DOCTOR OF PHILOSOPHY

The delivery of biodiversity benefits in the REDD+ climate mechanism

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Award date:
2015

Awarding institution:
Bangor University
Universita degli Studi di Padova

PRIFYSGOL BANGOR UNIVERSITY

UNIVERSITÀ DEGLI STUDI DI PADOVA

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PhD 2015

THE DELIVERY OF BIODIVERSITY BENEFITS IN THE REDD+ CLIMATE MECHANISM

A thesis for a joint degree of

Doctor of Philosophy

By

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April 2015

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EXECUTIVE SUMMARY

Habitat loss and climate change are two of the most important threats to biodiversity in the tropics. The climate mechanism to Reduce Emissions from Deforestation and forest Degradation (REDD+) can therefore, in theory, address both of these threats by funding forest conservation and slowing climate change. However there are concerns that, if not properly planned, REDD+ could in practice negatively impact biodiversity. In this thesis I introduce the emergence of biodiversity concerns in REDD+ and the relevant safeguards developed at the international negotiations. I present a conceptual framework for understanding opportunities and risks for biodiversity in REDD+, bringing together the literature on biodiversity co-benefits and safeguards. In the last seven years, REDD+ went through a readiness phase and was piloted in over 300 subnational initiatives across the tropics in preparation and anticipation for inclusion in the future global climate regime. I assess 22 of these REDD+ initiatives located in six countries and explore how biodiversity considerations are incorporated into the project design and the challenges faced in delivering biodiversity co-benefits. Many project developers demonstrated strong intentions to safeguard biodiversity, only a handful had explicit goals and interventions targeting biodiversity conservation; often citing the lack of capacity and incentives to protect biodiversity as challenges. I then focus on Indonesia where I use spatially explicit methods to explore the relationship between carbon and biodiversity and the potential for 1st generation REDD+ initiatives to deliver biodiversity benefits. I show that carbon and biodiversity are not correlated in Indonesia; while REDD+ initiatives tend to be (perhaps surprisingly) located in forests important for biodiversity, these are not necessarily the most threatened by future deforestation, thus limiting the contribution of REDD+ to conservation. I then focus on two newly approved subnational REDD+ initiatives and explore how the challenges in implementing REDD+ (especially the slow approval process and reduction in the proposed project area) have impacted orangutan conservation. I show that the Indonesian government will have to re-assess the way in which REDD+ projects are currently being approved if it is serious about its commitments toward orangutan conservation and emission reduction. This study strengthens the notion that REDD+ has the potential to deliver huge benefits for tropical forest biodiversity, especially when located forests most threatened to deforestation. However, progress of REDD+ at the international negotiations have been slow and its inclusion as part of the future climate regime is still uncertain in spite of the urgency of climate change and the potential irreversible negative implications a failed global REDD+ mechanism will have on climate, people and biodiversity.

SINTESI (ITALIAN SUMMARY)

La perdita di habitat e il cambiamento climatico sono due delle minacce più importanti per la biodiversità nei tropici. Il meccanismo per ridurre le emissioni da deforestazione e degradazione forestale REDD+ (Reduce Emissions from Deforestation and forest Degradation) può quindi, in teoria, affrontare entrambe queste minacce finanziando la conservazione delle foreste e rallentando il cambiamento climatico. Tuttavia si teme che, se non adeguatamente pianificata, REDD+ potrebbe in pratica avere un impatto negativo sulla biodiversità. In questa tesi viene quindi inizialmente introdotto il meccanismo REDD+, l'emergere di preoccupazioni riguardo al suo impatto sulla biodiversità e le relative garanzie elaborate durante i negoziati internazionali. Lo studio presenta un quadro concettuale per la comprensione delle opportunità e dei rischi per la biodiversità, riunendo la letteratura riguardante sia i suoi addizionali co-benefici che le necessarie tutele. Negli ultimi sette anni li meccanismo REDD+ ha attraversato una fase di preparazione ed è stato sperimentato in oltre 300 iniziative subnazionali nelle regioni tropicali, in anticipazione per la futura inclusione negli accordi globali sul clima. Nella presente tesi si è valutato 22 di queste iniziative localizzate in sei paesi, ed esplorato come le considerazioni della biodiversità sono state incorporate in questi progetti e le sfide per la realizzazione dei co-benefici addizionali della biodiversità sono state affrontate. Molti degli sviluppatori dei suddetti progetti hanno dimostrato forti intenzioni di salvaguardare la biodiversità, ma solo pochi hanno incluso obiettivi espliciti e interventi mirati la conservazione della biodiversità, spesso citando la mancanza di capacità e di incentivi per proteggere la biodiversità come problema. Successivamente lo studio si è concentrato sull'Indonesia, dove metodi spazialmente espliciti sono stati usati per esplorare il rapporto tra contenuto di carbonio e di biodiversità nelle foreste e il potenziale delle iniziative di 1a generazione REDD+ di fornire co-benefici. Si è dimostrato che il contenuto di carbonio e la biodiversità non sono correlati in Indonesia, e che mentre le iniziative REDD+ tendono ad concentrarsi (forse sorprendentemente) nelle foreste più importanti per la conservazione della biodiversità, queste non sono necessariamente quelle a più elevato rischio di futura deforestazione, limitando in tal modo il contributo del meccanismo REDD+ per la conservazione delle foreste. In particolare, sono state studiate due iniziative REDD+ subnazionali recentemente approvate in Indonesia. La tesi esplora come le sfide nella loro attuazione (in particolare quelle relative al lento processo di approvazione e alla riduzione dell'area proposta per il progetto) hanno influito sulla conservazione degli orangutan. Si è quindi dimostrato che il governo indonesiano dovrà rivalutare il modo attuale in cui i progetti

REDD+ vengono approvati, se vuole seriamente mantenere i suoi impegni verso la conservazione degli orangutan e riduzione delle emissioni di carbonio. Anche se le opportunità per la conservazione della biodiversità con il meccanismo REDD+ sono molteplici, i suoi progressi nei negoziati internazionali sono stati lenti e la sua inclusione negli accordi globali sul clima è ancora incerta. E' quindi importante ricordare l'urgenza del cambiamento climatico e le possibili implicazioni negative e irreversibili che il fallimento del meccanismo globale meccanismo REDD+ potrà avere sul clima, la popolazione e la biodiversità.

ACKNOWLEDGEMENTS

I am truly privileged to have had the support and advice from three amazing supervisors: Julia P.G Jones, Sven Wunder and Laura Secco. Julia, you have been a great mentor to me. Thank you for your dedication, for always having my back and for being an inspiration in so many ways. Sven, it is an honour knowing you, thank you for enriching my research with your great ideas and for the encouragements you gave me throughout my PhD. Laura, I am grateful your warm support during my stay in Padova and I thank you for your trust and the freedom to explore research areas new to us both.

I am privileged to have the opportunity to research alongside a talented group of people at CIFOR especially the GCS-REDD+ Module 2 team. Thank you for your contributions towards my research and the wonderful memories we made every time we got together. I also acknowledge my co-authors Richard Grenyer and Niels Raes for their contributions towards my research and their confidence in me. Richard, thank you for the privilege to learn from you and for your warm hospitality during my stay in Oxford.

A part of this thesis involved interviews, discussions and field observations in Kalimantan, Indonesia. I am grateful to PT. RMU and FFI-Indonesia for opening up their REDD+ projects to me. I am especially indebted to their staff; Rumi Naito, Pak Arwin Hasan, Rahmawati (Emma) and Aseng Tan for taking such great care of me in the field and for enduring my endless questions. I am grateful to the villages which hosted me in the field, thank you for the unique opportunity to experience life in the peat swamp forest of Borneo.

I have been blessed and extremely fortunate to have a strong support system in Bangor - a very international group of friends whom I call family. You are too many to mention but I am grateful to each and every one of you for your friendship, support and love.

I would not be who I am and where I am without the prayers of my family back home in Malaysia. I dedicate this PhD to my dear mother and brothers. Thank you for always being supportive of my endless quest for knowledge no matter where in the world my research has brought me. Your love and struggles have been my strength and determination.

Last but not the least to Harry, a full-time PhD candidate and partner, and a part-time proof reader, counsellor and entertainer. You survived my PhD with such grace and made what I anticipated to be a lonely journey so fun and exciting every day. Thank you for all your love, support and encouragement.

This PhD and research would not have been possible without the generous financial support from the European Commission through the FONASO Joint Doctorate Programme.

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CHAPTER 1 INTRODUCTION

1.1 Background

Biodiversity is crucial for a functional ecosystem yet biodiversity loss at the global scale continues at an increasing rate (Cardinale *et al.*, 2012) and the current rate of species extinction is exceptionally high when compared to before human actions elevated them (Pimm *et al.*, 2014). The key drivers of biodiversity loss are over exploitation, habitat loss and climate change (Morris, 2010). Habitat loss and climate change can act synergistically; creating a double jeopardy for biodiversity (Pereira *et al.*, 2010; Struebig *et al.*, 2015a).

Tropical forests harbour almost half of the world's species (Wilson, 1999) and these species face particularly high extinction risk (Pimm & Raven, 2000; Jenkins *et al.*, 2013), largely due to habitat loss caused by high rates of deforestation and forest degradation (Brooks, 2011; Gibson *et al.*, 2013; Rybicki & Hanski, 2013). The impacts of anthropogenic climate change on tropical forest biodiversity is less clear but it is increasingly being recognized as a significant threat (Morris, 2010; Brodie *et al.*, 2012; Akcakaya *et al.*, 2014). Some predict the extinction risk of anthropogenic climate change to be worse than habitat loss because climate-induced changes in habitat will 'commit' some of those species currently not threatened by human action to extinction (Thomas *et al.*, 2004; Pimm, 2008) and the ability of species to reach new climatically suitable areas will be hampered by habitat loss and fragmentation (Thomas *et al.*, 2004).

Deforestation and forest degradation in the tropics is responsible for approximately 15% of total anthropogenic CO_2 emissions to the atmosphere (Venter & Koh, 2011) making it the third largest source of greenhouse gas emissions i.e. larger than the entire transport sector (Eliasch, 2008). The Eliasch Review suggested that reducing emissions in the forest sector can be done at a relatively low cost when compared to mitigation in other emitting sectors (Eliasch, 2008). Tropical forest loss is a key contributor to climate change however, tropical forests also provides other ecosystem services such as water services, soil stability, clean air and food; all of which are crucial for maintaining life and livelihoods (TEEB, 2008). Therefore any effort to reduce deforestation and forest degradation in the tropics can be expected to have large benefits for the climate, people and biodiversity.

The United Nations Framework Convention on Climate Change (UNFCCC) is the key international treaty leading efforts to cope with and mitigate the effects of climate change. At the 1997 Conference of Parties (COP7) in Kyoto, the UNFCCC adopted the Kyoto Protocol which entered into force in 2005. The Kyoto Protocol, among other things, sets binding targets for greenhouse gas emissions below 1990 levels for the 37 industrialized countries which ratified it (termed Annex-I countries) (UNFCCC, 2005). Recognising the importance of carbon sinks in climate mitigation, Annex I-countries can meet a part of their emission reduction commitments by financing Afforestation or Reforestation (AR) activities in developing countries through the clean development mechanism (UNFCCC, 2013). However, the clean development mechanism ignores the fact that tropical forests are important CO_2 emitter from deforestation and forest degradation. At the COP11 in Montreal in 2005, the Coalition for Rainforest Nations, led by Papua New Guinea and Costa Rica, proposed that Reduced Emissions from Deforestation (RED) in developing countries to be included in the Kyoto Protocol (UNFCCC, 2005). At the COP13 in Bali, the UNFCCC provided the mandate for activities to Reduce Emissions from Deforestation and forest Degradation (plus the conservation, sustainable management and enhancement of forest carbon stock - REDD+) to be explored. This was viewed as the first step for REDD+ to be potentially included as part of the global climate regime (Angelsen, 2013).

Besides the immediate benefits for biodiversity arising from avoided habitat loss and reduced habitat fragmentation, there has been hope among conservationists that REDD+ will generate “co-benefits” for biodiversity (Paoli *et al.*, 2010; Busch *et al.*, 2011; Gardner *et al.*, 2012). These co-benefits include the protection and rehabilitation of threatened forest ecosystems (Miles & Dickson, 2010), potential to supplement current shortfall in conservation funding (Waldron et al. 2013) and the opportunity to address direct threats to biodiversity such as poaching and illegal logging (Imai *et al.*, 2014). However there are also concerns that if not properly planned, REDD+ could instead negatively impact biodiversity (Harvey *et al.*, 2010; Paoli *et al.*, 2010). In response to these concerns, the UNFCCC introduced ‘safeguards’ for biodiversity but these have been viewed by commenters as ambiguous and not readily operationalized (Epple *et al.*, 2011; Swan *et al.*, 2011; McDermott *et al.*, 2012).

The UNFCCC proposed a phased approach to REDD+ implementation starting with the readiness phase of national policy development, the establishment of pilot and demonstration projects, capacity building; followed by an implementation phase where result-based incentives will be awarded for emission reduction against an agreed baseline (UNFCCC, 2011a). REDD+ was originally conceived as a market-based carbon offsetting mechanism which includes the regulatory and voluntary markets (Jagger *et al.*, 2014). Future REDD+ financing could include anything from market mechanisms (regulatory or voluntary), non-market mechanisms (fund based financing), or a combination of these (hybrid mechanism) (Phelps *et al.*, 2012a). Currently, market based REDD+ financing is exclusive to the voluntary forest carbon market (Goldstein *et al.*, 2014), while the majority of financing in the ‘readiness’ phase of REDD+ under the UNFCCC has been fund based, largely coming from development aid through both bilateral and multilateral channels (Angelsen *et al.*, 2014)

REDD+ is still not part of the regulatory climate regime, but it continues to be a key agenda at the international negotiations along with the role of safeguards and biodiversity co-benefits. REDD+ feasibility is being tested globally at over 300 pilot projects (Simonet *et al.*, 2014). The readiness phase of REDD+ has revealed many obstacles such as those related to the monitoring, reporting and verification of emission reduction, REDD+ financing, additionality, leakage, and safeguards to avoid harm to biodiversity and negative impacts on local people (Sunderlin *et al.*, 2014a). The first commitment period of the Kyoto Protocol ended in 2012 with a new climate regime set to be agreed in Paris at the end of 2015. It is still not clear if REDD+ will be part of the post Kyoto climate regime however, it can be expected that the benefits of its inclusion would out weight its risks for biodiversity.

1.2 Biodiversity in the context of this research

The term biodiversity is used extensively throughout this thesis. Biodiversity could mean different things to different people based (Noss, 1990), depending on the context and on who benefits (Mayer, 2006). It is therefore important to define biodiversity here in this thesis, and what it means in the context of this research. The Convention on Biological Diversity (CBD) defines the term 'biodiversity' as "the variability among living organisms from all sources including, among others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (CBD, 1992 - Article 2). The CBD's definition has been criticised as being broad and non-operational (Feest *et al.*, 2010), however, it has also been recommended for use by many because it is considered inclusive and it recognises the complexity of biodiversity (DeLong, 1996; Sarkar & Margules, 2002; Mace *et al.*, 2012). The scope of biodiversity is broad (ranges from a single cell to the functioning of the ecosystem) therefore it is unlikely that any single precise definition will capture all of its intended referents. It has been recognised that species richness may not capture all aspects of 'biodiversity' (Sarkar & Margules, 2002) and that ecological process should be included in the definition of biodiversity because it is crucial for the maintenance of biodiversity (Noss, 1990; Mace *et al.*, 2012).

Therefore for the purpose of this research; I use different definitions for biodiversity for different chapters to reflect the potential different management implications for biodiversity based on its definition. I use the method suggested by (Mace *et al.*, 2012) whereby they divided biodiversity into two 'perspectives', and these are the:

'Ecosystem services perspective' - a functional role is implicit, biodiversity contributes more to regulating and cultural services, and to longer term resilience of ecosystem processes. This perspectives comes from the fact that there is stronger evidence for biodiversity effects on ecosystem stability than on ecosystem service stocks and flows.

'Conservation perspective' - usually focuses on a subset of biodiversity that includes charismatic species and those on threatened species lists and ignores the role of biodiversity in underpinning ecosystem processes.

For chapters two and three, I took the ecosystem services perspective to defining biodiversity; this is because the level (hierarchy) in which biodiversity could potentially be impacted when we discuss opportunities and risks for biodiversity. For chapters four and five, I took the conservation perspective t defining biodiversity, this is in line with the measure of biodiversity we chose - total, threatened and restricted range species and flagship species.

1.3 Aims and objectives

The central aim of this thesis is to assess the potential for the REDD+ climate mechanism to deliver biodiversity benefits and how these benefits can be maximised and the potential for harm minimised. I assess this at two levels; first I consider a broad overview looking at biodiversity considerations at the international negotiations and across a broad range of early REDD+ initiatives, second, I focus on Indonesia and investigate REDD+ implementation at the national and sub-national scale.

I begin with the aim to strengthen the understanding of opportunities and risks for biodiversity in the REDD+ mechanism by bringing together the disparate literature on this topic, covering theoretical work, policy pieces, and analysis of case studies. To do this I developed a conceptual framework on opportunities and risks for biodiversity and use the framework to clearly demonstrate the difference between safeguards and co-benefits in REDD+. Using this conceptual framework, I aim to investigate how biodiversity considerations are being incorporated into the design of early REDD+ initiatives and consider how this influences the potential of these projects to impact biodiversity. I also explore the key challenges faced by these initiatives in delivering biodiversity benefits on the ground.

I then focus on REDD+ at the national scale where I investigate the potential for REDD+ projects, as they are being implemented, to deliver additional gains for biodiversity conservation. I do this by assessing the spatial co-location of carbon, biodiversity and deforestation threat at the national and sub-national level. I also assess the potential for current REDD+ projects to delivery biodiversity benefits based on where they are located on the landscape. Finally I assess challenges faced by two projects on the ground in Indonesia (selected to represent the extremes in terms of the degree to which biodiversity concerns were included in their design) and how these implementation challenges have influenced their potential impact on biodiversity. I explore the barriers for biodiversity conservation from REDD+ implementation in Indonesia and its implications for the Bornean orangutan and its habitat.

1.4 Thesis structure

In this introduction (Chapter 1), I demonstrate why REDD+ has important implications for biodiversity conservation and present a background to the thesis. In **Chapter 2**, I present a conceptual framework for assessing opportunities and risks for biodiversity in the REDD+ mechanism, demonstrate how safeguards and co-benefits are different, and why safeguards alone will not be sufficient if REDD+ is to contribute to the mitigation of climate change and global biodiversity loss. In **Chapter 3**, I use the conceptual framework developed in Chapter 2 to investigate how biodiversity considerations are being incorporated in the design of sub-national REDD+ initiatives (using interviews with lead developers of 22 REDD+ initiatives in six countries). I also explore some of the key challenges faced by these REDD+ pioneers in delivering biodiversity benefits on the ground. In **Chapter 4**, I explore the relationship between carbon and biodiversity at the national and sub-national level in Indonesia. I then assess the potential for first generation REDD+ initiatives in Indonesia to deliver biodiversity benefits based on where they are located relative to where high carbon, high biodiversity, and high deforestation threat are located. Chapter 4 is divided into two parts. **Part I** contains the introduction, main methods and results, discussion. **Part II** contains additional information relating to the methods including details about the data sets used in the analysis, and further analysis not included in the main paper. In **Chapter 5**, I take an in-depth look at two of Indonesia's earliest REDD+ projects. Both have recently been approved but with considerable challenges especially in a slow REDD+ permit approval and large reductions in the approved project areas. I evaluate these challenges and their potential impact on the Bornean orangutan (a conservation flagship species at both projects) and their habitat. In **Chapter 6**, I discuss the progress of REDD+ both at the international negotiations and in Indonesia, I highlight some of the major contributions it makes to biodiversity conservation issues in the REDD+ mechanism. I also discuss the challenges faced and limitations of my work in this thesis and provide some suggestions for future research.

1.5 Authorship

In order to aid publication of the thesis, all chapters in this thesis have been prepared as manuscripts for peer review journals. Since the papers have multiple authors, I use the pronoun ‘we’ rather than ‘I’ throughout the body of the thesis. However, the input from my co-authors were limited to supervisory support and advice, provision of data and commenting on drafts. At the time of submission, Chapter 4 has been accepted for publication. Chapters 2 and 3 (combined) and Chapter 5 are in preparation for publication. Below I outline the contribution of the co-authors to each chapter.

Chapter 2 and 3: I conceived the study idea and design with Julia Jones (my main supervisor) and Sven Wunder (my co-supervisor who is an expert on REDD+ and Principle scientist at CIFOR). William Sunderlin (Scientist at CIFOR and Leader of the Global Comparative Study on REDD+) made the survey data in this analysis available. I analysed the data and wrote the chapters which were extensively commented on by Julia Jones and Laura Secco. Julia and I also co-authored a briefing paper (Murray & Jones, 2014) based on my work on these two chapters which was widely distributed at the UNFCC conference in Lima (COP20) as part of a safeguards information package (Appendix 6).

Chapter 4: this chapter has been accepted for publication as:

Murray, J.P., Grenyer, R., Wunder, S., Raes, N. & Jones, J.P.G. (2015) Spatial patterns of carbon, biodiversity, deforestation threat and REDD+ projects in Indonesia. *Conservation Biology* (in press).

I conceived the study idea and design with Julia Jones and Sven Wunder. Richard Grenyer (a spatial statistician from Oxford University) and I developed the methods for the congruence analysis. Niels Raes (Research Fellow at the Naturalis Biodiversity Centre in the Netherlands) developed the plant SDM used in the analysis. I wrote the paper with advice from Julia Jones and all co-authors commented on the draft of the paper.

Chapter 5: I conceived the study idea, analysed the data and wrote the chapter. Shijo Joseph (Research Fellow at CIFOR) provided the land cover maps used in the analysis. Erik Meijaard

(People & Nature Consulting International), Gail Campbell-Smith (International Animal Rescue) and Mark Harrison (Orangutan Tropical Peatland Project - OUTrop) provided the majority of unpublished orangutan datasets used in this analysis available, they also commented and helped improve on the orangutan density analysis. Julia Jones provided advice on the analysis. Sven Wunder commented on the draft of the chapter.

Chapter 2

BIODIVERSITY IN REDD+

Moving beyond safeguards to delivery biodiversity co-benefits

2.1 Abstract

Land use change and climate change are the two major drivers of biodiversity loss in the tropics. The mechanism to Reduce Emissions from Deforestation and Forest Degradation (REDD+) therefore has the potential to tackle these two major challenges simultaneously and deliver high benefits for biodiversity (termed co-benefits). However, there are concerns that if not properly designed, REDD+ activities could pose a risk to biodiversity. Safeguards were introduced at the international negotiations to mitigate risks for biodiversity however, safeguards alone will not be sufficient if REDD+ initiatives intend to delivery biodiversity co-benefits (because they only aim to avoid harm). In this chapter, we discuss the progress of the discussion on biodiversity co-benefits and safeguards at the international negotiations and draw a clear distinction between them. We then identify five key REDD+ features that have the potential to deliver opportunities as well as put biodiversity at risk: the location of REDD+ initiatives, REDD+ financing options, the scope of REDD+ interventions, the role of REDD+ actors and their interests, and the design of REDD+ initiatives. Using this conceptual framework we present the opportunities and risks for biodiversity, bringing together the literature on safeguards and co-benefits for biodiversity. We emphasize the importance for the REDD+ initiative to move beyond a risk-based approach to realizing opportunities for biodiversity. We conclude that existing safeguards need to be revised to ensure that biodiversity is not harmed by REDD+, and that additional investment will be needed to ensure REDD+ delivers its potential to positively impact biodiversity.

2.2 Introduction

The synergistic effects of habitat loss and climate change is predicted to create a double jeopardy for many threatened species and the implications are especially worrying in the tropics where deforestations rates are high (Struebig *et al.*, 2015a). Incentives to reduce emissions from deforestation and forest degradation (REDD+) as is being proposed at United Nations Framework Convention on Climate Change (UNFCCC) could, at least in principle, simultaneously tackle both of these major challenges.

The REDD+ mechanism proposes to incentivise landowners for keeping their forests standing which is expected to have huge positive effects on tropical forests' biodiversity because it prevents habitat loss, one of the key drivers of species loss in the tropics. REDD+ also has the potential to deliver additional benefits for biodiversity termed "co-benefits" which could include the rehabilitation of threatened forest ecosystems (Miles & Dickson, 2010), supplementing current shortfall in conservation funding (Waldron *et al.*, 2013) and the opportunity to address direct threats to biodiversity such as poaching and illegal logging (Imai *et al.*, 2014). It has even been suggested that the long term success of REDD+ forests to sequester carbon will depend on the state of its biodiversity (Díaz *et al.*, 2009; Hinsley *et al.*, 2015). However there are also concerns that if not properly planned, REDD+ could instead negatively impact biodiversity (Harvey *et al.*, 2010; Miles & Dickson, 2010; Paoli *et al.*, 2010). Negative impacts could arise from a carbon focused REDD+ implementation and / or interests to produce carbon credits at the lowest possible cost (Miles & Dickson, 2010; Phelps *et al.*, 2011; Venter & Koh, 2011). Concerns about the impacts of REDD+ on biodiversity led to the development of safeguards for biodiversity at the UNFCCC COP 16 in Cancun (UNFCCC, 2011b). It is also widely acknowledged that REDD+ has the potential to deliver additional benefits for biodiversity in the tropics at only a marginal increase in cost (Phelps *et al.*, 2012a; Venter *et al.*, 2013a). However, for REDD+ to realise its potential to deliver additional benefits for biodiversity, it will need to go beyond the minimum requirements of the Cancun safeguards (Pistorius *et al.*, 2010).

In this chapter, we first discuss the progress of the international negotiation on safeguards and co-benefits. We then draw a clear distinction between biodiversity safeguards and co-benefits, terms that are often conflated when discussing biodiversity in REDD+. Drawing on the safeguards and co-benefits literature, we developed a conceptual framework for opportunities and risks for biodiversity in REDD+. The conceptual framework is based on five key REDD+ features most likely to impact biodiversity: the location of initiatives, the financing of activities, the scope of REDD+, actors and their interests, and the design and implementation of initiatives on the ground. Lastly, we offer recommendations on how opportunities for biodiversity can be realised if REDD+ is to contribute to slowing biodiversity loss in the tropics. Throughout this chapter, we use the term "REDD+ mechanism" to broadly include the prospective regulated regime as well as the currently implemented voluntary carbon market.

2.3 Biodiversity co-benefits and safeguards at the international negotiations

The financial incentive to reduced emission from deforestation (RED) was first proposed to be included as a mitigation option in the post-Kyoto climate regime at the 2005 COP11 in Montreal. However, biodiversity concerns only entered the international negotiations in 2007 in Bali (COP 13) when the scope of RED was expanded to REDD plus (REDD+) to include the role of conservation, sustainable management of forests and enhancement of forest carbon stocks - Decision 1/CP. 13 - para 1b (UNFCCC, 2008) (Figure 2.1). The Bali Action Plan stated, for the first time, the term "co-benefit" (although not explicitly referring to biodiversity co-benefits) and the potential contribution of REDD+ to the Convention of Biological Diversity - Decision 2/CP.13. Biodiversity issues were formally discussed at the 2009 COP15 in Copenhagen when the UNFCCC recognised the importance of promoting biodiversity co-benefits in the REDD+ mechanism - Decision 4/CP. 15 (UNFCCC, 2010) largely due to widespread concerns for biodiversity from the expanded scope of REDD+.

Key outcomes for biodiversity were achieved at the COP16 in Cancun with the decision known as the Cancun Agreements - Dec. 1/CP.16 (UNFCCC, 2011b) where safeguard provisions for biodiversity conservation were introduced in order to avoid harm for biodiversity – Figure 2.1. The Cancun Agreement called for biodiversity to be promoted and supported by ensuring that REDD+ actions do not result in the conversion of natural forests to plantations, but instead be used to incentivize the conservation of natural forests and their ecosystem services, and enhance environmental benefits - Appendix 1-para (e)(UNFCCC, 2011b). While the negotiation text reads promisingly, it was considered ambiguous and could not be readily implemented (Swan *et al.*, 2011; McDermott *et al.*, 2012).

At the 2011 COP17 in Durban, the UNFCCC adopted guidance on developing Safeguard Information Systems (SIS), to ensure that "safeguards are promoted and respected", with "transparency, consistency, effectiveness and comprehensiveness"(Decision 12/CP.17) -

Figure 2.1. In Doha the following year, no new decisions were made regarding biodiversity. However, two components of decision one (Decision 1/CP18) were relevant to the delivery of biodiversity co-benefits: the inclusion of ways to incentivize non-carbon benefits (which includes biodiversity benefits) in the 2013 work program (Decision 1/CP.18 - para 29b); and a request to the Subsidiary Body for Scientific and Technological Advice (SBSTA) at its 38th session (Bonn, June 2013) to initiate work on methodological issues related to non-carbon benefits (Decision 1/CP.18 -para 40). The Warsaw Agreement, established at the 2013 COP 19, required that countries start reporting about their SIS by providing a summary report to the UNFCCC every two years in order to be eligible for results-based financing (Decision 12/CP.19) – Figure 2.1. At Warsaw it became evident that the UNFCCC will only incentivize the delivery of carbon benefits within the REDD+ mechanism, however, incentives will be contingent upon reporting on how safeguards are being respected (UNFCCC, 2013).

Decisions for the recent Conference of Parties in Lima (COP 20) were not available at the time of writing. However, prior to the COP 20 negotiations, the SBSTA invited parties to submit their views on experiences, lessons learned and the challenges they face in developing national SIS. Because national circumstances for addressing and respecting REDD+ safeguards vary from country to country, some parties noted there was a lack of guidance on what information should be included but others felt no additional guidance was necessary. Challenges such as cost, difficulty in engaging with the relevant stakeholders, and linking sub-national with national systems were outlined by parties (UNFCCC / SBSTA, 2014). See Figure 2.1 below for the timeline featuring key biodiversity decisions at the UNFCCC and the evolution of biodiversity concerns in REDD+ since it first emerged in 2007.

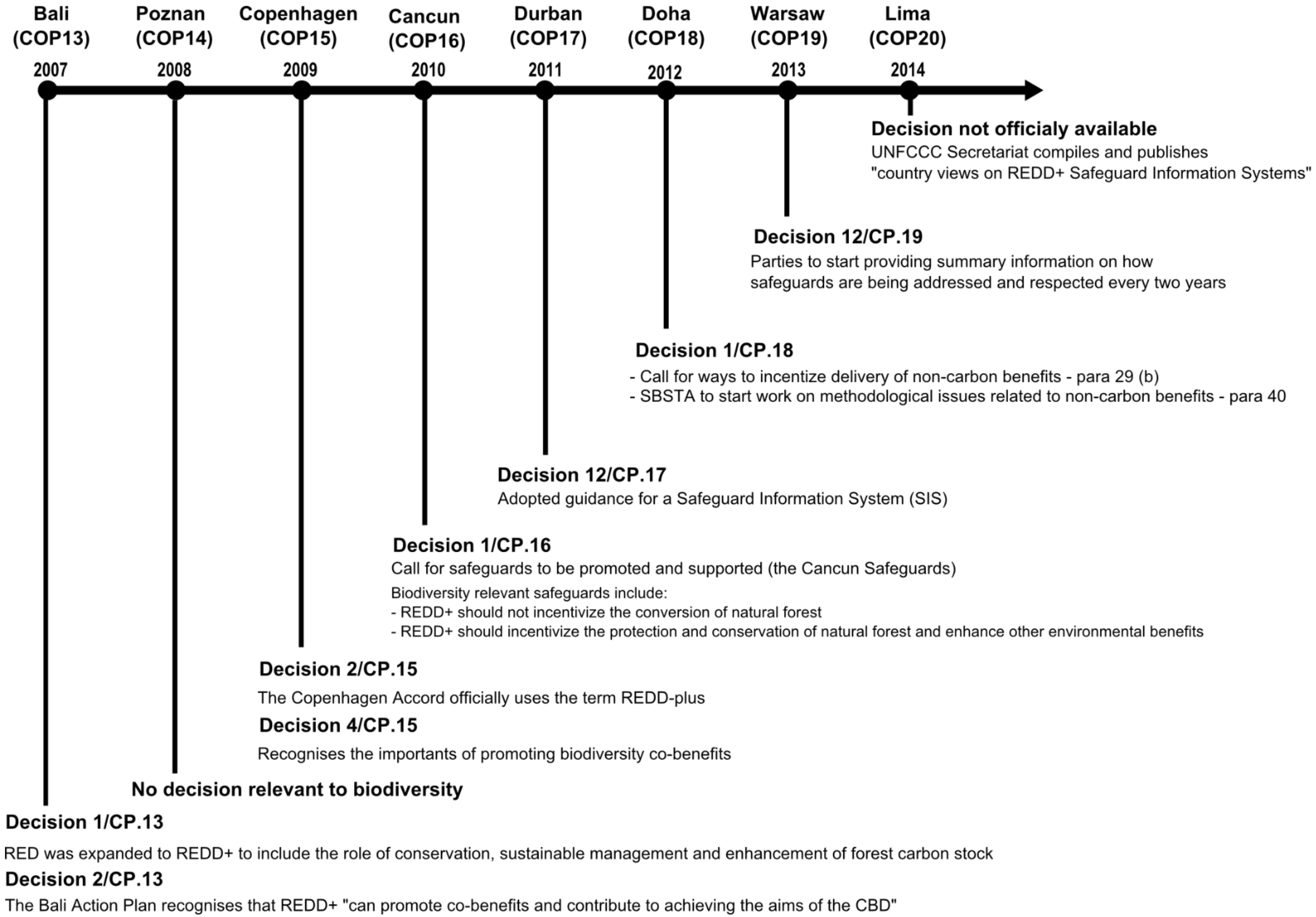


Figure 2.1: Timeline of key biodiversity decisions at the UNFCCC and the evolution of biodiversity concerns in REDD+ since it first emerged in 2007.

2.4 Safeguards vs Co-benefits

The terms 'safeguards' and 'co-benefits' have both been used at the UNFCCC negotiations to discuss issues related to biodiversity – Figure 2.1. However, the terms have been used somewhat interchangeably sometimes under the assumption that safeguards will deliver biodiversity co-benefits in REDD+ and confusion about these terms still exists among the political, scientific and NGO communities (Pistorius *et al.*, 2010; Arhin, 2014). Therefore, we clearly distinguish these two terms and demonstrate the importance of this distinction. REDD+ biodiversity safeguards have been defined as the "minimum requirement for all countries participating in REDD+ in order to avoid perverse and unintended harm to forest biodiversity" (Phelps et al. 2012b). Biodiversity co-benefits instead can be defined as "ancillary benefits in addition to carbon benefits obtained through the improved state of biodiversity from an agreed upon baseline through the activities implemented under REDD+" (Phelps et al. 2012b).

Based on these definitions and the way in which these have been discussed at the international negotiations, we propose that safeguards and co-benefits be viewed as being positioned along a spectrum - Figure 2.2. Safeguards are located at the centre (at a "zero" impact on biodiversity mark), describing the situation when REDD+ activities do not harm biodiversity nor deliver additional benefits for biodiversity conservation. Co-benefits are located on the right of the spectrum, where biodiversity value is positive, see Figure 2.2. REDD+ initiatives located at this end of the spectrum facilitate biodiversity conservation, delivering both carbon benefits and additional biodiversity benefits. REDD+ initiatives that do not have safeguards in place to avoid harm to biodiversity are located on the left of the spectrum (i.e. where the biodiversity value is negative) and have the potential to put biodiversity at risk.

Safeguards could also be viewed as a 'risk management approach' while co-benefits could be viewed as an 'opportunity realization approach' to managing biodiversity in REDD+. To realise additional benefits for biodiversity, REDD+ initiatives will need to go beyond the minimum safeguards by explicitly factoring biodiversity co-benefits into the planning, design and implementation of REDD+ projects on the ground in order to realise benefits for biodiversity In Figure 2.2. (Below), we present safeguards, co-benefits as well as opportunities and risks for biodiversity along a biodiversity spectrum.

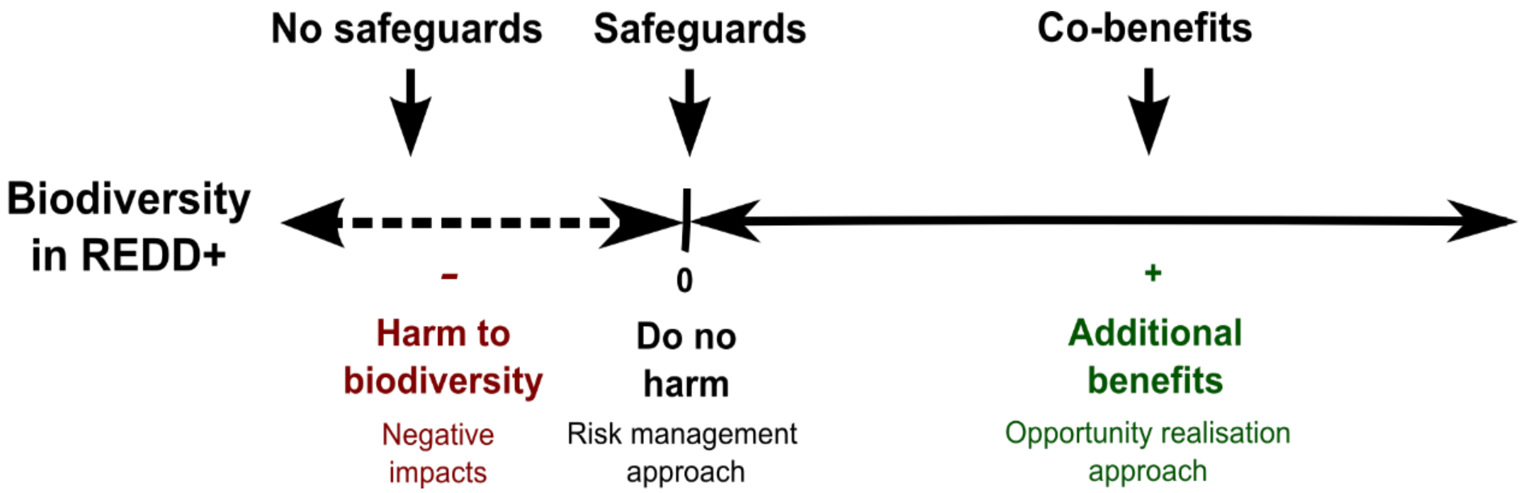


Figure 2.2: Biodiversity safeguards and co-benefits on the biodiversity spectrum

Note: The difference in the length of the biodiversity spectrum to the right and to the left of the 'zero' mark indicates the potentially large benefits for biodiversity associated with the REDD+ implementation.

2.5 A conceptual framework for opportunities and risks for biodiversity

The criteria that biodiversity must be safeguarded under REDD+ is well agreed on at international REDD+ negotiations, however, it is less well recognized whether REDD+ is expected to deliver co-benefits (Phelps *et al.*, 2012b). On one hand the Cancun safeguards call for REDD+ incentives to enhance environmental benefits (UNFCCC, 2011b), on the other hand, outcomes of the Warsaw Agreement cast doubt on whether REDD+ incentives will be used other than to incentivize carbon benefits - Figure 2.1. Here, we use a conceptual framework to highlight the opportunities and risks for biodiversity as well as options for the delivery of biodiversity co-benefits in the REDD+ mechanism based on a consolidation of findings from the vast literature on this topic.

From the literature, we identified five key REDD+ features most likely to have an impact on biodiversity at the national or sub-national level; these are 1) the location of interventions, 2) financing, 3) the scope of REDD+, 4) actors and their interests, and 5) the design of initiatives – Figure 2.3 (I to IV). Their order of appearance in the conceptual framework is based on the potential impact these features have on biodiversity moving from the National level (the location of REDD+ interventions) to the project level (design of REDD+ initiatives). Using these features, we assessed the opportunities (Figure 2.3 [O1 – O14]) and risks (Figure 2.3 [R1 – R14]) for biodiversity arising from REDD+ implementation. We demonstrate how REDD+ initiatives could avoid harm for biodiversity via “options for safeguard implementation” (Figure 2.3 [S1 – S13]) and / or deliver benefit for biodiversity conservation via the “options for additional benefits” (Figure 2.3 [B1 – R16]). We refer to “options for safeguard implementation” in the conceptual framework as the existing safeguards currently in place or new safeguards proposed in the literature in order to prevent harm for biodiversity; “options for additional benefits” are strategies or activities in which REDD+ initiatives could implement in order to realize opportunities for biodiversity.

In the following section, we expand on the conceptual framework by discussing each feature (I – IV). We briefly explain the rational for selecting the features used in the framework, followed by the potential risk (R) and opportunities (O) for biodiversity. We then discuss options to deliver biodiversity co-benefits (B) and safeguard (S). Some opportunities and risks for biodiversity affect more than one REDD+ feature; these links are not shown in the conceptual framework in Figure 2.3 but are described in the text.

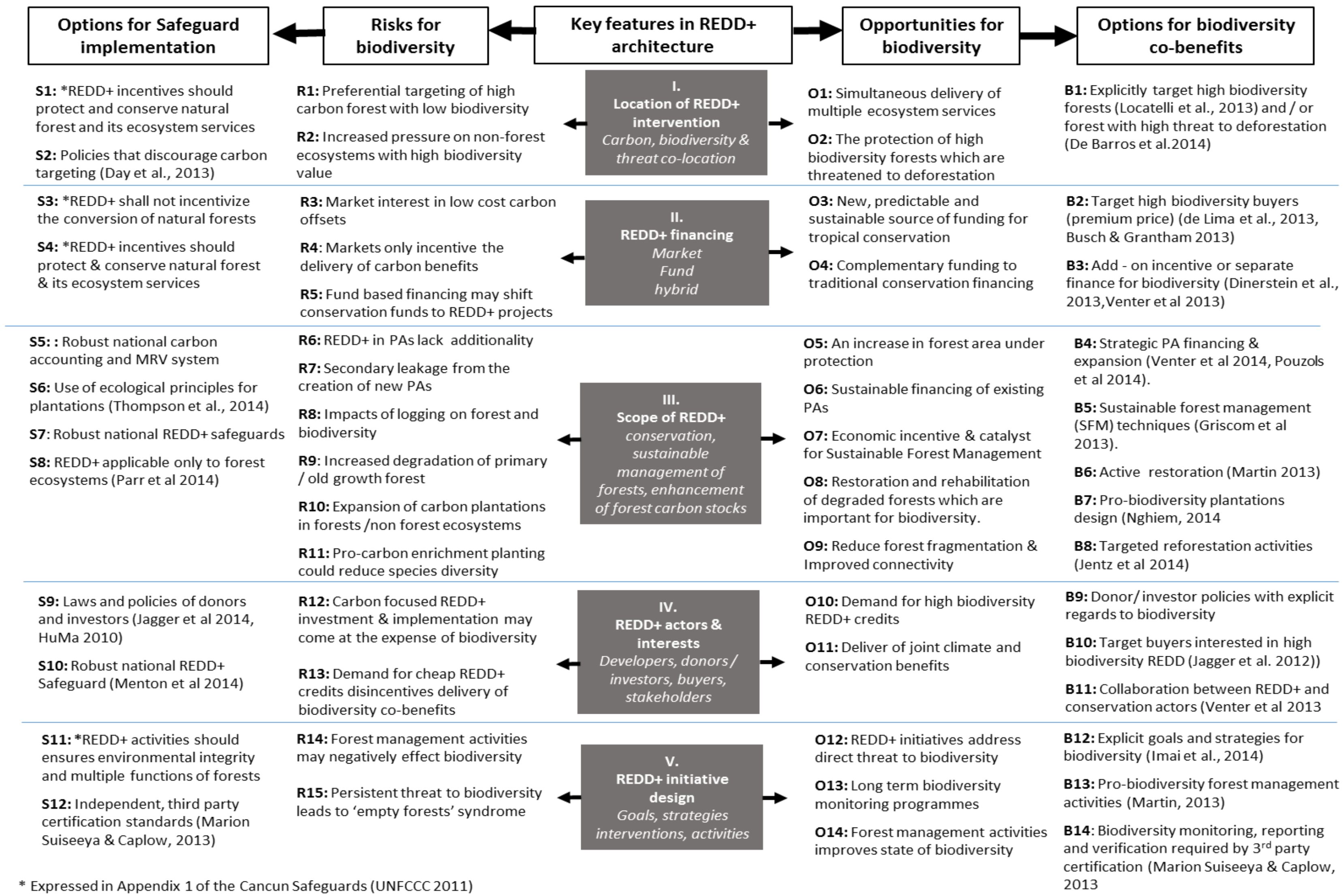


Figure 2.3: A conceptual framework showing five key REDD+ features (I-V), the opportunities (O1 - O14) and risks (R1 – R15) for biodiversity and options to safeguard biodiversity (S1 – S13) or delivery of biodiversity co-benefits (B1 – B14).

