sector, while simultaneously providing a wide range of environmental and societal co-benefits (IPCC, 2000; Houghton, 2005; Stern, 2006; Nabuurs *et al.*, 2007; Eliasch, 2008). Compared with other economic sectors, GHG emissions reductions in the forestry sector are generally considered more economically competitive since new technology is barely required to facilitate action and mitigation takes place mainly in developing countries (Sedjo *et al.*, 1995; van Kooten *et al.*, 2004; Hope *et al.*, 2008). Moreover, PES also support biodiversity conservation and watershed and soil quality protection (Sedjo *et al.*, 1995; Chomitz and Kumari, 1998; Stern, 2006; Ebeling and Yasué, 2008; Stickler *et al.*, 2009; World Bank, 2011; Strassburg *et al.*, 2012). Since the majority of deforestation occurs in developing countries (FAO, 2010), any international system including PES that channels finance from developed to developing nations to reduce forest loss is believed to have the potential to help alleviate poverty and improve forest management at the same time (Eliasch, 2008).

Although PES are assumed and expected to have the abovementioned multiple benefits, it turns out very difficult to empirically demonstrate and quantify these benefits in practice, owing to a number of uncertainties (Naeem *et al.*, 2015), and the context-dependent nature of the schemes where various design options may have differing impacts (e.g. Brouwer *et al.*, 2011). With respect to PES cost-effectiveness, the costs of ecosystem services provision have been shown to vary widely, especially for carbon sequestration (e.g. van Kooten *et al.*, 2004; 2009). While many if not most studies have focused on the forgone benefits or opportunity costs of land owners under various conservation scenarios (Kindermann *et al.*, 2008; Strassburg *et al.*, 2009), other important cost components, in particular transaction costs (TC) of implementing forest conservation policies tend to be overlooked. In fact, the TC incurred by various actors are typically unknown and not quantified and are therefore usually neglected in project design and evaluation (Falconer and Whitby, 1999; Challen, 2000; McCann *et al.*, 2005). The extent to which TC plays a role in forest policies in general and PES in particular thus represents a major knowledge gap and policy makers considering PES have lacked important information for policy design.

With regard to the joint production of ecosystem services and other co-benefits, the extent to which PES can actually deliver co-benefits is very much dependent on their socio-economic embedding (Ebeling and Yasué, 2008; Brouwer *et al.*, 2011; Strassburg *et al.*, 2012). For instance, the involvement of poor farmers, often without legal land entitlements and hence incentives to invest in the quality of the land they use, may contribute only marginally to improving ecosystems and the services they provide. Moreover, taking these additional benefits into account in policy design may well increase TC. Not surprisingly, studies on PES cost-effectiveness consequently report diverging results (e.g. Kosoy *et al.*, 2007; Locatelli *et al.*, 2008; Corbera *et al.*, 2009; Jindal *et al.*, 2012). To date, there has been little research that simultaneously quantifies both the socio-economic and environmental consequences of PES (Liu and Yang, 2013; Zheng *et al.*, 2013).

1.2 MAIN OBJECTIVE AND RESEARCH QUESTIONS

Motivated by these knowledge and information gaps and limitations, the overarching objective of this PHD thesis is to contribute to the current body of PES literature by further explaining the cost-effectiveness and co-benefits of PES. More specifically, this thesis aims to:

First, assess and explain the relationships between the cost of avoided deforestation and its main drivers in developing countries by systematically reviewing the cost estimates reported in the literature. The main research questions answered are how do the costs of avoided deforestation vary at global level and which factors explain these variations to support cost-effective policy and decision-making in global climate change mitigation? Here the net cost of avoided deforestation is defined as the sum of opportunity costs, start-up costs, on-going costs, and transaction costs less any benefit resulting from forest conservation.

Secondly, examine one specific cost component, namely the TC of forest-based carbon projects, both on a global scale surveying CDM-based and non-CDM-based carbon markets, and at regional scale zooming in on the TC of Payments for Forest Ecosystem Services (PFES) in a case study in Vietnam. Data of TC in both studies are collected using questionnaires and in-depth interviews. The main research questions here are which different types of TC can be distinguished in forest based PES projects, *ex ante* and *ex post* implementation, what are their main underlying driving factors, and what role does their institutional design play in this?