2.5.1 The location of REDD+ intervention

Tropical forest jointly provides carbon storage and biodiversity habitat, thus making it logical to integrate climate mitigation and biodiversity conservation in REDD+. Where REDD+ interventions are located could determine opportunities for biodiversity - Figure 2.3 (I). For example, initiatives strategically located in high carbon – high biodiversity forests have the potential to simultaneously deliver gains for carbon, biodiversity as well as other ecosystem services (Strassburg *et al.*, 2010). However, this is not always possible because places which have the highest carbon may not necessarily be the most important for biodiversity and vice versa (Paoli *et al.*, 2010; Thomas *et al.*, 2013; Venter *et al.*, 2013a)(See Chapter 4). Also, carbon and biodiversity are two very different ecological entities (Potts *et al.*, 2013), their spatial distribution is heterogeneous (Busch & Grantham, 2013), and they represent separate policy concerns (Phelps *et al.*, 2012b).

There are concerns that REDD+ developers will preferentially target areas with high carbon stocks which may not necessarily be the most important for biodiversity – Figure 2.3 (R1), thus directing funding for forest conservation away from high biodiversity areas – Figure 2.3 (R5). Carbon and biodiversity are correlated at the global scale but poorly correlated at national and sub-national scale i.e. the scale at which REDD+ will be implemented (Wendland *et al.*, 2010; Sangermano *et al.*, 2012; De Barros *et al.*, 2014)(also see Chapter 4). Preferential targeting of high carbon areas for REDD+ may increase pressure on forests with lower carbon but high in biodiversity (Harrison & Paoli, 2012; Day *et al.*, 2013) or non-forest ecosystems with high biodiversity value such as tropical grassy biomes (Parr *et al.*, 2014) and *Cerrado* grasslands (Paoli *et al.*, 2010) - Figure 2.3 (R2). Currently, safeguards established at the international negotiations call for REDD+ incentives to protect and conserve natural forests and their ecosystem services - Figure 2.3 (S1)(UNFCCC, 2011b) but safeguards do not prevent preferential targeting of forests purely based on carbon. Therefore, national REDD+ policies play an important role ensuring that REDD+ activities are prioritized in species-diverse forests and not just in high carbon forests (Day *et al.*, 2013)- Figure 2.3 (S2).

There is evidence of a lack of congruence between carbon and biodiversity at the national level (Egoh *et al.*, 2009; Wendland *et al.*, 2010) and sub-national level (Law *et al.*, 2014)(see Chapter 4). Therefore, spatial targeting in favour of biodiversity has been considered essential if REDD+ is to maximize delivery of biodiversity co-benefits as well as other ecosystem service (Venter *et al.*, 2013a; Jantz *et al.*, 2014; Struebig *et al.*, 2015b) - Figure 2.3 (B1). Studies have shown that such targeting can deliver improved outcomes for biodiversity and other ecosystem services with little reductions in carbon benefits - Figure 2.3 (O1). In a Costa Rican case study, Locatelli et al. (2013) found that targeting high biodiversity areas had the greatest co-benefits for other ecosystem services (e.g. biodiversity conservation, carbon sequestration, water regulation and scenic beauty) while targeting high carbon areas had the lowest. In a sub-global analysis, Thomas et al. (2013) found that a combined carbon-biodiversity strategy simultaneously protected 90 percent of carbon stocks (relative to a carbon-only conservation strategy) -Figure 2.3 (O1). Protecting forest with high threat to deforestation provides has the opportunity to protect both the biodiversity and trees within it – Figure 2.3 (O2) (De Barros *et al.*, 2014). Spatial targeting in favour of areas important for biodiversity, rather than just high in carbon, has been seen among early REDD+ initiatives such as those in Tanzania (Lin *et al.*, 2014), Brazil (De Barros *et al.*, 2014), and Indonesia (Chapter 5). Options to deliver additional benefit in REDD+ will therefore require that REDD+ initiatives explicitly target forests important for biodiversity if it intends to do more than just avoid harm to biodiversity (Locatelli *et al.*, 2013); especially if these are located in forests which are most threatened with deforestation (De Barros *et al.*, 2014) - Figure 2.3 (B1).

2.5.2 REDD+ financing

REDD+ was originally conceived as a market-based carbon offsetting mechanism where developed countries, socially responsible buyers, or individuals pay developing countries or landowners to reduce deforestation and forest degradation below a counterfactual scenario (Jagger *et al.*, 2014). Future REDD+ financing could potentially include market mechanisms (regulatory or voluntary), non-market mechanisms (fund based financing), or a combination of these (hybrid mechanism) – Figure 2.3(II) (Phelps *et al.*, 2012a). Currently, market based REDD+ financing is exclusive to the voluntary forest carbon market which have been traded in small quantities since 2009 (Goldstein *et al.*, 2014). The majority of financing in the ‘readiness’ phase of REDD+ has been fund based, coming from official development aid through both bilateral and multilateral channels (Angelsen *et al.*, 2014).

Because REDD+ is a climate mechanism, incentives will be based on the amount of carbon stored in the forest, therefore there are concerns that REDD+ could incentivize the prioritization of carbon at the expense of biodiversity. Further, attempts to achieve efficient emission reduction via a market-based REDD+ mechanism (reduce emission at the lowest possible price) (Angelsen *et al.*, 2014), could drive the establishment of carbon plantations which have little or no biodiversity value, avoid deforestation in areas with the lowest threat to deforestation (lowest opportunity cost) or carry out pro-carbon forest management activities which are harmful for biodiversity - Figure 2.3 (R3). There are also concerns that in the interest of reducing project cost, REDD+ developers would avoid additional activities associated with the delivery of biodiversity benefits such as additional planning and monitoring of biodiversity (Stewart *et al.*, 2010) - Figure 2.3 (R4). Some argue that a fund based REDD+ finance or hybrid (market + funds) financing will better serve a joint carbon-biodiversity agenda because it will not subject biodiversity to the unpredictability and volatility of a market mechanism (Phelps *et al.*, 2011). However, there are concerns that a fund based incentive mechanism may shift limited traditional conservation funds away from the protection of areas important for biodiversity into purely carbon rich areas; or conservation projects will need to compete with REDD+ initiatives for the same pool of funding - Figure 2.3 (R5) (Paoli *et al.*, 2010; Phelps *et al.*, 2012b).

REDD+ has been seen as a new source of predictable and sustainable financing for tropical conservation - Figure 2.3 (O3). However, studies have shown that pro-biodiversity REDD+ initiatives will cost more to implement and therefore how REDD+ is financed will determine how much REDD+ initiatives are able to prioritize the delivery of non-carbon benefits such as biodiversity conservation (Harvey *et al.*, 2010). Unless there are incentives to deliver additional biodiversity benefits (directly or indirectly) it is possible that projects will not make the extra effort. Busch (2013) found that money spent on a mixture of carbon payments and biodiversity payments have the potential to incentivize the provision of greater climate benefits more than an equal amount of money spent only on carbon payments –Figure 2.3 (O4). From a strict biodiversity perspective, Venter *et al.*, (2013a) found that the most effective way to finance biodiversity conservation in the presence of a REDD+ project is for biodiversity actors to allow the REDD+ project to protect forests that are REDD+ priorities, and then use biodiversity funds to protect the remaining, usually lower carbon areas – Figure 2.3 (O4). This is especially important in light of the decision made at the 19th COP in Warsaw indicating that REDD+ funds will unlikely incentivize the delivery of benefits other than carbon. Finance to supplement the delivery of biodiversity benefits could come from premium payments or by explicitly targeting buyers interested in purchasing high biodiversity REDD+ credits (Busch, 2013; de Lima *et al.*, 2013; Dinerstein *et al.*, 2013) – Figure 2.3 (B2). Hybrid financing mechanisms which includes add-on incentives could potentially finance the additional cost associated with the protection of biodiversity without burdening the REDD+ initiative or compromise the delivery of carbon benefits - Figure 2.3 (B3) (Dinerstein *et al.*, 2013; Potts *et al.*, 2013; Venter *et al.*, 2013a). More recently, there is a focus on non-market led / fund based financing of biodiversity in the REDD+ mechanism because this is potentially more efficient, flexible, and better suited to mobilise sufficient finance for biodiversity conservation than a hybrid approach - Figure 2.3 (O3) (Streck, 2012).

Currently, the Cancun Safeguards prevents REDD+ incentives from being used for the conversion of natural forests but instead these incentives should be implemented to protect and conserve natural forests and their ecosystem services – Figure 2.3 (S3 & S4)(UNFCCC, 2011b). Irrespective of the financing mechanism, high biodiversity non-forest ecosystems will be at risk as long as what is considered a forest is not clarified by the UNFCCC (Parr *et al.*, 2014) and remaining natural forest will be lost if the UNFCCC forest definitions do not differentiate between natural, modified and planted forests (Pistorius *et al.*, 2010; Putz K.H., 2010).

2.5.3 Scope of REDD+

The scope of REDD was expanded to REDD+ in order to maximize potential climate contributions from other forest land use and minimise leakage (international and intra national). This was achieved by including as many forest land use categories in the REDD+ mechanism (Harvey *et al.*, 2010) and allowing ‘high forest low deforestation countries’ to be eligible to participate in REDD+ (Harvey *et al.*, 2010; Angelsen *et al.*, 2012). However, the expanded scope of REDD+ has created the most concerns for biodiversity conservation, especially the enhancement of forest carbon stock (Lawlor *et al.*, 2010; Epple *et al.*, 2011) – Figure 2.3 (III)

Conservation of forest carbon stock: This scope of REDD+ is often shortened to imply conservation of forest. There are concerns that forest conservation in REDD+ would lack additionality if existing protected areas are labelled as REDD+ projects and receive payment for carrying out activities that would have been implemented anyway, without REDD+ financing – Figure 2.3 (R6) (Busch & Grantham, 2013). Further, the majority of national Protected Area (PA) networks are located in areas biased towards higher elevation, steeper slope, and greater distance from roads and cities (Joppa & Pfaff, 2009) and only a minority of national PA networks are located in species-rich ecosystems (Pouzols *et al.*, 2014). Therefore, REDD+ implementation in PAs could be an inefficient use of REDD+ financing and could potentially direct scarce conservation funds away from highly threatened forests which are important for biodiversity – Figure 2.3 (R5) (Venter *et al.*, 2013a). There are concerns that the creation of protected areas or conservation areas via REDD+ could cause both primary and secondary leakage through the displacement of land use pressure - Figure 2.3 (R7)(Miles & Dickson, 2010; Epple *et al.*, 2011; Venter & Koh, 2011).

However, this scope of REDD+ is expected to have the highest benefits for biodiversity because it creates an incentive to conserve large tracks of forests (regardless whether the forests are threatened or not) (Harvey *et al.*, 2010) and provides an opportunity to include protected areas in REDD+. In a sub-national analysis for Indonesia, improving protected areas management was one of the most cost effective means to reduce deforestation and forest degradation and provide substantial biodiversity co-benefits (Venter *et al.,* 2013b). Global PAs currently cover a small area and are performing at a 'barely acceptable' level, largely due to inadequate or unpredictable funding (Leverington *et al.*, 2008). A substantial number of PAs are exposed to high levels of threats from encroachment and forest degradation (Curran *et al.*, 2004; Gaveau *et al.*, 2012; Vidal *et al.*, 2013). REDD+ therefore has the potential to assist countries meet their commitment under the Convention of Biological Diversity's Aichi Targets[1] to expand global PA network from 13 % to 17% by 2020 - Figure 2.3 (O5).

For PA expansion to positively benefit biodiversity, new PAs created under the REDD+ label must have adequate and sustainable finances to carry out effective management - Figure 2.3 (O6) (SCBD, 2011; Venter *et al.*, 2014). REDD+ financing of existing PAs and the creation of new PAs should also spatially target forests that are the most threatened by deforestation in order to truly delivery additional benefits for climate and biodiversity (Pouzols *et al.*, 2014) – Figure 2.3 (B4). Safeguards for risks associated with leakage and additionality are applicable at the national level and are beyond the scope of international safeguards but should be incorporated into national SIS – Figure 2.3 (S5). To ensure additionality, robust carbon verification standards require some form of additionality test to be satisfied (McFarland, 2011) - the same should be expected of forest conservation type REDD+ initiatives under the UNFCCC, i.e. REDD+ initiatives pursuing forest conservation should be able to demonstrate that REDD+ incentives are essential for the effective management of the PA - Figure 2.3 (S5)**.** Under a dynamic land use system, leakage is often unavoidable but manageable and quantifiable (Henders & Ostwald, 2012), REDD+ can reduce leakage-related risks to biodiversity, via robust national REDD+ rules and accounting - Figure 2.3 (S5)(Harvey *et al.*, 2010).

Sustainable Management of Forest: Sustainable management of forest was included in the REDD+ mechanism to accommodate the interests of countries with active commercial forestry (Angelsen *et al.*, 2012) which is a key contributor to global greenhouse gas emissions from deforestation of forest degradation (Pearson *et al.*, 2014; Abood *et al.*, 2015). The

[1] http://www.cbd.int/sp/targets/

inclusion of sustainable management of forest in the scope of REDD+ could potentially impact both carbon and biodiversity since large extents of tropical forests (approximately 400 million hectares) are being managed as estates for permanent timber harvest (Edwards *et al.*, 2014).

There are concerns however that the expanded scope of REDD+ to include sustainable management of forests could incentivise commercial logging, something conservationists are particularly concerned about because all forms of logging are harmful to certain species (Edwards *et al.*, 2012b) - Figure 2.3 (R8). If REDD+ incentives are used to subsidize logging on land previously considered uneconomical to harvest (Griscom & Cortez, 2013), some of which will be old growth forests (Greenpeace, 2009; Stewart *et al.*, 2010), this would be a risk for biodiversity - Figure 2.3 (R9). These concerns remain valid because the scope of REDD+ has not been defined neither are appropriate safeguards or rigorous accounting methodologies in place to ensure that negative outcomes do not arise (Merger *et al.*, 2011).

When compared to conventional logging, forests managed under the principles of sustainable forest management (SFM) have a better opportunity to achieve climate mitigation benefits, avoid leakage and demonstrate clear additionality (Griscom & Cortez, 2013; Medjibe *et al.*, 2013; Venter *et al.*, 2013b; Brana-Varela, 2014; Fisher *et al.*, 2014; Griscom *et al.*, 2014; Pearson *et al.*, 2014). Sustainable forest management (SFM) practices such as the application of Reduced Impact Logging (RIL) can reduce emissions by 30-50% when compared to conventional logging (Griscom *et al.*, 2014). Emission reduction is achieved in RIL via activities such as careful pre-harvest planning, improved harvesting techniques, reduced harvest and post-harvest silvicultural treatments (Imai *et al.*, 2014; Pearson *et al.*, 2014); the impacts of these methods on biodiversity have been well tested and proven to benefit biodiversity in the long term – Figure 2.3 (B5)(Castro-Arellano *et al.*, 2007; Griscom & Cortez, 2013; Bicknell *et al.*, 2014). Selectively logged forests are known to harbour most of their biodiversity and retain much of their ecosystem functions including carbon storage (Struebig et al., 2013; Edwards et al., 2014).

However, the implementation of RIL can increase forest management cost substantially when compared to conventional logging, largely due to the additional activities involved as well as reduced harvest rates (Medjibe & Putz, 2012); perhaps explaining the low uptake of RIL in the tropics (Bicknell *et al.*, 2014). If REDD+ incentives could be used to encourage a shift from conventional logging to SFM in the tropics which will have increased benefits for biodiversity - Figure 2.3 (O7) (Brotto *et al.*, 2010). REDD+ activities in production forests could also incentivize the adoption of SFM in the tropics via the use of performance based, independent, third party forest certification standards such as the Forest Stewardship

Council's (FSC) certification. According to Griscom and Cortez (2013), in the absence of safeguards, independent third-party auditing systems such as those promoted in certification standards can act as a form of safeguard against unintended harm to forest and its biodiversity - Figure 2.3 (S7). There are high costs associated with getting a forest certified and currently, there is a lack of a premium price for timber coming from certified forests (Bloomfield, 2012). This perhaps explains why only a small percentage of forests in the tropics are sustainably managed and less than one percent are currently certified under some form of SFM standard (Griscom & Cortez, 2013). REDD+ incentives could finance SFM and catalyse the expansion of RIL and forest certification in the tropics - Figure 2.3 (O7) (Brotto *et al.*, 2010).

Enhancement of forest carbon stock: The opportunities for carbon and biodiversity arising from forest carbon stock enhancement activities are many especially since approximately half of tropical forests are degraded or have been subjected to some form of land clearing (Asner, 2009). Degraded natural forests can support high levels of biodiversity (Edwards *et al.*, 2010a,b; Struebig *et al.*, 2013) but often have a high risk for conversion due to their perceived low economic value (Edwards *et al.*, 2013). 'Enhancement of forest carbon stocks' referenced under REDD+ is generally seen as being different from the afforestation and reforestation (AR) activities which falls under the Clean Development Mechanism (CDM) (Olander *et al.*, 2012), the voluntary carbon market also considers AR as being different from REDD+ (Goldstein *et al.*, 2014).

Carbon stock enhancement through natural regeneration, diverse plantings of mixed species in degraded forest lands, improved forest management (Griscom & Cortez, 2013), and if enhancement helps promote landscape connectivity (Jantz *et al.*, 2014) could be positive for biodiversity. But could be negligible or negative if exotic monocultures are established (Lindenmayer *et al.*, 2012). Efforts to enhance forest carbon stocks through the expansion of carbon plantations (which have little or no biodiversity value) in natural forest or non-forest ecosystems will have negative impacts on biodiversity - Figure 2.3 (R10) (Epple *et al.*, 2011; van Asselt, 2011; Venter & Koh, 2011; Huettner, 2012; Lindenmayer *et al.*, 2012). While the Cancun safeguard provides some protection against the conversion of natural forest, there is no guidance on where, and under what conditions, forest carbon stock enhancement activities could be carried out. There are also concerns that REDD+ may incentivize selective species enrichment planting as a means to enhance forest carbon stock which could reduce overall floral diversity and threaten the fauna that depend on these plants - Figure 2.3 (R11) (Lawlor *et al.*, 2010).

Enhancement of forest carbon stock under the scope of REDD+ therefore has the potential to deliver positive outcomes for biodiversity in degraded landscapes via restoration and forest rehabilitation - Figure 2.3 (O8). The REDD+ financing could incentivize the restoration of degraded tropical forests which have been limited due to high costs associated with restoring high-diversity forest (Shoo & Catterall, 2013). Activities to enhance forest carbon stocks also have the opportunity to reduce forest fragmentation and improve connectivity – Figure 2.3 (O9). Reforestation of degraded mosaic forests such as those serving as important biodiversity corridors (Wendland *et al.*, 2010) or between protected areas is expected to deliver multiple ecosystem services at low economic opportunity costs (Jantz *et al.*, 2014).

Activities to enhance forest carbon stocks will not deliver additional benefits for biodiversity unless planning, designing and implementation of these activities are carried out with explicit regards to biodiversity conservation – Figure 2.3 (B6). Martin (2013) for example, found that because carbon pools and biodiversity have different recovery periods (80 and 100 years, respectively), passive restoration under natural regeneration will not benefit biodiversity; pro-biodiversity reforestation requires active management and human interventions such as planting of trees and seed dispersal - Figure 2.3 (B6). A typical plantation for timber production or carbon sequestration (monoculture, fast growing, short rotation) is not favourable for forest biodiversity (Brockerhoff *et al.*, 2008). Nghiem (2014) found that for timber plantations to be optimal for biodiversity conservation, a longer rotation cycle will be needed which will increase costs (Nghiem, 2014) - Figure 2.3 (B7). Spatial targeting of restoration activities in areas which have the highest benefits for biodiversity (such as biodiversity corridors) have high benefits for biodiversity then when randomly located in degraded landscape (Jantz *et al.*, 2014) – Figure 2.3 (B8).

2.5.4 REDD+ actors and their interests

It has been established that it is beyond the mandate of the UNFCCC to address biodiversity issues in more depth i.e. beyond safeguards which must remain general if it is to be applied at the international level (Pistorius & Reinecke, 2013)**.** REDD+ actors such as national governments, project developers, investors and donors, those buying REDD+ credits, institutions developing and verifying standards and the wider scientific community will have an influence on the degree to which biodiversity is considered in the design and implementation of REDD+ schemes and projects – Figure 2.3 (IV) (Thompson *et al.* 2011; Jagger *et al.* 2014). Few risks associated with REDD+ actors and their interests have been explicitly identified in the literature. The key concerns are that carbon driven REDD+ development and investment may prioritize the delivery of carbon at the expense of biodiversity - Figure 2.3 (R12); and the demand for cheap carbon offsetting opportunities by carbon credit buyers may disincentivise the delivery of biodiversity co-benefits which can be expected to have a higher cost per unit of carbon produced (Dinerstein *et al.*, 2013) - Figure 2.3 (R13. These risk mainly stem from the overall negative implications of a carbon a focused REDD+ which is closely linked to risks associated with REDD+ financing and the scope of REDD+ - Figure 2.3 (R1) & (R3).

There are however, many opportunities for REDD+ actors to contribute or influence the delivery of biodiversity co-benefits REDD+ (McDermott *et al.*, 2012). Donors and investors are inevitably the most influential group of actors and therefore have the ability to drive REDD+ initiatives based on their interests (Entenmann & Schmitt, 2013). Experience from first generation pilot projects show that all REDD+ initiatives will require some sort of start-up funding in order to launch their activities which could include the establishment of baseline information (carbon, biodiversity and social), project verification and third party certification and stakeholder engagement (Sills *et al.*, 2014, Chapter 3). Often these sources of funding come from donors (e.g., philanthropists, NGOs, multilateral donors) or investors (e.g., bi-lateral aid, banks). The main difference between donors and investors in the case of REDD+ is that donors (usually) do not expect a return on their investment, whereas investors use REDD+ initiatives with the intent to capture a share of credits in anticipation of a REDD+ regulatory market (Streck, 2012). However, both have been known to seek joint carbon-biodiversity outcomes in their REDD+ investment (Sills *et al.*, 2014). These actors have the responsibility to ensure that their investments do not harm biodiversity, they also have the ability to pressure REDD+ developers to not only avoid risks for biodiversity but also to deliver additional biodiversity benefits - Figure 2.3 (B9). For example, parties interested in accessing the World Bank's readiness funds are required to comply with the World Bank Operational Policies and their Strategic Environmental and Social Assessment. The UN-REDD programme has developed social and environmental principles and criteria in response while bilateral donors (e.g. the United States, Norway and Australia intend to develop safeguard policies) (Chapter 3). However, these safeguards currently reflect a "do no harm commitment" (Jagger *et al.*, 2012) instead of explicitly requiring that REDD+ activities also deliver additional benefits for biodiversity (McDermott *et al.*, 2012) - Figure 2.3 (B11)

Here we differentiate donors and investors from REDD+ credit buyers. Donors and investors are engaged at the onset of the REDD+ initiative and have the ability to influence early project design. In contrast, buyers are engaged much later in the REDD+ implementation process i.e. when carbon credits are ready to be sold therefore their influence on REDD+ initiatives differ. While REDD+ credits are currently only available in the voluntary carbon market, it can be expected that in the future regulatory market, REDD+ credit buyers would react the same towards REDD+ credits. Buyers with expectations for high biodiversity carbon credits and are willing to pay a premium for such credits could drive the supply of high biodiversity credit – Figure 2.3 (O10) (Jagger *et al.*, 2012). Increasingly, companies as part of their corporate social responsibility claims have shown a preference for high biodiversity REDD+ credits thus creating a niche market for such a demand (Goldstein *et al.*, 2014). Instead, buyers interested purely in offsetting their carbon emissions at the lowest possible cost will seek out cheap credits; this could flood the market place, bring the price of carbon down and reduce the incentive to deliver benefits other than carbon – Figure 2.3 (R10).

There are multiple actors which make up key stakeholders in REDD, with varying potential to influence the delivery of biodiversity co-benefits REDD+ (Pistorius & Reinecke, 2013). Where biodiversity actors, such as large environmental NGOs, are engaged with REDD+ they have a powerful role to play and can influence the biodiversity benefits from REDD+ (e.g. through selecting the location of the project - Chapter 3) – Figure 2.3 (B11). Venter et al. (2013) found that such collaboration also substantially reduces the cost of meeting both climate and biodiversity conservation targets when compared to a scenario where these two actors do not collaborate – Figure 2.3 (O11).

2.5.5 The design of REDD+ initiatives

The REDD+ mechanism was developed at the international negotiations to address the global issue of climate change. The UNFCCC compliance and reporting will likely be at the national scale but its implementation will be at the local scale, most likely at the sub-national or project level, as it is currently being implemented in the voluntary carbon market (a nested approach)(Sills *et al.*, 2014). Therefore at any REDD+ initiative the opportunities and risks for biodiversity will depend on the specific activities planned under the scope of REDD+; these include the extent to which biodiversity conservation is planned for, managed and monitored – Figure 2.3 (V) (Miles & Dickson, 2010). There are concerns that forest management activities for carbon could be counterproductive for biodiversity (R14), these are directly linked with the risks associated with the scope of REDD+ (Figure 2.3 [R6 – R11]). Such was seen in a community lead REDD+ initiative in Nepal, Pandey et al. (2014) reported a reduction in biodiversity (tree diversity) three years into REDD+ implementation, in favour of species which were fast growing with high carbon sequestration potential. Protecting forests for carbon will not automatically protect the biodiversity values within it because REDD+ forests will still be subjected to direct and indirect threats to biodiversity (Putz & Redford, 2010). The empty forest syndrome initially coined by Redford (1992) has re-emerged in the discussions of REDD+ risks for biodiversity (Putz & Redford, 2010; Wilkie *et al.*, 2011; Entenmann *et al.*, 2014; Hinsley *et al.*, 2015) largely warning of the potential negative impacts of ignoring direct and indirect threats to biodiversity – Figure 2.3 (R15). For example, hunting is proposed to have a greater negative impact on biodiversity than habitat loss and logging combined (Harrison *et al.*, 2013). Hunting will remain a threat for wildlife in REDD+ protected forest unless its boundaries are well secured from encroachment and hunting regulations are imposed.

Nonetheless, REDD+ initiatives have the opportunity to address threats facing biodiversity while delivering carbon sequestration benefits – Figure 2.3 (O12), however, this will require patrolling of the REDD+ project boundary and ensuring that direct threat to biodiversity is addressed. For example, initiatives located in forests where local communities depend on subsistence (hunting, timber and non-timber harvesting) will need to work closely with communities to determine sustainable harvesting rates as well as alternative livelihood options and, where applicable, payments from REDD+ should compensate for the restriction on forest (Hein & van der Meer, 2012) – Figure 2.3 (O12). Forest management under the REDD+ mechanism also offers the opportunity to carry out systematic biodiversity monitoring programmes which are crucial in order to assess the state of biodiversity as well as to assess the impacts of REDD+ forest management practices on biodiversity– Figure 2.3 (O13) (Harrison *et al.*, 2012; Entenmann *et al.*, 2014).

Requiring REDD+ initiatives to account for biodiversity in their design, planning and implementation may over complicate its design, increase the cost of REDD+ implementation and perhaps lead to a reduced uptake of REDD+. However, REDD+ initiatives which have explicit goals and strategies for biodiversity can be expected to deliver positive gains for biodiversity as well as address wider landscape level threat– Figure 2.3 (B12) (Imai *et al.*, 2014). Pro-biodiversity forest management practices such as those described in (B4 – B8) could ensure that forest managed under the REDD+ mechanism not only prevents harm for biodiversity but instead improve that state of biodiversity – Figure 2.3 (O14).

The role of private governance or non-state market driven governance such as voluntary certification schemes are considered an increasingly important system of safeguarding biodiversity in the REDD+ mechanism (Levin *et al.*, 2009; Marion Suiseeya & Caplow, 2013) – Figure 2.3 (S12). This is largely because carbon credit buyers at the voluntary carbon market are driven by global market demands, brand reputation and, corporate social responsibility where their success depends on their ability to respond to international concerns regarding environmental impacts. Independent third party certification standards such as the Climate, Community and Biodiversity Alliance's (CCBA), Plan Vivo Standards, and the Forest Stewardship Council (FSC) which have requirements for biodiversity conservation embedded in their standard and have been the main driver behind pro-biodiversity management activities among early REDD+ developers (Marion Suiseeya & Caplow, 2013) (See Chapter 3). REDD+ initiatives which adhere to robust voluntary certification standards not only safeguard biodiversity but also demonstrate delivery of additional benefit for biodiversity – Figure 2.3 (B14). Such voluntary schemes in turn provides an opportunity to monitor and better understand biodiversity trends in forests outside PAs, which have not been extensively studies in the pass.

2.6 Recommendations

It is evident that REDD+ can deliver many opportunities for biodiversity conservation however these opportunities often do not arise automatically; to achieve additional co-benefits, substantial investment will be needed. Here, we provide recommendation on how this could be achieved.

2.6.1 Looking beyond the Cancun safeguards

Safeguards are important to prevent harm to biodiversity in the REDD+ mechanism; however, safeguards cannot ensure the delivery of additional biodiversity benefits. Although we recognise the importance of keeping the safeguards at the UNFCCC level applicable to all REDD+ countries, we also stress that the Cancun Safeguards, in their current form, are not enough to prevent harm to biodiversity. Based on the current level of safeguards, some of the risks identified for biodiversity may not be prevented. For example, the Cancun Safeguards do not mention non-forest ecosystems or provide any form of safeguards for such ecosystems from being exploited for carbon. The Cancun Safeguards also do not address the problems associated with permanence in carbon stock; REDD+ initiatives that cannot deliver long-term carbon storage will only have short-term benefits for biodiversity and an overall net negative effects on climate and biodiversity. There is a need therefore to refine the Cancun Safeguards, especially if major national and sub-national safeguard initiatives such as the Forest Carbon Partnership Facility Strategic Environmental and Social Assessment and the UN-REDD Programme Social and Environmental Principles and Criteria are linking their safeguards to the UNFCCC safeguards (Latham *et al.*, 2014). Further refinement is also important because SIS required by the UNFCCC is based on the safeguards referred to in the Appendix 1 of the Cancun agreement. National level safeguard reporting to the UNFCCC should be strengthened and streamlined with other national biodiversity targets or commitments; such as the Convention of Biological Diversity or based on national conservation strategies and action plans to ensure that all sub-national REDD+ initiatives within the country work towards meeting the same national targets.

Robust national safeguards have an important role to play in safeguarding biodiversity and in ensuring that the integrity of environmental governance in REDD+ because in the context of forests, the most important policies directing management activities are defined at the national and subnational levels (McDermott, 2014) and REDD+ initiatives are legally accountable to the national laws. Based on the current 'nested' approach to REDD+ implementation i.e. national level reporting to the UNFCCC but sub-national implementation and taking into consideration multilevel governance of forests in developing countries, it is necessary for national safeguards to ensure that national biodiversity safeguards policies are effectively implemented at the sub-national level.

2.6.2 Incentives for the delivery of biodiversity co-benefits

In our framework (Figure 2.3) we show that opportunities for biodiversity in REDD+ are possible across the different REDD+ features. However, additional effort will be required from REDD+ developers at an increase in cost largely associated with additional planning and interventions, administrative costs associated with third party certification as well as opportunity cost loss from trade-offs between carbon and biodiversity. In light that the REDD+ mechanism under the UNFCCC will most likely only incentive the delivery of carbon benefit, REDD+ projects aiming at delivering biodiversity co-benefits will need to tap into other sources of financing. While explicitly targeting high biodiversity and threatened forests will offer the greatest benefits for biodiversity (Locatelli et al., 2013, De Barros et al.2014, Jantz et al 2014, Struebig et al., 2015) (Figure 2.3), it will also cost more to acquire (secure tenure) and protect (Thompson *et al.*, 2013). Therefore, it can be anticipated that REDD+ initiatives that deliver additional benefits for biodiversity will face higher costs. Incentives will play an important role in making co-benefits attractive to REDD+ initiatives because often what gets paid gets protected.

In our framework, we propose two key options for financing pro-biodiversity activities in REDD+, focusing more on financing mechanisms that do not burden the REDD+ mechanism in order to achieve greater gains for biodiversity. Due to the limited funds available to fund biodiversity conservation (Auerbach *et al.*, 2014), we stress the importance of conditionality when financing the delivery of biodiversity benefits in REDD+. Past conservation efforts have been implemented with little care about their effectiveness or measure of success (Kapos *et al.*, 2008; Laycock *et al.*, 2011). If biodiversity conservation via REDD+ is to be more effectively and efficient than traditional conservation approaches, financing of biodiversity conservation in REDD+ should be results-based i.e. conditional upon the delivery of biodiversity benefits.

2.6.3 What is the future for biodiversity in REDD+?

In spite of all the concerns for biodiversity and the emphasis on the importance for REDD+ initiatives to deliver additional benefits for biodiversity, we recognise that the progress made by REDD+ initiatives with regards biodiversity has thus far been encouraging. With regards to the location of REDD+ intervention, early REDD+ developers have been found to select forest with the highest ability to delivery biodiversity benefits (Cerbu *et al.*, 2011; Lin *et al.*, 2014). Studies in Tanzania (Lin *et al.*, 2012), Brazil (De Barros *et al.*, 2014) and Indonesia (See Chapter 5) suggest that REDD+ initiatives spatially target high-biodiversity areas instead of purely carbon-rich areas. As for REDD+ financing, there is increasing evidence that add-on incentives to supplement biodiversity conservation in REDD+ is possible (Busch, 2013), with examples of successful results-based carbon and wildlife premium projects in Kenya, Peru, and Nepal (Dinerstein *et al.*, 2013).

Our conceptual framework shows that the scope of REDD+ has the highest number of potential risks for biodiversity (as well as the most opportunities for biodiversity), with forest carbon stock enhancement interventions potentially the most risky. However, evidence from first generation REDD+ projects in six countries show that the most common intervention is forest carbon stock enhancement but not necessarily via the implementation of carbon plantations. Instead, projects proponents plan to implement a wide range of restoration and reforestation of degraded land which may have multiple benefits for biodiversity conservation and other ecosystem services (Sills *et al.*, 2014; Chapter 3). The focus of REDD+ initiatives on biodiversity has been strong, with over a third of REDD+ initiatives having conservation as their main objective (Simonet *et al.*, 2014). This is perhaps linked to the role of conservation NGOs in the readiness phase of REDD+; over half of global REDD+ initiatives are reportedly being spearheaded by conservation NGOs (Simonet *et al.*, 2014). There is currently little evidence that REDD+ investors / donors are requiring REDD+ initiatives to explicitly demonstrate the delivery of biodiversity benefits (Daviet *et al.*, 2013; Dinerstein *et al.*, 2013), however, there is strong indication in the voluntary carbon market of REDD+ credit buyers' willingness to pay more for carbon credits that deliver biodiversity benefits (Goldstein *et al.*, 2014). As a reaction to the demand for high biodiversity REDD+ credits, REDD+ initiatives have been inspired to design their initiatives in accordance with standards that verify the delivery of biodiversity benefits such as the Climate Community and Biodiversity standards (CCBA)(Merger *et al.*, 2011). The market share of voluntary carbon standards have also increased in favour of standards that embed co-benefits within the carbon methodologies such as the Gold Standard and Plan Vivo which sold their credits at above average prices (USD 8.5/tCO_2 for the Gold Standard and USD6.9/tCO_2 for Plan Vivo) (Goldstein *et al.*, 2014; Hinsley *et al.*, 2015). These are positive indications that early REDD+ actors (buyers and sellers) value biodiversity and that the future for biodiversity in REDD+ is encouraging.

2.7 Conclusion

At first glance, because REDD+ offers funding to slow deforestation and forest degradation it should be positive for biodiversity; the reality is more complex and REDD+ offers both opportunities and risks for conservation. Since 2007, concerns about the potential negative impacts of REDD+ on biodiversity have been formally recognised by the UNFCCC and a commitment to ensuring safeguards to mitigate these risks have been agreed. However, despite 7 years of discussions about how biodiversity threats can be minimised, and the potential benefits for biodiversity of the mechanism realised, progress of the REDD+ mechanism at the UNFCCC have been limited. Following the UNFCCC COP20 in Peru it remains unclear if REDD+ will be included as part of the post-Kyoto climate regime which will be decided in at the COP21 Paris in 2015. If it is, and if REDD+ funding is therefore increased globally, biodiversity benefits will not be automatic. Our conceptual framework shows how key features of REDD+ architecture can offer opportunities for additional biodiversity benefits. However, realising these benefits requires additional investment, human resources, expertise, time and effort. Ensuring safeguards for biodiversity are met is also non-trivial and may not occur without further investment and clarity from regulators.

CHAPTER 3

DO REDD+ PROJECTS CONSIDER BIODIVERSITY OUTCOMES?

Insights from 22 early initiatives in six countries

3.1 Abstract

As the REDD+ climate mechanism moves from 'readiness' towards a result-based implementation phase, lessons learnt from the over 300 first-generation REDD+ initiatives implemented on the ground are important to inform the post-Kyoto global climate regime. At the international negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) there have been discussion on the potential delivery of biodiversity benefits in REDD+, and safeguards have been developed to ensure that REDD+ will not harm biodiversity. However, we know little about the extent to which or how these good intentions are being translated into the planned design of REDD+ pilots.

In this chapter, we explored 22 early REDD+ initiatives located in six REDD+ implementing countries. Using key informant interviews with project proponents, we scrutinized how biodiversity considerations are being incorporated into the plans of early REDD+ initiatives. Responses from project proponents were assessed against five key REDD+ features we predict will have an impact on biodiversity: the location of REDD+ intervention, REDD+ financing, the scope of REDD+, REDD+ actors and their interests, and the design of REDD+ initiatives (Chapter 2). We then determined which of these REDD+ initiatives have the potential to deliver high gains for biodiversity, and assessed key implementation challenges.

The majority of the REDD+ projects in our sample were extensions of existing conservation or development initiatives perhaps explaining why we found the incorporation of biodiversity considerations are encouraging at many of these REDD+ projects. Voluntary certification standards which promotes the delivery of biodiversity co-benefits was a strong driver for biodiversity considerations at almost all projects. Yet, fulfilling their potential to deliver biodiversity benefits will depend on their capacity to develop robust biodiversity programs with additional funding beyond carbon-based finance. Ultimately, opportunities to deliver biodiversity as well as carbon benefits will depend on the ability for REDD+ incentives to compete with lucrative drivers of deforestation.

3.2 Introduction

The climate mechanism to reduce emission from deforestation and forest degradation and the conservation, sustainable management and enhancement of forest carbon stocks (REDD+) developed under the United Nations Framework Convention on Climate Change (UNFCCC) is nearing the end of its 'readiness' phase and moving towards a results based implementation phase. If and how REDD+ will be incorporated into the post-Kyoto global climate regime will be decided in Paris at the UNFCCC's 21st Conference of Parties (COP 21) in December 2015. In 2007, at the COP13 in Bali, the UNFCCC first provided the mandate for the feasibility of REDD+ to be tested on the ground via the development of pilot and demonstration activities (UNFCCC, 2008). REDD+ was initially planned as a national level initiative; however, much of the REDD+ action on the ground since Bali has been at the sub-national or project level, with over 300 initiatives launched as of late 2014 (Simonet *et al.*, 2014).

The Cancun Safeguards call for REDD+ activities to not only prevent harm for biodiversity but also to enhance environmental benefits (UNFCCC, 2010, 2011b); however, so far there is little empirical evidence on whether and how these intentions are being translated into the design and planned activities of REDD+ pilot initiatives on the ground. As the regulatory REDD+ mechanism is still being developed, and REDD+ implementation in the voluntary carbon market remains relatively limited (9% of the voluntary carbon market in 2013)(Peters-Stanley *et al.*, 2013), ex-post evaluation of REDD+ project impacts has not yet been possible (Caplow *et al.*, 2011), so claims remain speculative (Huettner, 2012). Therefore, pilot and demonstration initiatives are important testing grounds for REDD+ and they provide valuable insights as to how REDD+ might unfold which could inform future implementation(Lin *et al.*, 2012; Thompson *et al.*, 2013).

Various recent papers share experiences from REDD+ pilot projects on issues such as land tenure (Larson *et al.*, 2013; Awono *et al.*, 2014; Duchelle *et al.*, 2014; Sunderlin *et al.*, 2014b), Monitoring Reporting and Verification (MRV) of carbon benefits (Palmer Fry, 2011; Joseph *et al.*, 2013), REDD+ project governance (Markus, 2011; Korhonen-Kurki *et al.*, 2014) and impacts on communities (Maraseni *et al.*, 2014). To our knowledge, none have reviewed the question of how biodiversity issues are being incorporated into pilot projects, and what lessons can be learnt for the design of a future REDD+ regulatory mechanism. Here, we use a mix of key informant interviews and document review to assess how 22 early REDD+ initiatives in six countries plan to incorporate biodiversity considerations into their project design. We also explore the challenges faced by these early REDD+ movers in the delivery of biodiversity benefits at the project level. The 22 REDD+ initiatives used in this study are part of the larger Global Comparative Study on REDD+ (GCS-REDD+), initiated by the Center for International Forestry Research (CIFOR) to assess national and subnational REDD+ experiences in designing and implementing effective, efficient, and equitable REDD+ policies and projects.

3.3 Methods

We produced a conceptual framework for opportunities and risks for biodiversity, based on five key REDD+ features most likely to effect the delivery of biodiversity benefits (Chapter 2). The five features were selected based on a review of the literature and they are: 1) the location of REDD+ initiatives, 2) the source of REDD+ financing, 3) the scope of REDD+, 4) REDD+ actors and their interests, and 5) the design and implementation of REDD+ initiatives on the ground – Figure 3.1 (1 - 5). We assessed the 22 REDD+ initiatives against these features, and evaluated how REDD+ project proponents planned to incorporated biodiversity considerations into these design features. See Figure 3.1 for the overall study design and Figure 3.2 for the map showing the location of the 22 REDD+ initiatives in six countries.

3.3.1 Site Selection

All 22 REDD+ initiatives analysed in this study are part of the CIFOR's Global Comparative Study on REDD+ (GCS-REDD+) Module 2 on subnational implementation of REDD+ initiatives located in six countries – Figure 3.2. This study used baseline data collected by the GCS-REDD+ to obtain ex-ante insights on REDD+ development, and how biodiversity considerations are being incorporated into the design of early REDD+ initiatives on the ground. The GCS-REDD+ selected these countries based on the following criteria: a) key greenhouse gas emissions countries (e.g. Brazil and Indonesia), representing diverse stages of forest transition (e.g. high deforestation in Indonesia, low in Vietnam) and strong donor interest (Brazil, Indonesia and Tanzania) (Sunderlin *et al.*, 2010). Sills et al. (2014) tested the representativeness of the GCS-REDD+ sample to the wider global implementation at 329 initiatives in 47 REDD+ countries against key characteristics such as location (ecological zone / forest type) , lead proponent organisation type, and proportion selling carbon credits and found that the GCS-REDD+ sample was reasonably representative when compared to other REDD+ projects globally (Simonet *et al.*, 2014). Research findings from the GCS-REDD+ have been extensively featured in the literature covering issues such as land tenure and REDD+ (Larson *et al.*, 2013; Awono *et al.*, 2014; Duchelle *et al.*, 2014; Resosudarmo *et al.*, 2014; Sunderlin *et al.*, 2014b), Monitoring

Reporting and Verification (Joseph *et al.*, 2013), the political economy of REDD+ (Luttrell *et al.*, 2014), REDD+ implementation challenges (Sunderlin *et al.*, 2014b), and social safeguards and co-benefits in REDD+ (Cromberg *et al.*, 2014; Jagger *et al.*, 2014). However, none have assessed these 22 REDD+ initiatives from the perspective of biodiversity conservation, or their potential to delivery of biodiversity co-benefits.

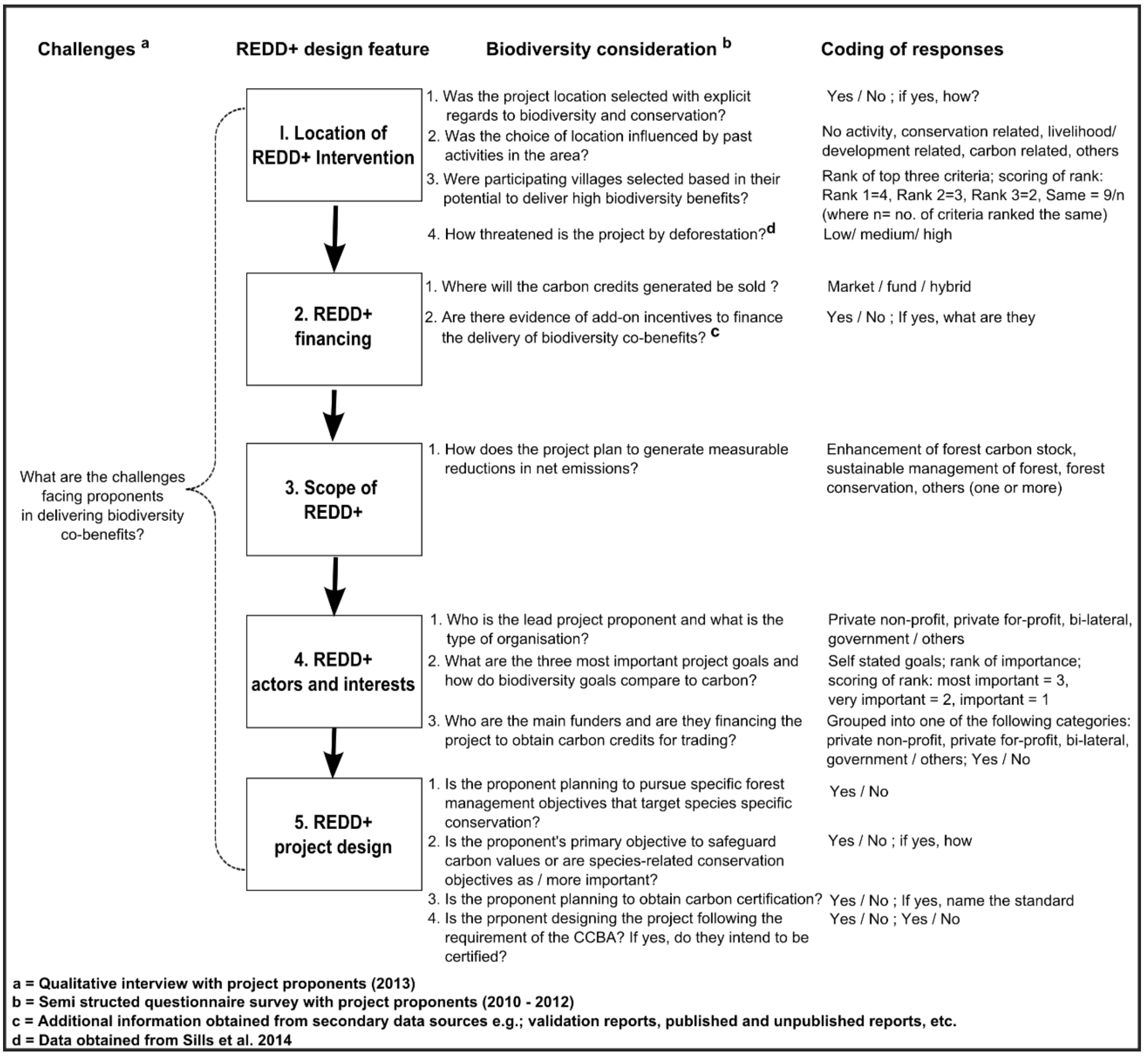


Figure 3.1: Study framework showing the REDD+ design features (1 to 5), the biodiversity considerations and challenges, the biodiversity relevant questions and how these were coded.

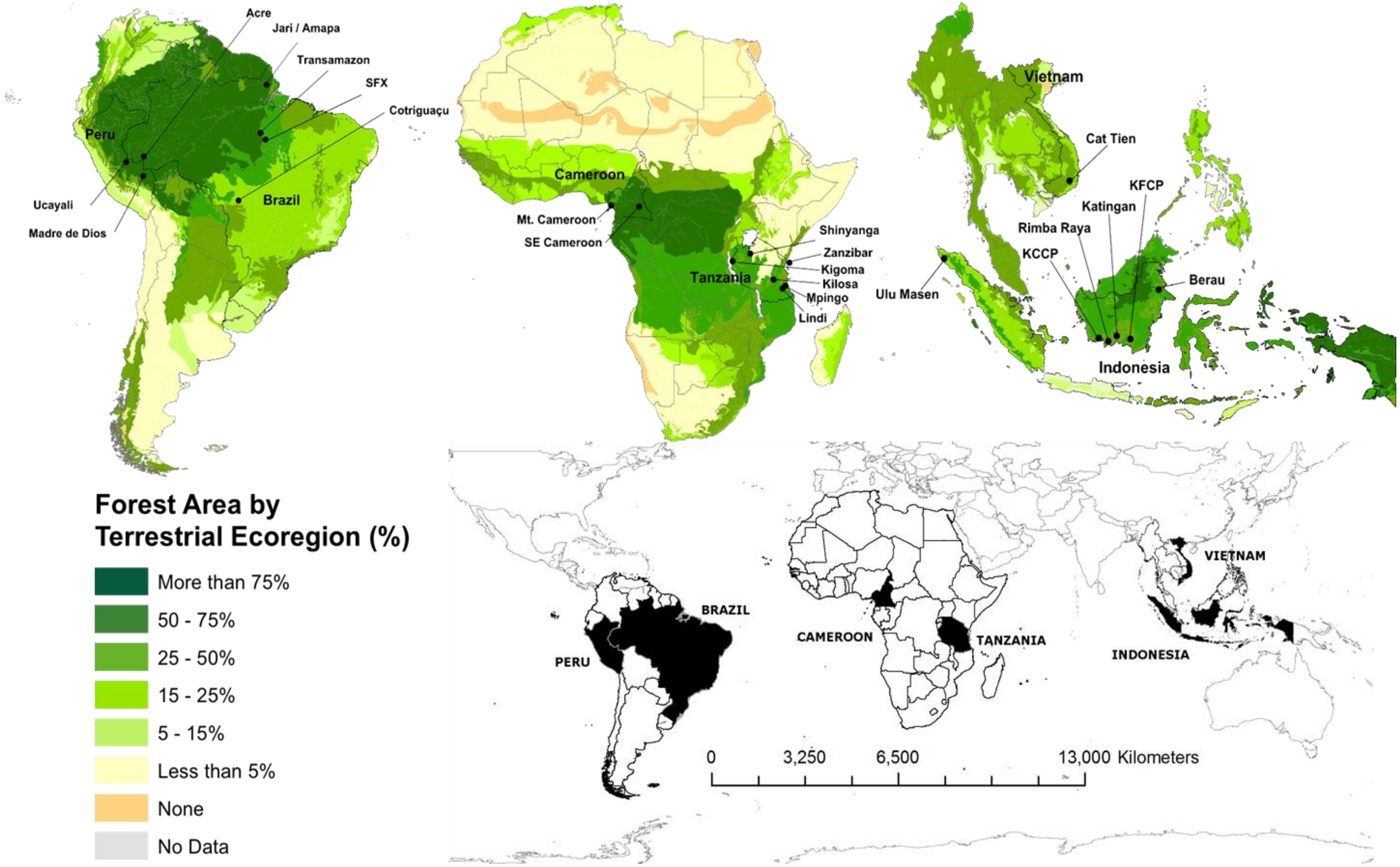


Figure 3.2: Location map showing the 22 REDD+ initiatives in 6 countries used in this study.

Note: Details about the REDD+ projects including their complete names and project developers can be found in Appendix 1. The base map, developed by the Nature Conservancy (Hoekstra *et al.*, 2010) shows the percentage of ecoregion area covered with forest using forest and woodland cover data derived from the Global Land Cover 2000.

3.3.2 Data collection

A combination of questionnaire surveys and secondary data sources were used in this study. Questionnaires were designed by the GCS-REDD+ and all interviews were targeted at proponents of the 22 REDD+ initiatives. Here, we define REDD+ proponents as the key organization spearheading the initiative and responsible for most of the design, fundraising as well as implementation of REDD+ related activities. The two surveys used in this study are (see below):

3.3.2.1 Project proponent survey (2010 – 2012)

This was a semi-structured questionnaire survey carried out in the period of 2010 – 2012 to capture project implementation prior to the introduction of performance based incentives. Questionnaire surveys were administered by 22 GCS-REDD+ field research supervisors working closely with each project on the ground. The questionnaire covers a wide range of themes, however, only those particularly relevant to the delivery of biodiversity benefits and conservation were extracted and analysed for this study. The main respondents were senior staff from the proponent organisation who have decision making and oversight authority over the REDD+ project; in most cases, more than one respondent contributed to answering different aspects of the questionnaire.

We used the information obtained from the project proponent survey to assess if biodiversity considerations were incorporated into the project design of the 22 REDD+ initiatives. See Figure 3.1, for how this survey is incorporated into the overall study design and how the responses are coded for analysis.

3.3.2.2 Project challenges survey (2013)

The project challenges survey was carried out in the first half of 2013 to obtain first-hand information about the challenges faced by project proponents in the delivery of biodiversity co-benefits at the project level – Figure 3.1. Interviews were carried out by two senior CIFOR scientists and the interviews were targeted at project proponents. The questionnaire contained both closed-option and open-ended questions on a range of topics; only information relevant to the challenges faced in realising the delivery of biodiversity co-benefits and the proposed solutions to these challenges were used in this study. This survey was design in light of challenges faced by REDD+ developers on the ground due to a slow REDD+ progress both at the international discussions as well as nationally at the various countries. Proponents were asked the following three biodiversity related questions during the survey:

1. In this project, are you intentionally aiming to conserve the biodiversity of local forests?
2. [If yes] What are the main challenges you have experienced in designing and implementing a project that conserves the biodiversity of local forests?
3. What solutions do you envision to assure that your project will conserve the biodiversity of local forests?

The descriptive data obtained from the interviews were treated individually in order to understand project specific challenges. Responses were also coded in order to assess the common challenges faced across 22 REDD+ initiatives; coding was based on key words and common themes identified in the responses. Only biodiversity related challenges are assessed, analysed and presented in this study. Other challenges faced by REDD+ proponents have been assesses using a different method to code the interviews and can be found in Sunderlin *et al.*, (2014a).

3.3.2.3 Secondary data

A documents review was carried to fill the information gaps in this study; we assessed a wealth of secondary data such as reports, media coverage, publish papers, etc. pertaining to the 22 REDD+ initiatives in this study. Because the project proponent surveys were carried out at the early stage of the REDD+ project implementation, secondary data allowed for project updates as well as to draw links between stated information (gathered from the surveys) and non-stated ones (missed during the interview). In order to assess how threatened the REDD+ initiatives in our sample were to deforestation, information on their deforestation rate was obtained from Sills *et al.*, (2014) using deforestation data from Hansen *et al.*, (2013). For the purpose of our study, we classified the deforestation rates into three classes; low, medium and high using equal intervals. Refer to **Appendix 1** for the complete list of projects, their lead proponents, deforestation rates and their current status.

3.3.2.4 Follow up questions

In order to explore which of the projects in our sample had highest potential to delivery biodiversity benefits we assessed the 22 initiatives in our study consistently against three questions. The key assumption is that REDD+ initiative which are located in an area important for biodiversity, even if by chance, will have a higher potential to deliver benefits for biodiversity. Instead, projects which are not located in areas important for biodiversity, even with good deliberate efforts would be bound to have low biodiversity impact. We therefore use this as a starting point to assess the 22 REDD+ initiatives in our sample on their potential to deliver biodiversity benefits. We also assessed how these projects are located in relation to deforestation threat.

Additional gains for biodiversity will require additional effort, these could include; explicitly targeting high biodiversity areas, designing the project with explicit regards to biodiversity and/ or carrying out pro-biodiversity REDD+ intervention (see Chapter 2). Therefore, projects which have explicit goals for biodiversity conservation will be more likely to invest in additional effort. Based on this logic, we then assessed the 22 REDD+ initiatives against two additional questions on proponent’s goals for biodiversity and their specific management objectives - see Figure 3.3.

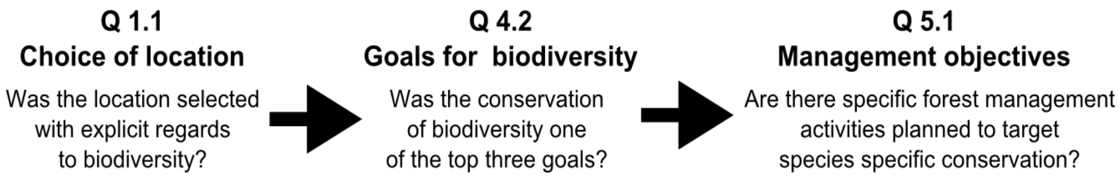


Figure 3.3: The three follow up questions used to consistently test the 22 REDD+ initiatives for their potential to delivery high biodiversity benefits.

Note: Questions Q1.1, Q4.2 and Q5.1 correspond to the questions presented in the study design framework (Figure 3.1).

3.4 Results

The results are presented in the following the order: first we show how biodiversity considerations are being incorporated in the design of the 22 REDD+ initiatives based on the REDD+ design features in Figure 3.1; then we use the follow up questions to show which out of the 22 REDD+ initiatives in our sample have made interventions in ways consistent with the highest potential to deliver high biodiversity benefits based on a cross analysis of three design features in Figure 3.3. Lastly, we illustrate some of the challenges faced by early REDD+ developers and proposed solutions moving forward with REDD+

3.4.1 The location of REDD+ interventions

More than 50% (n=12) of the proponents stated that they chose their project location with explicit regards to biodiversity and conservation. The majority of these proponents stated that they spatially targeted areas known to be important for biodiversity such as; locating districts in national biodiversity hotspots (Lindi, Kilosa and Cat Tien) or areas known to have exceptionally high biodiversity (Zanzibar and Kigoma in Tanzania). A number of proponents targeted project location in areas important for a specific species of conservation interest or flagship species such as chimpanzees (Kigoma in Tanzania), orangutan (Ketapang and Rimba Raya in Indonesia) and Brazil nuts (Madre de Dios in Peru). For example, Flora and Fauna International's (FFI-Indonesia) Community Carbon Pool initiative in the Ketapang District in West Kalimantan explicitly targeted orangutan habitat with the aim to develop corridors connecting key remaining forests to important orangutan habitat (see Chapter 5 for the detailed case study). Below are some quotes from the project proponents illustrating how they have explicitly targeted forests important for biodiversity:

> "The project area has high potential biodiversity, one that we are targeting is chimpanzees, and the foundation is built on chimpanzee research. Also has other plant and animal species that we think are endangered, endemic" – Kigoma project proponent, Jane Goodall Institute

> "The Brazil nut tree is a flagship species for the department of Madre de Dios and the basis of the ecosystem of its forest. Their conservation thereby ensures the conservation of many other species of wildlife that depend on its protection" – Madre de Dios project proponent, Bosques Amazonicos.

There are also project proponents who chose to locate their REDD+ projects adjacent to existing protected areas (PAs) in order to provide a protective buffer for this threatened PAs. These projects include The Rimba Raya Biodiversity Reserve Project (Rimba Raya) for Tanjung Puting National Park, The Ketapang Community Carbon Pool project for Gunung Palung National Park (West Kalimantan, Indonesia) and the Cat Tien REDD+ project (Cat Tien) for the Cat Tien National Park (Lam Dong District, Vietnam). Proponents from the private non-profit sector were largely locating their initiatives with explicit regards to biodiversity and conservation while this was less common for proponents from other sectors. The Madre de Dios and the Rimba Raya projects were the only two projects led by the private for-profit sector and the Acre REDD+ initiative is the only government led REDD+ initiative to explicitly target forests important for biodiversity. Figure 3.4 shows how the different proponent organization types are explicitly locating their REDD+ initiatives with regards to biodiversity and conservation.

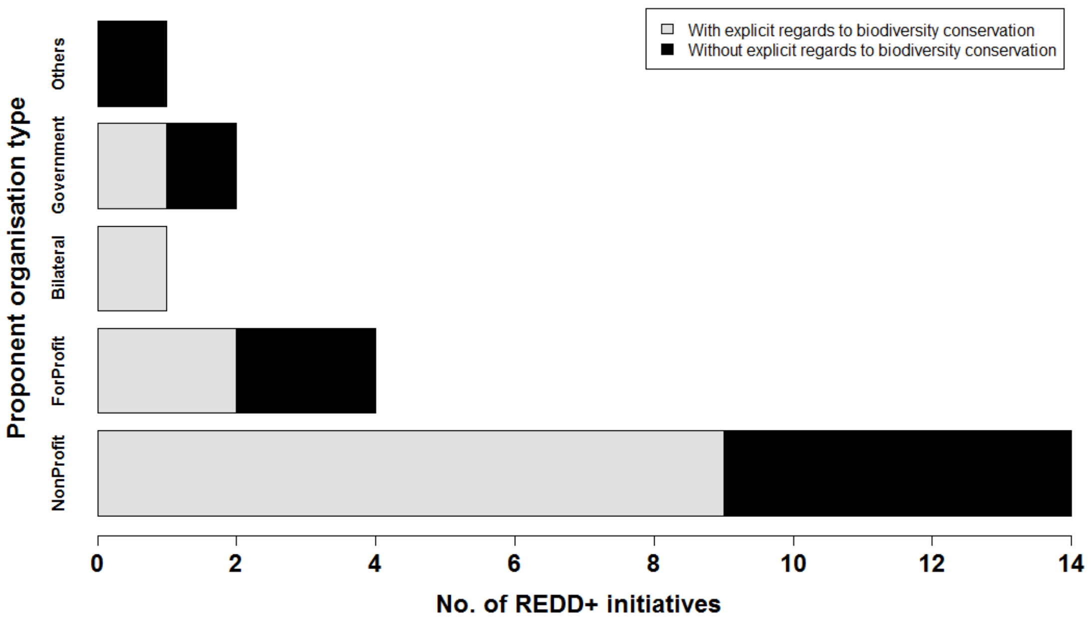


Figure 3.4: The bar graphs show the number of REDD+ initiatives which were located with explicit regards to biodiversity and conservation and how these are distributed among the different proponent organization types.

Over 80% (n=18) of the REDD+ initiatives in our sample had some sort intervention in the area where their project is located prior to the establishment of the REDD+ initiative; over 50% were initiatives led by proponents in our sample. These "past activities" can be grouped into three types: biodiversity conservation, livelihood or community engagement and, carbon sequestration or combinations of these. Of the past interventions led by proponents in our sample (with the exception of Mpingo in Tanzania), all were engaged in conservation related activities prior to the conception of REDD+ in the area. These proponents were also largely from the private non-profit sector or conservation NGOs to be specific – see Figure 3.1. For example, Flora and Fauna International (FFI-Indonesia), proponent of the Ketapang REDD+ project in Indonesia has been working in the Ketapang district since 2003 and have been carrying out High Conservation Value (HCV) forest assessments and orangutan conservation activities prior to REDD+ project development. The Jane Goodall Institute, proponent of the Kigoma project has been carrying out chimpanzee conservation work in the area for over a decade before REDD+ development. The Tanzania Traditional Energy Development and Environment Organization (TaTEDO), proponent of the Shinyanga project has been working in the project area since 2007 carrying out conservation and community development activities prior to the conception of the REDD+ initiative. Only three initiatives which are located with explicit regards to biodiversity and conservation were newly created initiatives i.e. these projects were developed explicitly as REDD+ initiatives and the proponents had no activities in the area prior to REDD+. These projects are; Lindi (Tanzania), Ulu Masen and Cat Tien (Vietnam).

Table 3.1: REDD+ proponents involved in pre-REDD+ activities in the project area, the year since they were active and the type of activities they were engaged in.

Country	REDD+ initiative	Proponent from a conservation NGO?	Year active in the area	Project activities prior to REDD+		
				a	b	c
Brazil	Transamazon	Yes	2000	■	■	
	Sao Felix de Xingu	Yes	2009	■	■	
Peru	Ucayali	Yes	2002	■	■	■
Cameroon	Mt. Cameroon	No	2004	■	■	
Tanzania	Shinyanga	No	2007	■	■	
	Zanzibar	Yes	2006	■	■	
	Kigoma	Yes	2007	■	■	
	Mpingo	Yes	2006		■	
Indonesia	Ketapang	Yes	2003	■		
	Berau	Yes	2003	■	■	■

Key: a = conservation related, b= livelihood and community engagement, c=carbon sequestration; the area shaded in grey represents the activities carried out by these proponents prior to the conception of REDD+.

Proponents were asked to describe the criteria used to select villages to participate in the REDD+ initiative and to rank these in the order of importance The criteria described by the proponents can generally be divided into five broad categories and these are; carbon effectiveness, good governance, high potential to deliver biodiversity co-benefits and strong institution and rule of law, within these broad categories, are more specific sub-categories – see Figure 3.5.

Villages with the potential for high carbon effectiveness was generally the most important criteria for selection to participate in the REDD+ initiative. Villages located in / around forests with high carbon stocks were an important selection criteria for proponents (n=17) followed by villages in areas with significant threat of future deforestation/ degradation (n=15) and areas with significant threat of current deforestation / degradation (criteria 2) (n=14). Only three projects (Lindi, Kilosa and Ketapang) ranked high potential to deliver biodiversity co-benefits as their most important selection criteria for selecting villages to participate in their REDD+ initiative. We found that the choice of carbon and biodiversity as a criteria was not mutually exclusive; at least nine projects selected both carbon and biodiversity as the most important selection criteria while three project proponents considered the two equally important (Madre de Dios, Rimba Raya, Berau). A large majority of project proponents also considered villages with high likelihood of intervention success (n=17) as an important selection criteria.

However when the top three choices were weighted according to their rank of importance (Figure 3.5), villages located in or around forests with high level of forest carbon stock was the most important criterion (score of 33) and this was followed by villages located in or around forests with high potential to deliver biodiversity co-benefits (score of 22). The third and fourth most important criteria for selecting villages to participate in the REDD+ initiatives were villages located in and around forests with high rate of ongoing deforestation /degradation (score of 16) and in villages where the proponent organization has previous or ongoing conservation project (score of 16). Overall the selection of villages to participate based on their ability to delivery co-benefits may not be the most important criteria when compared to the other criteria such as carbon effectiveness and institutions; however, the importance of selecting a village to participate based on its ability to deliver biodiversity co-benefits was the most important co-benefits sub-criteria. See Figure 3.5 for the bar graph showing rank scores for each criteria and sub-criteria.

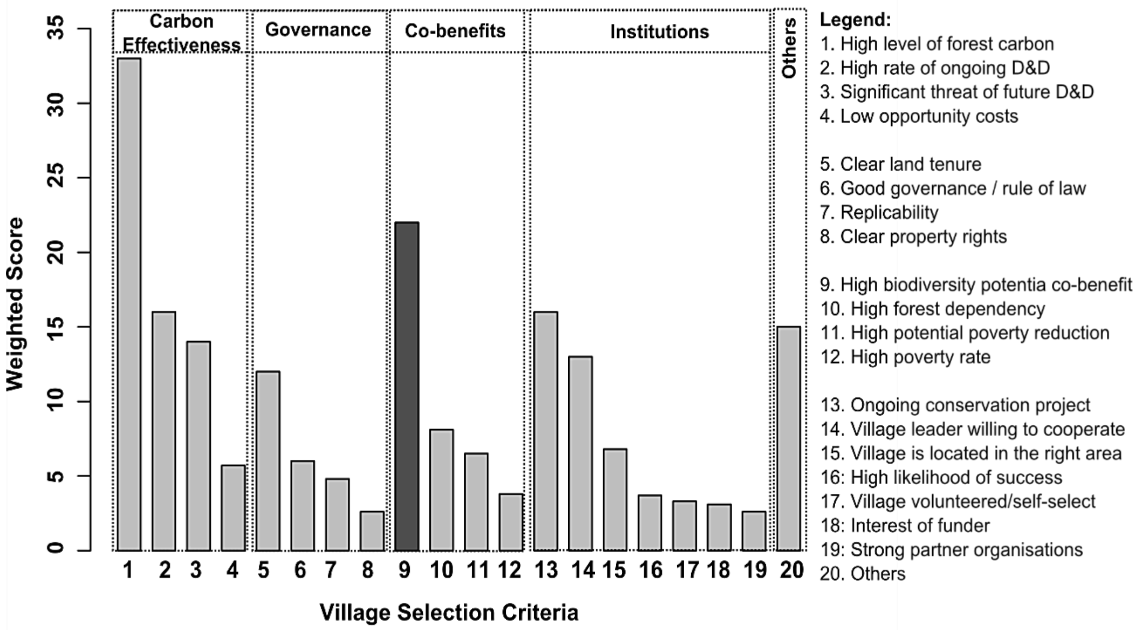


Figure 3.5: The three top criteria (weighted) used by 22 REDD+ proponents when selecting villages to participate in the REDD+ initiatives.

Note: The results have been weighted taking into consideration rank of importance and the bar in black indicates the criteria relevant to biodiversity co-benefits. D & D = deforestation and degradation.

3.4.2 REDD+ financing

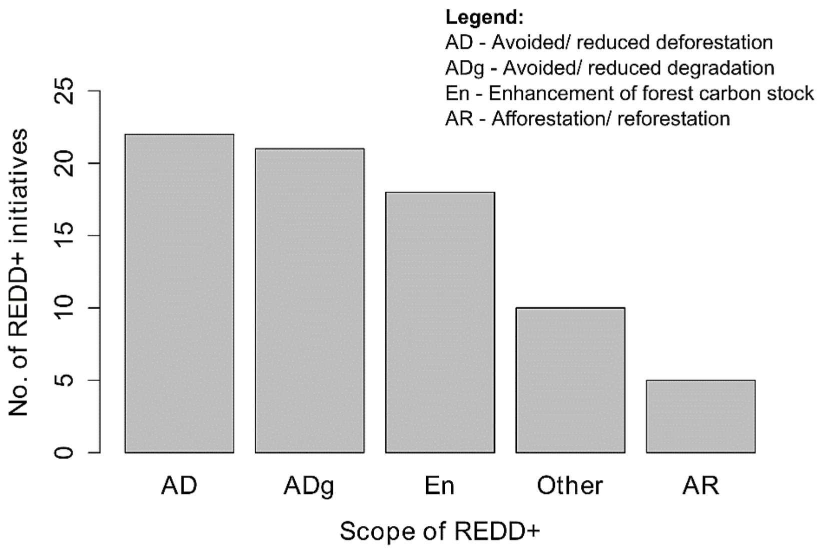
Currently, only three REDD+ initiatives in our sample are selling REDD+ credits in the voluntary carbon market while the Transamazon project (Brazil) is currently receiving results based financing from the Amazon fund and it is the only project currently receiving fund based financing (Cromberg *et al.*, 2014). At least 15 others have expressed interest to sell carbon credits of which nine intend to sell their credits in the voluntary carbon market and seven in the future regulated market which can be further broken down into the national regulated market (n=2; both government led REDD+ initiatives) and the international regulated market (n=5) – see Appendix 1 (Table S2) for the list showing the REDD+ project's financing options and their progress with carbon and non-carbon certification schemes. Of these, five initiatives planning to sell their future REDD+ credits in both the voluntary and regulatory carbon markets.

As for the three REDD+ initiatives in our sample currently selling carbon credits - the Jari/Amapa initiative (Brazil), the Madre de Dios REDD+ initiative (Peru) and the Rimba Raya initiative (Indonesia), all three are led by proponents from the private for-profit sector and are selling their credits in the voluntary carbon market. Proponents are subscribed to the VSC standard to verify their emission reduction and the CCBA (Gold level) to verify their delivery of exceptional biodiversity benefits (Madre de Dios and Rimba Raya) or the Forest Stewardship Council's (FSC) certification for sustainable forest management implementation (Jari/Amapa). A review of the project design documents of these REDD+ does not indicate the use of 'add-on incentives' to supplement funding needed implement biodiversity programs. The Rimba Raya project is using the finances generated from the sale of carbon credits to increase patrolling efforts in order to reduce encroachment into their forest and to reduce fire risks both of which are key threats to their flagship species, the orangutan (InfiniteEARTH, 2015). The Jari/Amapa project proponents have developed a partnership with the universities of Lancaster and Cambridge in the United Kingdom to assist the project in the delivery of biodiversity related objectives. They are selecting appropriate indicator species to monitor biodiversity in the project area; the proponent is however seeking additional financial support in order to implement more effective biodiversity strategies (Biofilica, 2013).

3.4.3 The scope of REDD+

On average, the REDD+ initiatives in our study have plans to use a combination of at least three activities to generate measurable emission reduction (n=19), eight proponents have the intention to carry out a combination of more than 3 activities. Proponents at almost all REDD+ initiatives stated that they intend to generate measurable emission reduction via activities to avoid / reduce deforestation (n=22) and avoid / reduce forest degradation (n=21). A relatively large number of proponents (n=18) were planning to enhance existing forest carbon stocks via activities such as forest restoration, improvement of forest management activities and enrichment planting. At least five proponents stated that they plan to carry out afforestation and reforestation type activities, these are the Madre de Dios, SE Cameroon, Ketapang, KFCP and the Transamazon REDD+ initiatives, and as many as four REDD+ initiatives plan to use 'other' indirect methods to reduce net emissions, these include activities such as improving cattle ranching practices (Cotriguaçu), improved fallow system (SE Cameroon) and increasing energy efficiency (fuel wood use, cooking stoves)(Shinyanga, Zanzibar)– See Figure 3.6**.**

We were not able to assess how REDD+ proponents intended to explicitly incorporate biodiversity consideration into the interventions because when interviews were carried out, the majority of proponents were in the early stages of project planning and their REDD+ implementation designs were not yet well developed. An assessment of secondary literature such as project design documents and published reports, indicates that projects have intentions to carry out pro-biodiversity restoration activities such as in the Transamazon initiative (Cromberg *et al.*, 2014; Sills *et al.*, 2014), Madre de Dios initiative (Bosque Amazonicos, 2014), KFCP initiative (The Australia - Indonesia Partnership, 2009) and Katingan initiative (Marchant *et al.*, 2014) which could benefit biodiversity. The Madre de Dios REDD+ initiative for example will be implementing reduced impact logging and carry out pro-biodiversity enrichment planting as part of their plan to deliver biodiversity benefits at the project level (Bosque Amazonicos, 2013). We also found that at least five initiatives are pursuing or are certified by the FSC which have biodiversity requirements embedded in their standards. We also know that the majority of REDD+ projects in our sample are not located in existing PA or planning to create new PA; only the Mt. Cameroon project is partly located in a newly established PA and the Sao Felix de Xingu and Cotriguaçu sub-national initiatives which cover protected areas within their jurisdiction.



* This would include conservation of forest stock under the UNFCCC scope of REDD+
** This would include sustainable management of forest under the UNFCCC scope of REDD+

Figure 3.6: The scope to reduce deforestation and forest degradation at the 22 REDD+ initiatives

3.4.4 REDD+ actors and their interests

The Proponents: The majority of REDD+ initiatives in our sample are being led by the private non-profit sector with over 60% (n=14) of the project proponents coming from this sector. We note that the figure is representative of global REDD+ initiatives where approximately 58% were reported to be spearheaded by the private non-profit sector (Simonet et al. 2014). Four projects in our sample are being developed by proponents from the private sector and two were government lead projects and one public bilateral partnership**.**

From within the private non-profit sector, proponent organizations can be further broken down into the following categories based on their main organizational objective or mission; e.g. conservation, development, research organizations. The majority of proponents from the non-profit sector were conservation NGOs (n=7), these include big international organisations like The Nature Conservancy (Berau in Indonesia and Sao Felix de Xingu in Brazil), Jane Goodall Institute (Kigoma in Tanzania) and Flora and Fauna International (Ketapang in Indonesia) – See Appendix 1. The self-stated goals of the REDD+ proponents (more than one per proponent) generally fell into one of the following predetermined categories: to reduced carbon emissions in order to obtain carbon funding or tradable credits (n=10), to demonstrate viability of REDD+ to reduce carbon emissions (n=10), biodiversity and conservation (n=10), poverty reduction (n=9), community development (n=12), sustainable forest management (n=8), improve governance and rule of law (n=5), and others (n=3).

When the rank of importance was taken into account, biodiversity conservation was the most important project goal for only two REDD+ initiatives (Ketapang and Rimba Raya in Indonesia). Eight REDD+ proponents considered reducing carbon emission in order to obtain carbon funding or tradable credits their most important project goal, this followed closely with seven proponents considered demonstrating REDD+ viability as the most important project goal. Over 50% of the REDD+ proponents considered community development as one of their top three goals however, these were often less important than their forest management or carbon goals. Two proponents considered other goals the most important for their REDD+ initiatives and these were; to increase value of standing forest and its ecosystem services (Acre, Brazil) and to build capacity for REDD+ (Kigoma, Tanzania). Overall, when the rank of importance was taken into consideration, the goal to reduce emission in order to obtain carbon funding or tradable credits had the highest weighted scores (score of 28) and the delivery of biodiversity conservation emerged as the third most important project goal (score of 13).The private non-profit sector, which is largely made up of conservation NGOs did not score biodiversity conservation as their most important goal. However they instead considered emission reduction and project viability goals more important – Figure 3.7.

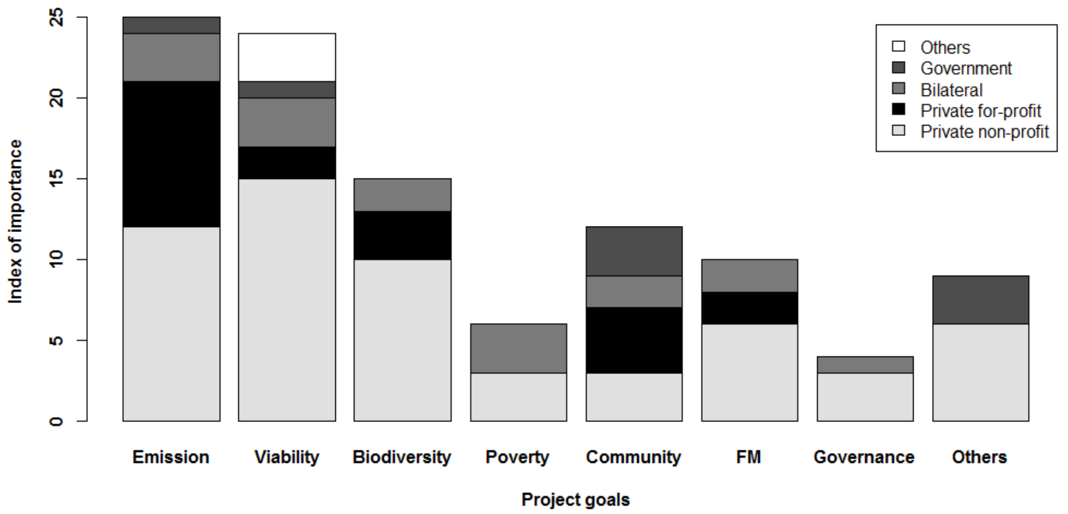


Figure 3.7: Stated top project goals across 22 REDD+ projects with responses weighted to show their relative importance and how this is distributed among the different proponent organization types.

The financers: Early REDD+ financing at our projects can broadly be divided into four financing categories: bilateral, foundation, NGO, and private for-profit. Projects often had more than once source of financing – see Appendix 1 (Table S3)**.** It is evident at our 22 sites that most of the early REDD+ financing was to stimulate REDD+ development and not narrowly for the purpose of obtaining tradable credits or offsets –Figure 3.8. The large majority of financing in our sample (>60%) were from bi-lateral aid ; these includes direct from donor countries (e.g. the Norway, Australian and British Governments) or through the support of a fund or through an local NGO (e.g. The Amazon Fund). Bilateral donors were not interested in funding REDD+ for tradable credits although two projects stated that bilateral donors were 'maybe' interested in funding their REDD+ initiative for future tradable credits.

Private for profit investors were financing four REDD+ initiatives in our sample, these include private for-profit led REDD+ initiatives which are self-funded (Madre de Dios and Jari/Amapa); all private for profit investors were interested in tradable REDD+ credits. REDD+ proponents from the private for-profit sectors were the ones receiving finance from private investors. In our sample, only two projects had private foundations as their key source of financing, both of which have interest in tradable credits. We found that in our sample, private foundations have a key role in financing early REDD+ initiatives, as projects often receive supplementary financing from private foundation – Appendix 1 (Table S3). Private foundations who are major supporters if REDD+ include The David & Lucille Packard Foundation, The Clinton Foundation and the Climate and Land Use Alliance which is supported by a group of private foundations.

A recent update on the REDD+ initiatives indicates that three out of the four private for-profit initiatives in our study have begun selling carbon credits (Madre de Dios - Peru, Rimba Raya-Indonesia and Jari / Amapa – Brazil). Initiatives from other organization category have not begun selling their credits although some may have already introduced some form of compensation to communities affected by the project (Sills *et al.*, 2014).

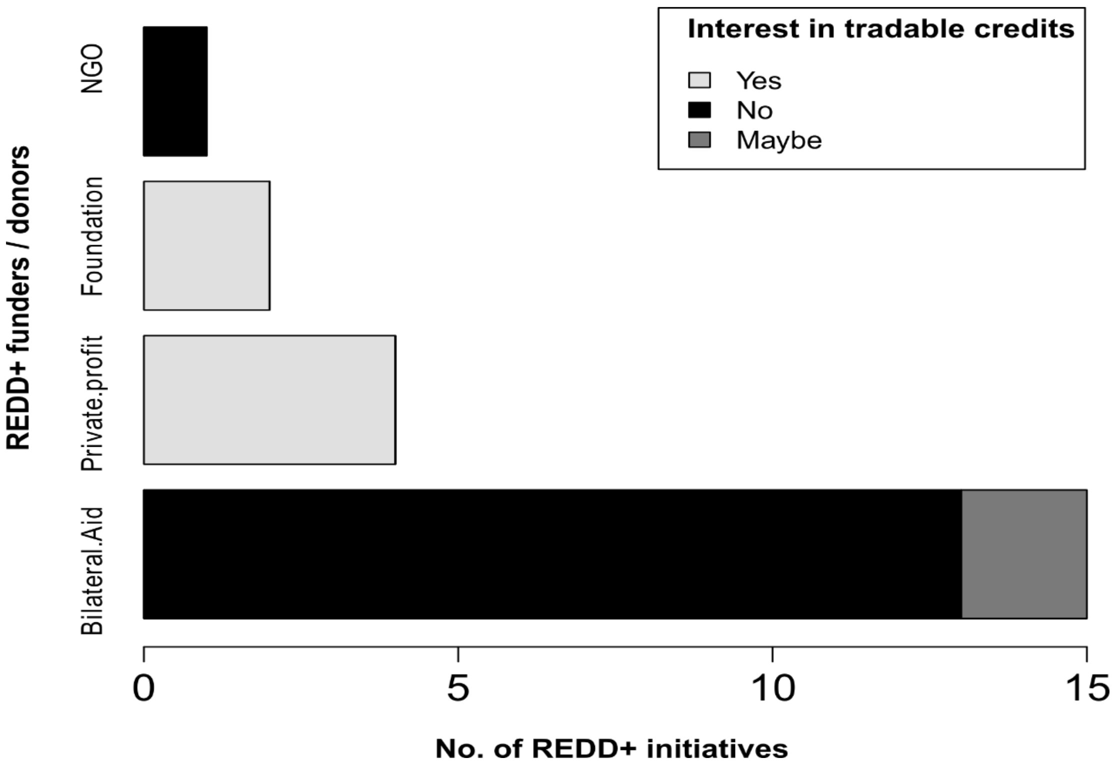


Figure 3.8: Lead funders of the 22 REDD+ initiatives and their interest on tradable credits.

Note: this figure only captures the lead funder for each REDD+ initiative, projects are often financially supported by at least three funders, the complete list can be found in Appendix 1.

3.4.5 REDD+ project design

Forest management objectives: Of the 22 REDD+ initiatives in our sample, only seven have plans to carry out forest management objectives that target species specific conservation; of these, four considered their forest management objectives to protect biodiversity more important that their carbon objectives while three proponents considered both objectives equally important.

Two private for-profit led REDD+ initiatives considered their conservation objectives more important that their carbon objectives. The Madre de Dios project which is located in a Brazil nut forest considered the ecosystem where their project is located as an "indigenous ecosystem" which has been the basis for the local economy, therefore restoring and preserving this ecosystem is their most important forest management objective.

> "Without a healthy ecosystem, there is no possibility of developing any effective strategy for conserving forests and likewise for generating carbon revenues". – Project proponent, Bosque Amazonicos

The Rimba Raya project considered their conservation objectives more important for their organization and its stakeholders where they explicitly chose to locate their initiative in the buffer zone of the Tanjung Puting National Park.

> "Yes very important. Without the Rimba Raya project, this area would be lost to planned oil palm development. The habitat protected by the Park and the Reserve is home to dozens of endangered species, including the Bornean orangutan". – Project proponent, InfiniteEARTH (PT. Rimba Raya)

Two NGO-led REDD+ initiatives considered their biodiversity objectives more important than their carbon objectives. The proponent from Fauna Flora International in Indonesia considered their species – specific conservation objective to be the most important objective for their REDD+ project especially for their focal species, the orangutan. Their planned REDD+ intervention includes activities to connect key remaining patches of forests in the Ketapang district with the Gunung Palung National park to form wildlife corridors (refer to **Chapter 3** for the case study on this project). Project proponents from the Mpingo Conservation and Development Initiative, considered the overall implementation of SFM. more important than just carbon. The project proponents plan to carry out forest management that targets the conservation of the Mpingo tree species.

> "It's not species conservation it is species utilization, but we are not expanding Participatory Forest Management beyond Mpingo, there are other species people are interested in but we are only working with Mpingo. So, primary is sustainable forest management is the primary objective". – Project proponent, Mpingo Conservation and Development Initiative

Three project proponents considered their conservation objectives equally or as important as their carbon objectives; these are the Lindi and Kilosa projects in Tanzania and the Cat Tien project in Vietnam. The Tanzania Forest Conservation Group, project6 proponent leading the Lindi and Kilosa projects, said that both are important because carbon and biodiversity objectives are integrated. The Cat Tien project proponent, the Netherlands Development Organization (SNV) considered objectives to safeguard biodiversity and carbon values equally important and that both were their central goals. However, SNV acknowledge that project's financial sustainability is dependent on its carbon and not biodiversity.

> "The extent that future sustainability of the project through carbon financing depends on carbon values, which probably have to take precedence. However, unlikely project will engage in any activities where these two goals would be conflicting". – Project proponent, Netherlands Development Organization (SNV).

Verification systems: A large majority of the REDD+ initiatives in our sample were designing their project following both carbon and non-carbon voluntary verification systems. The Verified Carbon Standard (VCS) was the most popular carbon verification and certification system among the REDD+ projects in our sample, 19 projects stated their interest in the VCS. At least three REDD+ initiatives in our sample intend to verify their carbon using the Plan Vivo scheme which is exclusive for community based carbon initiatives. The Plan Vivo standard requires that projects not only measure the delivery of carbon but also their, social and environmental benefits simultaneously.

With regards to voluntary non-carbon certification systems, i.e. voluntary standards which verify and certify the delivery of biodiversity benefits at the project level; the Climate, Community and Biodiversity (CCBA) was the most popular in our sample. About 90% (n=20) of the REDD+ initiatives in our sample stated their interest in the CCBA standard, proponents of 19 REDD+ initiatives are designing their projects following the requirements of the CCBA intended to seek CCBA certification, of which 12 stated their intentions to obtain Gold Level, i.e. projects which demonstrated exceptional climate adaptation, community and/or biodiversity benefits. We also found that at least six projects have the intention to certify their forest following the Forest Steward Council (FSC) certification standard i.e. voluntary standard for sustainable forest management.

Three REDD+ initiatives in our sample were currently not interested in voluntary certifications systems. The Transamazon project in Peru currently had no plans to sell carbon credits, the KFCP project in Indonesia is a demonstration initiative thus had no plans to sell carbon credits and the Sao Felix de Xingu initiative in Brazil only have plans to sell carbon credits in either the national or international regulated market and not in the voluntary carbon market due to the perceived risks associated with the voluntary carbon market. We found a very strong VCS – CCBA link in the REDD+ initiatives in our sample (n=19), perhaps these proponents are taking advantage of the newly introduced joint certification process which offers streamlined processes which is expected to speed up the verification process and cut cost.

3.4.6 Which of the 22 REDD+ initiatives have high considerations for biodiversity?

From our assessment, we can expect that at least five REDD+ initiatives have a strong potential to delivery high biodiversity gains based on the fact that they are located in important biodiversity areas, they have explicit goals for biodiversity and they have plans to implement forest management activities which species specific conservation (score 111) - Figure 3.9**.** All of these five initiatives with high biodiversity potential are led by the private non-profit sector with the exception of the Rimba Raya projects which is led by proponents from the private for-profit sector. While we found that half of the REDD+ initiatives in our sample located their projects with explicit regards to biodiversity and conservation, however, only six had biodiversity as one of their top three goals (Ketapang and Rimba Raya had biodiversity as their most important goal).

At the opposite end, we can expect that six of the initiatives in our sample have a lower overall potential to delivery biodiversity benefits based on the fact that they responded no to all the our three follow up questions (score 000) – Figure 3.9. We do acknowledge that while half of the proponents in our sample may not have located their project with explicit regards to biodiversity, however, these could still be in areas important for biodiversity. In this case, projects which have high goals for biodiversity conservation or plan to pursue forest management activities that target species specific conservation could have high potential to deliver high gains for biodiversity. At least four projects in our sample fall under this category (score 001 and 010) –Figure 3.9**.** Our assessment of their location with regards to deforestation threat indicated that three projects were located with explicit regards to biodiversity and located in forests with high threat to deforestation (Rimba, Raya, Cat Tien and Zanzibar); four were located in forests with medium deforestation rates (Acre, Lindi, Kilosa, Ketapang) and five were in forests with low deforestation rates (Madre de Dios, Ucayali, SE Cameroon, Mt. Cameroon and Kigoma).