Thirdly, investigate the multiple, i.e. environmental and socio-economic, impacts of PFES on local forest ecosystems and PES participants' livelihood, also referred to as co-benefits. The research question posed here is to what extent do PFES yield multiple benefits? Using a survey, socio-economic impacts are assessed based on changes in income levels and livelihoods of both PES participants and non-participants, before and after the introduction of PFES in Vietnam, while environmental impacts are evaluated based on satellite images.

1.3 RESEARCH METHODOLOGY AND NOVELTY

To address the research questions raised in the previous section, a combination of methodologies is employed, most importantly (1) a systematic literature research that draws upon *secondary data* and information obtained from existing studies that examine the economic costs of avoided deforestation applying meta-analysis, and (2) different survey methods to collect *primary data* and information from forest carbon project managers and households participating in PFES schemes. Below, we briefly discuss the main characteristics of these methods as applied in this PhD thesis and their methodological novelty and contribution to the existing literature in this field.

1.3.1 Meta-analysis

When dealing with large amounts of data from different primary studies, meta-analysis is a useful tool for extracting information from such a data pool in order to provide a comprehensive, systematic assessment of the relationship between various common factors and synthesize key results (e.g. Glass *et al.*, 1981; Smith and Kaoru, 1990; Curtis and Wang, 1998). Compared to qualitative analysis, meta-analysis avoids researcher selection bias on the input side by including, in principle, all studies that meet objective criteria, and subjective interpretation of results on the output side (Glass *et al.*, 1981). It enables researchers to explain differences in outcomes found in single studies on the basis of differences in underlying assumptions, standards of design or measurement. By using statistical regression techniques, a significant common trend can be found even where individual studies examining the same phenomenon might have failed to achieve significant results (Mann, 1990; Nelson and Kennedy, 2009). An important objective to apply quantitative meta-analysis here is to better identify and explain the reasons behind variation (between and within study) in the unit costs of avoided deforestation and TC. In environmental economics, the use of meta-analysis has become increasingly popular owing to its large potential applicability (e.g. Loomis and White, 1996; Brouwer *et al.*, 1999; Woodward and Wui, 2001; van Kooten *et al.*, 2004, 2009; Murphy *et al.*, 2005; Brander *et al.*, 2006; Zandersen and Tol, 2009; Brouwer *et al.*, 2011; Brander *et al.*, 2014).

In this PhD thesis, meta-analysis is applied in chapters 2 and 3. In chapter 2, we employ this approach to review and explain the relationships between the cost per tonne of carbon of avoided deforestation and its main driving factors. To our knowledge there are only two existing studies that systematically review and compare different cost estimates of avoided deforestation based on quantitative meta-regression models. Van Kooten *et al.*

(2004) initially reviewed 55 studies, followed by van Kooten *et al.* (2009), who examined 68 studies covering a wide range of literature published between 1989 and 2007. The application of the meta-analysis presented in this PhD research differs from the two previous studies in a number of important ways methodologically speaking, besides presenting an update of the existing studies up to and including 2012 and zooming in more specifically on developing countries where most deforestation occurs. Most importantly, the meta analysis presented here includes new variables to further and better explain the observed variation in the unit cost estimates of avoided deforestation. These new variables relate to factors 'internal' to the studies themselves such as the inclusion of TC, co-benefits of forest conservation, alternative land uses and beneficiaries of non-forested land uses, and 'external' factors taken from other information sources than the original studies self, such as national or regional deforestation rates and the share of agriculture in Gross Domestic Product (GDP) to better capture other exogenous trends. Moreover, compared to the two previous reviews, a more detailed assessment is given of relevant issues in the specific context of REDD implementation in developing countries.