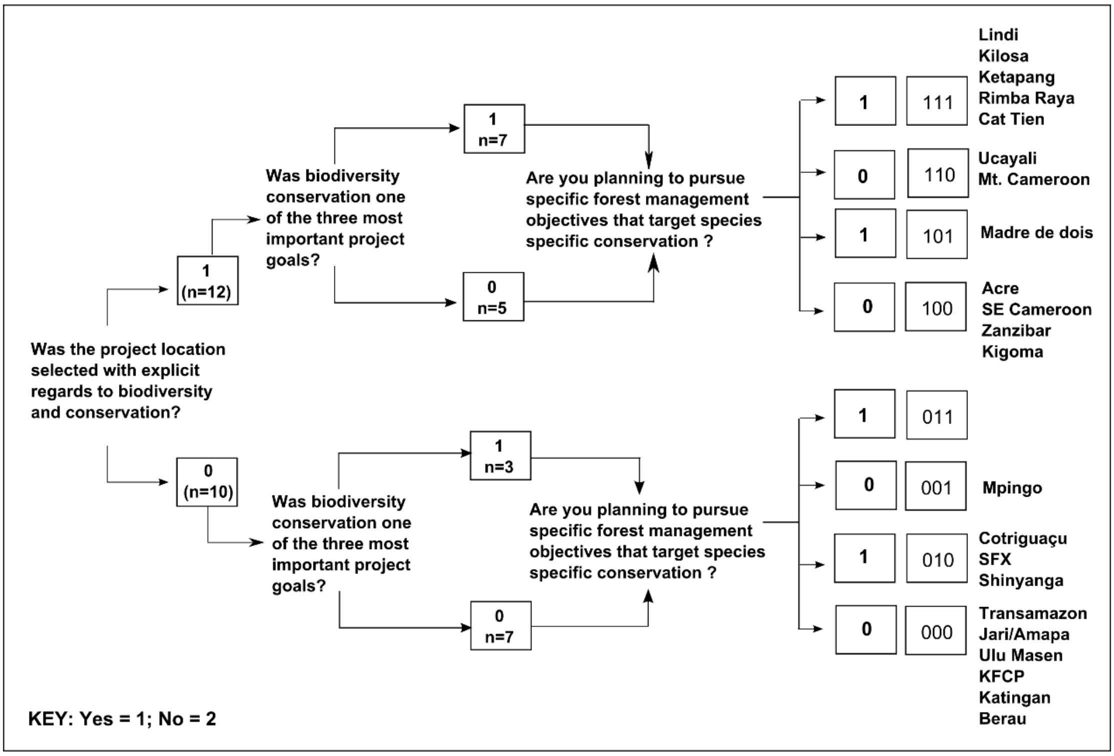


Figure 3.9: Diagram illustrating responses from 22 REDD+ proponents to three follow-up questions which indicate dedicated attention to biodiversity and conservation.

Note: These questions correspond to questions Q1.1, Q4.2 and Q5.1 in the study design in Figure 3.3. The Ketapang and Katingan projects are used as case studies in Chapter 5.

3.4.7 Challenges in the delivery of biodiversity benefits

The majority of REDD+ initiatives in our sample were conceived in 2009 (the earliest project was Ulu Masen in 2007 and the last was Jari/Amapa in 2011). Between then up to January 2015 (approximately 7 years), only three initiatives have begun selling carbon credits while four have ceased to operate (Shinyanga, Zanzibar, Kigoma, and KFCP), and two are on-going but decided not to use the REDD+ label (Cotriguaçu and Sao Felix de Xingu) – see **Appendix 1.** Progress of the REDD+ initiatives in our sample were slow and this is a reflection of the state of REDD+ progress globally as demonstrated by Simonet et al. (2014).

The challenges faced by project proponents in delivering biodiversity benefits at the 22 REDD+ project sites can generally be grouped into four main categories. The biggest challenge faced by approximate a third (n=7) of REDD+ proponents was that there is a strong business-as-usual interests to clear forests coupled with the lack of policies and incentives at the national level to support REDD+ implementation and biodiversity conservation (Challenge 1). Many projects (n=6) also considered the lack of knowledge and capacity to assess, monitor and report on biodiversity values a major problem (Challenge 2). Five REDD+ proponent considered addressing direct threat to biodiversity a key challenge (Challenge 3) and three project proponents also considered the conflict between community objectives and biodiversity objectives a challenge because biodiversity protection as a threat to their livelihood (Challenge 4) - see Table 3.2 for the key challenges faced in designing and implementing biodiversity protection and the REDD+ initiatives most affected by these challenges.

Challenge 1: Seven proponents in our sample found the strong business-as-usual interests to clear forests and the lucrative financial gains for such activities when compared to REDD+ makes implementing REDD+ especially one that aims to protect biodiversity particularly challenging. The lack of policies incentives at the national and sub-national level that promotes the protection of forest and its biodiversity further contributed to this challenge. Proponents from the Transamazon, Rimba Raya and the Berau initiatives all face the challenge of competing with more lucrative land uses such as forest clearing linked to market demand for commodities which take precedent over forest protection. The Rimba Raya project for example, had been waiting for over four years for their REDD+ project permit to be approved (project approved in 2013). The delay was due to permit overlaps between the proposed boundary with oil palm and timber concessions which was financially more attractive to the district government than the REDD+ project which had key objectives to protect the block of peatswamp forest and its biodiversity. Cotriguaçu is a sub-national (municipality) initiative and according to the proponents, biodiversity conservation is not in the agenda of the municipality in which the initiative is located therefore it is a challenge to promote biodiversity conservation.

> “By obtaining the license we prevent the conversion of the land and biodiversity will be conserved” – Rimba Raya project proponent, InfiniteEARTH

> “We're trying to bring to the agenda the role of conservation to the municipality, and what are the potential benefits that it brings, but there is a staff shortage, but once it is acknowledged by the municipality then we can incorporate it in daily dialogue”- Cotriguaçu project proponent, Instituto Centro de Vida

One of the key solutions suggested by two sub-national proponents (Berau, Cat Tien) was to work with the commodity market by integrating biodiversity requirements and safeguard standards as part of the sub-national low carbon development and to promote the use of sustainability standards such as the Forest Stewardship Council or Roundtable for Sustainable Palm Oil standards at timber and oil palm concessions. At least two REDD+ proponents considered the difficulty in putting a value on biodiversity because unlike carbon sequestration benefits, the link between the protection of biodiversity and its benefits is more complex. The Acre project proponent suggested that as a solution could be through REDD+ where the delivery of biodiversity conservation is integrated into REDD+ as a co-benefit; alternatively, the delivery of biodiversity services can be valued separately and financed separately via additional add-on incentives of funding. The following quotes illustrate some of the challenges associated with valuation of biodiversity.

> “We first need to know the environmental services of biodiversity. The second is the proper mechanisms for the valuation of biodiversity” - Acre project proponent, Acre State Secretariat for the Environment

> “There is a low awareness on the biodiversity values of the forests. Both in the part of the local communities and local government” – Kilosa project proponent, Tanzania Forest Conservation Group

Challenge 2: The Lack of knowledge and capacity to develop robust methodologies, develop biodiversity baseline, monitor and report trends on biodiversity was a key challenge for six proponents. This is a requirement under certification schemes adhered to by proponents in our sample such as the CCBA, FSC and PlanViVo. Third party audits are carried out on projects based on biodiversity monitoring plans and monitoring reports and certification is given based on satisfactory delivery of these. The Ketapang project proponent found biodiversity conservation a challenge for their community managed REDD+ project because local communities lack the technical capacity to carry out these activities following the requirement of certification standards. While designing robust biodiversity assessment and monitoring plans are a challenge for the proponents (Katingan, Jari/ Amapa, Sao Felix de Xingu), according to the proponents of the Sao Felix de Xingu project, designing one that is cost effective is another challenge. There are also challenges associated with the science of assessing and monitoring biodiversity such as in understanding species interaction (Madre de Dios) and in conserving specific wildlife (Ucayali).

> "The main challenge is the lack of knowledge and capacity to conduct long term - biodiversity and ecological monitoring and to provide scientific feedback to project managers and work with local communities to implement biodiversity conservation programs that are in line with livelihood objectives" – Katingan project proponent, PT Rimba Makmur Untama

The key solution to this challenge suggested by proponents is to look for expertise outside the project either via collaborations or hiring the right expertise. The Jari / Amapa proponents, for example, are in collaboration with Orsa Florestal (NGO) and the universities of Lancaster and Cambridge which are assisting the project with the biodiversity monitoring. The Madre de Dios project have resorted to hiring experts to assist them with the delivery of biodiversity conservation in their concession. Building capacity was also a key strategy suggested by proponents especially those working closely with local communities such as the Ketapang and Katingan projects.

> "We need to facilitate field research in the area by supporting exchange program, long term research program with scientific institutions. We need to develop an effective communication strategy to find ways how these research efforts contribute to the wellbeing of the local communities" – Katingan project proponent, PT Rimba Makmur Untama

Challenge 3: Proponents in Africa (Cameroon and Tanzania) largely considered reducing direct threat to biodiversity a major challenge for their REDD+ initiative to deliver biodiversity conservation benefits. Direct threats for biodiversity at these REDD+ initiatives include; poaching (using snares) and, encroachment (illegal cutting of wood), bush meat hunting and human-wildlife conflict. The following quotes from project proponents illustrate the nature of the challenge associated with reducing direct threat for biodiversity:

> "We need to know how to protect wildlife against the community itself. No biological survey has been done but we know hunting is happening" – SE Cameroon project proponent, Centre pour l'Environnement et le Development

> "We do natural regeneration. Many different species are coming back in. Some were not there before. The challenge is how to protect the ngitilis (management unit) from encroachment, especially from livestock, tree cutters, and wildlife" – Shinyanga project proponent, TaTEDO

The solutions proposed by REDD+ proponents to address the challenges associated with reducing direct threat large surrounded increasing law enforcement (stricter laws and bigger penalties), intensifying patrolling and creating alternative income options for villages. The following quotes from project proponents illustrate some of the solutions proposed by the proponents in our sample:

> "The use of by-laws touching on the management of the forest and introduction of fees and fines for intruders and people who break laws. The penalties are quite high" – Shinyanga project proponent, TaTEDO

> "Intensify forest patrols, and work with partners. Partners can provide information on the status of forest. Also, possible use of cameras" – Kigoma project proponent (The Jane Goodall Institute)

> "Consolidating the co-management approach and developing NTFP income. Improve economic opportunities". – Mount Cameroon project proponent (GFA ENVEST).

Challenge 4: At least three REDD+ proponents found there to be conflicts between people and conservation objectives at their REDD+ initiatives. This is largely due to the fact that communities see biodiversity protection as a threat to their livelihood. The following quotes demonstrates some of these challenges:

> "Local residents often perceive conservation as a law enforcement effort directed against their interests, or restricting their rights of access, rather than as a benefit". – KFCP project proponent, Indonesia-Australia Forest Carbon Partnership

> "There is contradiction between community needs and potential benefits. Community only recognizes forest function based on law terminology (legal status)". – Ulu Masen project proponent, REDD+ task force (Aceh).

Strong benefit sharing has been recognized by the project proponents as a way to reduce conflict between people living in and around the REDD+ initiatives and their biodiversity objectives. Communities which depend on the forest for survival should be assisted via alternative income in order to allow for a shift in community dependence on the forest. The following quotes describes some of the proposed solutions by the REDD+ proponents:

> "The introduction of Income Generating Activities to shift people from relying on forest for their livelihoods and supporting tree planting" – Zanzibar project proponent, CARE International in Tanzania

> "Link REDD+ incentives with clear community benefits to indicators of environmental quality or conditions that promote conservation" – KFCP project proponent, KFCP project proponent, Indonesia-Australia Forest Carbon Partnership

Table 3.2: The 5 key challenges faced by proponents and their proposed solutions

	Main Challenges	Count	REDD+ projects	Key suggested solutions by proponents
Challenge 1	A strong business-as-usual interests to clear forests coupled with the lack of policies and incentives at the national level to support biodiversity protection efforts.	7	Cotriguaçu Transamazon Rimba Raya Berau Cat Tien Acre Kilosa	• Integrate biodiversity requirements and safeguards standards as part of the national / subnational low carbon development agenda • Promote the use of third party certification standards with high biodiversity conservation requirements (e.g. CCBA, FSC, Round Table for Sustainable Palm Oil- RSPO) • Incentivize the delivery of biodiversity benefits under REDD+ or separate from REDD+ via add-on incentives
Challenge 2	Lack of knowledge and capacity to develop robust methodologies, develop biodiversity baseline, monitor and report trends on biodiversity	6	Madre de Dios Jari / Amapa Katingan Sao Felix de Xingu Ketapang Ucayali	• Collaboration with universities, research institutes and conservation NGOs to build capacity within the project as well as among communities associated with the REDD+ initiative. • build capacity within project and with local communities
Challenge 3	Reducing direct threat to wildlife (Encroachment, hunting, illegal logging)	5	SE Cameroon Mt. Cameroon Shinyanga Kigoma Mpingo	• The development and implementation of stricter laws and larger penalties to protect biodiversity • Working with partners to strengthen enforcement (patrolling, monitoring) • Introduce alternative livelihood programs
Challenge 4	Project torn between community vs. biodiversity objectives (communities see biodiversity protection as a threat to their livelihood)	3	Zanzibar Ulu Masen KFCP	• The REDD+ initiative must identify and implement alternative incentives or livelihood options which will assist a shift in community dependence on the forest

3.5 Discussion

3.5.1 How did the 22 REDD+ projects fare?

A number of recent studies are in opinion that spatial targeting of high biodiversity forests is necessary if REDD+ is to deliver additional benefits for biodiversity (Sangermano *et al.*, 2012; Venter *et al.*, 2013a; De Barros *et al.*, 2014; Jantz *et al.*, 2014). Targeting in favor of biodiversity can deliver improved outcomes for biodiversity and other ecosystem services with little reduction in the delivery of carbon benefits (Locatelli *et al.*, 2013; Thomas *et al.*, 2013; De Barros *et al.*, 2014)(See Chapter 2). More than half of the REDD+ initiatives selected their project location with explicit regards to biodiversity, however, many were also extensions of existing conservation related activities which existed prior to the REDD+ conception. In our study, we assume that REDD+ initiatives located in areas important for biodiversity will be better able to deliver biodiversity benefits, however, the highest gains can be expected when projects are located in forests with the highest threat to future deforestation (Busch *et al.*, 2012)(see Chapter 5). REDD+ projects which are extensions of existing conservation initiatives may not necessarily be located in places with the highest threat to deforestation unless these initiatives were not effective prior to REDD+ and proponents are looking to REDD+ for opportunities to secure tenure and obtain long term sustainable financing in order to carry out their conservation interventions more effectively.

Future REDD+ financing could include market mechanisms (regulatory / voluntary), non-market mechanisms (fund based financing), or a combination of these (hybrid mechanism) (Phelps *et al.*, 2012b). The REDD+ initiatives in our sample have demonstrated a strong interest in the voluntary carbon market although there are initiatives interested to only sell their credits in the regulatory market. While there are concerns that market-based REDD+ financing will encourage projects to reduce emission at the lowest possible price (Angelsen *et al.*, 2014) and cause proponents to avoid additional activities which are costly to the project such as biodiversity conservation (Harvey *et al.*, 2010; Stewart *et al.*, 2010); we found that almost all the projects in our sample were also pursuing third party voluntary certification to demonstrate delivery of biodiversity benefits. Proponents were designing their projects following the requirement of the CCBA standard which is considered the most robust available to verity the delivery of biodiversity benefits (Harrison & Paoli, 2012). Proponents are also subjecting their projects to third party certification which have high costs and additional requirements associated with it (Merger *et al.*, 2011). On top of that, at least six REDD+

initiatives in our sample (half of which are led by private for-profit organizations) are seeking certification by other types of sustainability standards such as the FSC certification which have high biodiversity conservation requirements integrated into the standards such as maintenance of ecosystem services, avoidance of natural forest conversion, conservation of rare and endangered species (Roe *et al.*, 2013) and high associated costs (Griscom *et al.*, 2014).

We were not able to assess the prevalence of any add-on incentive used to finance the additional costs associated with the delivery of biodiversity benefits in our study because, these projects are still in the early stage of their project implementation and the majority have not started selling carbon credits. As for the three projects already selling REDD+ credits, where two have Gold level CCBA certification for the delivery of exceptional biodiversity benefits (Madre de Dios and Rimba Raya) and one is certified by the FSC (Jari/Amapa); there was no evidence of additional incentive to subsidize costs associated with obtaining these certification. Perhaps market benefits associated with the compliance of these certification schemes such as potential market access, improved public image and price premiums have motivated their uptake (Chen et al 2010). A recent report on the state of the voluntary carbon market shows that such projects do in fact sell credits at above average prices in the voluntary carbon market in 2014 (Peters-Stanley *et al.*, 2014).

The expanded scope of REDD+ provides the opportunity to deliver additional benefits for biodiversity by creating incentives to sustainably manage forests, restore and rehabilitate degraded forest and increase the area under protection. A review of Project Design Documents of the REDD+ initiatives in our study revealed the ability to demonstrate that their initiatives had strong threat to deforestation and forest degradation. Therefore avoiding deforestation and reducing forest degradation alone will have large gains for biodiversity. The large majority of projects in our sample have plans to enhance forest carbon stocks in existing forests via restoration, improvement of forest management activities and enrichment planting which will further benefit biodiversity. However, when the REDD+ proponents were interviewed, the large majority of these initiatives were still in their planning stage therefore we had limited knowledge on how biodiversity consideration were being incorporated into these broad interventions under the scope of REDD+. We can expect projects which have expressed intention to pursue forest management objectives targeted at biodiversity conservation will be better able to incorporate biodiversity consideration into their forest management activities (n=7) (Figure 3.9). Options include the implementation of reduced impact logging at projects aiming to improve forest management (Griscom & Cortez, 2013), carry out targeted forest restoration activities i.e. those that have the largest benefits for species of conservation interest (Jantz *et al.*, 2014) or design pro-biodiversity forest management. e.g. choice of species or rotation length that is beneficial for biodiversity (Nghiem, 2014) (See Chapter 2).

While our study only looked at REDD+ proponents and their funders, REDD+ actors could include the government, those buying REDD+ credits, institutions developing and verifying standards and the wider scientific community; all of which have been known to have an influence on the degree to which biodiversity is considered in the design and implementation of REDD+ schemes and projects (Thompson *et al.* 2011; Jagger *et al.* 2014). We focused on REDD+ proponents and funders because of their role in the early stage of REDD+ development. Like other global assessment of early REDD+ proponents (Cerbu *et al.*, 2011; Lin *et al.*, 2012; Simonet *et al.*, 2014), the majority (60%) of our sample was led by the private non-profit sector more specifically conservation NGOs. We would expect that such proponents will have the highest goals for biodiversity and conservation but our results indicate that the main goals of these proponents were to reduce carbon emissions and demonstrate viability of REDD+. Perhaps due to the urgency of climate change and its irreversible impact on people and biodiversity, these proponents were eager to demonstrate the feasibility of REDD+ to positively contribute to emission reduction whist contributing to biodiversity conservation and sustainable development. Other studies have also shown that early REDD+ initiatives have been built on prior forest management approaches, such as integrated conservation and development projects, as a springboard for REDD+ (Minang & van Noordwijk 2013) and a testing ground for proof of concept (Murdiyarso et al. 2012).

Donors and investors in REDD+ have the ability to safeguard biodiversity via donor policies and lending rules and increasingly, donors are developing monitoring and evaluation systems, especially with the increased use of results-based funding instruments for REDD+ (Daviet *et al.*, 2013). Funders can respond to a failure to implement safeguard protections in a variety of ways, options include to withhold, reduce, cancel or demand repayment of funds; however in practice, this is hard to implement (Angelsen, 2013). The legal agreements between bilateral donors and recipient countries often include safeguard conditionality. Norway is the largest bi-lateral donor for REDD+ initiatives in our study, funding initiatives in Brazil via the Amazon Fund and Tanzania via the Norwegian Embassy. The Norway government's requirements for selecting pilot projects is in the form of principles and criteria (Tipper, 2010); the general principles guiding pilot project selection one criteria is that "the project should show the potential for protection and conservation of the environment and natural resources and the extent to which this will contribute to income generating possibilities and thus reduction of poverty". The Amazon fund which is largely funded by the Norwegian government has guidelines and criteria for fund application highlights three basic eligibility criteria and these are; environmental impact assessment, environment monitoring and compliance with relevant legislation. The German government (funding three initiatives in our sample) via the Germany's REDD+ Early Mover programme states that funds acquired via its programme can also be used to incentivize forest conservation and not just emissions reductions activities (Daviet *et al.*, 2013). To date, much of REDD+ financing has gone toward country or project "readiness" activities aimed at preparing developing countries for successful implementation of REDD+ but it can be expected that moving forward, in the implementation phase of REDD+ donor or investors will need to take potential biodiversity (and social) risks more seriously.

3.5.2 The delivery of additional biodiversity benefits

Additional benefits for biodiversity from the REDD+ mechanism will depend on whether or not projects are located in the right places and this includes i) if they are located in areas important for biodiversity and ii) if these forests are threatened by deforestation. More than half of our REDD+ proponents had selected their project location with explicit regards to biodiversity conservation, perhaps reflecting the fact that the majority of these projects were led by conservation NGOs. However, the fact that these projects were extensions of on-going conservation and development initiatives means that they may not necessarily be the most threatened to future deforestation as they were already benefiting from some form of protection. This is perhaps a situation which can be expected from pilot REDD+ initiatives in the readiness phase of REDD+ which are donor led and where the key objective is to prove that REDD+ is a feasible climate mitigation mechanism. It can be expected that in the operational phase of REDD+, projects will need to demonstrate that it is vulnerable to on-going or future deforestation threat in order to obtain REDD+ incentives. REDD+ projects which are located in forest most important for biodiversity may not automatically protect biodiversity (Putz & Redford, 2009) because these forests will still be vulnerable to external threat such as encroachment and hunting (Clements *et al.*, 2010b; Linkie *et al.*, 2014). In order to obtain maximum gains for biodiversity, projects will still need to develop goals and strategies for biodiversity (Imai *et al.*, 2014) and pro-biodiversity forest management activities (Martin *et al.*, 2013) in order to protect the biodiversity values within (Putz & Redford, 2010) and address wider landscape level threat (Harrison *et al.*, 2012). However, it can be anticipated that project proponents will face considerable challenges in developing and developing robust methodologies and in implementing monitoring programs.

Our study indicates that market pressure could likely drive projects to deliver additional benefits for biodiversity instead of drive projects to delivery credits at the lowest cost. Voluntary carbon credit buyers and perhaps also future credit buyers have demonstrated high interest in REDD+ credits which offer more than just carbon benefit (Goldstein *et al.*, 2014). Market pressures such as premium price and market access in the voluntary carbon market could be a strong drive for REDD+ project developers to deliver biodiversity benefits even if it is not one of their top project goals. At our projects, voluntary standards such as the CCBA and FSC standards have been a force behind the uptake of pro-biodiversity management activities such as the development of biodiversity baseline, the development of a biodiversity monitoring plan and the identification, maintenance and enhancement of High Conservation Values (HCV). However, there has been little guidance on how these are to be carried out (Waldon *et al.*, 2011) and REDD+ initiatives often lack the capacity (knowledge and human resource) and financial resources to implement. Designing and implementing pro-biodiversity forest management interventions will be especially challenging for the REDD+ initiatives which are not led by conservation NGOs and partnerships will be important if REDD+ is to achieve its climate and biodiversity goals.

3.5.3 REDD+ challenges and the way forward

The REDD+ projects in our sample expressed some of the challenges they faced in designing and implementing projects that conserves biodiversity; these are real and important challenges which leaders at the international negotiations need to consider if or when they set binding requirements for the delivery biodiversity benefits in REDD+. The lack of support which includes political and financial support to keep forests standing was cited as the reason why a third of the REDD+ proponents in our study considered the delivery of biodiversity benefits a challenge. These challenges were largely experienced by jurisdiction level initiatives (e.g. Transamazon, Cotriguaçu, Acre, Berau) which face pressure of implementing REDD+ as well as increasing the economy of the state or district where clearing forests to other land use such as agriculture and logging is more lucrative than protecting forests under REDD+.

Experiences from our 22 projects also show that challenges vary from country to country because their threat to biodiversity and the capacities differ; therefore national or sub-national biodiversity guidance and safeguards will be important in the operational phase of REDD+. While the challenges faced by our proponents in the delivery of biodiversity benefits are important, it is equally important to note that these were not their biggest challenges. Sunderlin et al. (2014a), in their assessment of the challenges in implementing REDD+ at the same 22 REDD+ initiatives (not limited to biodiversity challenges) found that tenure issues were the most daunting challenge experienced by proponents, followed by what they categorized as the "disadvantageous economics of REDD+," which includes the international, national and sub-national political-economy issues in REDD+. The multiple challenges faced by the proponents of early REDD+ initiatives could be the reason why the large majority of the REDD+ projects in our sample have not started selling carbon credits while as many as six initiatives have either ceased to exist or have chosen not to use the REDD+ label (see Appendix 1). The three REDD+ initiatives which have made progress are from the private for-profit sector, partly self-funded and partly funded by investors interested in the carbon credits generated by these REDD+ projects; the drive to recover investment and ensure investors' confidence could be the reason why these initiatives have been successful at overcoming their challenges and accessing the carbon credits (Sills et al., 2014).

What is also important to note is that the majority of the REDD+ initiatives in our sample were extensions of on-going conservation and development initiatives where only four initiatives were created explicitly for REDD+. If REDD+ is to truly reduce deforestation and benefit biodiversity in the tropics, its future expansion will need to be located in forest with high threat to deforestation. However, without a stable international mechanism as well as predictable and sustainable source of financing, it will be a risky for REDD+ proponents to venture out into deforestation frontiers which have higher associated opportunity costs.

3.6 Conclusion

The extent to which biodiversity is considered by the REDD+ initiatives in our sample is encouraging in spite of the general lack of emphasis at the international negotiations to date and in the absence of result based incentives to encourage projects. We found that NGO led REDD+ initiatives which have been closely associated with early REDD+ implementation could be the reason why more than half of the REDD+ proponents in our sample were locating their projects with explicit regards to biodiversity, had pre-existing conservation related intervention prior to the REDD+ project conception and considered the delivery of biodiversity benefits one of their top project goals. We anticipate that the focus of REDD+ initiatives in the implementation phase of REDD+ will shift and REDD+ initiatives will have stronger focus on the ability to demonstrate threat and emission reduction which will have overarching benefits for biodiversity. We found that projects are largely incorporating biodiversity considerations into their REDD+ project design because of their commitment to voluntary certification schemes such as the CCBA and the FSC. This could perhaps be due to market pressure whereby REDD+ credit buyers are interested in credits which also deliver other co-benefits such as biodiversity and social co-benefits. It can be anticipated that such standards will remain important when REDD+ moves into the implementation phase. While project proponents face some challenges in delivering biodiversity benefits, the biggest challenge faced by conservation in the tropics is to halt deforestation and forest degradation. Whether or not REDD+ forms part of the post-Kyoto climate regime will influence outcomes for forests and its biodiversity however, outside the international negotiations, donor countries committed to climate mitigation have a role key in promoting to influence results based REDD+ financing via bilateral means.

CHAPTER 4

PART I – MAIN PAPER

CAN REDD+ DELIVER BIODIVERSITY CO-BENEFITS?

Spatial patterns of carbon, biodiversity, deforestation threat and REDD+ projects in Indonesia

Published as: Murray, J. P., R. Grenyer, S. Wunder, N. Raes, and J. P. G. Jones. 2015. Spatial patterns of carbon, biodiversity, deforestation threat and REDD+ projects in Indonesia. Conservation Biology (in press).

4.1 Abstract

There are concerns that Reduced Emissions from Deforestation and Forest Degradation (REDD+) may fail to deliver potential biodiversity co-benefits if it is focused on high carbon areas. We explored the spatial overlaps between carbon stocks, biodiversity, projected deforestation threats, and the location of REDD+ projects in Indonesia, a tropical country at the forefront of REDD+ development. For biodiversity, we assembled data on the distribution of terrestrial vertebrates (ranges of amphibians, mammals, birds, and reptiles) and plants (species distribution models for 8 families). We then investigated congruence between different measures of biodiversity richness and carbon stocks at the national and sub-national scales. Finally, we mapped active REDD+ projects and investigated the carbon density, potential biodiversity richness and modeled deforestation pressures within these forests relative to protected areas and unprotected forests. There was little internal overlap among the different hotspots (richest 10% of cells) of species richness. There was also no consistent spatial congruence between carbon stocks and the biodiversity measures: a weak negative correlation at the national scale masked highly variable and non-linear relationships island by island. Current REDD+ projects were preferentially located in areas with higher total species richness and threatened species richness but lower carbon densities in relation to protected areas and other unprotected forests. Although a quarter of the total area of these REDD+ projects is under relatively high deforestation pressure, the majority of the REDD+ area is not. In Indonesia at least, first-generation REDD+ projects are located where they are likely to deliver biodiversity benefits. However, if REDD+ is to deliver additional gains for climate and biodiversity, projects will need to focus on forests with the highest threat to deforestation, which will have cost implications for future REDD+ implementation.

4.2 Introduction

There has been a lot of interest in the potential of forest carbon sequestration projects such as those being discussed under the climate mechanism to Reduce Emissions from Deforestation and forest Degradation (REDD+) to deliver benefits for biodiversity. Under the proposed mechanism, REDD+ payments are intended to protect threatened tropical forests by providing economic incentives for continued forest integrity (Venter & Koh, 2011). The 'plus' in REDD+ expands the scope to include the conservation, sustainable management, and enhancement of forest carbon stocks as means to reduce emissions from deforestation and forest degradation (UNFCCC, 2008). Some argue that REDD+ offers 'unprecedented' opportunities for biodiversity (Gardner *et al.*, 2012) and provide new funding for conservation (Venter *et al.*, 2009a), rehabilitation of critical habitat (Alexander *et al.*, 2011), and the establishment of new protected areas (Macdonald *et al.*, 2011). However, many have also drawn attention to potential risks for biodiversity that are associated with preferential targeting of REDD+ projects in high carbon areas, such as displacement of land use pressure (leakage) into high biodiversity but low carbon areas (Harrison & Paoli, 2012) and the diversion of funds for forest conservation away from high biodiversity low carbon areas (Phelps *et al.*, 2012b).

The degree to which carbon and biodiversity services are co-located in the landscape will influence the potential for delivery of biodiversity benefit; more opportunities are expected where there is congruence between high carbon and biodiversity stocks (Strassburg *et al.*, 2010). There are strong synergies between carbon and biodiversity at the global level (Strassburg *et al.*, 2010). National scale analyses, particularly important for planning REDD+ as an inter-governmental mechanism (Gardner *et al.*, 2012), have been variable in quality and provide ambiguous results. National level analyses (Madagascar and Bolivia) with finer scale biodiversity data show little congruence between carbon and biodiversity (Wendland *et al.*, 2010; Sangermano *et al.*, 2012). However the additional gains from REDD+ for carbon, biodiversity, and other ecosystem services depends on spatially specific threats of deforestation and forest degradation (Busch & Grantham, 2013); to our knowledge, none have included both spatial congruence and deforestation threat in their analysis.

Indonesia is the third largest tropical forest country, a major contributor to global greenhouse gas emissions from deforestation, forest and peat degradation (Margono *et al.*, 2014), and a mega-biodiversity country (Sodhi *et al.*, 2004). Indonesia has made commitments to reduce emissions (GOI, 2012) and received significant donor funding for REDD+

implementation (Brockhaus *et al.*, 2012). We assessed the distribution of biodiversity in Indonesia, using species ranges of terrestrial vertebrates (mammals, birds, reptiles, and amphibians) and species distribution models covering eight plant families which are available for Sundaland only. We explored the congruence between carbon and biodiversity based on three measures of richness; total, threatened and restricted range species richness. We then assessed the location of REDD+ projects relative to deforestation threats and spatially determined potential for these to deliver positive outcomes for carbon and biodiversity.

4.3 Methods

4.3.1 Data

Our biodiversity analyses was based on recently updated global species range data for the distribution of mammals, reptiles, and amphibians (IUCN, 2012b); birds (BirdLife International and NatureServe, 2012); and species distribution models (SDMs) for eight major plant families (Dipterocarpaceae, Ericaceae, Fagaceae, Lauraceae, Moraceae, Myristicaceae, Sapindaceae, and Leguminosae) in Sundaland(Raes *et al.*, 2013). See Part II (Section 1) of this chapter for additional information on the biodiversity datasets used in this study.

We used newly available high resolution carbon data sets for above ground biomass (Baccini *et al.*, 2012) and soil organic carbon up to 100 cm depth (Hiederer & Köchy, 2012).

A database of active REDD+ projects in Indonesia was developed for the purpose of this research. We contacted all known REDD+ project developers in Indonesia via email to identify active projects, their central coordinates, and the project size. We achieved a 72% response rate and filled in gaps with best guesses based on available grey literature and web-based reports. We mapped the location of individual projects based on known project boundaries (n = 22), district boundaries for district level projects (n = 3), and circular boundaries for projects for which we did not have exact boundary information (n = 11). For the circular boundaries, we drew a circle around the project centroid based on information about project area provided by project developers. Refer to Part II (Section 2) of this chapter for additional information about the REDD+ projects developed for this study.

The protected area dataset for Indonesia was obtained from the newly updated World Database on Protected Areas (IUCN &UNEP-WCMC 2013). We included protected areas in categories I – VI and nationally recognized protected areas (PAs) without an IUCN category (280 in total). We used the econometric model OSIRIS-Indonesia developed by Busch et al.

(2010) to predict deforestation in the absence of REDD+ carbon incentives. The model predicts deforestation based on estimated potential gross agricultural revenues and the cost of converting land from forest to agriculture.

4.3.2 Analysis

Data sets were analysed at 5 x 5 km resolution in the WGS 1984 World Mercator projection. We clipped global data sets to the Indonesian Archipelago (total terrestrial land areas), which covers 79,555 terrestrial cells. Refer to Part II (Section 3) of this chapter for detail about the spatial methods used in this study.

Species distribution maps were developed using polygon vector ranges of 367 amphibian, 281 reptile, 665 mammal, 1559 bird species and SDMs of 1720 plant species. Following Wang et al. (2013), we calculated species richness as the number of species range polygons that intersect each grid cell. We used three measures of species richness: total species, threatened species, and restricted range species. Threatened species were those classified by the IUCN (2012) as critically endangered, endangered, and vulnerable. Restricted range species were species with a global range in the lowest quartile of their range class (Orme *et al.*, 2005; Grenyer *et al.*, 2006). Threatened and restricted range species richness were analyzed only for vertebrates. We identified the richest grid cells (hereafter 'hotspots'[Orme et al. 2005]) for each richness measure for vertebrates and plants (total richness for Sundaland only). We explored the degree to which hotspots overlapped when defined as the richest 10% of cells and the effects of using different hotspot definitions (richest 5%, 10% and 25%). We found that regardless of the definition used, there was no overlap between hotspots identified based on different measures of species richness. Refer to Part II (Section 4) of this chapter for additional information on the implications of using four different hotspot definitions and three different measures of species richness when defining biodiversity hotspots.

Indonesian islands differ in size, isolation, topography, climate, and geology, which results in very different island mean biodiversity and carbon values. We therefore investigated congruence at two levels - national and within the five major islands (Sumatra, Borneo, Papua, Sulawesi, and Java) - to investigate if national-scale patterns are consistent within islands. We selected above ground biomass (AGB) and soil organic carbon (SOC) up to 100 cm depth based on findings that when congruence was evaluated at three soil depths (0 cm, 30 cm and 100 cm), SOC depth had a clear effect on the congruence patterns, particularly in areas identified as carbon rich peat swamp forests. Refer to Part II (Section 5) of this chapter for the additional information on the tests carried to assess the effects of different SOC depths on the congruence between carbon and biodiversity.

Congruence between carbon and the three measures of biodiversity richness were assessed using Spearman's rank correlation coefficient; the effective degrees of freedom were corrected by the level of spatial autocorrelation in the data following Dutilleul (1993). We used hexagonal binning (an aesthetic mapping technique that shows differences between data rich and data sparse parts of the distribution) to visualize the relationship between carbon and biodiversity and fitted a generalized additive model with 95% Cis (R package – ggplot2) (Wickham, 2009). All statistical analyses were carried out in R statistical software Version 3.2.1 (R Core Team, 2013). Congruence maps were developed in ArcGIS 10.1 with the RGB composite band tool.

We assessed the distance and overlap between REDD+ projects (centroid) and PAs (polygon) with the 'near' function in ArcGIS 10.1. We explored the distribution of carbon and biodiversity in Indonesia for three categories of forested areas: REDD+ project areas, PAs, and other unprotected forest (outside REDD+ projects and PAs). We defined *'forest'* as those pixels comprising mangrove, peat swamp forest, lowland forest, lower montane forest, upper montane forest, and plantation or regrowth (Miettinen *et al.*, 2012). We sampled 1000 random points from all three forest categories and compared the means of the three groups using one way analysis of variance (ANOVA) followed by a post-hoc Tukey's honestly significant difference (HSD) test to determine categories that were significantly different.

The modelled deforestation data from OSIRIS-Indonesia version 1.5 showing predicted deforestation in the absence of a REDD+ mechanism (Busch *et al.*, 2010) was exported into ArcGIS 10.1 and resampled to 25km^2 grid cells (from 9km^2). We calculated predicted deforestation per hectare for all grid cells classed as forest in 2010. We extracted predicted deforestation values (percent) for each forested cell and reclassified these into five deforestation threat classes (very low to very high) based on natural breaks (Table 4.2). Using the zonal statistic function in ArcGIS, we calculated the proportion of REDD+ project area, PAs, and unprotected forests that fell into each deforestation class. Details about the OSIRIS model can be found in Section 7 - Part II of this chapter.

4.3.3 Limitations

Our analyses relied on available data sets, such as vertebrate vector range maps, which tend to overestimate the likelihood of species occurrence. Some species will be absent in fragments, logged forests, and recently deforested areas. We dealt with this by refining the species range maps and confining our analyses to remaining forest area based on 2012 forest cover map, as suggested by Jenkins et al. (2013). We also assumed that most species persist in logged or secondary forests based on the large body of literature which supports this (e.g. Sitompul et al. 2013; Struebig et al. 2013; Edwards et al. 2014). Our projected deforestation threat was based on econometric modeling, the results are therefore a scenario specific prediction of where threats are most likely to occur given the defined model assumptions. The model predicts deforestation based on the conversion of forest land to agriculture (See Part II Section 7 for details about the predicted deforestation model used in this analysis).

4.4 Results

4.4.1 Patterns of biodiversity distribution

Patterns of potential species richness were highly variable from taxon to taxon and depended strongly on the richness measure used. For total species richness, the highest potential vertebrate species richness was in Sumatra; lower potential species richness was to the East of Wallace's Line in Sulawesi and Papua (Fig. 1a). When both plant and vertebrate data were combined (possible for Sundaland only), the highest total richness shifted from lowland Sumatra to lowland Kalimantan (Fig. 1d), and the northern tip of Kalimantan had the highest total potential species richness (>1270 species in a single cell).

Threatened vertebrate species richness was distributed differently. The highest potential richness was concentrated in coastal lowlands of Sumatra and sub-montane regions of Kalimantan (Fig. 1b), while Papua had the lowest potential threatened species richness. Potential restricted range species richness was mostly concentrated in the uplands (Java, Sulawesi, and Papua) and the smaller islands of Buru, Seram, and Halmahera in the Wallacea ecoregion (Fig 1c). See Part II (Section 1) of this chapter for the species richness patterns for individual taxa. Hotspots of biodiversity richness identified based on different measures did not generally overlap, further emphasising that the identification of areas important for biodiversity depended on the measure used (Fig. 1). For example, when hotspots were defined as the richest 10% of cells, no cells were identified as hotspots for all three measures of total species richness (vertebrates and plants). Part II (Section 5) of this chapter provides additional information on the effects of using different hotspot definitions (5%, 10%, 15% and 25%) on hotspot overlap for each measure of biodiversity richness.

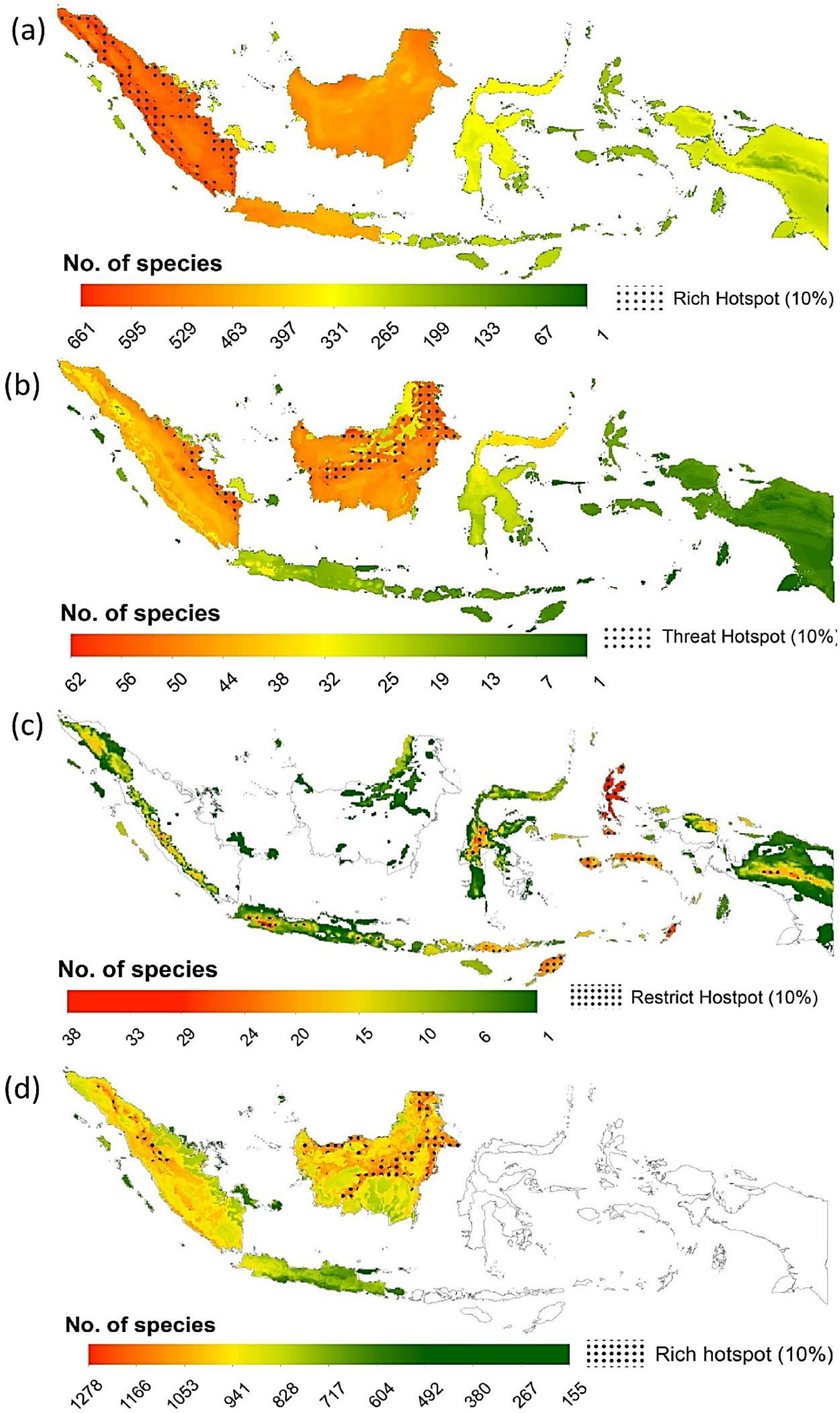


Figure 4.1: The distribution in Indonesia of (a) total vertebrate species richness, (b) threatened vertebrate species richness, (c) species richness of restricted range vertebrates, and (d) total species richness of vertebrates and plants for Sundaland

4.4.2 Congruence between carbon and biodiversity

At the national scale, there was some evidence of a negative relationship between organic carbon stock and all three measures of terrestrial vertebrate richness (Table 4.1, Figure 4.2). This negative relationship was significant at the 5% level for threatened species richness and restricted range species richness but was not significant for total species richness. However, this relationship did not hold when analysed for islands independently (Table 4.1, Figure 4.2).

The relationship between carbon density and total species richness was either not significant or only weakly correlated for each of the major islands. With the inclusion of plants, there was a strong negative relationship between carbon and overall species richness in Kalimantan (r_s = -0.306, $p \leq 0.001$), and Sumatra (r_s = -0.516, $p \leq 0.001$) (Table 4.1, Figure 4.2d). This result reflected the fact that peat swamp forests store very large amounts of carbon but do not have particularly high overall plant species richness.

The relationship between carbon density and threatened species richness was neither strong nor monotonic in any of the four major islands (Table 4.1, Figure 4.2b). The relationship was strongest in Java, where the correlation was broadly positive (r_s=0.29, $p \leq 0.001$). Montane regions of Kalimantan and Papua coincided with the highest concentrations of restricted range vertebrate species (Figure 4.2c), however, these regions have relatively low carbon densities; thus, a generally negative relationship between carbon and restricted range species richness was evident in in Kalimantan (r_s = -0.075, p= 0.016) and Papua (r_s = -0.222, $p \leq 0.001$) (Table 4.1, Figure 4.2d). The opposite trend was evident on Java (r_s = 0.61, $p \leq 0.001$), where there was a nearly monotonic positive relationship between carbon and restricted range vertebrate species (Table 4.1, Figure 4.2c), both of which are confined to remaining upland forests.

The relationship between each measure of species richness and carbon was also greatly influenced by which taxa were included in the analyses; for example, restricted range birds (r_s = 0.636, $p \leq 0.001$) and mammals (r_s = 0.49, $p \leq 0.001$) in Java had strong positive correlation with carbon, whereas plants had a strong negative correlation with carbon in Sumatra. Refer to Part II (Section 5) of this chapter for the table showing the relationship between carbon and individual taxa according to three measures of biodiversity richness.

Table 4.1: Correlations between carbon density (above ground biomass [AGB] and soil organic carbon [SOC] at 100 cm depth) and three measures of terrestrial biodiversity richness (total vertebrate richness, threatened vertebrate richness, restricted range vertebrate richness, and total species richness including plants) at five islands and the whole of Indonesia.

Islands	Total richness			Threatened			Restricted			Total richness + plants[a]		
	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)
Kalimantan	0.14	<0.001	1287 (21028)	0.04	0.159	1418 (21023)	-0.08	0.016	1021 (3736)	−0.306	<0.001	884 (20508)
Sumatra	0.01	0.821	519 (17522)	0.14	0.019	266 (17480)	0.34	<0.001	1060 (5397)	−0.516	<0.001	860 (16782)
Java	0.23	<0.001	224 (4832)	0.29	<0.001	162 (4808)	0.61	<0.001	2307 (4224)	0.244	0.007	118 (4639)
Papua	0.00	0.944	446 (15714)	-0.13	0.114	147 (15480)	-0.22	<0.001	939 (8858)	-	-	-
Sulawesi	0.22	<0.001	213(6746)	0.31	0.040	85(6724)	0.42	<0.001	176(5165)			
Indonesia	-0.06	0.234	444 (72684)	-0.08	0.007	1236 (71996)	-0.06	<0.001	29343 (33471)	-	-	-

Key:
r_s, Spearman rank correlation coefficients of all cells
p, P-value
CDF, Clifford's corrected degrees of freedom
df, actual degrees of freedom
[a] Only for Sumatra, Kalimantan and Java

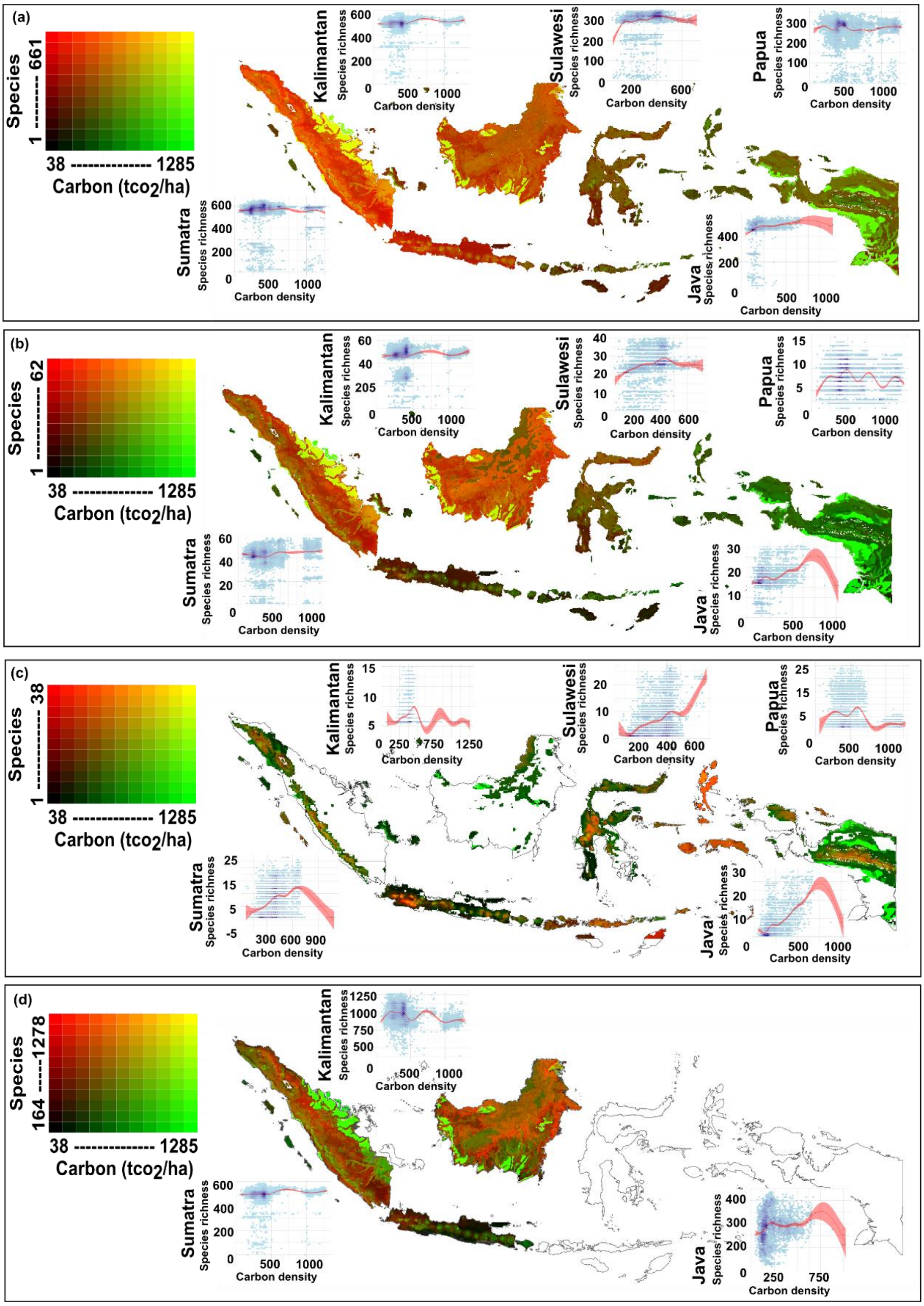


Figure 4.2: The relationship between biomass carbon (AGB + SOC at 100 m) and three measures of terrestrial species richness; (a) total vertebrate richness, (b) threatened vertebrate richness, (c) restricted range vertebrate richness, and (d) total vertebrate and plant richness (for Sundaland only)

Key: Species, number of species; carbon density units of measure, tCO2; 95% CI is displayed around the fitted general additive model; data for island graphs shown on a hexagonal grid shaded logarithmically from white to dark blue to indicate the degree of over plotting).

4.4.3 Carbon, biodiversity, and deforestation threat

We identified 36 active REDD+ projects in 15 provinces of Indonesia (25 projects reported as no longer active). Projects varied in size from site level activities to those operating at the district or sub-province level. Over half (53%) of the project developers were conservation nongovernmental organizations (NGOs), 33% were private for profit organizations, and 17% were projects established in collaboration with the Indonesian government or bilateral agencies. At least 25% of REDD+ project centroids overlapped with the boundaries of PAs - See Part II (Section 2) of this chapter for details about the REDD+ database.

REDD+ forests tended to have, on average, lower carbon densities (mean = 433.5 tCO_2/ha) than PAs (mean = 493.2 tCO_2/ha) and unprotected forests in Indonesia (mean = 447.6 tCO_2/ha) (Figure 4.3a). Mean carbon density did not differ significantly between REDD+ projects and unprotected forests (F = 17.39 on 2877 df, $p = 3.1 \times 10^{-8}$) The REDD+ projects had significantly higher potential total vertebrate species richness (F = 130.2 on 2966 df, $p = 2 \times 10^{-16}$) and threatened species richness (F = 152.2 on 2930 df, $p = 2 \times 10^{-16}$) (Figure 4.3b and c). This relationship held true when plants were included in the measures of potential species richness (F = 16.35 on 2730 df, $p = 8.77 \times 10^{-8}$). Restricted range species showed a very different pattern; REDD+ projects and unprotected forests had on average lower potential species richness per cell than protected areas (F = 17.2 on 1631 df, $p = 4.07 \times 10^{-8}$) (Figure 4.3d). See Part II (Section 6) for the summary statistics of the ANOVA and TukeyHSD tests.

At least 23% (or 2.9 million ha) of the area of REDD+ projects was located in forests that had medium to high predicted deforestation threat, whereas 11% (or 2 million ha) of PA and 21% (or 20 million ha) of unprotected forest were under this level of threat. Forests currently not protected by REDD+ or PAs had a much larger area exposed to high deforestation threats; 1 million ha were predicted to be under very high deforestation threat (10 – 36% deforestation/ha) (Table 4.2).

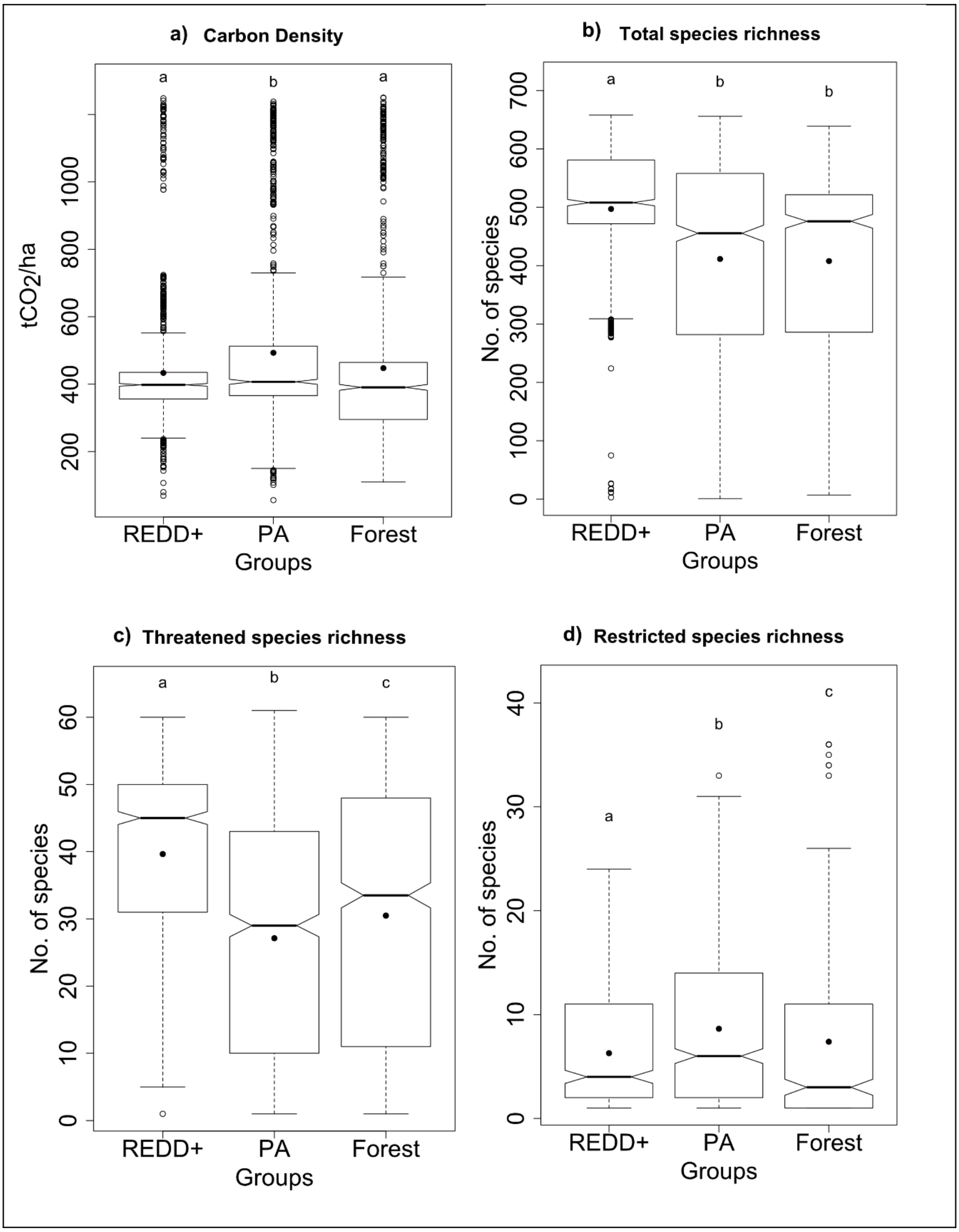


Figure 4.3: Distribution of carbon and total, threatened, and restricted-range vertebrate species richness in REDD+ project areas (REDD+), protected areas (PA), and unprotected forests (Forest) in Indonesia.

Key: Solid dot, mean; notches in bars, approximate 95% CI around the median value; letters above boxes, different letters show significant difference with Tukey Honestly Significant Difference (TukeyHSD) test.

Table 4.2 modeled deforestation in REDD+ projects, protected areas, and unprotected forests in Indonesia based on 5 deforestation threat categories

Deforestation per ha (%)	Threat level	REDD+			Protected areas			Unprotected forest		
		Area (1000s ha)	Mean (%)	% of area	Area (1000s ha)	Mean (%)	% of area	Area (1000s ha)	Mean (%)	% of area
0.0002 - 0.88	very low	6443	0.3	51	13193	0.2	71	44975	0.4	46
1.88 - 2.13	low	3280	1.4	26	3408	1.5	18	32063	1.4	33
2.13 - 4.55	medium	2190	2.9	17	1748	2.8	9	15330	3.0	16
4.55 - 9.52	high	493	6.1	4	243	5.9	1	3530	6.1	4
9.52 - 36	very high	170	12.3	1	53	12.0	0.3	1218	13.1	1

4.5 Discussion

4.5.1 Potential biodiversity co-benefits from REDD+

We found that patterns of biodiversity identified depended on the measure of biodiversity used; the protection of forests with the highest species richness (in Sumatra) may not protect forests with the highest number of threatened species (Kalimantan and coastal Sumatra) or restricted range species (highlands and small islands). Patterns of species richness were also highly variable between taxa, as has been demonstrated globally (Grenyer et al 2006; Jenkins et al. 2013). Therefore, it is not possible for REDD+ projects to be located in such a way as to be 'good for all measures of biodiversity' simultaneously.

We found no clear and consistent relationship between carbon and any of our proxy measures of biodiversity in Indonesia, there was a weak negative relationship at the national scale, but relationships within islands were sometimes weakly positive, sometimes non-existent, and sometimes strongly negative. The lack of a clear relationship between carbon and species richness has also been found in South Africa (Egoh *et al.*, 2009) and Madagascar (Wendland *et al.*, 2010). This is perhaps not surprising because of the fundamental ecological differences (definition and substitutability) between carbon and biodiversity (Potts *et al.*, 2013). There are concerns that a lack of congruence between carbon and biodiversity could result in REDD+ investments focusing on high carbon areas which will put biodiversity at risk (Venter *et al.*, 2009a; Harrison & Paoli, 2012). While we did not find congruence between carbon stock densities and biodiversity richness in Indonesia, we also did not find REDD+ projects targeting areas with the highest carbon stocks. Instead, they seemed well positioned to deliver biodiversity gains because they tended to be located in areas with higher potential species richness (of total and threatened species).

One factor which may explain why REDD+ projects in Indonesia tended to be located in areas important for biodiversity is that REDD+ development in Indonesia has been spearheaded by conservation NGOs. Such project developers may be seeing REDD+ as a novel funding stream for conservation rather than simply seeking to maximize potential carbon revenues. Our results for Indonesia are consistent with findings from studies in Tanzania (Lin et al. 2014) and Brazil (De Barros et al. 2014), which show evidence of REDD+ initiatives spatially targeting high biodiversity areas. The REDD+ project areas may tend to have lower than average carbon stock because remaining forests outside PAs have mostly been logged (Margono *et al.*, 2014). We also found that many REDD+ projects in our sample are pursuing reforestation and forest restoration as their key project activities, we expect such projects with aims to enhance forest carbon stock to be located in degraded or secondary forests, with perhaps lower than average carbon content.

4.5.2 Contribution of REDD+ to conservation in Protected Areas

Implementing REDD+ in PAs has been criticized as not being ‘additional’ (Macdonald *et al.*, 2011) because supposedly PAs are already conserved. However, given the underfunding of many protected areas worldwide, it could be argued that improved funding could result in additional gains (Macdonald *et al.*, 2011). Despite their protected status, many PAs in Indonesia are under continuing threat; with over 12% of primary forest loss in Indonesia (2000-2012) located in PAs (Margono *et al.*, 2014), and enforcement is lax (Gaveau *et al.*, 2012). Similarly, we found that PAs were not completely spared from the threat of deforestation; at least 11% (or > 2 million ha) of PA area was in areas predicted to have medium to high deforestation threat. We found evidence that REDD+ is indeed being used to support conservation in Indonesia’s protected areas; at least 25% of REDD+ project boundaries overlapped with PAs (Supporting Information). If REDD+ funding could be used to increase the effectiveness of PAs, the benefits for biodiversity could be large. The REDD+ projects located adjacent to current PAs could also play an important role in ‘softening the matrix’,. which would reduce the effective isolation of species in the PAs and improve population viability (Jantz *et al.*, 2014).

4.5.3 Priorities for achieving biodiversity co-benefits with REDD+

Peat swamp forests in Indonesia have global importance in climate mitigation and they are highly threatened because they represent the last frontiers for production of food, pulp, and biofuels (Posa *et al.*, 2011). Recent findings show that 43% (2.6 million ha) of primary forest loss in Indonesia (2000-2012) took place in peatlands, which have an overall increasing rate of loss greater than lowland primary forests (Margono *et al.*, 2014). A large number of REDD+ projects are located in carbon-rich peat swamp forests (Harrison & Paoli, 2012). We also found this to be true; however, the total area covered by these projects were much smaller than projects on mineral soils (Supporting Information). Highly threatened lowland mineral soil forests, such as those in the lowlands of Borneo and Sumatra, should remain a priority for future REDD+ planning in spite of having below average carbon content. Large expanses of selectively logged forests in Indonesia are now degraded and under high threat of conversion because these are prime agriculture lands where the Indonesian government intends to locate future palm-oil plantations in an attempt to divert palm-oil development away from carbon rich peat swamp forests and pristine mineral soil forests (Gingold, 2010). Margono et al. (2014) found that from 2000 to 2012, 98% (15.8 Mha) of forest loss took place in degraded forests. However, even heavily logged forests can be of high conservation value (Struebig *et al.*, 2013). Meijaard and Sheil (2007) estimate that about 75% of Bornean orangutans (*Pongo pygmaeus*) live in logging concessions, and Sitompul et al. (2013) found that at least 1.6 million ha of Sumatran elephant (*Elephas maximus sumatranus*) habitat is in active logging concessions or in previously logged areas. These forests contain important biodiversity that would be reduced if they were logged again or cleared for oil palm or pulpwood plantations (Edwards *et al.*, 2012a). Opportunities for biodiversity in the REDD+ mechanism does not rely on the spatial congruence between carbon and biodiversity alone. The REDD+ policies are important if biodiversity conservation is to be integrated into the national REDD+ architecture (Phelps *et al.*, 2012b). Biodiversity-specific management will need to be incorporated in the planning, design, and implementation of REDD+ on the ground (Martin *et al.*, 2013) because protecting existing forest carbon stocks alone will not automatically protect other forest values (Huettner, 2012).

4.5.4 Cost of delivering biodiversity co-benefits in REDD+

Our results show that first generation REDD+ projects in Indonesia are not necessarily located in the highest threat areas. This is consistent with the findings of Cerbu et al. (2011), who showed that predicted future deforestation appeared to be less of a criteria among first generation developers for the location of REDD+ projects than the interests of NGOs or government agencies. Early REDD+ projects have built on prior forest management approaches, such as integrated conservation and development projects, as a springboard for REDD+ (Minang & van Noordwijk, 2013) and a testing ground for proof of concept (Murdiyarso *et al.*, 2012). The REDD+ projects in our study are in the early stages of development and are operating largely from bilateral REDD+ funding. As the REDD+ mechanisms develop, the conditions under which project location is selected will differ; the non-co-location of carbon and biodiversity priority areas in Indonesia highlights an important structural feature which will affect the cost of delivering biodiversity co-benefits in future REDD+ projects.

It can be assumed, based on our findings, that REDD+ projects located in forests most important for biodiversity will cost more per unit of carbon delivered than those located in high carbon forests because forests with the highest biodiversity tend to have low carbon densities but high threat to future deforestation due to high agriculture rent (Busch *et al.*, 2010). Our results show that expanding REDD+ in forest with the lowest deforestation threat (generally on cheaper land) will have low incremental benefits for both biodiversity and carbon. We recommend that future research explicitly assess the costs associated with locating REDD+ projects in forests most important for biodiversity conservation, in light of the limited co-location between carbon and biodiversity we found. A future regulatory mechanism is likely to focus on cost-effective delivery of carbon benefits and not the large-scale delivery of non-carbon benefits (Busch, 2013). Biodiversity conservation in the context of REDD+ is therefore likely to require additional investment (Phelps *et al.*, 2012b). Options include the introduction of premiums for the delivery of biodiversity benefits (Dinerstein *et al.*, 2013), to allow REDD+ credits to protect forests that are carbon priorities, and use of supplementary funds to protect biodiversity priority areas even when they exhibit low carbon content (Venter *et al.*, 2013a). It is an empirical question which of these strategies would be more cost-effective under different contextual preconditions.

4.6 Conclusion

We found that patterns of biodiversity varied strongly among taxa and depended on the measure of biodiversity. It would therefore not be possible to place REDD+ projects in areas which are universally good for all measures of biodiversity. In Indonesia carbon stocks correlate poorly with all measures of biodiversity both at the national level and within major islands. However, REDD+ projects under development in Indonesia were located in areas with below average carbon stock but relatively high biodiversity (according to most measures we used), possibly reflecting the prominent role of conservation NGOs in the development of these first-generation REDD+ projects. While nearly one-quarter of REDD+ project area was located where deforestation threat was predicted to be relatively high, the majority of their area was not in highly threatened forests. This limits the opportunity to achieve the greatest benefits for both emissions reductions and biodiversity conservation. The patterns of biodiversity, threat and locations of REDD+ projects in Indonesia suggest that biodiversity co-benefits could be achieved through REDD+ in Indonesia, especially if future expansion focused on areas under high deforestation threat. As the world looks toward a global mechanism to address climate change to be agreed upon at the 21st Conference of Parties in Paris at the end of 2015, these findings are an important contribution to debates surrounding the design of REDD+ to maximize the potential for co-benefits. The realized benefits of any REDD+ network will of course depend not only on the design and spatial planning, but also on the effectiveness of interventions on the ground.

CHAPTER 4

PART II – ADDITIONAL INFORMATION

CAN REDD+ DELIVER BIODIVERSITY CO-BENEFITS?

Spatial patterns of carbon, biodiversity, deforestation threat and REDD+ projects in Indonesia

Part II of Chapter 4 contains additional information relating to the methods including details about the data sets used in the analysis, and further analysis not included in the main paper. Part II will be available online as supporting information for the paper accepted for publication in Conservation Biology (Murray *et al.*, 2015).

Section 1 Biodiversity datasets and their distribution patterns

We mapped biodiversity richness using improved digital species-range maps (BirdLife International and NatureServe, 2012; IUCN, 2012a, 2013) of well know terrestrial vertebrate taxa (mammals, birds and amphibians and reptiles) (Table 4.3). These ranges are based on species Extent of Occurrence (EOO) or Area of Occupancy (AOO). Range maps based on EOOs and AOOs tend to overestimate species ranges (Rocchini *et al.*, 2011) and are less accurate when compared to species distribution models. These nonetheless remain important sources of biodiversity data especially when analysing species richness across large areas (Hurlbert & Jetz 2007).

The databases we used in our analysis are considered some of the most comprehensive available for a large study areas like ours and have proven valuable in exploring a variety of broad scale ecological and conservation issues (Jenkins et al. 2013; Cantú-Salazar et al. 2013). These range maps are heavily relied upon when assigning threat status to species (Possingham *et al.*, 2002), for example: over 45% of species and 75% of amphibians' threat status are determined solely based on range measures (Gaston & Fuller, 2009). The quality of the IUCN and Birdlife range maps have improved in recent years (Jenkins *et al.*, 2013) therefore we consider their use here is justified. We included plants as a proxy for biodiversity with modelled data made available by (Raes *et al.*, 2009, 2013) which covers Sundaland[2] i.e. three out of the five major islands in our study area (Java, Sumatra, Kalimantan, Papua and Sulawesi). The eight modelled plant families are highly diverse and have characteristic roles in all ecosystems ranging from tropical lowland to montane forests. The inclusion of plants makes the dataset used in our study a comprehensive measure of biodiversity richness.

The overall pattern of biodiversity distribution is a reflection of the patterns in the various taxa which make up the dataset. All taxa were treated equally i.e. no weighting was carried out in our analysis. Birds dominate the patterns of total richness and threatened species richness while restricted range mammals are numerically more abundant and these dominate the richness pattern for restricted range species (Figure 4.4). Plants have a distinct richness distribution pattern from vertebrates and therefore its inclusion significantly change the pattern of total richness when they are included. In Figure 4.4, we show how the species richness distribution patterns varies between taxa based on the three measures of richness used in our study.

[2] Sundaland or the Sunda shelf which includes Borneo, Sumatra, Java, Bali and the Peninsular Malaysia

Table 4.3: Biodiversity dataset showing of the five taxonomic groups according to three measures of biodiversity richness.

Taxonomic groups	Species richness measure (number of species)		
	Overall species	**Threatened species**	**Restricted range species**
Amphibians	369	28	81
Mammals	668	162	178
Birds	1559	122	339
Reptiles	281	6	34
Plants*	1720	-	-
Total	2877	318	632

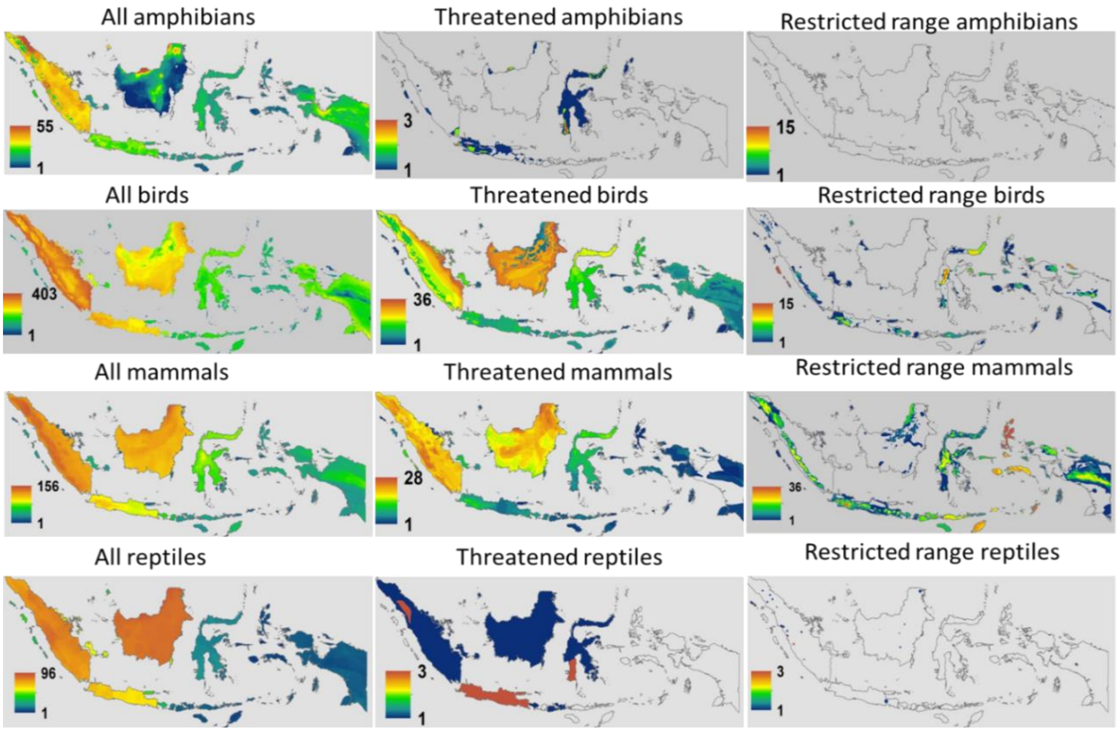


Figure 4.4: Species distribution pattern for amphibians, birds, mammals and reptiles in Indonesia using three measures of biodiversity richness (total, threatened and restricted range species richness)

Section 2 REDD+ project database for Indonesia

We developed a preliminary list of REDD+ projects in Indonesia by cross-referencing eight online databases[3] and two recently published reports on REDD+ projects in Indonesia (Pusat Standardisasi dan Lingkungan, 2011; Mardiastuti, 2012). We contacted all project developers identified and asked i) if their project is still active, ii) the project's central coordinates, and iii) the project's size. Projects not considered as REDD+ projects by their developers were not included in the analysis. We achieved a 72% response rate. For non-respondents, project information was obtained from online websites, reports and project design documents. A total of 36 active REDD+ projects were identified (Table 4.5: The list of active REDD+ projects in Indonesia, their project developers and organization type.). We mapped the location of individual projects using known project boundaries (n = 22), district boundary for district level projects (n = 3) and circular boundaries for projects we do not have boundary information (n = 11). These project boundaries were 'unknown' largely due to the need to keep the boundaries of projects not officially approved by the ministry of forest confidential.

The protected area dataset for Indonesia was obtained from the newly updated World Database on Protected Areas (IUCN and UNEP-WCMC, 2013). We assessed the distance between the REDD+ projects and their nearest PA. Distances were conservatively measured from the centroid of each REDD+ project to the boundary of a PA. We found that at least 11 (30%) REDD+ projects located within existing PAs (Figure 4.5) and more than half were close (<20km) from a PA. This analysis was carried out using the 'near' analysis in ArcGIS 10.1, we measured the distance between reach REDD+ projects to its nearest PA.

We also assessed the representativeness of the different forest categories in the REDD+ projects in Indonesia. The forest land use categories are those defined by Miettinen *et al.*, (2012). We found that approximately half of the REDD+ project area is located in lowland forests (44.2%). Like Paoli et al. (2010), we found many REDD+ projects located partly or entirely on peatlands however, in terms of area covered, it is small (9%). REDD+ projects on mineral soil forests are also relatively larger than those on peatlands. We also found that at least 23 % of REDD+ project area are located in plantation or regrowth areas which includes

[3] http://www.redd-indonesia.org/, http://www.forestsclimatechange.org/, http://www.forestcarbonasia.org, http://forestclimatecenter.org, http://redd-database.iges.or.jp/redd/, http://www.theredddesk.org/countries, http://www.climate-standards.org/category/projects/, http://www.gcftaskforce-database.org/.

degraded forests, young secondary forests and intensively logged forests where canopy cover is dominated by regrowth (Miettinen *et al.*, 2012) – See Table 4.4

Table 4.4: The REDD+ project area (ha) (n=36) and the percentage of area it covers according to their forest type.

Forest Category	AREA (ha)	% of REDD+ area
Mangrove	37,500	0.3
Peat Swamp Forest	1,132,500	8.9
Lowland forest	5,657,500	44.2
Lower Montane forest	2,015,000	15.8
Upper Montane forest	930,000	7.3
Plantation / regrowth	3,017,500	23.6

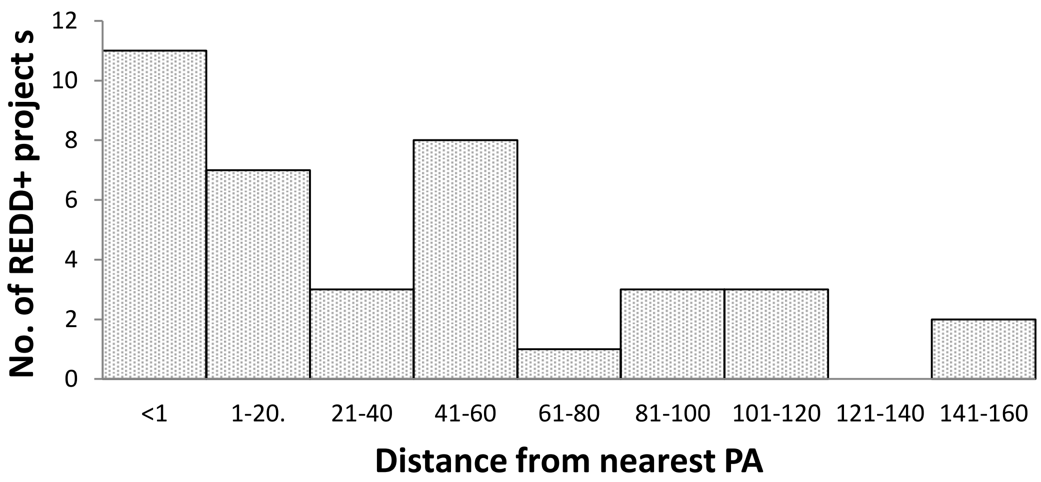


Figure 4.5: Distance between REDD+ projects and their nearest PA.

Note: Projects located at <1km distance are located within PAs.

Table 4.5: The list of active REDD+ projects in Indonesia, their project developers and organization type.

ID	Project	Project Proponent	Code
1	Ulu Masen Ecosystem – A Triple-Benefit Project	Carbon Conservation	3
2	Leuser Ecosystem REDD Project	Global EcoRescue	3
3	Batang Toru REDD project	Conservation International	1
4	Tesso Nilo Pilot Project	World Wide Fund for Nature (WWF)	1
5	The Kampar Peninsular REDD+ Project	Sinarmas Forestry & PT Putra Riau Perkasa	3
6	Kampar Ring - REDD and HTI	Asia Pacific Resources International Limited (APRIL)	3
7	REDD+ Pilot Project in Bengkalis and Siak	Sinarmas Forestry	3
8	Siberut Project	Global Green	3
9	Berbak Carbon Inititiative (BCI)	Zoological Society London (ZSL)	1
10	Community Carbon Pool in Jambi: Kerinci Seblats buffer zone forest	Flora and Fauna International (FFI)	1
11	Rehabilitation of Degraded Peatland in Ogan Komering Ilir, South Sumatra	Sinarmas Forestry	3
12	Lebong Carbon Conservation Project	Arthasuaka & Carbon Conservation	3
13	Meru Betiri National Park	Forest Research & Development Agency (FORDA)	2
14	Mamberamo River Basin Forest Carbon Project	Conservation International (CI)	1
15	Cyclops Mountains REDD Pilot Project	Flora and Fauna International (FFI)	1
16	Jayapura REDD+ Readiness	World Wide Fund for Nature (WWF)	1
17	Sustainable Management of Poigar Forest	Office National des Forêts (ONF) International	3
18	Sulbar Habitat REDD+	Keepthehabitat	1
19	Berau Forest Carbon Project	The Nature Conservency	1
20	FORCLIME - Berau Demonstration Activity (REDD via SFM strengthening)	GoI, Berau District Gov, GFA, GTZ-KfW	2
21	FORCLIME - Malinau Demonstration Activity (Kayan Mentarang NP)	GoI, Berau District Gov, GFA, GTZ-KfW	2
22	East Borneo Project	Global Green	3
23	Hutan Lestari untuk Orangutan: Kehje Sewen Forest	Borneo Orangutan Survival(BOS)	1
24	REDD in Kutai Barat District (i-REDD project)	World Wide Fund for Nature (WWF)	1
25	Kalimantan Forest and Climate Partnership (KFCP)	GoA, GoI, Care	2
26	Katingan Peat Conservation Project	Starling Resources, PT RMU	3
27	Community Carbon Project for Lamandau Wildlife Reserve	RARE & YAYORIN	1
28	REDD in Sebangau National Park	World Wide Fund for Nature (WWF)	1
28	Rewetting of Peatland to avoid emission in Sebangau National Park	World Wide Fund for Nature (WWF)	1
29	The Rimba Raya Biodiversity Reserve Project	Infinite Earth / OFI	3
30	Danau Siawan-Belida Ecological Restoration Concession	FFI & PT. Wana Hijau Nusantara	1
31	FORCLIME - Kapuas Hulu Demonstration Activity (Sustainable Management and Conservation of Peat swamp forest)	GoI, Berau District Gov, GFA, GTZ-KfW	2
32	Ketapang Community Carbon Pool: Laman Satong & Pematang Gadung Village	Flora and Fauna International (FFI)	1
33	Kapuas Hulu Community Carbon Pool: Piasak & Jongkong Kiri Hilir Villages & Nanga Betung Village	Flora and Fauna International (FFI)	1
34	Reducing Emission from Deforestation caused by the Oil Palm Sector in Ketapang: PT. Cipta Usaha Sejati & PT. Jalin Vaneo	Flora and Fauna International (FFI)	1
35	Reducing Emission from Deforestation caused by the Oil Palm Sector in Ketapang: PT. Kayong Agro Lestari	Flora and Fauna International (FFI)	1
36	Korea-Indonesia Joint Project for Adaptation and Mitigation of Climate Change in Forestry (North Batu kliang protection forest)	Forest Research and Development Agency (FORDA)	2

Note: Data updated July 2013. Organization type code: 1 = NGO, 2 = Bilateral/ Government and 3 = Private)

Section 3 Spatial analysis methods

This section provides additional information about the map projection and spatial resolution used for all the spatial analysis Chapter 4.

Projection: We chose the WGS84 World Mercator as the coordinate system because it is centred around the equator, causing minimal distortion in the distance and size. It is also a zone independent projection system which allowed us to carry out the analysis for whole of Indonesia which spans across a few zones. The Mercator projection is also in meters which eased further analysis.

Spatial resolution: We carried out all our spatial analysis at a spatial resolution of 5km x 5km. To test the effect scale had on our analysis, we carried out a spatially restricted analysis on for Central Kalimantan at two spatial resolutions - 5km x 5km and 1km x 1km. The results show that there were no differences in the correlation co-efficient. The effective sample size (corrected degrees of freedom) also generally did not differ. The results of this sensitivity analysis indicate that analysing the data at a finer spatial resolution of 1km x 1km does not change the results. We are aware of the pitfalls of using coarse resolution such as for our analysis, however, we chose to carry out our spatial analysis at a relatively course resolution of 5km x 5km because:

I. When using best available datasets for analysis on large areas that datasets will be at different spatial resolutions. The dataset we used with the finest resolution is the carbon density data (500 m x 500 m) and the coarsest data is our plant SDM dataset is 10km x 10km resolution. Our choice of 5km x 5km was a compromise in order to get a balance between all our datasets.
II. Global species range maps like the IUCN species range maps we use in our analysis were not designed to be used at such fine resolution (Jenkins et al. 2013). Bringing the resolution down to 1km will not necessarily increase the accuracy. As for our plant SDMs, the spatial resolution of approximately 10 × 10 km at the equator is considered the accuracy range in which they can carry out their analysis (Raes et al. 2013).
III. The speed of analysis was a factor especially if increasing the resolution does not increase the accuracy. Carrying out fine scale analysis for the whole of Indonesia would take a very long time to run. For example when restricting the sensitivity test to just Central Kalimantan at 1km x 1km resolution, the analysis took approximately 4 whole days to complete (Table 4.6). Running the analysis at this scale for the whole of Indonesia and islands separately would have required computing power we don’t have available.

Table 4.6: Spatially restricted sensitivity analysis on Central Kalimantan to test for the effects of using different spatial resolution (25km^2 and 1km^2) on the correlations between carbon and three measures of biodiversity richness

Central Kalimantan: Congruence between carbon (AGB + SOC at 100cm depth) and three measures of biodiversity richness at two spatial resolutions												
Spatial Resolution	**Measures of vertebrate species richness**									**d. Total Richness (+ Plants)**		
	a. Total Richness			**b. Threatened**			**c. Restricted**					
	r_s	p	**CDF (df)**	r_s	p	**CDF (df)**	r_s	p	**CDF (df)**	r_s	p	**CDF (df)**
5km x 5km	0.20	0.032	113 (6112)	0.05	0.493	212 (6112)	-0.02	0.699	302 (457)	-0.35	0.001	82 (6078)
1km x 1km	0.20	0.009	168 (152824)	0.05	0.403	288 (152824)	-0.02	0.403	1408 (11449)	-0.35	<0.001	138 (151974)

CDF, Corrected Degrees of Freedom
df, actual degrees of freedom
r_s , Correlation Coefficient
p, p-value

Section 4 The effect of using different hotspot definitions

Throughout the main paper (Chapter 4 – Part I) we defined areas important for biodiversity or 'hotspot' as the richest 10% of cells and found little overlap between hotspots of the three different measures of biodiversity used in our study. We are aware that this findings could be different if we chose to define hotspots differently. Here we explored the degree to which hotspots overlapped using different definitions i.e. 5%, 10%, 15% and 25% of the richness cells.

When defining hotspots as 10% of the richest cells, the three hotspots occupied 23.8% (18969 cells) of Indonesian's land surface however, only 2% (1602 cells) of the area had an overlap of hotspots for at least two measures of biodiversity richness and there was no overlap between all three hotpots - Table 4.7. We also found that this overlap did not increase significantly with the change in hotspot definition; even when defining hotspots as the richest 25% of cells and there was very little overlap between hotspots of all the three measures of biodiversity used in this study - Table 4.7. These overlap between hotspots were lower with the inclusion of plants and the difference between different definitions were smaller.

In terms of spatial distribution of these hotspots, we found that regardless of the hotspot definition used, Kalimantan is a priority area for total (vertebrate + plants) species richness; Sumatra is a priority for vertebrate species richness, while the smaller islands and mountains of Papua are hotspots for restricted range species. With the inclusion of plants, the coastal and sub-montane forests of Sumatra lose their role as centres of total species richness while sub-montane areas in Kalimantan show prominence - Figure 4.6.

Table 4.7: Degree of overlap between hotspots of total, threatened and restricted range species richness using different hotspot definition (5%, 10%, 15% and 25%).

No. of hotspot overlaps	Hotspot definitions							
	5%	10%	15%	25%	5%	10%	15%	25%
	Vertebrate				Vertebrate (+ plants)			
1	9767	17367	27419	31456	5890	9546	13707	20467
2	491	1602	5662	9081	654	1909	3681	6969
3	0	0	2	12	0	0	0	1
Total cells	10258	18969	33083	40549	6544	11455	17388	27437
% of Indonesia	12.9	23.8	41.6	51.0	8.2	25.5	38.6	61.0

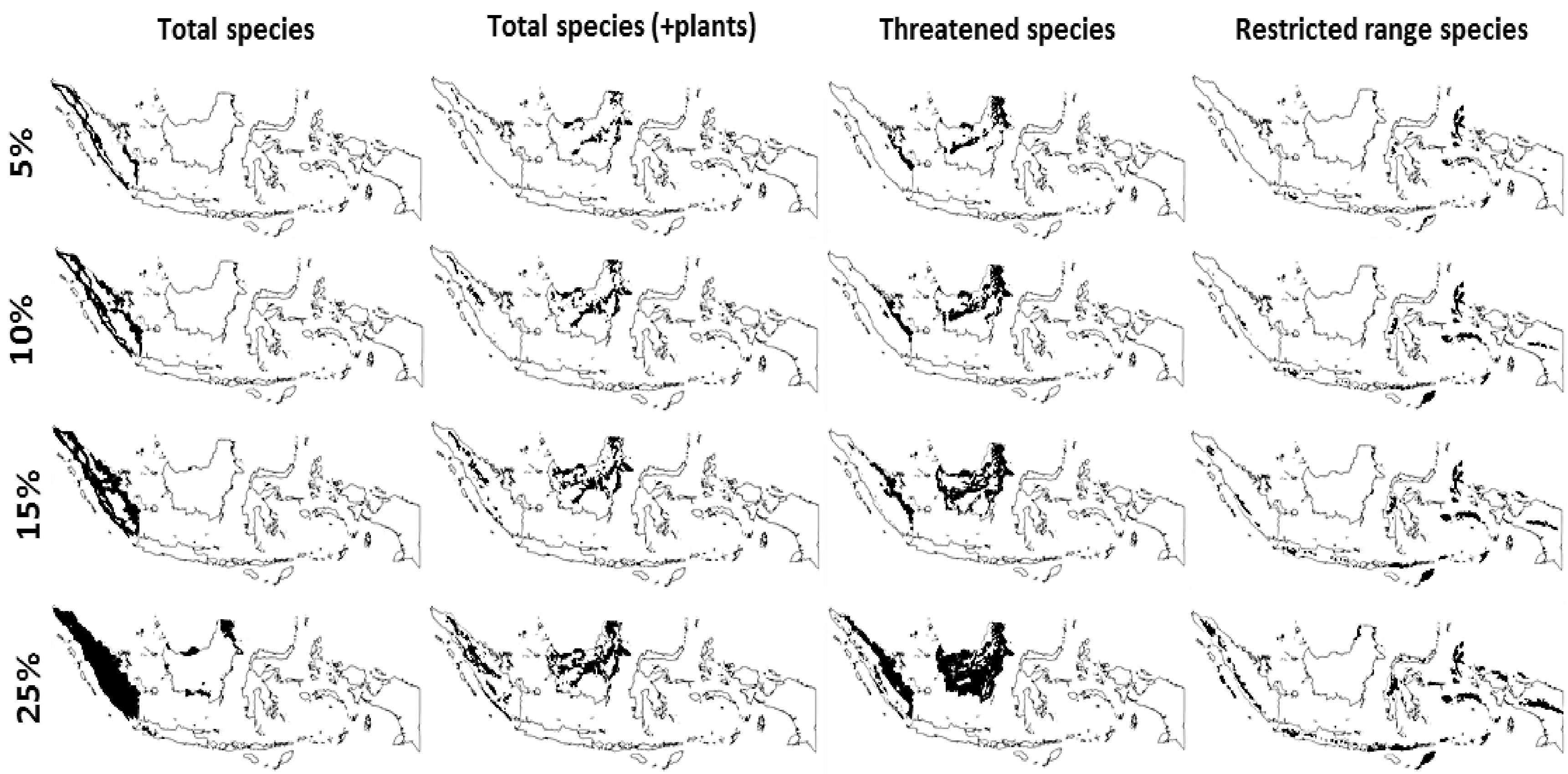


Figure 4.6: Spatial distribution of species rich hotspots for total, threatened and restricted range species using four different hotspot definitions.