In the meta-analysis presented in chapter 3, the main purpose is to investigate the relations between TC and the characteristics of the specific forest carbon project in which they occur, the characteristics of the transaction and transactors involved, and specifically the projects' institutional design. Although various studies exist which attempt to estimate the size of TC (e.g. Milne, 1999; Adhikari and Lovett, 2006; Wunder *et al.*, 2008; Alston and Andersson, 2011; Ray and Bhattacharya, 2011; Cacho *et al.*, 2013; Thompson *et al.*, 2013), this is the first systematic review and quantitative meta-analysis related to TC in the forestry sector. Existing studies tend to report a wide range of cost estimates, depending on the specific setting of the case study, and specific types of TC examined.

1.3.2 Survey methods

Surveys involve the collection of information from a sample of individuals through their responses to questions (Check and Schutt, 2012). Depending on the nature of the investigation and the characteristics of the study population, different means to survey a sample population exist (Kumar, 2005). For a large population of respondents, a questionnaire is commonly used, while an open or semi-structured interview schedule is considered more relevant if the survey purpose is to obtain in-depth information from a small number of respondents. In the field of environmental economics research, surveys have been widely applied given their advantages in collecting large amounts of data, for both qualitative and quantitative analysis. In this PhD thesis, a mixture of survey techniques is applied, including semi-structured in-person interviews and structured in-person and online questionnaires.

Interviewing is a method of collecting information through person-to-person interaction between interviewers and interviewees (Kumar, 2005). Depending on the degree of flexibility, such interviews are often categorized as unstructured, semi-structured, and structured. For more qualitative research, semi-structured in-depth interviews are the most widely used interviewing format (Check and Schutt, 2012). In the case study in Vietnam focusing on TC, semi-structured interview protocols were developed and applied in which respondents were asked a set of both open- and semi-structured questions in person. Using the same semi-structured interview protocol for different interviewees, with built-in flexibility to allow for other unprepared questions to emerge spontaneously from the dialogue between the interviewer and interviewee, the information obtained from these interviews is still relatively easy comparable.

A *questionnaire* is a research instrument that uses a series of structured questions for gathering information from respondents, oftentimes in a large number. As questionnaires often have standardized answers that make it simple to compile and process data, this data collection tool is often designed for numerical statistical analysis (Check and Schutt, 2012). Similarly to interviews, the questions used can be open-ended where the respondent can formulate her own answer in her own words or closed-ended multiple choice where respondents are offered to pick an answer from predetermined response categories (Kumar, 2005). Most frequently used administration modes, are face-to-face, mail, phone, computer assisted and online (web-based) surveys. In this PhD study, both face-to-face (in person) and an online questionnaire surveys were carried out. In Chapter 3an online survey was developed and implemented targeting project developers of existing forestry carbon

projects worldwide while in Chapter 5 face-to-face interviews were conducted targeting rural households living in the province Lam Dong in Vietnam. In the latter case hired trained interviewers present the questions verbally to the respondents whereas in the former case questions are presented to respondents via the internet, therefore without any interviewer interference.

Equally important, to find out the impact of an intervention, in this case the introduction of a PFES scheme or institutional design differences between forest carbon projects (e.g. CDM-based or non-CDM based), typically two population groups are sampled, namely a control group (e.g. households not participating in the PFES scheme) and an experimental group (e.g. households participating in the PFES scheme). These groups are expected to be comparable as far as possible in every respect except the specific intervention. This often poses challenges in practice. In Chapter 3, of prime interest studying TC is the influence of institutional market design. Hence, a distinction is made between regulated CDM markets and non-CDM voluntary markets so that the effect of a regulated CDM market on TC can be compared to that of a voluntary non-CDM market. In Chapter 5both PFES participants and non-participants living in the same area are sampled to allow a comparison of the impact PFES introduction on rural livelihoods.

1.4 THESIS STRUCTURE

The PhD thesis consists of six chapters. The structure of the thesis is presented in Figure 1.1. After this introduction, Chapter 2 offers a global investigation of the costs of avoided deforestation in developing countries where most deforestation takes place, examining unit cost estimates in the existing literature and identifying possible explanatory factors. The cost per ton of carbon is regressed in a meta-analysis on various explanatory factors that are categorized into different groups. The results from the meta-analysis call for the need to further examine two main knowledge gaps in the field of forest carbon projects, namely TC and co-benefits. Following this outcome and conclusion, Chapter 3 presents a global survey of forest carbon projects worldwide and another meta-analysis with the aim to shed more light on the types of TC arising *ex ante* project implementation, quantify their magnitude and assess how different factors impact the TC of marketing forest carbon credits, in particular their institutional design. The meta-analysis is based on a significant modification of existing conceptual frameworks in the literature for identifying and explaining transaction costs.

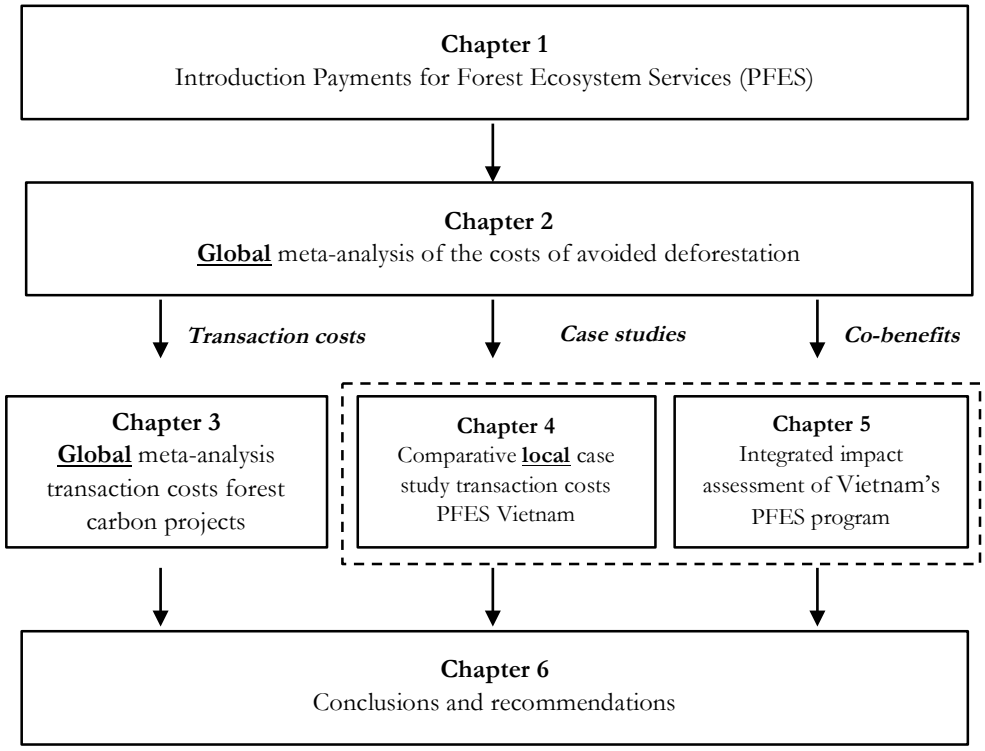

Figure 1.1 Structure of the PhD thesis

Moving from the global to the local level, chapters 4 and 5 present two case studies focusing on Vietnam's PFES schemes. The studies have been carried out in the province Lam Dong where PFES were first introduced and implemented in Vietnam. Chapter 4 applies and tests the developed conceptual framework in Chapter 3 to TC on a more local perspective, and examines and compares recurrent *ex post* TC borne by two PFES coordinating organizations with different institutional designs. Differences in TC at local level can partly be explained due to these differences in institutional design. The issue of co-benefits is studied in Chapter 5 by quantifying the impacts of Vietnam's oldest PFES scheme on forest ecosystems, household livelihoods, and income levels. Changes in forest cover are analysed using satellite images over a period of 15 years between 2000 and 2014, while changes in income levels are measured based on rural household surveys targeting both households who participate and those who do not as a control group over a period of 7 years (2008-2014). Finally, Chapter 6 revisits the main research questions, concludes and provides a critical discussion of the main outcomes of the PhD thesis.