Section 5 Factors which influence congruence between carbon and biodiversity

We found a number of factors influencing the congruence between carbon and biodiversity in Indonesia. Firstly, we found that the correlations between the two variables change when being analysed for Indonesia as a whole or when analysed by island; which we addressed in the main paper in Chapter 4 (Part 1). Secondly, the congruence patterns were also different at the taxon level i.e. birds, amphibians, reptiles and plants correlated different with carbon. Thirdly, we found big changes in the congruence patterns when we considered soil organic carbon (or not) as our measure of carbon stock.

We carried out the correlation analysis at the taxon level to assess how individual taxa correlate with carbon in Indonesia as well as at the level of four major islands. We found a general negative correlation between carbon and amphibians, mammals and plants while a positive correlation is seen between carbon and birds and reptiles. There were some exceptions depending on the islands and the measure of richness used (total, threatened or restricted range). In Table 4.8, we show how individual taxa correlated with carbon at the island level and using different measure of richness.

We tested the effects of using different soil organic carbon (SOC) by running the congruence analysis under three carbon scenarios i) AGB (Above-ground biomass only) ii) AGB+SOC30 (Above-ground biomass + soil organic carbon at 30cm depth) and ii) AGB + SOC 100cm (Table 4.9) showing the relationship between carbon and biodiversity at different SOC depth. Statistically, there are changes in the correlation between carbon and biodiversity when comparing AGB only and AGB + SOC100cm but less so for AGB+SOC30cm. In Java where SOC depth does not affect overall carbon stock, we also find that the correlation coefficient does not change for all measure of richness and at all SOC depths. Clear differences can be seen for threatened species across the three SOC depths especially in Kalimantan, Papua and Sumatra. We found little change with SOC depth for restricted range species perhaps due to the fact that restricted range species are concentrated on montane areas which are not affected by change in SOC depth. We can link the differences in congruence patterns with the change in soil depth to the effect of high carbon peat swamp forests. This is clearer when visualised in Figure 4.7, where clusters of cells with very high changes the over GLM. Because of the importance of peat swamp forests in both climate mitigation and biodiversity conservation in Indonesia, we therefore include SOC up to 100 cm depth in the main analysis.

Peat swamp forests in Indonesia are responsible for 61% of carbon emission in Indonesia (Rehman et al 2014) and the most common deforestation pressure in carbon rich peat swamp forests is the conversion to oil palm plantations (>70% between 1990s – 2000) (Ramdani & Hino, 2013). Based on these analysis, we decided to use AGB + SOC 100 throughout this paper.

Table 4.8: Taxa level correlation between carbon and biodiversity at four major islands in Indonesia and based on three measures of species richness.

Major Islands	Birds								
	Total species			Threatened sp.			Restricted range sp.		
	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)
Kalimantan	0.194	<0.001	384(21097)	0.051	0.173	712(21083)	-0.053	0.121	845(3465)
Sumatra	0.097	0.05	408(17555)	0.035	0.681	140(17549)	0.387	0	2096(5071)
Java	0.283	<0.001	206(4924)	0.29	0	176(4919)	0.636	0	1178(4108)
Papua	0.139	0.028	248(15746)	-0.013	0.861	173(15685)	-0.196	0	1164(8548)
Major Islands	**Amphibians**								
	Total species			Threatened sp.			Restricted range sp.		
	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)
Kalimantan	0.056	0.052	1185(19452)	-0.111	0.2	132(497)	-0.064	0.11	620 (3)
Sumatra	-0.064	0.275	291(17536)	-0.426	0.001	61(678)	-0.06	0.726	34 (35)
Java	-0.125	0.052	238 (4912)	0.306	<0.001	2267(3243)	-	-	-
Papua	-0.146	0.056	170(15664)	None			0.015	0.884	100 (109)
Major Islands	**Mammals**								
	Total species			Threatened sp.			Restricted range sp.		
	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)
Kalimantan	–0.015	0.664	822(21077)	–0.029	0.574	369(21057)	-0.091	0.203	194 (265)
Sumatra	–0.185	0.034	130(17530)	–0.181	0.122	72(17509)	–0.099	0.009	693(2061)
Java	0.286	<0.001	181(4904)	0.353	<0.001	143(4909)	0.49	<0.001	1252(1749)
Papua	–0.299	<0.001	148(15669)	-0.202	<0.001	564(10011)	–0.285	<0.001	236(2052)
Major Islands	**Reptiles**								
	Total species			Threatened sp.			Restricted range sp.		
	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)
Kalimantan	0.136	<0.001	1287(21028)	0.037	0.159	1418 (21023)	-0.075	0.016	1021(3736)
Sumatra	0.01	0.821	519 (17522)	0.143	0.019	267 (17480)	0.336	<0.001	1060(5397)
Java	0.23	<0.001	224 (4832)	0.293	<0.001	162 (4808)	0.61	<0.001	2307(4224)
Papua	0.003	0.944	446 (15714)	-0.13	0.114	147 (15480)	-0.222	<0.001	939 (8858)
Major Islands	**Plants**								
	Total species			Threatened sp.			Restricted range sp.		
	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)	r_s	*p*	CDF (df)
Kalimantan	-0.374	<0.001	1287(21028)						
Sumatra	-0.634	<0.001	519 (17522)						
Java	0.157	0.075	224 (4832)						
Papua									

CDF, Corrected Degrees of Freedom; df, actual degrees of freedom; rs , Correlation Coefficient; p, p-value

Table 4.9: The effects of using different soil organic carbon depth (0cm, 30cm and 100cm) on the congruence between carbon and three measures of biodiversity richness

Congruence between carbon (AGB + SOC at 100cm depth) and three measures of biodiversity richness												
Major Islands	**Measures of vertebrate species richness**									**d. Total Richness (+ Plants)**		
	a. Total Richness			**b. Threatened**			**c. Restricted**					
	r_s	***p***	**CDF (df)**	**Rs**	**P-value**	**CDF(df)**	**Rs**	**P-value**	**CDF(df)**	**Rs**	**P-value**	**CDF (df)**
Kalimantan	0.14	<0.001	1287 (21028)	0.04	0.159	1418 (21023)	-0.08	0.016	1021 (3736)	−0.306	<0.001	884 (20508)
Sumatra	0.01	0.821	519 (17522)	0.14	0.019	266 (17480)	0.34	<0.001	1060 (5397)	−0.516	<0.001	860 (16782)
Java	0.23	<0.001	224 (4832)	0.29	<0.001	162 (4808)	0.61	<0.001	2307 (4224)	0.244	0.007	118 (4639)
Papua	0.00	0.944	446 (15714)	-0.13	0.114	147 (15480)	-0.22	<0.001	939 (8858)	-	-	-
Sulawesi	0.22	<0.001	213(6746)	0.31	0.040	85(6724)	0.42	<0.001	176(5165)			
Indonesia	-0.06	0.234	444 (72684)	-0.08	0.007	1236 (71996)	-0.06	<0.001	29343 (33471)	-	-	-
Congruence between carbon (AGB + SOC at 30cm depth) and three measures of biodiversity richness												
Major Islands	**Measures of vertebrate species richness**									**d. Total Richness (+ Plants)**		
	a. Total Richness			**b. Threatened**			**c. Restricted**					
	Rs	***P-value***	**CDF (df)**	**Rs**	***P-value***	**CDF(df)**	**Rs**	***P-value***	**CDF(df)**	**Rs**	***P-value***	**CDF (df)**
Kalimantan	0.11	0.002	776(21047)	0.02	0.395	1304(21035)	-0.01	0.898	652(3746)	-0.21	<0.001	799(20369)
Sumatra	0.02	0.666	410(17463)	0.11	0.104	237(17444)	0.36	<0.001	1122(5391)	-0.46	<0.001	1124(16666)
Java	0.27	<0.001	217(4899)	0.36	<0.001	217(4899)	0.65	<0.001	2088(4286)	0.149	<0.001	215(4662)
Papua	0.028	0.478	629(15735)	-0.11	0.221	119(15508)	-0.27	<0.001	975(8866)	-	-	-
Sulawesi	0.240	<0.001	201(6746)	0.33	0.004	74(6724)	0.40	<0.001	178(5165)			
Indonesia	-0.11	0.048	24(72684)	-0.11	<0.001	985(71996)	-0.05	<0.001	28186(33471)	-	-	-
Congruence between carbon (AGB only) and three measures of biodiversity richness												
Major Islands	**Measures of vertebrate species richness**									**d. Total Richness (+ Plants)**		
	a. Total Richness			**b. Threatened**			**c. Restricted**					
	Rs	***P-value***	**CDF (df)**	**Rs**	***P-value***	**CDF(df)**	**Rs**	***P-value***	**CDF(df)**	**Rs**	***P-value***	**CDF (df)**
Kalimantan	-0.03	0.547	355 (21131)	-0.04	0.465	341 (21119)	0.27	0.002	124 (3782)	0.19	0.02	151(20398)
Sumatra	0.02	0.604	923(17623)	-0.23	<0.001	401(17581)	0.35	<0.001	827(5463)	-0.21	<0.001	799(20369)
Java	0.28	<0.001	148(5181)	0.37	<0.001	153(5169)	0.59	<0.001	2782(4551)	0.05	0.400	273(4894)
Papua	0.16	<0.001	684(15955)	0.21	0.059	77(15679)	-0.25	<0.001	2548(8921)	-	-	-
Sulawesi	0.23	<0.001	309(6903)	0.31	0.005	77(6874)	0.35	<0.001	298(5260)	-	-	-
Indonesia	-0.15	0.003	399(74505)	-0.10	0.138	222(73649)	0.11	<0.001	7715(34432)	-	-	-

AGB = Above Ground Biomass; SOC = Soil Organic Carbon

CDF, Corrected Degrees of Freedom; df, actual degrees of freedom; rs , Correlation Coefficient; p, p-value

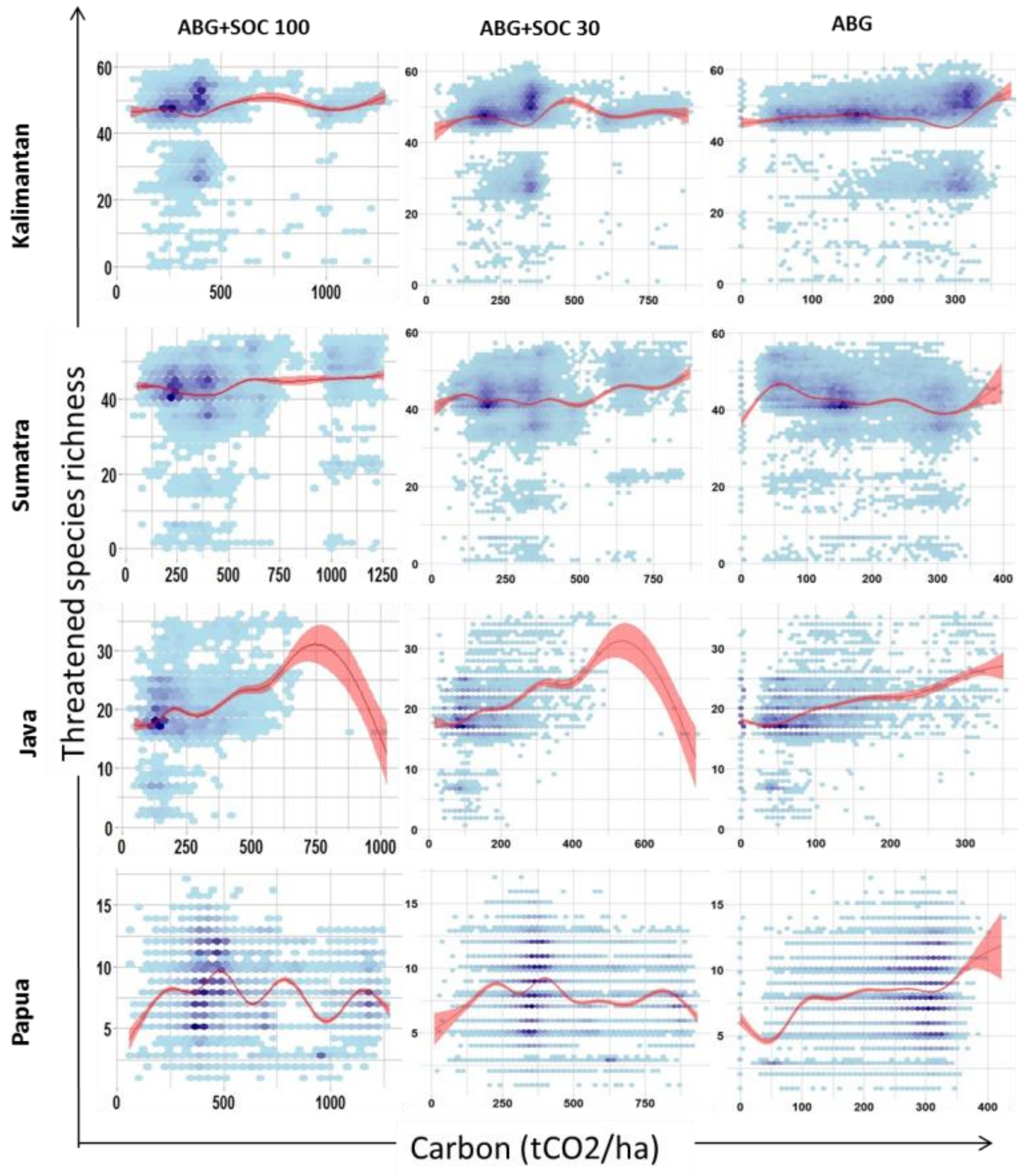


Figure 4.7: The effects of using different soil organic carbon depth on the spatial correlation between carbon and three measures of biodiversity richness at four major islands in Indonesia.

Section 6 Summary Statistics

In this section we provide the summary of the statistics carried out in this study. Figure 4.8 shows the results of the TukeyHSD paired wised comparison which was carried out to show how significantly different the means between REDD+, PA and non-protected forest were for the distribution of carbon and the three measures of vertebrate richness used in our study

We assess how the distribution patterns change with the inclusion of plants as proxy for biodiversity. With the inclusion of plants, REDD+ projects still have on average higher overall species richness per cell (mean = 960) compared to PAs (mean= 917) and un-protected forests (mean = 943). Figure 4.9 shows the distribution of vertebrate and plants (boxplots) in three groups: REDD+ projects, PAs and non-protected forests, and how significantly different their means are in a paired wise comparison text (TukeyHSD).

We present the summary statistics for the ANOVA and post hoc TukeyHSD test. We carried out the analyses using 1000 random sampled points from three groups (REDD+ project| PA| Forest) for carbon and three measures of biodiversity richness – see Figure 4.10

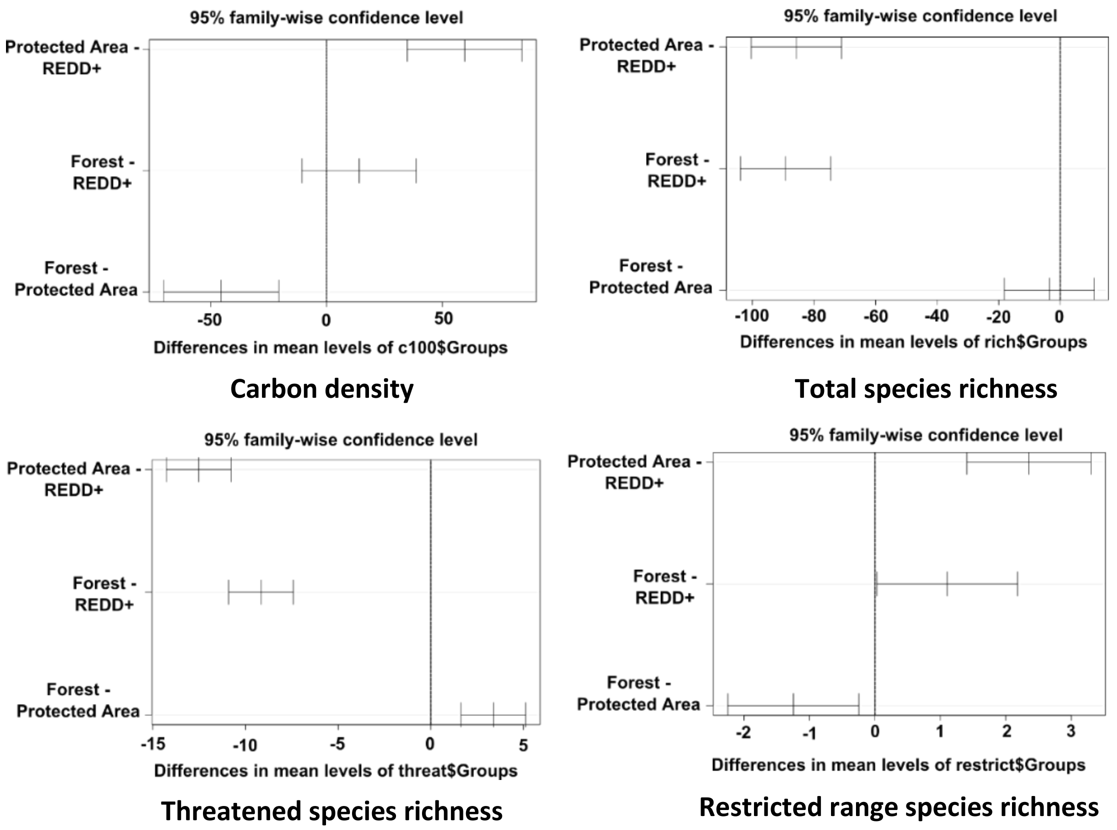
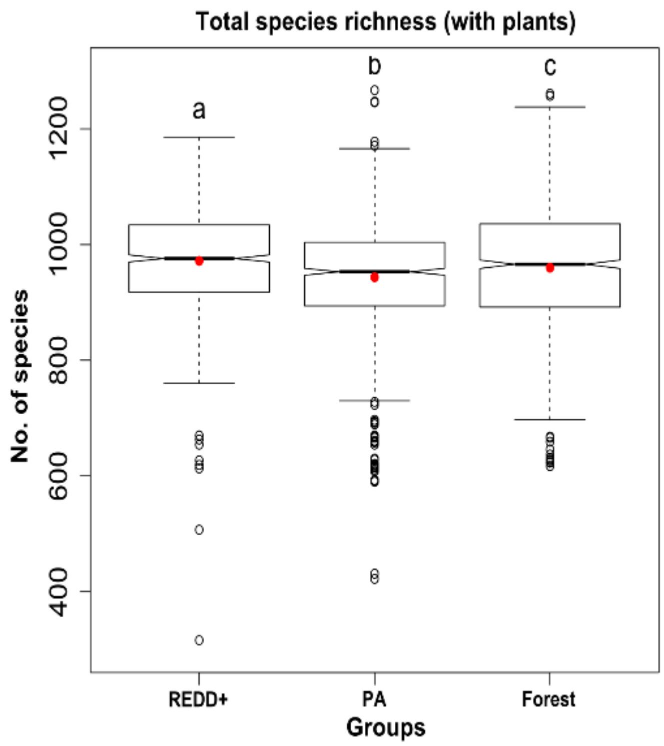


Figure 4.8: TukeyHSD pairwise comparison of the means for the distribution of carbon and three measures of vertebrate richness.



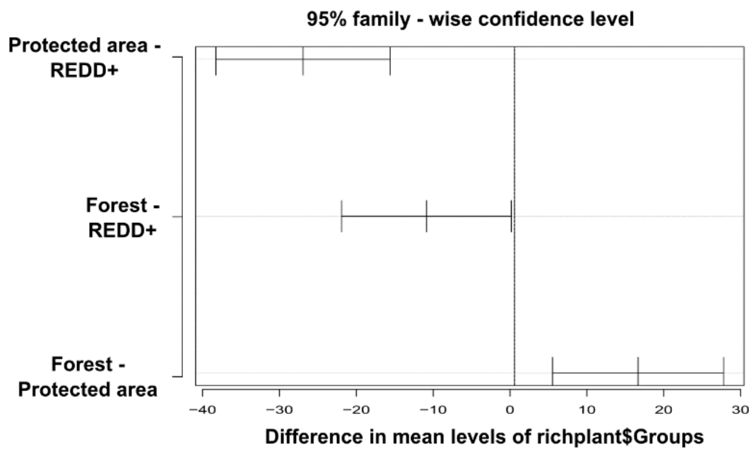


Figure 4.9: Distribution of carbon and total species richness (vertebrate + plants) in REDD+ project areas (REDD+), protected areas (PA), and unprotected forests (Forest) in Indonesia

Solid dot, mean; notches in bars, approximate 95% CI around the median value; letters above boxes, different letters show significant difference with Tukey Honestly Significant Difference test).

Figure 4.10: Summary statistics for the ANOVA and post hoc TukeyHSD

Carbon Density					
Analysis of Variance (ANOVA)					
	Df	Sum Sq	Mean Sq	F Value	Pr(>F)
Carbon$ Group	2	1865721	932860	17.39	3.1e-08 ***
Residuals	2877	154296834	53631		
TukeyHSD : Multiple comparisons of means at 95% family-wise confidence level					
	diff	Lower	Upper	p adj	
REDD - PA	59.63312	34.87191	84.39433	0.000000	
Forest - REDD	14.03688	-10.72433	38.79809	0.378951	
Forest - PA	-45.59623	-70.43454	-20.75792	0.000051	
Total Species Richness					
Analysis of Variance (ANOVA)					
	Df	Sum Sq	Mean Sq	F Value	Pr(>F)
Rich $ Group	2	5043416	2521708	130.2	<2e-16 ***
Residuals	2966	57456250	19372		
TukeyHSD : Multiple comparisons of means at 95% family-wise confidence level					
	diff	Lower	Upper	p adj	
REDD - PA	-85.736388	-100.42775	-71.04502	0.000000	
Forest - REDD	-89.261184	-103.93414	-74.58823	0.000000	
Forest - PA	-3.524796	-18.17538	11.12578	0.839168	
Threatened Species Richness					
Analysis of Variance (ANOVA)					
	Df	Sum Sq	Mean Sq	F Value	Pr(>F)
Threat $ Group	2	82151	41076	152.2	<2e-16 ***
Residuals	2930	790668	270		
TukeyHSD : Multiple comparisons of means at 95% family-wise confidence level					
	diff	Lower	Upper	p adj	
REDD - PA	-12.521847	-14.264234	-10.779461	0.000000	
Forest - REDD	-9.154111	-10.895157	-7.413064	0.000000	
Forest - PA	3.367736	1.624461	5.111011	0.000018	
Restricted Range Species Richness					
Analysis of Variance (ANOVA)					
	Df	Sum Sq	Mean Sq	F Value	Pr(>F)
Restrict $ Group	2	1654	827.1	17.2	4.07e-08 ***
Residuals	1631	78450	48.1		
TukeyHSD : Multiple comparisons of means at 95% family-wise confidence level					
	diff	Lower	Upper	p adj	
REDD - PA	2.351206	1.40413412	3.2982784	0.000000	
Forest - REDD	1.10306	0.02794969	2.1781705	0.042785	
Forest - PA	-1.248146	-2.2504065	-0.2458858	0.009883	
Total species richness (+plants)					
Analysis of Variance (ANOVA)					
	Df	Sum Sq	Mean Sq	F Value	Pr(>F)
Rich $ Group	2	355954	177977	16.35	8.77e-08 ***
Residuals	2730	29724232	10888		
TukeyHSD : Multiple comparisons of means at 95% family-wise confidence level					
	diff	Lower	Upper	p adj	
REDD - PA	-28.27771	-39.921213	-16.634201	0.000000	
Forest - REDD	-11.78453	-23.127052	-0.4420015	0.039521	
Forest - PA	16.49318	5.052993	27.933367	0.002116	

Note: Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Section 7 The predicted deforestation model

To predict deforestation at the REDD+ project sites relative to Protected Areas and other non-protected forests in Indonesia, we used the Open Source Impacts of REDD+ Incentives Spreadsheet (OSIRIS) econometric model which predicts deforestation based on the relationship between observed patters of historical deforestation and spatial variation in geographic and agricultural characteristics of a particular site. OSIRIS-Indonesia (Busch et al. 2012) which was adapted from the OSIRIS-International model (Busch et al. 2009) is used in our study to predict deforestation under the without REDD+ scenario i.e. the scenarios whereby REDD+ payments do not affect land-use decisions. The analytical framework for OSIRIS is a one-period global partial equilibrium market for a single commodity – the commodity in the OSIRIS model is a composite index of agricultural and timber output produced on one hectare of land cleared from the tropical forest frontier ("frontier land agricultural output"). The OSIRIS-Indonesia model takes in to account underlying national demand for agriculture and timber (more accurate that than using a global prediction model).

The model: The model has been developed in Microsoft Excel thus making it available to a wide range of users including this with limited modeling experience. In the OSIRIS-Indonesia model, Indonesia is divided into 166,343 3km x 3km grid cells for which forest cover was present in 2000. Baseline forest cover in the year 2000 was estimated by applying a 50% threshold to the Percent Tree Cover Layer of the 500 m Moderate Resolution Imaging Spectroradiometer (MODIS)-based Vegetation Continuous Fields (VCF) product for the year 2000 (Hansen et al., 2003). The main model predictors are slope and elevation (Jarvis et al., 2008), Euclidean distance from road and nearest provincial capital (NGA, 2000) and boundaries of 33 provinces, 440 districts, national parks and protected areas and logging concessions, timber concession and estate crop (oil palm) concessions. The model was estimated with a Poisson Quasi-Maximum Likelihood estimator.

The econometric model (Eq. 1) was used to predict deforestation at every site in the absence of REDD+ (Eq. 2) (the "reference scenario"). This generates an effective land rental value for every site (Eq. 3), based not only on potential gross agricultural revenues but also on the proxies fixed and variable land conversion costs.

Eq. 1 – Predicted deforestation at sites in the absence of REDD+ based on observable site characteristics

$$yi = \exp(\beta_{k0} + X_i'\beta_{k1} + \beta_{k2Ai} + \epsilon)$$

Here $y_i = (F_i{}^o - F_i')/F_i{}^o$ is percent deforestation at site i, where $F_i{}^o$ is forest cover at site i at the start of the 2000-2005 observation period, and F_i' is forest cover at site i at the end of the observation period. $k \in 1{:}\,4$ are classes of observations stratified by initial forest cover. X_i is a matrix of observable site characteristics, including slope, elevation, natural logarithm of the distance to the nearest road, natural logarithm of the distance to the nearest provincial capital, and the percent of site within a national park, other protected area, logging concession, timber concession, or estate crop concession. A_i is the net present value of gross agricultural revenue potential per hectare at site i. The term β_{k0} captures unobserved constant components of the expected net benefits of deforestation.

Eq. 2 – Expected deforestation at sites in the absence of REDD+

$$\hat{Y}_i -_{without\ REDD+} = \exp(\hat{\beta}_{k0} + X_i'\hat{\beta}_{k1} + \hat{\beta}_{k2}A_i)$$

Here $\hat{Y}_i -_{without\ REDD+}$ is the expected deforestation at site i in the absence of REDD+. The distribution across the country of all $\hat{Y}_i -_{without\ REDD+}$ is the reference scenario.

Eq. 3 – Effective land rental value at a site

$$A_i + (\hat{\beta}_{k0} + X_i'\hat{\beta}_{k1} / \hat{\beta}_{k2})$$

Effective land rental value at a site includes not only potential gross agricultural revenue but also costs.

Sensitivity analysis / model testing: Sensitivity tests were carried out on the model which has been ellaborated in Busch et al., (2012). Under the 'without REDD+ incentive' scenario, the model generated a deforestation prediction (691,000 ha/y) that was within 1% of observed historical deforestation (687,000 ha/y). The explanatory variables used to construct the reference scenario which we used in the OSIRIS model were significantly correlated with observed deforestation ($r_s < 0.05$)(See Supplementary Information in Busch et al., 2012). The correlation between observed deforestation and predicted deforestation was lower at the finer geographic scales of the province (R = 0.81; n = 31), district (R = 0.68; n = 401) and the 3-km × 3-km pixel (R = 0.34; n = 166,296). Predicted diforestation was also consistent with those widely observed elsewhere in Indonesia (including those observed in Chapter 5) i.e. higher at lower and flatter sites, and closer to roads and provincial capitals, deforestation was also lower in national parks and other protected areas, and higher in timber and estate crop concessions (controlling for other factors). Alternative biomass carbon data (WHRC, 2011) and peat emission factors were explored in a sensitivity analysis. The alternative data set on forest cover loss (Miettinen et al., 2012) which was explored in a sensitivity analysis (which showed comparable results) was the same data used in our study to define forest and forest land use categories

Chosing the OSIRIS-Indonesia model: We recognise that the differences between different models could yield quite different estimates for predicted deforestation. The OSIRIS-Indonesia model was adapted from the OSIRIS-International model which means that that the model has been trained and adapted to the Indonesia conditions, thus reducing potential errors in predictions. The model has also been tested at the National, subnational (district) and site (3km x 3km) consistent with the scale at which we carried out the spatial analysis in our study. The Indonesia specific predictors used in the OSIRIS-Indonesia model such as the percentage of pixels located in protected areas, logging concessions, timber concession and estate crop (oil palm) concessions were especially important for our study because they have implications for future REDD+ planning and incentive structure in Indonesia.

Chapter 5

REDD+ IMPLEMENTATION AND IMPLICATIONS FOR FLAGSHIP SPECIES CONSERVATION

Exploring two REDD+ projects in Indonesia

5.1 Abstract

Indonesia is a key REDD+ player: it has made a voluntary commitment to reduce its national carbon emissions up to 26 percent by 2020. However, the progress with REDD+ in Indonesia has been slow with only a handful of projects approved to date. Projects take a long time to be approved and subsequently experience major reduction in area size due to counter land claims from the timber and agriculture sector. One species with strong potential to benefit from REDD+ implementation in Indonesia is the orangutan, because it is directly dependent on limited remaining lowland forests which REDD+ projects aim to protect. Here, we investigate the potential for two newly approved first generation REDD+ projects, which differ in the degree to which biodiversity concerns drove their development, to deliver biodiversity conservation in spite of the obstacles facing REDD+ implementation in Indonesia. First, we carried out a forest cover change analysis at three time periods (2003-2006, 2006-2009 and 2009-2012) to assess the impact of the slow REDD+ approval progress on natural forest loss. Using approved and proposed REDD+ project boundaries, we assessed the impacts of approved project area reduction on natural forest and orangutan conservation. We developed a spatially explicit map of orangutan density and modelled predicted deforestation pressure for the three districts where our projects are located. We found both projects to be located in important orangutan forests which are also predicted to be highly threatened to deforestation. We found that the delay in REDD+ project approval had little impact on forest loss. However, the reduction in approved project area have potent negative consequences on natural forest and orangutan conservation. We also found that certain REDD+ project features (such as tenure, design, forest management) have the potential to enhance overall delivery of biodiversity benefits regardless of whether REDD+ projects are developed with explicit regards to biodiversity conservation. Our results show that the way REDD+ project size is currently determined is detrimental for orangutan survival, especially orangutan habitat units located on peatlands. A landscape approach to national REDD+ planning is essential to ensure that REDD+ funding is targeted in areas which effectively contributes to climate mitigation and biodiversity protection.

5.2 Introduction

At the 13th Conference of Parties (COP 13) in Bali (2007), the UNFCCC called for Parties to stimulate the implementation of activities to reduce emissions from deforestation and forest degradation (plus the role of conservation, sustainable management and enhancement of forest carbon stocks) (REDD+) by carrying out demonstration activities on the ground (decision 2/CP.13)(UNFCCC, 2008). This led to a mushrooming of REDD+ pilot projects in the tropics and strong funding commitments followed with support from multilateral donors such as the World Bank's Forest Carbon Partnership Facility and the United Nations (UN-REDD Programme) as well as bilateral donors of sub-national pilot initiatives such as Norway, Australia, Germany and the United Kingdom (Simonet *et al.*, 2014). In 2010, at the COP 16 in Cancun, governments drew up the Cancun Agreements, a set of significant decisions and methodological guidance towards realising REDD+. While REDD+ was created as a mechanism to mitigate climate change, expectations were high for REDD+ to also deliver 'unprecedented' opportunities for biodiversity conservation in the tropics (Miles & Dickson, 2010; Gardner *et al.*, 2012; Huettner, 2012).

Deforestation in Indonesia is the highest in the world (Hansen et al., 2013). It is the third largest forest country (after Brazil and the Democratic Republic of Congo) and its forests harbour over half of the world's 48,170 threatened species (Paoli et al., 2010). There has been hope that REDD+ payments could slow deforestation in Indonesia, thus helping to safeguard threatened forest species (Venter et al., 2009b). One species with strong potential to benefit from REDD+ implementation in Indonesia is the orangutan, a conservation flagship species. According to Verissimo et al., (2011) a flagship species is "a species used as the focus of a broader conservation marketing campaign based on its possession of one or more traits that appeal to the target audience." The orangutan is therefore a an important flagship species because it draws (the much needed) attention to urgent environmental issues such as habitat and species loss (Meijaard & Sheil, 2008) and has been known to attract significant conservation resources (Struebig et al., 2015a). It is also an umbrella species for other forest-dependent animals due to its strong dependence on trees and relatively intact forests (Gregory et al., 2014) and its important ecological role in forests as ecosystem engineers and seed dispersers (Meijaard et al., 2012).

The orangutan (Pongo spp) is classified as endangered according to the IUCN Redlist (Ancrenaz et al., 2008) and both orangutan species (Pongo pygmaeus and Pongo abelii) in Indonesia are threatened with extinction in the wild (Wich et al., 2008). Orangutans are particularly vulnerable because they directly compete for limited lowland forest with the production of palm oil - a key driver of forest loss in Indonesia (Swarna Nantha & Tisdell, 2009; Morrogh-Bernard et al., 2014). Here, we focus on the Bornean orangutan (Pongo pygmaeus), which is divided into three geographically distinct sub-species (P. p morio, P. p pygmaeus and P. p wurmbii). The Bornean orangutan have experienced a decline of up to 50% in the last 60 years (Ancrenaz et al., 2008); key threats to the species include habitat loss (Wich et al., 2008), fragmentation (Ancrenaz et al., 2014), and hunting (Meijaard et al., 2011).

REDD+ is being negotiated at the international level however, current arrangements emphasises a national and sub-national or a ‘nested approach’ to its implementation (Phelps *et al.*, 2010; Pedroni *et al.*, 2012). However, decentralised governments in developing countries like Indonesia struggle with multilevel challenges in rolling out REDD+, such as the political economy of land use change which includes the distribution of power and incentives between the central and local governments and (Corbera & Schroeder, 2011; Irawan *et al.*, 2014). Initial progress towards REDD+ in Indonesia after the Bali conference was encouraging. It was the first country to introduce a domestic REDD+ legal framework to encourage and promote REDD+ piloting (Steni 2012) which led to a boom in pilot and demonstration projects across Indonesia. Regulations were developed by the Ministry of Forestry (MoF) on the implementation of demonstration activities, mechanisms to carry out REDD+ and the issuance of licenses for developing carbon projects in production and protected forest [laws: P.68/Menhut-II/2008, P.30/Menhut-II/2009) P.36/Menhut-II/2009]). The private for-profit sector saw REDD+ as a business opportunity while environmental non-profit sector saw REDD+ as an opportunity to fund the biodiversity conservation agenda (Sunderlin & Sills, 2012). Both sectors began searching out the best locations to pilot REDD+, believing that REDD+ would take-off both in Indonesia and globally.

At COP 15 in Copenhagen, the Government of Indonesia announced a voluntary commitment to reduce emissions of greenhouse gases by up to 26 percent (up to 41 percent with international assistance) from a business as usual scenario by the year 2020. REDD+ seemed high on Indonesia’s political agenda, however, in spite of a promising start, REDD+ implementation in Indonesia has been slow(Brockhaus *et al.*, 2012; Kant & Wu, 2014). By mid-2013, there were at least 36 REDD+ projects in Indonesia pending approval (see Chapter 4). The Ministry of Forestry approved its first REDD+ project, the Rimba Raya REDD+ Biodiversity reserve located in Central Kalimantan, at the end of May 2013. This came more than five years after the proposal was first presented to the Indonesian government. Not only was the concession license approval process long and costly (Rimba Raya reportedly cost USD 2 million); the area proposed was significantly reduced (from 90,000 ha to 37,151 ha) (MoF, 2014a). This is a commonly reported problem in Indonesia, with project proponents often facing difficulties in upholding their claim over at least some part of their proposed project site or in securing a project license because of counter-claims by other commercial concession holders (Resosudarmo et al., 2013).

In this chapter, we assess two of Indonesia's earliest REDD+ projects, both of which have the Bornean orangutan as their flagship species. These two projects are different in many aspects of their set up and design, however, both faced similar obstacles with regards to REDD+ implementation in Indonesia. Both projects were subjected to a long delay in their REDD+ project approval and a subsequently large reduction in area. We explore how these challenges had an impact on forest and orangutan conservation and the extent to which project differences had a role to play. We discuss our findings in the context of orangutan conservation and provide recommendations on how future REDD+ implementation could be improved to benefits flagship species such as the Bornean orangutan.

5.3 Method

5.3.1 Study sites

The two REDD+ projects used as case studies are The Katingan Peatland Restoration and Conservation Project (the Katingan Project) and the Ketapang Community Carbon Pool (Ketapang Project), both located in Kalimantan on the island of Borneo – See Figure 5.1 for map showing location of the REDD+ projects. Both projects are first generation REDD+ initiatives which were conceived towards the end of 2008. The Katingan project was approved by the Ministry of Forestry (MoF) in December 2013, the project developers intend to sell carbon credits in the voluntary carbon market as well as explore the feasibility of regulatory bilateral offset mechanisms. The Ketapang Project has been verified by the Ministry of Forestry and is currently at the final stage of approval; this project aims to pool together carbon from six individual village forests under the umbrella of one REDD+ project and to sell pro-biodiversity REDD+ credits in the voluntary carbon market.

Site selection: The two REDD+ projects chosen were part of the Centre for International Forestry Research's (CIFOR) Global Comparative Study on REDD+ (GCS-REDD+) for 22 REDD+ projects in six countries (see Chapter 2). Six of these projects are located in Indonesia, two of which were selected as case studies in this work. We did not intend for this study to be a comparative case study, instead, we deliberately chose two REDD+ initiatives which were very different from each other in order to cover a range of possible REDD+ set up in Indonesia and to assess these against two similar challenges faced in developing a REDD+ project in Indonesia: a slow approval process and a subsequent reduction in project area.

We started by selecting two REDD+ initiatives which were located with and without explicit regards to biodiversity. Out of the six GCS-REDD+ initiatives in Indonesia, two were located with explicit regards to biodiversity and conservation (the Ketapang and Rimba Raya initiatives) and four without (the Ulu Masen, KFCP, Katingan and Berau initiatives) - see the Chapter 3 (Figure 3.9). We then selected one project from each of these two broad groups, intentionally selecting two projects with as many types of differences between them as possible. We finally chose the Ketapang and Katingan REDD+ projects because of the following key differences: their biodiversity goals, lead proponent type (for-profit vs non-profit), REDD+ license type (ERC vs village forest), and forest type (one contiguous block vs many small blocks of forest) – see Table 5.1 in the results for a complete list of differences between the two REDD+ projects. In addition to that, the Katingan and Ketapang projects are more than pilot or demonstration REDD+ initiatives, both had recently obtained approval for REDD+ implementation; therefore findings from this study could feed back to actual project implementation

5.3.2 Datasets

5.3.2.1 Field data

Between November 2012 and January 2013, field visits were carried out at both REDD+ project sites. Informal interviews were conducted with project developers and key project staff in order to better understand how the REDD+ projects were being implemented on the ground. Interviews were carried out with villagers, local social and conservation NGOs and officers from the Ministry of Forest (MoF) who provided detailed information about each of the sites, such as deforestation threat and biodiversity conservation activities as well as policies relevant to REDD+ and land use at the local (district / provincial) level. These information allowed us to identify differences between project sites and to link these differences to some of the barriers to REDD+ implementation in Indonesia.

Project proponents shared important project documents such as the Project Design Documents (PDD), carbon, biodiversity and social baseline reports, GIS data which includes project boundary information, as well as other relevant reports. Additional information about the two project proponents were also available from a questionnaire survey carried out by CIFOR in 2011 (see Chapter 3).

5.3.2.2 Land cover data

The land cover dataset used in this study was from the Ministry of Forestry (MoF). This dataset was generated from visual classification of mosaic Landsat TM/ETM+ data (30 m x 30 m resolution) for the years 2000, 2003, 2006, 2009 and 2012. The entire classification process from image pre-processing and image classification to validation was undertaken by the forest management unit at sub-national levels. Land cover classification approaches and accuracy assessments of the land cover data is described in detail by Wijaya *et al.*, (2015)

A full description of the methods and the 22 land cover classes defined by the MoF land cover data can be found in Romijn et al. (2013). The land cover data consists of 22 land cover classes, including six natural forest classes: upland forest (forest on mineral soil), swamp forest and mangroves, with separation between primary and secondary forest types. Primary forests were described as forests which do not show evidence of logging or other disturbances, while secondary forest types show evidence of logging, slash and burn or forest fire. See Appendix 2 (Table S4) for the complete list of land cover classes, the classification system and definition of the land use change data.

In this chapter, we used a different land cover data set from that of Chapter 4 because we had the opportunity to use a recently availability, unique and high resolution land cover data for Indonesia. The MoF land cover data in 2013 was made available by the MoF via our research collaboration with CIFOR. This land cover data is the same one used by the MoF to determine their national forest reference emission level and to monitor their emission reduction as part of their national reporting to the UNFCCC. The dataset is also of a higher resolution which is importance for fine scale project level analysis such as those in this chapter.

5.3.2.3 Orangutan density data

We chose the Bornean orangutan as the focal species in our study because of their ecological role as an umbrella specie (direct link to lowland forests important for REDD+, ecosystem engineers and seed dispersers) but also because of their role as a conservation flagship for both REDD+ projects in this study. The orangutan sub-species relevant to our case study sites is *Pongo pygmaeus wurmbii*. It is restricted to Central Kalimantan and south-western part of West Kalimantan (Ancrenaz *et al.*, 2008). While a recent estimate of the

Bornean orangutan distribution have been developed for the whole of Borneo in 2012, this is based on predictive modelling which has its own limitations (Wich *et al.*, 2012). Sampling efforts throughout Borneo is not evenly distributed and this have been known to adversely affect distribution model prediction, potentially leading to high omission or commission errors (Struebig *et al.*, 2015a).

In this study we used primary survey data to develop a spatially explicit orangutan density map for the Ketapang, Katingan and Kotawaringan Timur districts. We searched the literature for published orangutan density data and contacted key orangutan scientists working in West and Central Kalimantan to obtain unpublished orangutan density data such as survey reports, High Conservation Value (HCV) forest assessment reports in logging concessions and other forms of expert estimates. We consulted with three orangutan experts in West and Central Kalimantan to verify our completed maps based on their knowledge and experience in the region.

5.3.2.4 Modeled deforestation

Deforestation: We used the OSIRIS-Indonesia econometric model developed by Busch et al. (2010) to predict deforestation in the absence of REDD+ carbon incentives. The model predicts deforestation based on estimated potential gross agricultural revenues and the cost of converting land from forest to agriculture. We use this modeled data to assess future deforestation threats faced by orangutans in the district where our projects were located (refer to Chapter 4 Part II - Section 7 for details about the OSIRIS-Indonesia model).

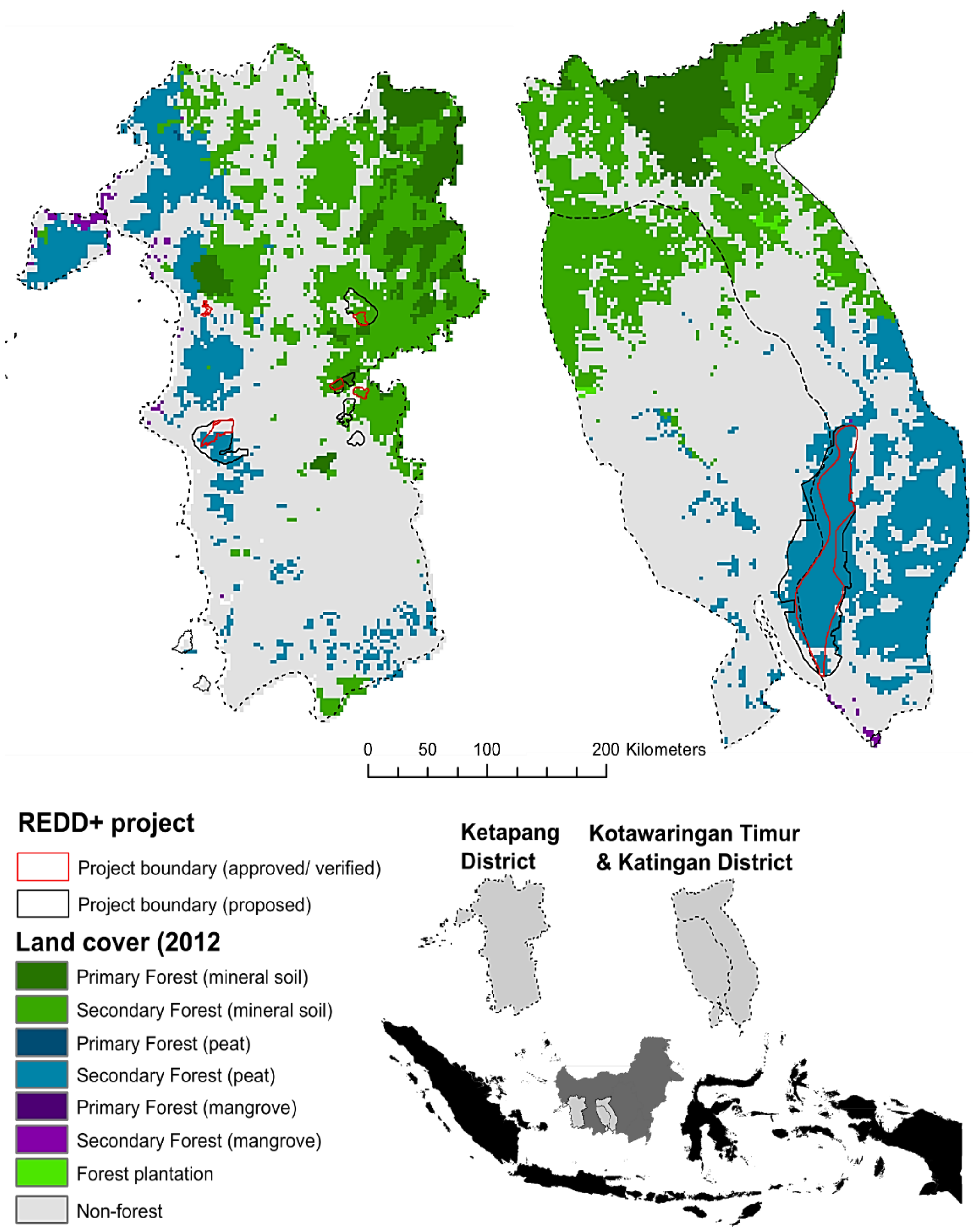


Figure 5.1: Location map showing the location of proposed and approved boundaries of the Ketapang Community Carbon Pool project in West Kalimantan (A) and the Katingan Peat Conservation Project in Central Kalimantan (B) on the island of Borneo. Data source: REDD+ project boundaries were provided by the project proponents and Land cover data is from the Ministry of Forestry.

5.3.3 Data Analysis

We first qualitatively explored the differences and similarities between the two REDD+ projects in order to link project level differences with the results we see. We then assessed i) the impacts of the delay in the REDD+ approval on natural forest cover at the two REDD+ project sites and ii) the impacts of REDD+ project area reduction on natural forest cover and orangutan conservation. We carried out a land cover change analysis by comparing natural forest land cover classes (primary mineral soil, secondary mineral soil, primary peat, and secondary peat) with non-forest land use classes at the following intervals (2000-2003, 2003–2006, 2006–2009, and 2009–2012). Here, forest is defined as vegetation cover dominated by intertwined tree crowns with ≥ 60% canopy cover. We note that this definition which is adopted by the MoF and complies with UNESCO terminology (see Appendix 2 – Table S5). Noteworthy that based on the FAO definition, forest is categorised as trees with ≥ 10% of tree-crown coverage (Romijn *et al.*, 2013).Deforestation and forest degradation is defined below following Romijn *et al.*, (2013):

Deforestation: Any change from natural forest land cover class (both primary and secondary natural forests) to non-forest classes.

Degradation: Any change from primary natural forest class to secondary natural forest class.

We focused on forest cover changes in the periods 2006 - 2009 (period before REDD+ application began) and 2009 – 2012 (period during REDD+ approval delay). Impacts of area reduction on natural forest cover and orangutan distribution were explored using the proposed and approved boundaries of the projects. We assessed impacts of area reduction on natural forest cover for the year 2012 and we evaluated the location of the REDD+ projects (proposed area) and the potential impacts of REDD+ project area reduction (approved area) on overall orangutan conservation in the districts where the projects are located.

In Indonesia, land use classification determines the purpose of forest land, where REDD+ can be located and the kind of forest management which can be implemented (Brockhaus *et al.*, 2012). Forest land in Indonesia is categorized by its function with: i) protection forest (*hutan lindung*) for watershed protection, ii) conservation forest (*hutan konservasi*) for protected areas, iii) limited production forest (*hutan produksi terhad*) - where logging is to be accompanied by measures to reduce impact on soil erosion, iv) production forest (*hutan produksi*) for commercial logging, and v) convertible production forest (*hutan produksi konversi*) – conversion of degraded production forest to agriculture or other uses. Non-forest land (*areal penggunaan lain*) is designated for all other non-forest uses. Based on the assumption that current forest land classification is a strong predictor of future land use, we assessed the forest land classification of areas excluded from the final approved boundaries in order to determine the likely land use in the absence of REDD+ protection.

5.3.3.1 Orangutan density map

We used the IUCN species range map for the Bornean orangutan (UNEP-WCMC and IUCN, 2008) as the starting point to map out orangutan distribution for the three districts relevant to our two projects. The orangutan range was clipped to the Katingan and Kotawaringan Timur districts in Central Kalimantan and Ketapang district in West Kalimantan. We refined the range maps to remaining forest cover as suggested by Jenkins *et al.*, (2013) for use at local scales. We extracted individual / distinct forest blocks which we term Orangutan Habitat Units (OHU) and assigned numbers to each block. Orangutan habitat units which fell on land no longer under forest cover (based on the 2012 land cover map) were excluded from the analysis. An OHU is the primary determinant of the orangutan survival of a population and they are important units because extinction of populations happens at this level (Singleton et al. 2004). In our analysis we use the term OHU to refer to isolated forest patches / blocks which fall within the IUCN orangutan range; we note that this may not necessarily be the same definition as the OHU referred to in the Orangutan Population and Habitat Viability Assessments (Singleton *et al.*, 2004). The criteria used to determine an OHU in this study are; i) isolated habitat block within the IUCN Bornean orangutan range ii) a forest patch large enough to support viable orangutan populations – 250 individuals (Singleton *et al.*, 2004; Meijaard, 2014b) and not smaller than the minimum home range size for Bornean orangutans – 150 ha to 850 ha (Singleton *et al.*, 2009). Relatively large forest patches (i.e. more than 150 ha) but isolated by non-forest land-use including oil palm plantations were labelled as 'density unknown' (rather than zero) to reflect uncertainties in our data as well as the versatility of orangutans in adapting to forest degradation (Ancrenaz *et al.*, 2014) (see Figs 5.6 and 5.7)

We matched the density information to their blocks (OHU) aided by secondary information such as district boundary maps, protected area boundaries, concession maps (logging, timber and oil palm), High Conservation Value Forest (HCV) survey map and forest cover map for 2012. We extracted density data from these sources of information and assigned them to their relevant OHUs, creating a spatially explicit map of orangutan density throughout its range. Orangutan Habitat Units with no density information but located in forests (based on 2012 land cover map) were retained and assigned a density of `zero'. All mapping was carried out in ArcGIS 10.

We shared the results of the mapping exercise with three orangutan experts in West and Central Kalimantan in order to fill in gaps as well as validate our orangutan density map. These experts are primatologists affiliated with leading orangutan conservation NGOs based in West and Central Kalimantan with years of applied experience with orangutan conservation. The experts were largely in agreement with the density mapping and the deforestation threat *exercise. Changes were made to orangutan densities in three blocks based on recommendations from the experts.*

5.3.3.2 Deforestation threat and orangutan density

We assessed the future threat of all the OHUs in our study by modelling their predicted deforestation to agriculture conversion. We used modelled deforestation data from OSIRIS-Indonesia v1.5 showing predicted deforestation in the absence of a REDD+ mechanism at 3km x 3km spatial resolution (Busch *et al.*, 2010). We used the OSIRIS model to predict deforestation at each OHU under the 'without REDD+' scenario.

5.4 Results

5.4.1 Differences between projects

The Ketapang project, which is being implemented by the conservation NGO Flora and Fauna International (FFI-Indonesia), has biodiversity conservation as its most important project goal. The Katingan project, is being developed by a private for-profit business, and has emission reduction in order to obtain carbon credits or in order to sell carbon credits as its main project goal. These project goals are reflected in the proponent's decision on where to locate their project i.e. the Ketapang project proponents stated that they had located their project with explicit regards to biodiversity conservation (orangutan conservation in particular) while the Katingan project proponent stated that they sought out forest with the highest carbon potential. A closer assessment of the projects on the ground revealed several other important differences which may impact (positively or negatively) overall outcomes for forest and orangutan conservation. These include: tenure arrangements, drivers of deforestation and forest degradation, and the choice of voluntary certification. We found that the projects were approaching REDD+ implementation using different tenure arrangements; the Ketapang project is using the village forest (*Hutan Desa*) management, a legal designation giving forest management rights of state forests to communities as the legal basis for developing a REDD+ project (Larson *et al.*, 2013). The Katingan project instead is using the Ecosystem Restoration Concession (ERC), a legal designation allowing deforested, degraded or damaged production forests to return to their 'biological equilibrium'(Walsh *et al.*, 2012). The choice of tenure arrangement determines project duration, tenure security, as well as cost (these are summarized in Table 5.1) and have implications for forest and orangutan conservation. The key drivers of deforestation common to both project sites were oil palm plantation development, logging / illegal logging, mining / illegal mining, fire (mostly on peatlands) and monoculture plantation development. The Ketapang project had two other drivers of deforestation and these are the construction of the trans-borneo road and transmigration.

Some similarities exist: both projects aim to reduce deforestation and forest degradation at the project level via avoided deforestation, enhancement of forest carbon stocks and forest conservation activities. Both projects are also targeting the voluntary carbon standards and third party certification of both carbon and non-carbon values. The Katingan project will be using the Voluntary Carbon Standard (VCS) to verify the carbon in its entire project area. The Katingan project will use the VCS only for village forests located on peat, and the PlanViVo standard for village forests located on mineral soil. Both projects will be developing and verifying the delivery of non-carbon benefits (biodiversity and social values) following the Climate Community and Biodiversity Alliance (CCBA) standard.

Table 5.1: Key difference between the two REDD+ projects which have relevance to the delivery of biodiversity conservation.

Key project differences	The Ketapang Community Carbon Pool Project	The Katingan Peat Conservation and Restoration Project
Project proponent	Flora & Fauna International - private non-profit (NGO)	PT Rimba Makmur Utama - private for-profit
Project size (ha)	Proposed: 58,634 Approved: 15,082	Proposed: 203,569 Approved: 108,226
Population (density - persons/km²)[c]	• 445,751 (14/km²)	• Katingan – 155,100 (9/km²) • Kotawaringan Timur - 405,700 (24/km²)
Top three project goal (in the order of importance)[a]	• Biodiversity and conservation • Poverty reduction • Community development	• Emission reduction for carbon trading • Community development • Sustainable forest management
Deforestation rate[b] (2000 – base year) (2000 – 2012)	• 1042 ha (2%) • 3440 ha (5.9%)	• 446 ha (0.2%) • 7327 ha (3.6%)
Drivers of deforestation and biodiversity loss	• Oil Palm plantation • Logging / illegal logging) • Mining / illegal mining • Fire (peatland) • Transborneo road • Monoculture plantations • Transmigration	• Oil palm plantation • Logging / illegal logging • Mining / illegal mining • Fire (peatland) • Monoculture plantations
Tenure	Village forest (*Hutan Desa*)	Ecosystem Restoration Concession (ERC)
REDD+ Tenure	35 years. Renewable +35 more years	60 year. Renewable +35 more years.
Strength of tenure security	Weak. This is only a management/use right and not a land ownership status.	Strong. Concession belongs to the project managers and legally binding.
Legal (concession) fee	No fees required but high transaction cost associated with negotiating and contracting	Very High - Taxes and concession fees for 60 years to be paid up front – this was USD 4 million for the Katingan project
Scope of REDD+	• Avoided deforestation • Enhancement of forest carbon stock • Forest conservation	• Avoided deforestation • Enhancement of forest carbon stock • Forest conservation
Third party carbon and non-carbon certification standards	• Carbon - Verified Carbon Standards (VCS) and Plan Vivo • Non- carbon - Climate, Community and Biodiversity (CCBA)	• Carbon - Verified Carbon Standards (VCS) • Non- carbon - Climate, Community and Biodiversity (CCBA)
Sale of future carbon credits	The proponent intends to target buyers interested high biodiversity credits	The proponent is interested to pursue a bilateral offsets as well as the voluntary carbon markets.

[a] Source: Proponent Appraisal – CIFORs Global Comparative Study on REDD+ (See Chapter 2)

[b] Deforestation rate calculated for the proposed project area using the MoF dataset (from this study)

[c] District level population density as reported in (PBS - Badan Pusat Statistik, 2014a,b,c)

5.4.2 Barriers to REDD+ implementation

Based on field observations, key informant interviews and document review, we found that the two challenges facing REDD+ implementation which we assessed in our study were largely bureaucratic, and deeply rooted in the political economy surrounding forests in Indonesia as illustrated by Luttrell *et al.*, (2014); with potential negative implication for both climate mitigation and biodiversity conservation. Both project proponents expressed considerable frustration about the hurdles of government red tape and the delays in obtaining licenses for their projects. Delays in the issuance of the REDD+ permit was associated with the involvement of many branches of the government and many procedures. Project proponents cited the decentralised governance in Indonesia as an important reason for delays in the issuance of permits needed to implement REDD+ on the ground. For example, the central government had granted approval for the Katingan project proponent to be a prospective concession holder as early as May 2009 (a year after the application process started), the district government however objected to the project and was in favour of converting the area for oil palm plantations (personal communication, Darsono Hartono). The district head had allocated parts of the area proposed for REDD+ development to nine mining and six oil palm companies (Hartono, 2011). In the media, PT. Rimba Makmur Utama (RMU) highlighted its efforts in getting a license 'by the book,' that is, without bribing, pulling strings or taking shortcuts, which partially explains the long delay in obtaining a license (Hartono, 2012; Butler, 2013).

As for the Ketapang project in West Kalimantan, the central government verified and approved the village forest working area in 2011. However the villages are still waiting for the final management rights to be approved by the governor of West Kalimantan province. The Pematang Gadung village, part of the large peat block in the Ketapang project, is still waiting for their area to be approved by the MoF. According to a key informant from the village, delays are partly because two oil palm concessions (PT Perana Indah Gemilang and PT Goon Yew) and gold miners have expressed interest in the area (personal communication Abdurahman Al Qahdri). From the interviews with key project staff, the reduction in the project area has largely been due to the overlapping claims on the land. Provincial and district governments have the mandate to issue concessions permits under the decentralised governance. However, Indonesia does not have a streamlined national land use plan, and this has led to overlapping claims. The national government dealt with this by removing contested land from the proposed REDD+ boundary, thus reducing the overall area proposed for REDD+ development.

5.4.3 The impact of the slow REDD+ approval on natural forest

During the period of **2003 – 2006**, i.e. before the conception of REDD+, the Ketapang project experienced the highest rate of forest loss when compared to the rest of the assessment period (2000 - 2012). Approximately 1725 ha of secondary peatswamp forest experienced land cover change to ‘swampy bush’ (88%) and ‘open land’ (12%). During the same period, the Katingan project did not experience any land cover change from natural forest to any non-forest cover – Figure 5.2 and Figure 5.3.

During the period of **2006 – 2009**, i.e. the period immediately before the REDD+ application at both project sites started, the Ketapang project experienced natural forest loss of approximately 647 ha, a large majority (92%) of which took place in forest on mineral soil. During this period, the Katingan project experienced the highest natural forest loss in the 12 years of the study (2000 – 2012). Approximately 6100 ha of secondary peatswamp experienced land cover change to ‘swampy bush’ (94%) and and plantations (6%) – Figure 5.2 and Figure 5.3

During the period of **2009 – 2012**, i.e. the period immediately after the REDD+ application was submitted but before the REDD+ projects were verified or approved, both projects recorded the lowest natural forest cover loss in 12 years - Figure 5.2. The Ketapang project area experienced approximately 28 ha of forest cover change which was entirely from peatland to mining and approximately 770 ha of land cover change from secondary peatswamp forest to ‘swampy bush’.

Our results generally show that during the period when the REDD+ project applications were being processed (2008 – 2012), there was no major increase in land cover change from natural forest to non-forest - Figure 5.2. Instead, we found that natural forest loss was greatest in the period immediately before the REDD+ application began (Katingan Project) and before the conception of REDD+ (Ketapang project). Figure 5.2 shows natural forest loss in the Ketapang and Katingan REDD+ projects for the period 2000 – 2012. In the discussion section, we explore some of the possible storylines for the patterns of forest cover change we see at both our project sites.

See Appendix 2 (Figure S1) for the land cover losses and gains from 2000 – 2012 for all forest and non-forest land cover classes in the Ketapang and Katingan REDD+ projects. The two maps in Figure 5.3 and Figure 5.4 show district level forest cover for 2012, proposed and approved REDD+ project area and forest loss within the REDD+ project boundary for the period 2000 – 2012 for the Ketapang project and Katingan project.

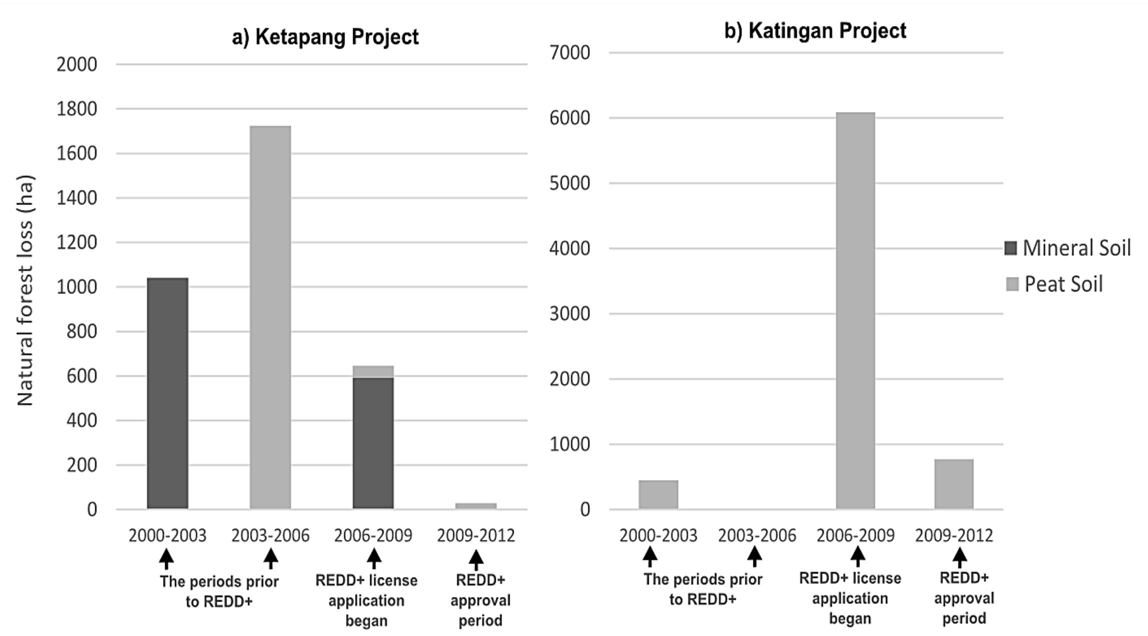


Figure 5.2: Natural forest cover loss (deforestation) in the Ketapang and Katingan REDD+ projects from 2000 – 2012

5.4.4 Impacts of reduction in REDD+ project area on natural forest

Here we assess how project area reduction could potentially negatively impact natural forest cover and orangutan conservation at the Ketapang and Katingan projects. Our key interest is in the characterisation of the forest types (forest quality) excluded from REDD+ protection, the fate of these forests (based on the legal classification of the land) and how these could potentially effect orangutan populations.

At the Ketapang project, an area of approximately 58,634 ha was submitted by the project developer Flora and Fauna International (FFI) for 10 village forest license applications, out of which only 15,082 ha (6 applications) was verified by the MoF for final approval. This represents a reduction in approximately 74% of the original area proposed for the REDD+ project development. Based on the 2012 land cover map, we found that due to the reduction in the project area, approximately 31,643 ha (i.e. 74% of the total area excluded from REDD+ approval) of natural forest will not be eligible for REDD+ protection - Table 5.2. This is equally distributed between natural mineral soil and peat swamp forest. These figures include the Pematang Gadung Block which is still pending approval as well as the three village forests initially declined by the MoF (details can be found in Appendix 3 – Table S6).

The area originally proposed by the Katingan project proponent for REDD+ development was 203,846 ha of peatswamp forest of which 108,226 ha (or 53%) was approved in 2013.

Approximately 83% (or 80,000 ha) of the area excluded from the final REDD+ approval was in natural forest - Table 5.2. The proposed REDD+ project area was located in two districts (the Katingan and Kotawaringan Timur districts); however the approved project area was restricted only to the Katingan district. We overlaid the map showing the priority restoration areas with the newly approved concession boundary and found that two of the three priority restoration areas have been excluded from the approved project boundary (see Appendix 3 – Figure S3).

Table 5.2: Proportion of forest and non-forest area proposed, approved and excluded from REDD+ protection for the Katingan Project (a) and Ketapang project (b)

Forest Type	**a) The Katingan Project**				**b) The Ketapang Project**			
	Area (ha)		**Excluded**		**Area (ha)**		**Excluded**	
	Proposed	**Approved**	**(ha)**	**(%)**	**Proposed**	**Approved**	**(ha)**	**(%)**
Natural Forest	182,916	103,393	79,523	**39**	42,032	10,389	31,643	**54**
Non-forest	20,930	4,833	16,097	**8**	16,602	4,693	11,909	**20**
Total	203,846	108,226	95,620	**47**	58,634	15,082	43,552	**74**

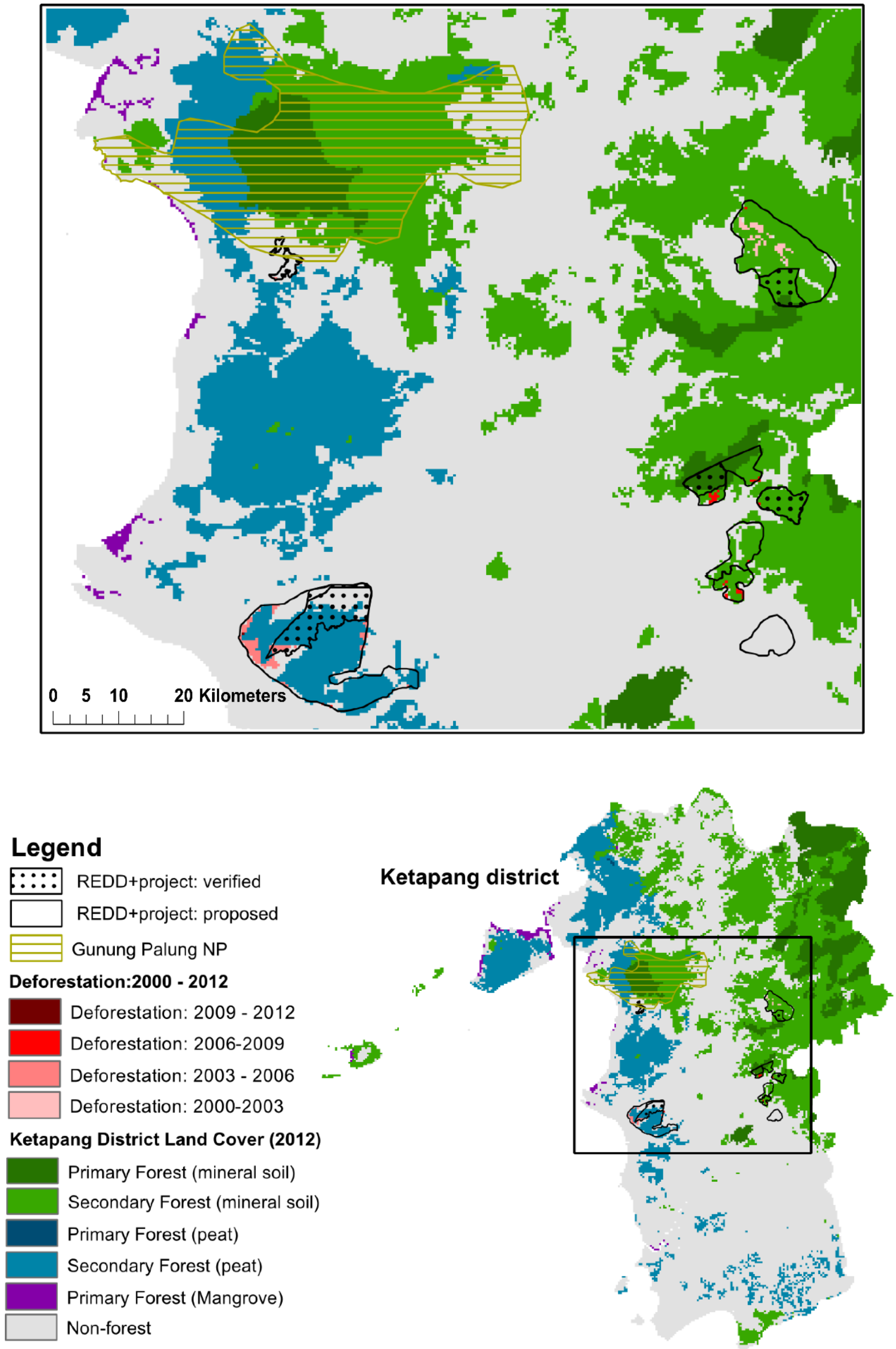


Figure 5.3: Map of the Ketapang district showing remaining forest cover, the proposed and approved REDD+ project area (village forest boundaries) and deforestation within the REDD+ project boundary for the period 2000 – 2012 (inset).

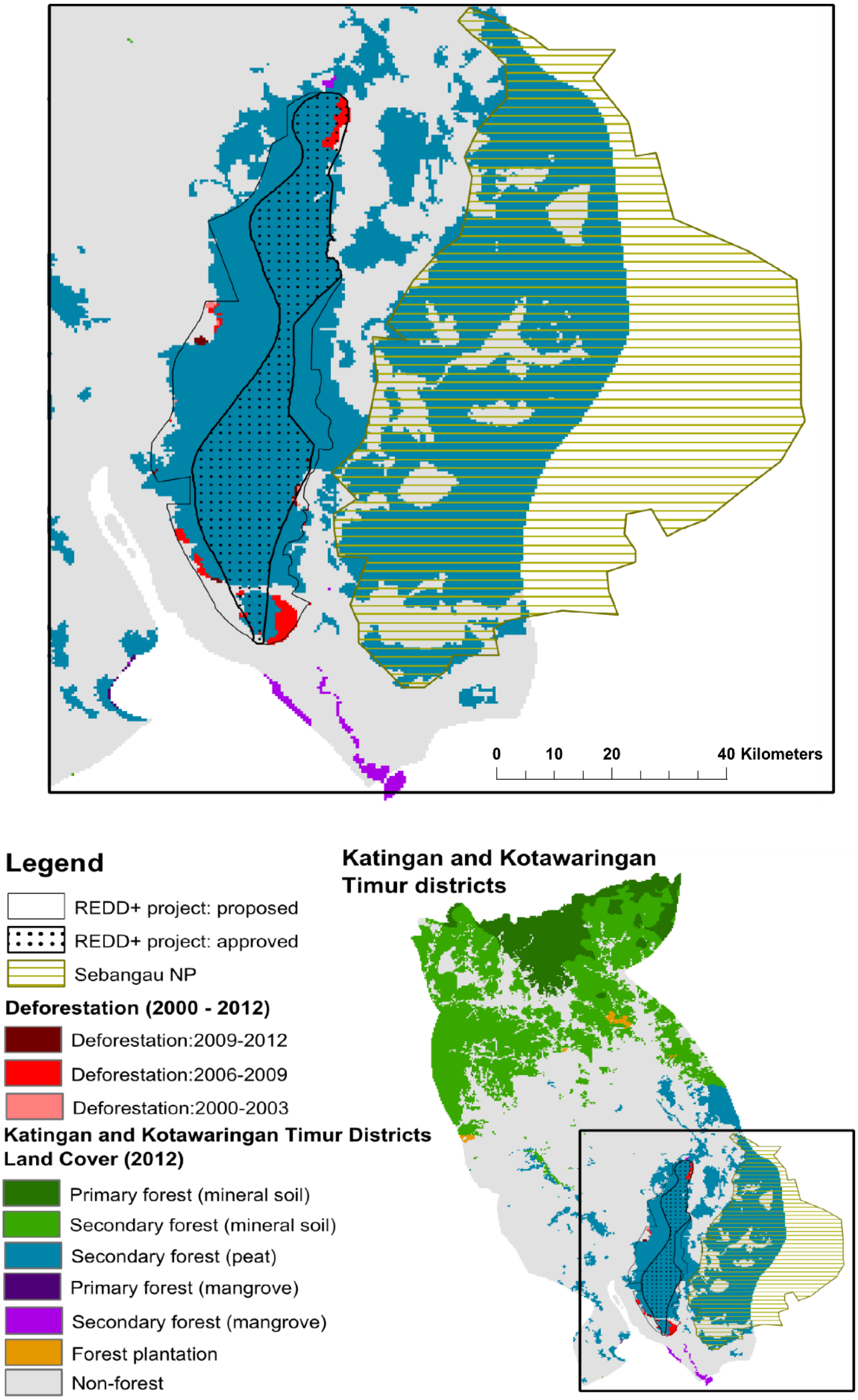


Figure 5.4: Map of the Katingan and Kotawaringan Timur districts showing remaining forest cover, the proposed and approved REDD+ project area, and deforestation within the REDD+ project boundary for the period 2000 – 2012 (inset).

5.4.5 What is the fate of forests not approved for REDD+?

More than 95,000 ha of land was excluded from future REDD+ protection at the Katingan project; this consists of approximately 24,681 ha (26%) of land legally classified as ’convertible production forest’ and 70,939 ha (74%) legally classified as ‘production forest’ - Figure 5.5. These forests have a high likelihood to be converted for oil palm development or timber plantations depending on the deforestation pressure in the area (see Appendix 3 – Figure S4). Many ex-logging concessions in land classified as production forest such as those located in parts of the Katingan project, have been depleted of commercial timber stock, following overexploitation and fire events in the past decades. Such forests have been known to be reclassified for industrial tree plantations and in some cases for oil palm development (Obidzinski & Chaudhury, 2009; Wich *et al.*, 2012). Based on the MoF land cover map we used in our analysis, the entire Katingan project is classified as ’secondary swamp forest’ which is defined as forest with traces of logging, or burned (see Appendix 2 for the full definition of the land cover classes). Of the area excluded from REDD+ protection, approximately 80,000 (or 83%) was under this land cover class. The area which corresponds to ‘secondary swamp forest’ in our land use analysis corresponds to high density primary and secondary peat swamp forest under a different definition used by the Katingan project proponents.

The forest definition used by the Katingan project is based on tree density which divides the Katingan block into high, medium or low primary and secondary swamp forest (Rimba Makmur Utama, 2012). Based on the classification used by the proponent, we found that a large portion of the high density primary and secondary peat swamp forest fell outside the ‘approved’ area, and two of its three priority reforestation areas were located outside the area approved for future REDD+ development (Marchant *et al.*, 2014). See Appendix 3 (Figure S3) for the map showing PT. RMU’s priory restoration areas and the proposed and approved project boundaries. This suggests that a large portion of the forest excluded from future REDD+ protection is not heavily degraded, and clearing of these forests to make way for oil palm or timber plantations (highly probable based on its legal classification and proximate drivers of deforestation) would be a loss for biodiversity and because the Katingan project is on a peat dome, this will also impact the wider peat ecosystem.

Approximately 43,000 ha of land was excluded from the proposed Ketapang project. Over 40% of this (18,561 ha) is legally classified as convertible production forest while 23% and 27% is legally classified as production forest and limited production forests respectively - Figure 5.5. With regards to the land cover of the area excluded from REDD+ protection, at least 70%

consist of secondary forest, equally divided between forest on mineral soil and peatswamp. We overlaid the Ketapang REDD+ project boundaries with the boundaries of concession (timber, logging and oil palm) designated in 2012 and found that almost all the forests excluded from REDD+ protection overlapped with existing concessions (see Appendix 3 – Figure S4a) indicating that they were excluded due to existing land claims, which partly explains the forest loss we found in our land use change analysis. The land excluded from future REDD+ protection at the Ketapang project, which is legally classified as convertible production forest would therefore have high probability of being cleared for oil palm development timber plantations regardless of the forest quality.

When compared to the Ketapang Project (village forest license) the Katingan project appears to have less pressure from industries such as the timber and the oil palm sector (see Appendix 3 – Figure S4b), this could perhaps be due to policy measures which have been in place such as the ban on illegal logging (2005), the moratorium on peat (2007) and the moratorium on new licenses and peat (2011) which was introduced as part of the USD 1 billon pact between the Norwegian government and the Indonesian government (Murdiyarso *et al.*, 2011; Sloan *et al.*, 2012). However, the Katingan forest faces pressure from illegal logging and mining activities both of which were active and visible during the field surveys, although interviews indicated that this has dropped significantly since the ban in illegal logging began when enforcement got stricter and the number prosecutions increased.

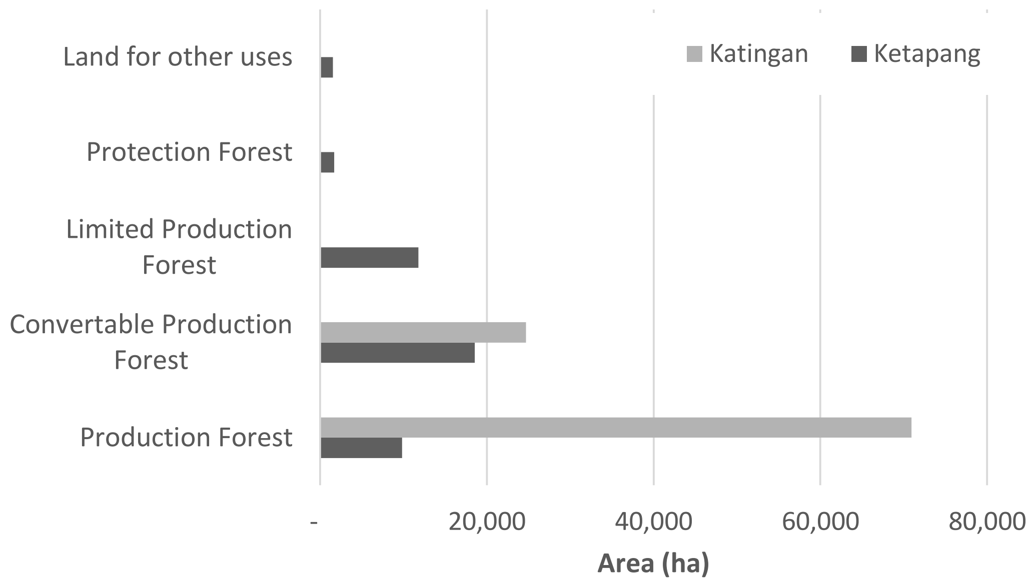


Figure 5.5: Classification of forest and non-forest land which was excluded from final REDD+ approval for the Ketapang and Katingan projects.

5.4.6 Orangutan range and density distribution

The results of the orangutan density mapping shows that the remaining forested land in all three districts in this study (Ketapang, Kotawaringan Timur and Katingan) are part of the remaining orangutan (*P. p. wurmbii*) range – Figure 5.6 and Figure 5.7. The Katingan project is located entirely in an Orangutan Habitat Unit (Block 2), with one of the highest orangutan densities in the Katingan and Kotawaringan Timur districts (second after the Sebangau National Park (Block 1) - Figure 5.7. The OHU Block 2 has a density of 2.3 individuals / km^2 and an estimated population of 4,149 ±1,127 orangutan (Marchant *et al.*, 2014). The Katingan forest block (Block 2) and the Sebangau Catchment (Block 1) are two distinct Orangutan Habitat Units and with the two most intact forests in the districts where they are located (Figure 5.7 and Figure 5.4).

Five out of the six village forest at the Ketapang REDD+ project are located in four OHUs (blocks 1, 3, 29 and 35). The Ketapang REDD+ project is located in forests with very high to moderate orangutan density; the highest being the Pematang Gadung forest (block 3) (where two village forests have been verified for approval and one pending) which has an orangutan density of 3.8 individuals / km^2 and an estimated population of 500 – 800 orangutan (Mering, 2013). The Sebadak Raya village forest is also located in forest important for orangutan conservation as it is part of the larger Arut-Belantikan forest complex (Block 35) which has 3.34 individuals / km^2 and an estimated population of 6,000 individuals (Wich *et al.*, 2008). The highest orangutan density is in the Kuala Satong forest block (block 36) with an estimated 4.35 individuals / km^2 reported with an estimated population of 108 individuals (FFI, 2010). The Laman Satong village forest could function as an important corridor for orangutans and other wildlife connecting the Gunung Palung National Part (Block 5a, 5b and 5c) to the Sungai Putri Block and Kuala Totak forest complex (Block 17) - Figure 5.6.

Our results show that the two REDD+ initiatives have the potential to protect critical orangutan habitats. However, the reduction in the project area means that both projects will be ineffective in delivering orangutan conservation. Our findings on the fate of land excluded from future REDD+ protection indicates that the carbon loss associated with the reduction in the REDD+ project area could potentially be equal to or higher than its biodiversity loss. This is because both projects are located on peatland where soil organic carbon losses are much higher than biomass carbon loss and soil organic carbon losses continues through peat draining.

The original proposed village forests in the Pematang Gadung forest block (three village forests were proposed in this block) had the opportunity to protect one of the last remaining blocks of peatswamp forest in the Ketapang district and an important orangutan stronghold (Figure 5.7); however to date only 26% of the Pematang Gadung Block has been verified for village forest approval while the majority of the proposed forest block overlap with oil palm concessions (see Appendix 7)**.** The Sebadak Raya village forest is part of the the Arut-Belantikan forest complex (block 35) which have been identified in the Orangutan Population and Habitat Viability Assessment (Singleton *et al.*, 2004) as one of the six "highest priority where most strenuous effort must be made to save all of these Habitat Units"; only 2425 Ha (out of the proposed 14,247 ha) was approved for future REDD+ protection and the areas excluded are overlapping with logging and timber concessions (see Appendix 3 – Figure S4). The reduction in the project area means that the village forests alone are too small to function as viable habitat for orangutan and could face further isolation when surrounded by concessions such as oil palm, timber and /or logging concessions; such as the isolated Tanjung Berulang village forest where the OHU 29 with a density of 2.74 individuals / km^2.

The reduction in the Katingan project area could negatively affect the orangutan population as the project is part of a larger relatively intact peatswamp forest block recognized as a priority habitat in the Orangutan Population and Habitat Viability Assessments (Singleton *et al.*, 2004). Key orangutan studies have acknowledged the importance of the forest block – referring to it under different names such as the 'Katingan Floodplain' (Husson *et al.*, 2009), the Katingan-Sampit Swamps (Singleton *et al.*, 2004) and Katingan Block (Wich *et al.*, 2008). The reduction in the Katingan Project area compromises the integrity of the forest block especially since at least 24,000 ha of the area excluded from REDD+ protection is classified as convertible production forest – Figure 5.5. Possible future land use in those areas include oil palm plantation and mining, this is based on interviews with villagers surrounding the project which indicate that there has been a lot of interest from oil palm companies and project documents show that there are least nine mining permits and six oil palm plantation permits issued by the district head.

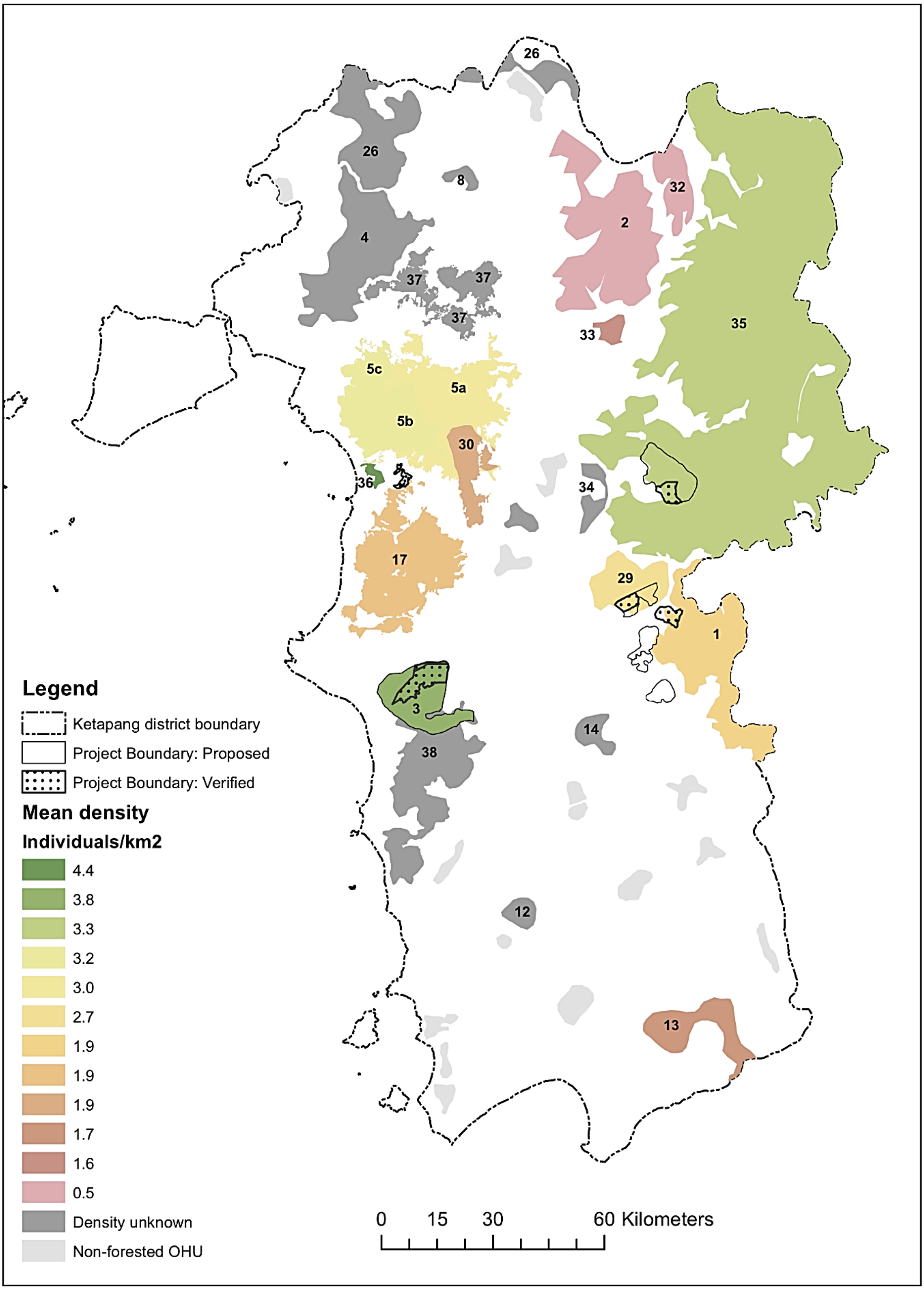


Figure 5.6: The location of Orangutan Habitat Units (in numbers), their mean orangutan densities and the location of the village forests in the Ketapang district.

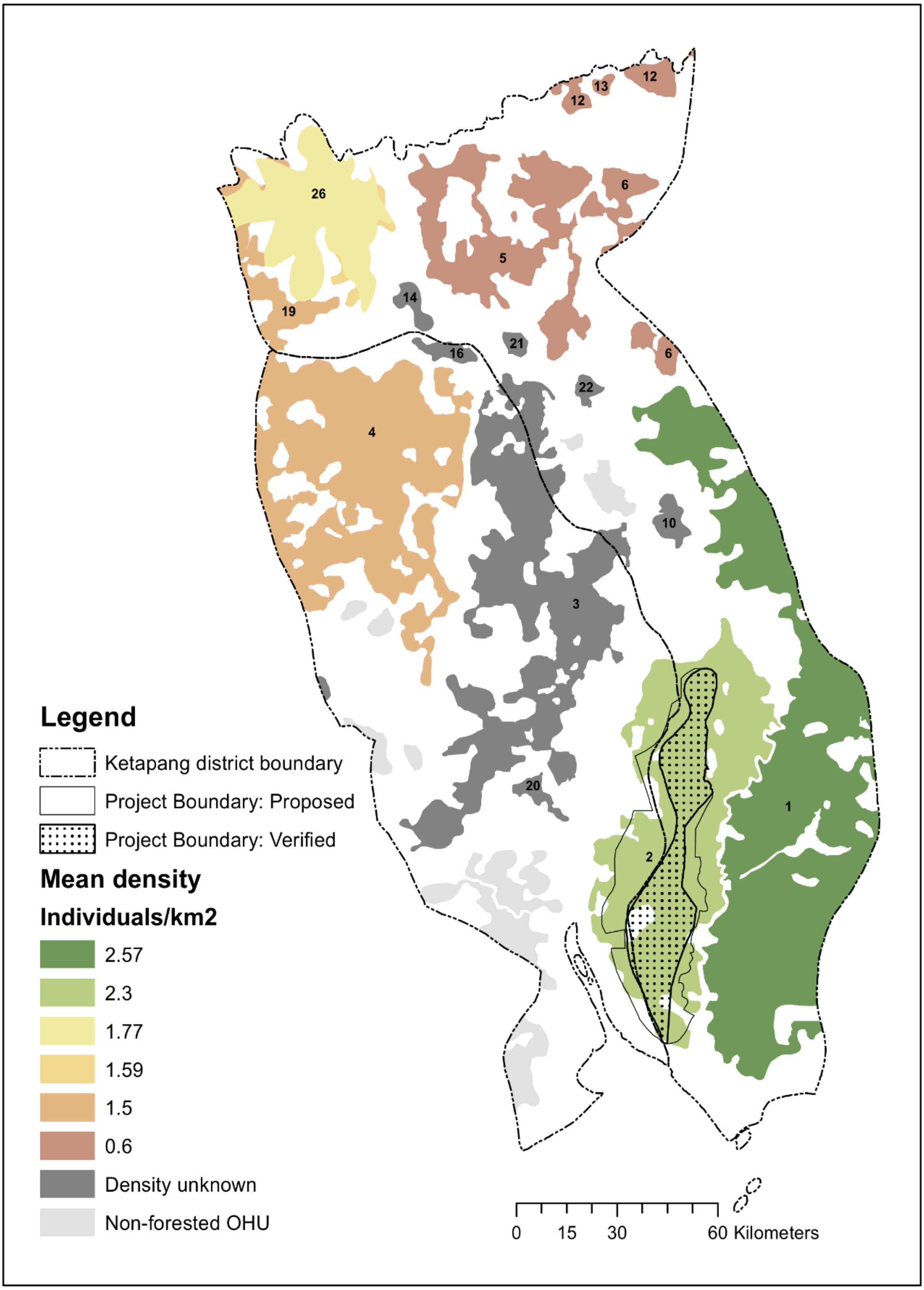


Figure 5.7: The location of Orangutan Habitat Units (in numbers), their mean orangutan densities and the location of the REDD+ project boundaries in the Katingan and Kotawaringan Timur districts

5.4.7 Predicted deforestation threat throughout the orangutan range

The modeled deforestation analysis shows that remaining OHUs in the Ketapang, Katingan and Kotawaringan Timur districts face significant threat to future deforestation, the lowland forests face the highest threat with a maximum deforestation threat per hectare reaching 31% (Katingan and Kotawaringan Timur) and 44% (Ketapang) – See Figure 5.8 (a & b). The OHUs located within our REDD+ project forests were some of the most threatened to future deforestation when compared to the other OHUs within the districts where they are located. The highest predicted threat areas also correspond to peatswamp forests e.g.: Pematang Gadung in the Ketapang District, and the entire Katingan block in the Katingan district (Figure 5.8 and 5.9).

In the Ketapang district, OHUs located in village forests on mineral soil are not those predicted to be at highest risk to future deforestation - Blocks 1, 29 and 36 which have predicted deforestation threat of 2.3%, 3.1% and 1.8% - Figure 5.9 (a). The Pematang Gadung however - Block 3 in Figure 5.9 (a) is the most threatened of the four OHUs linked to the Ketapang project with predicted deforestation of up to 15%. This forest block also has one of the highest orangutan densities in the Ketapang district with a mean density of 3.8 individuals per hectare Figure 5.9 (a); there are two village forests are located in this OHU block 3. Other highly threatened OHUs in the Ketapang district are; block 17 (the Sungai Tolak and Sungai Putri forest complex) with predicted deforestation of up to 44% and reported to have a high orangutan density of 4.4 individuals / km^2, and block 36 (Kuala Satong forest) with a 17% predicted deforestation and a reported orangutan density of 1.9 individual / km^2 – Figure 5.9**.**

The Katingan Project is located in OHU block 2 which is predicted to have high risks to deforestation when compared to Katingan district’s average – Figure 5.8b. The OHU block 2 is predicted to have a max deforestation of 27% (maximum deforestation for the two districts is approximately 31%) with most of the high predicted deforestation areas located outside the approved project boundary including the area which was originally proposed but not approved for REDD+ protection (to the west of the approved project boundary) – See Figure 5.8. The Katingan block also has one of the highest orangutan densities in the Katingan and Kotawaringan Timur districts with a mean density of 2.3 individual / km^2 (Figure 5.8b). Our threat analysis also show that the Sebangau National Park which has an orangutan density of 2.57 individual / km^2 is not spared from future deforestation, the model predicts up to approximately 15% deforestation within the national park.

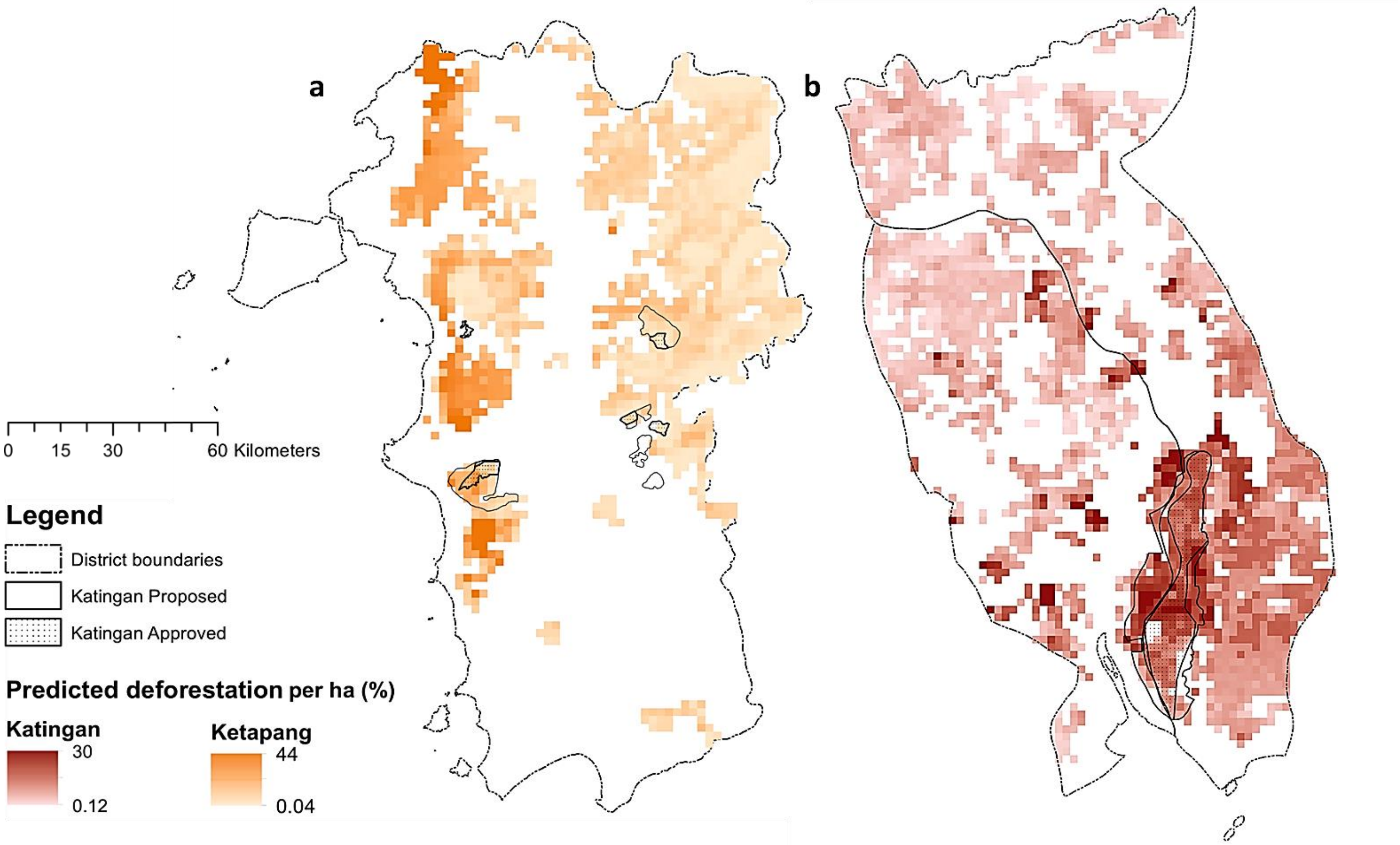
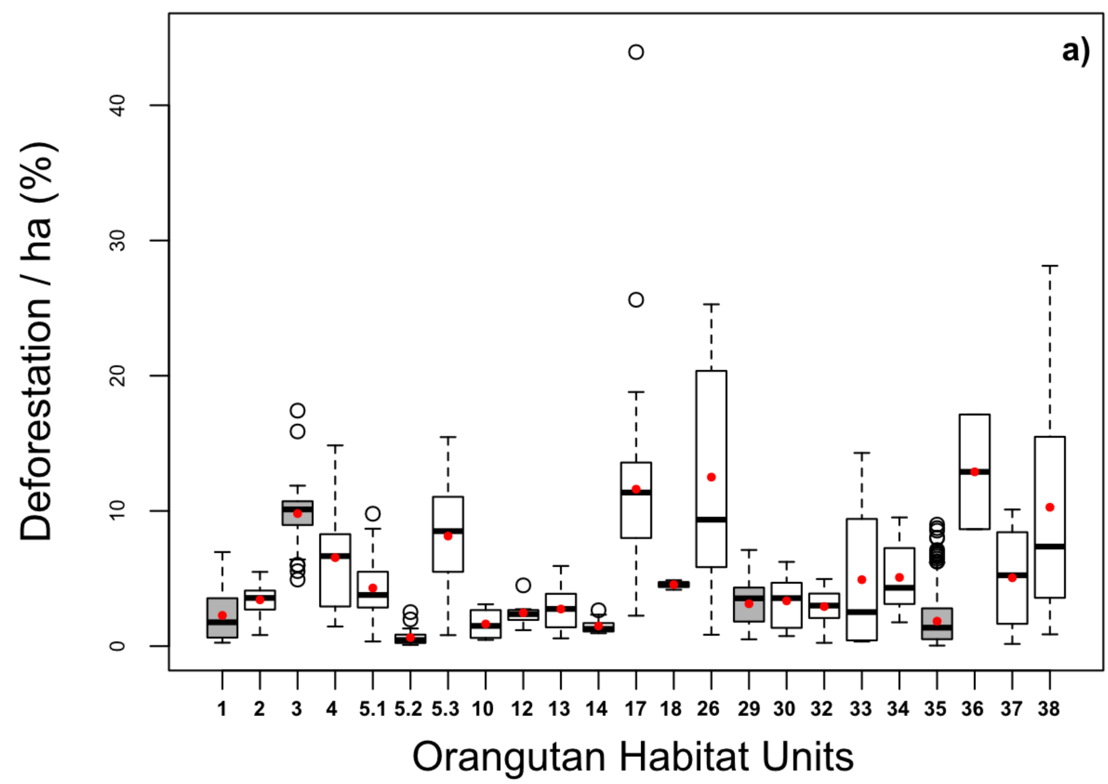


Figure 5.8: Predicted deforestation throughout the *P. p. wurmbii* range in the Ketapang district (a) and the Kotawaringan Timur and Katingan districts (b)



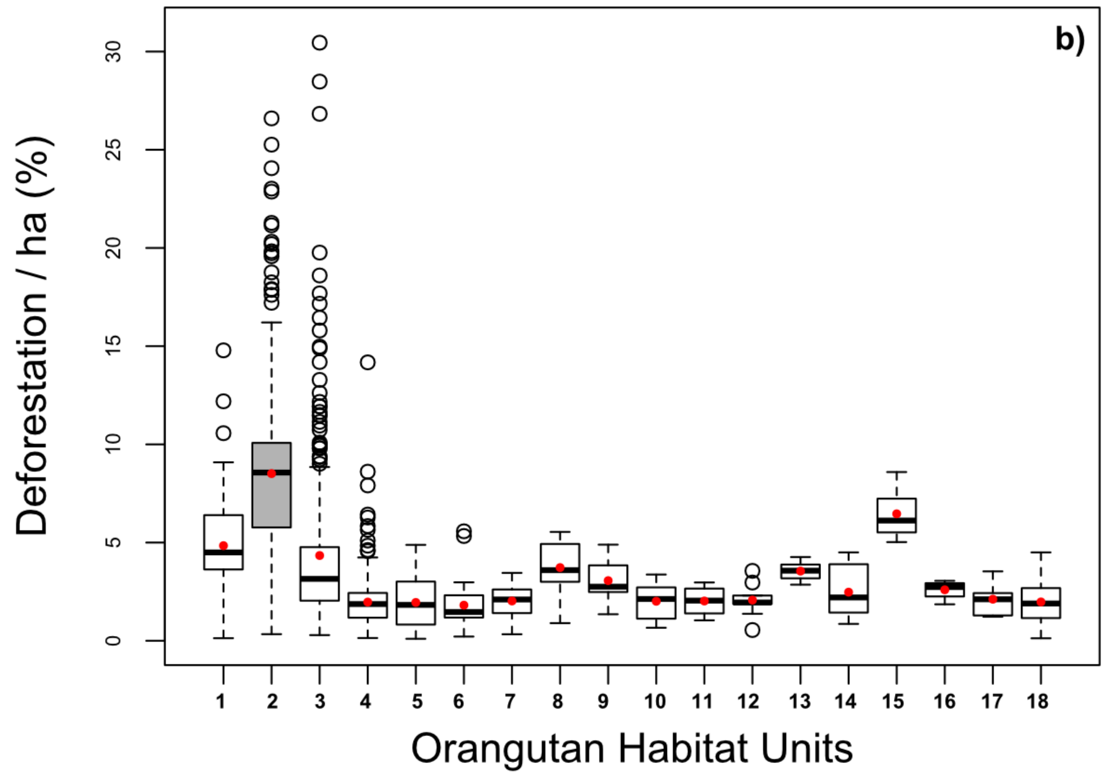


Figure 5.9: Predicted deforestation per ha/year (%) for Orangutan Habitat Units (OHUs) in the Ketapang district (a) and the Katingan and Kotawaringan Timur districts (b).

Note: Numbers on the x-axis represents forested OHUs (see Figure 5.6 and Figure 5.7) and shaded boxplots represent OHUs which are located within the Ketapang REDD+ project (a) and the Katingan REDD+ project (b). The red dots represent the means.

5.5 Discussion

5.5.1 The multiple drivers of forest cover change

In this study, we set out to explore the potential impacts of the slow REDD+ project approval could have on forests and orangutans. Indonesia is currently considered the highest deforestation country in the world (Margono *et al.*, 2014). Due to its key role in the global effort to reduce emission from deforestation and forest degradation, Indonesia have received strong donor support to roll out REDD+ (Edwards *et al.*, 2012a). However, its progress has been particularly slow when compared to other key REDD+ countries in Latin America such as Brazil, Peru and Mexico, or emerging REDD+ countries in Africa (Goldstein *et al.*, 2014). Perhaps like the REDD+ projects in our study, other projects are facing a slow and tedious process to obtain the permits needed to implement REDD+ in Indonesia. Our hypothesis was that a delay (often between 2 – 5 years in Indonesia) could put forests and its biodiversity at risk; this is especially true for ERCs because these forests are not covered by any form of forest licences, making them more vulnerable to encroachment and claims by interested parties (Walsh, 2012). However, we found that that the delay in REDD+ license issuance did not accelerate the rate of forest loss at both project sites. Instead, in the period of 2009 – 2012, the proposed Ketapang project area recorded its lowest forest loss and the Katingan project experienced a six fold drop in forest loss compared to 60,000 ha of forest loss in the period of 2006 – 2009. There are many interacting factors which could explain the pattern of forest cover change obtained in this study. For example, climatic events like the El Niño Southern Oscillation which caused large and prolonged forest fires in peat swamp forests at both our project sites just before the year 2002 and at the start of 2007 (Page *et al.*, 2002; Fuller *et al.*, 2011). Major deforestation events in Borneo have been associated with fire and land severely damaged by fire may not naturally regenerate, recovery is particularly low in peatswamp forests (Blackham *et al.*, 2014).

Another important factor driving forest cover change is the change in the forest policy environment in Indonesia. In 2007, the Indonesia government introduced a ban on oil palm development on peatlands, however, this was retracted slightly over a year after it was introduced (Koh, 2009). We could link this to the particularly high increase in deforestation in the period of 2006 – 2009 although a proper land cover analysis looking specifically at oil palm development during that period will need to be carried out to confirm this. In May 2010 as part of the USD 1 billion deal with the Norway government, the Indonesian government implemented a forest clearance moratorium which was a two year suspension on all new concessions for conversion of peat and natural forest, this applies to new logging or agricultural concessions (including oil-palm and paper-pulp tree plantations) in primary dryland forests and peatlands (Presidential Instruction No. 10/2011) (Sloan et al., 2012). This was extended for another 2 years in May 2013. While there has been strong opinions about the moratorium having little additional gains for unprotected forests (Koh, 2009) and having not had any positive impacts on reduction in forest loss at the national level (Margono et al., 2012), perhaps these effects are more obvious at a smaller scale and the effects are evident in our case studies because they are located on peatlands. We can link the high deforestation on mineral soil forest in the Ketapang district in 2000 – 2003 to the peak in logging in the area, i.e at the start of the decentralization policy introduced in 1999 when district heads had the power to issue permits to cooperatives or individuals to boost district revenue (Intarini *et al.*, 2014; Shah & Baylis, 2015).

At the Katingan project, the high deforestation rate in the period of 2006 – 2009 could be associated with the establishment of the Sebangau National Park in 2006 which increased forest protection in the adjacent park, but shifted drivers of deforestation to the Katingan forest block (pers. comm. Mark Harrison) (Shah & Baylis, 2015). While the drop in deforestation in the period of 2009 – 2012 (after the project's permit application was submitted but before approval was granted) could be attributed to the fact that much of the expansion of oil palm and settlements have been completed and accessible, parts of the forest had been cleared in the previous period (personal communication Mark Harrison). Alternatively, this could perhaps be linked the presence of the REDD+ project in the area.

The unofficial presence of the REDD+ project in the area could have deterred the issuance of new extractive license by the district head or reduced illegal activities such as illegal logging/ land clearing in the area. The presence of the project proponent and their partner organizations were very evident on the ground during field observations. Prior to the verification or approval of the REDD+ project, proponents and their collaborating partners were actively carrying out activities on the ground in preparation for the REDD+ approval such as the development of carbon and non-carbon baselines (including biodiversity baselines), conducting Free Prior and Informed Consent and socializing the REDD+ concept at potential REDD+ villages. The Katingan project had also begun alternative livelihood and community engagement activities in a few pilot villages prior to their license approval. It is important to note that a limitation of our forest loss analysis may have failed to capture fine scale forest degradation such as those caused by the removal of individual trees by illegal loggers. The delay in license approval also means that the project did not have the mandate to protect its forests from encroachment such as illegal logging and illegal hunting which were observed to be still widespread at both projects.

5.5.2 The effects of REDD+ project area reduction

Both project proponents expressed concerns with regards to the reduced REDD+ project size and acknowledged that some of the areas excluded from the approved REDD+ project are areas important for biodiversity protection and ecosystem services (Intarini *et al.*, 2014)(pers. Comm Andjar Rafiastanto, FFI-Indonesia). Proponents were especially concerned about the potential negative implications of protecting only parts of the peat dome on the conservation efforts inside the project boundary. Proponents also expressed how they intend to address the issue associated with the reduction in their project area; the Katingan project proponent intended to acquire an ERC license for the remaining portion in the Kotawaringan Timur district which was excluded from the REDD+ approved area (Indriatmoko *et al.*, 2014). While according to a senior staff member of FFI-Indonesia - “FFI together with the villages will carry out further negotiations with the MoF (or district level authority) on the potential for land-swaps (*perubahan fungsi*) where land for other non-forestry use (APL land) within key bio-corridors or at key conservation areas can be swap with highly degraded or non-forest land within the approved Hutan Desa license area” – Carbon and Biodiversity Technical Advisor, FFI-Indonesia.

We found that the reduction in project area had greater implications for both efforts to reduce deforestation and flagship species conservation. The reduction in project area (as well as delays) have been linked to conflicts between central and district governments over the use of forest resources (Luttrell *et al.*, 2014). Province / district governments have greater flexibility and ability to directly influence local land use; they can delay or stop the issuance of ERC and village forest licenses for a variety of reasons and also propose land swaps (*perubahan fungsi*) for the area that are within production forests (Busch *et al.*, 2012). However, land management decisions in Indonesia are strongly influenced by the distribution of benefits among diverse actors with asymmetrical influence; therefore, land cover outcomes may reflect land use value accrued to dominant agents, rather than net market value (Carlson et al. 2012).

From a carbon business perspective, REDD+ project delays have far reaching economic consequences and these were expressed by the proponents of the two projects. Both projects had to bear high transaction costs throughout the REDD+ project application process which also meant that project developers missed out on the opportunity to secure REDD+ funding when the REDD+ concept was making headlines and investors' confidence was high. The removal of conflicted land and re-defining the project boundary to exclude these areas can be seen as a way taken by project developers to move the project approval process forward and get on with business; for example, the move by the Katingan project to exclude approximately 3000 ha of land at the start of the ERC application process for allocation to an oil palm concession at the request of the district head (personal communication with senior project staff). Both projects also expressed concern about the high costs associated with keeping a presence in the project area and engaging with local communities during the approval period in order to gain their trust towards the REDD+ project. High costs also came in the form of meeting the requirements of the MoF for REDD+ implementation as well as the many stages in the permit application. While both the project developers in our study persevered and received strong financial support from their donors and funders throughout the 4 – 5 year waiting period, other REDD+ projects may not be so fortunate.

5.5.3 Implications for orangutan and peat swamp forest conservation

More than 75% of Indonesia's CO_2 equivalent emissions are attributed to land cover change (Ekadinata & Dewi, 2011). According to Indonesia's National Climate Council on Change (NCCC), approximately 38% of Indonesia CO_2 emission comes from carbon rich peatswamp forests (NCCC, 2010); finer scale studies found this to approximate 41% for Riau (Ramdani & Hino, 2013) and 35% for Kalimantan (Carlson *et al.*, 2013). Studies have shown that peatlands are preferred for REDD+ project development, whether a project is carbon driven or conservation driven (Harrison & Paoli, 2012), because not only do these forests store the largest amount of carbon than any other tropical forest ecosystem (Page *et al.*, 2011), tropical peat swamp forests are highly threatened ecosystems (less than 37% of its original extent remain - Posa *et al.*, 2011). Peatlands are also important for species conservation with at least 32% of all mammal species and birds in Borneo found in peat swamp forests; a high percentage of these are listed as threatened in the IUCN redlist (45% mammals and 33% birds); the ecosystem is also strongly associated with the Bornean orangutan (Page *et al.*, 2011; Struebig *et al.*, 2015a) which tend to be found in higher densities compared to mineral soil forests (Meijaard, 2014b).

If the trend in REDD+ project reduction continues, it will have negative implications for peatswamp forests and the Bornean orangutan. Unless a nationwide spatial planning is carried out, there is the potential for continued land use conflicts between the national and sub-national governments on the allocation of land for REDD+ vs other more lucrative land use such as oil palm or timber plantations. This means that REDD+ projects will continued to be slashed to accommodate economic interests which is likely to negatively impact climate mitigation and biodiversity conservation needs. This is particularly alarming for peatlands more than any other forest ecosystem because peat swamp forests are more susceptible to the synergistic effects of multiple human disturbance large due to the balance that exists among vegetation, peat and hydrology that can easily be degraded once this balance is upset (Page *et al.*, 2011). This is evident at our two project sites where 74% of the Pematang Gadung Block (block 3 in the Ketapang district), and 53% of the Katingan peat block was excluded from REDD+ protection.

Areas excluded were largely classified as 'production forest' and 'convertible production forest', which could end up being developed entirely for oil palm plantations, mining or logging. Oil palm is increasingly being developed on peatlands (Carlson *et al.*, 2012). Conversion to oil palm begins with the construction of canal system to drain the soil; this intensifies peat decomposition by microbial oxidation which lowers the peat surface and changes the peat swamp forest characteristics. Oxidation and burning before planting oil palm releases large amounts of CO_2 and other greenhouse gasses, which is counterproductive to REDD+ objectives. Logging on peatlands changes the forest structure and composition. Canals need to be dug in order to float logs out which is damaging for peat swamp forests because it reduces the water table making the forest vulnerable to fire. Logging in peatswamp forests has been reported to directly impact orangutan populations (Morrogh-Bernard et al. 2003) and anthropogenic forest disturbance has increased terrestriality in orangutans (Ancrenaz *et al.*, 2014). Many have argued that oil palm development should be banned on peatlands especially in light of the findings of Carlson et al. (2012) showing that peatland protection from REDD+ benefits can exceed export tax revenues from oil palm in Kalimantan (assuming burning is practiced and carbon price is USD 10 per ton CO_2). To maximize the conservation value of peatland forest protection, as large areas as possible should be included under REDD+.

The recent ministerial decree which puts a limit to the size of a ERC to 50,000 ha (MoF, 2014b) will have direct negative impacts on biodiversity and can views as an impediment to Indonesia's ability to implement REDD+ effectively on peatlands, and disadvantages peat domes larger than 50,000 ha because it requires multiple licenses, which are likely to drive up transactions costs for conservation and rehabilitation initiatives (Indriatmoko *et al.*, 2014). Large peatlands store more carbon and may need to be prioritized for protection and rehabilitation; the fulfilment of the purpose of an ERC can be undermined by issuing a concession area that is too small for ecological reasons, which has economic implications. Partial protection of a peat dome could have negative impacts on the area inside the REDD+ boundary.

5.5.4 Tenure arrangements and the potential for biodiversity conservation

We intentionally choose two of our REDD+ case studies to reflect choice of location and biodiversity goals. The Ketapang project proponent had located the REDD+ initiative with explicit regards to biodiversity conservation. The Katingan proponent, actively sought locations with high carbon sequestration benefits and their key project goal was to reduce carbon emission in order to obtain tradable REDD+ credits. Even without deliberately locating REDD+ initiatives in an area important for orangutan conservation, we found that the Katingan project is favourably located in a very important OHU and in a forest with one of the highest threat to deforestation in the Ketapang and Kotawaringan Timur districts. As for the Ketapang project, its strategic location meant that the village forests were located within the orangutan range in the Ketapang district and protected one of the most threatened forest in the district. We also choose the two REDD+ projects in our study to be as different as possible in order to reflect a range of possible REDD+ set ups in Indonesia. Here, we found that these project level differences had, to some extent, an influence on the potential delivery of benefits for biodiversity which could put certain REDD+ projects in a better position to deliver additional gains for biodiversity. Features such as tenure type, length of license period and forest management options, are briefly discussed in the follow section.

Large, contiguous and good quality forests are quickly becoming a rarity in the tropics and the importance and advantage of scale in forest conservation for the delivery of ecosystem services has long been clear (Laurance, 2005). Larger forest blocks have fewer edge effects, more biological diversity and are thus more resilient to disturbance as well as threats from climate change (Zuidema *et al.*, 1996; Gibson *et al.*, 2013). Orangutan and many other large mammals depend on such forests and would benefit from the protection of large tracts of forest; for example, the minimum population threshold necessary for an orangutan population to be self-sustainable is estimated to be 250 individuals (Meijaard, 2014b) and the minimum reliable home range size of adult orangutan females are ca. 150 ha while sub-adults and adult males use ranges of at least ca. 850 ha (Singleton *et al.*, 2009). However, this study shows that the Indonesian government both at the national and subnational level are somewhat reluctant to issue licenses over large areas.

Ecosystem Restoration Concessions tend to be larger in size when compared to the village forest tenure arrangement. In spite of the area reduction, the Katingan ERC license is the largest of the 12 ERC licenses issued to date (MoF, 2014a) but possibly the last due to a recent ministerial decree issued by the MoF in 2014 which puts a limit on the size of an ERC to 50,000 ha (MoF, 2014b) thus limiting the opportunity for REDD+ under the ERC to maximize on the scale necessary for effective biodiversity conservation. Village forests tend to be small because their size is determined by area deemed manageable by households in a village for subsistence farming, this ignores the fact that the use of village forest tenure in REDD+ is often for forest conservation which requires minimal labour input. Therefore, other things being equal, the Katingan project is at a better position to effectively delivery biodiversity benefits as their overall size tend to be larger when compared to village forests tenure.

Tenure type also determines the project's ability to ensure permanence in carbon and biodiversity conservation (project duration). It also affects the kind of forest management allowed to be implemented to reduce carbon emissions. Ecosystem restoration concessions were introduced in 2004 by the MoF as a strategic and new approach to the management of logged-out production forests by supporting efforts to return deforested, degraded or damaged production forests to their biological equilibrium (Walsh *et al.*, 2012). Ecosystem Restoration Concessions are granted for 60 years (extendable for 35 years), upon approval, property rights are guaranteed similar to that of a commercial forest concession license. The village forest tenure system was introduced in 2008 to reconcile forest management targets and livelihood interests of forest-edge villages within the framework of a permanent forest estate (Akiefnawati *et al.*, 2010). Approved villages are granted management rights for 35 years (extendable for 35 years). REDD+ forests protected via the ERC tenure option have longer (and stronger) tenure security as well as a better guarantee for permanence in carbon sequestration and biodiversity protection. The village forest tenure is not only shorter, it has also been linked to a weaker form of security (i.e. it does not have a land ownership status but rather a management right to the land) (Akiefnawati *et al.*, 2010).

With regards to forest management options, the ERC is centred around active forest restoration, rehabilitation and reforestation, while village forest management rights centre on the use of environmental services (such as water and non-timber forest products). It has been suggested that plant biodiversity takes twice the time to recover from forest disturbance when compared to carbon which has been reported to recover after about 50 years under passive, secondary succession (Martin *et al.*, 2013), though of course this will be highly variable from place to place. The ERC via its management activities has the ability to restore approximately 80 million ha of the 133 million ha of the Indonesia's forest estate that have been logged more than once (Walsh & Hidayanto, 2010), while the village forest tenure offers little opportunity to actively manage forests (not even to increase forest carbon stocks).

To some extent, tenure also influences the location of REDD+ projects. The area that can become a village forest has to be administratively part of the village and there cannot be existing concession rights overlapping with the proposed area. We found that the verified Ketapang project area is mostly located on forest land classified as 'limited production forest' and 'protection forest', which tend to be on steep terrain - thus making it protected by default and less desirable for timber or agriculture production. These are also forest land classes which are protected for water and soil conservation. Village forest land management rights have been viewed as a mere transfer of responsibility for the protection forests to local communities with a net benefit for local forest authorities (Akiefnawati *et al.*, 2010). The ERCs instead are intentionally targeted at degraded forests which are highly threatened to conversion to non-forest land-use. The Katingan project is largely located on forest land classified as 'production forest' and it is also on highly threatened lowland peatswamp forests. A large majority of its forest area has been logged with areas highly degraded, our deforestation results show that the project is located in a high predicted deforestation threat area; according to the Katingan Project Design Document (Rimba Makmur Utama, 2012), without REDD+ the area would most likely be converted for oil palm production under the without-project-scenario.

5.6 Recommendations for orangutan conservation in REDD+

1. **REDD+ project size:** As a low-fecundity, long-lived, forest-dependent species, the orangutan is particularly susceptible to the negative effects of habitat fragmentation (Gregory et al., 2012); it is therefore important that REDD+ projects in Indonesia and especially those in key orangutan areas remain large enough to sustain viable populations of orangutan. As for REDD+ initiatives located on peatlands, it is vital that entire peat domes are allocated for REDD+ protection if REDD+ is to effectively protect orangutan habitats as well as mitigate climate change. Our case study shows that regardless of whether the project is preferably located in key orangutan habitats, these two projects may not be able to realise the most effective orangutan conservation measures because the REDD+ initiatives had failed to protect the entire habitat units /

entire peat dome. We recognise that this factor is outside of the project proponent's own planning horizon. Therefore, to effectively protect peatswamp forests and its biodiversity, the Indonesian government will need to ensure that better national and subnational planning at the landscape level is carried out.

2. **The location of REDD+ initiatives**: For REDD+ to directly contribute to orangutan conservation in Indonesia, REDD+ initiatives will have to spatially target areas which are the most important to protect viable orangutan populations (Wilson *et al.*, 2014). However, orangutan distribution and abundance is poorly known where many areas have not been extensively surveyed in Kalimantan (Indonesia) and areas surveyed then to be more intensively surveyed, and surveys in Indonesian Borneo concentrated around research sites (Struebig *et al.*, 2015a). The first step will be to identify viable orangutan populations that make substantial contributions to orangutan survival, a priority action identified in the conservation strategy for orangutan (Singleton *et al.*, 2004). There are attempts underway to develop new orangutan population estimates for Borneo (personal communication Erik Meijaard) and this should be better supported by the Indonesian government and non-governmental organizations. With such information, spatial planning or priority setting assessments at the district, province or national-level could be carried out - example for Borneo have been carried out by Abram *et al.*, (2014) and Struebig *et al.*, (2015a). Finding from such assessment could than be fed back to district, province or national-level spatial planning, including, when deciding on the location and size of REDD+ projects.
3. **Pro-biodiversity REDD+ action** – Studies have shown that REDD+ projects which protect existing forest carbon stocks will not automatically deliver additional benefits for biodiversity(Martin *et al.*, 2013; Imai *et al.*, 2014). Similarly, REDD+ initiatives will not automatically deliver additional gains for the orangutan unless REDD+ planning, design and implementation is with explicit regard to orangutan conservation because there are forest management and monitoring activities that are more compatible with orangutan conservation then others (Marchant *et al.*, 2014). Especially in Kalimantan where hunting is a major threat to orangutan survival (i.e. the rate of loss due to hunting is of a similar order of magnitude to forest destruction) (Meijaard *et al.*, 2011) and orangutan populations are currently predicted to be below their carrying capacity due to past hunting (Meijaard *et al.*, 2010), habitat protection alone will not ensure the survival of orangutans in Kalimantan unless effective reduction of orangutan killings are carried out (Davis *et al.*, 2013). Wilson et al. (2014) suggests other 'extra protection'

measures which include prevention of illegal logging, fires, and agricultural encroachment, as well as implementing anti-poaching patrols, and human-orangutan conflict management which will benefit orangutans in REDD+ forests.

4. **Zero deforestation in all viable OHU**: Our results show that all OHUs, especially those with high orangutan densities are threatened by future deforestation. Remaining orangutan habitats are small, highly fragmented and over populated (Wich *et al.*, 2012; Morrogh-Bernard *et al.*, 2014) therefore all remaining viable orangutan populations must be maintained (Meijaard, 2014b). The National Orangutan Action Plan which was developed and endorsed by the Indonesian Government states that (p. 15) "Orangutan conservation requires existing forests to remain as forests and not be converted to another use…."(MoF, 2009). However, according to Meijaard(2014a), orangutan habitats continue to be lost at alarming rates. Not a single orangutan population has experienced a positive land use change nor has any new protected area been set up for orangutan conservation (Meijaard, 2014a). The REDD+ mechanism has the potential to provide financial incentives to keep such forest standing (avoided deforestation) and to rehabilitate, restore and connect degraded orangutan habitats and should be used to the advantage of orangutan conservation.

5.7 Caveats

In this chapter, our intention was not to make a direct comparisons between the two case studies. We intended for this to be more of an exploratory case study where we evaluate some of the possible outcomes associated with a slow REDD+ approval process and a subsequent reduction in project size on forest and orangutan. We decided to do this firstly because REDD+ implementation is new and our two case studies represents one of the first few REDD+ projects to be approved in Indonesia and secondly, it is still unclear how the two challenges faced by the REDD+ proponents would actually impact biodiversity on the ground. We also acknowledge that our case studies do not allow for a comparison between sites, however, with a more rigorous case study selection method (e.g. based on some sort of matching technique, or based on assessments using a before-after-control-intervention method) comparisons between sites may have been possible. We also acknowledge that there are limitations in our land cover change assessment which do not control for factors outside the boundaries of the REDD+ projects such as climatic events, national policy environment, and commodity market. We also do not assess this as a wider landscape i.e. sub-national or national scale to properly assess drives of biodiversity loss. Therefore much of what we see for both our project sites may only express how much general pressure or opportunity there was for land conversion in a particular period, rather than the imminent project-specific causes of deforestation. Lastly, we assumed that legal classification of land is a strong predictor of future land use land use in Indonesia, while we acknowledge that in practice this may not always happen as planned, such an assumption has been used to predict future land cover change (Margono *et al.*, 2012) as well as used to proximate drivers of land use change in order to determine fate of future forest land (Romijn *et al.*, 2013).

5.8 Conclusion

At both project sites, we found that the slow REDD+ progress had little direct impact on forest loss; there were other factors which better supported patterns of deforestation we found in our REDD+ project sites such as climatic events, stricter enforcement and newly introduced policies. However, at both project sites, the reduction on the approved project area has more direct implications for forest and orangutan conservation. Overall, we found that whether or not REDD+ proponents had high biodiversity intentions at the onset of their REDD+ implementation was less important in determining the extent to which these projects were able to deliver 'high' orangutan conservation benefits. Instead, indirect factors had a stronger role to play in determining how projects were able to deliver effective orangutan conservation. While the approval of the two REDD+ projects in our study is a step in the right direction with anticipation for more of such approvals to follow; if REDD+ intends to maximize its ability to protect as much remaining natural forest and biodiversity as possible, the Indonesian government will need to change the way in which projects are currently approved. The REDD+ application process will need to be fast tracked and the process of obtaining a REDD+ permit need to be streamlined and less bureaucratic. Nationwide spatial planning will be important to clearly identify and categorize land important for carbon, biodiversity and those that are most threatened to deforestation and priorities those for REDD+ protection. This study shows the extent to which the political economy influences natural resource management in Indonesia; therefore, for REDD+ to effectively contribute to climate mitigation and biodiversity conservation and orangutan conservation in particular, this strong political economy influences need to be factored into the design of REDD+ at the national level.

5.9 Acknowledgements

We are deeply indebted to the PT RMU and Starling Resources, and Flora and Fauna International (FFI), for allowing us to research on their projects, for their time and cooperation. We thank the FFI and Yayasan Puter field staff as well as villagers at both project sites for their hospitality and assistance in the field. We are grateful to CIFOR for permitting us to research at the GCS-REDD+ project sites and for sharing baseline data used in this analysis. We acknowledge the Ministry of Forestry Indonesia for making their Land cover maps available for our analysis. We acknowledge and are grateful to Dr. Erik Meijaard (People & Nature Consulting International), Dr. Gail Campbell-Smith (International Animal Rescue) and Dr. Mark Harrison (Orangutan Tropical Peatland Project - OUTrop) for making all the unpublished datasets available and for commenting on the orangutan analysis.

CHAPTER 6 DISCUSSION

> "The battle against climate change cannot be won without the world's forests - this is now clear" - UN Secretary-General Ban Ki-moon at the Copenhagen Climate Change Conference (COP15) in 2009.

Climate change is 'unequivocal' and scientists are confident that humans are the main cause of global warming (IPCC, 2013). The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) echoes findings from many climate studies which indicate that further warming will increase the likelihood of severe, pervasive and irreversible impacts for people and ecosystems, and to avoid this, global temperature must be kept at below 2 degrees to pre-industrial levels (IPCC, 2014). Given the significant contribution from tropical deforestation and degradation to greenhouse gas emissions, it is now widely accepted (see quote from the UN secretary general above) that any solution to tackle climate change must include tropical forests. Forests have also been proposed as a low cost method to achieve effective emission abatement. However, realizing this will incur opportunity cost (e.g. foregone profits from timber and agriculture commodities). The Eliasch review estimates that finance required to halve emissions from the forest sector by 2030 is approximately USD17-33 billion per year and abatement of up to 75 percent can be achieve if forests are included in the global cap and trade system (regulatory carbon market) (Eliasch, 2008).

Since its conception in 2007, the REDD+ mechanism has undergone radical changes in terms of how it is perceived and how it is applied in practice, and has become something very different from what it was originally intended (Angelsen *et al.*, 2012). In what was originally envisaged as a relatively simple and low cost way to mitigate climate change, REDD+ has now become very complex with high expectations to delivery multiple benefits besides carbon, such as poverty alleviation, improved forest governance, indigenous rights, and biodiversity conservation (Angelsen, 2013). REDD+ is a fast moving area. When I embarked on planning this research to assess the delivery of biodiversity benefits in REDD+, it was during the Copenhagen – Cancun period (2010 – 2011) when REDD+ pilot activities were peaking (Cerbu *et al.*, 2011), REDD+ credits were gaining strength in the voluntary carbon market (both in terms of volume and value) (Diaz *et al.*, 2011), and biodiversity issues in REDD+ took centre stage (see time line in Chapter 2). There was therefore an air of confidence about the potential for REDD+ to be included as part of the global climate mechanism and at least the REDD+

initiatives my study (the 22 initiatives in six countries discussed in Chapter 3 and the two Indonesian initiatives in Chapter 5) were fairly confident that they would be selling their carbon credits within a couple of years (Sunderlin *et al.*, 2014a). While there has been progress at the international negotiations it has been slower than anticipated and this has affected progress at the national and sub-national levels. In this discussion I start with a brief update on the global progress of REDD+, focusing on implications for biodiversity, and then discuss political changes in Indonesia and how these will likely impact national REDD+ implementation. I then discus the contributions of this thesis , limitations of the study and what further research is needed to ensure REDD+ delivers on its potential to contribute to biodiversity conservation.

6.1 Progress of REDD+ globally

REDD+ became an integral part of the UNFCCC negotiations at the 2007 COP13 in Bali. Since then, there has been incremental progress at the international negotiations to facilitate its future implementation. This includes systems to safeguard biodiversity benefits, a climate fund to finance mitigation and adaptation activities (the Green Climate Fund) and systems to monitor, report and verify national emission reduction. A disappointing aspect of REDD+ is perhaps that after seven years, it is still not part of the global regulatory carbon market; REDD+ credits are currently only available in small quantities in the voluntary carbon market. However, many voluntary market participants as well as pilot initiatives are hopeful for the emergence of regulatory markets to form a potentially stable and significant source of REDD+ financing (Peters-Stanley *et al.*, 2014; Sills *et al.*, 2014). This is largely due to the emergence of new jurisdiction mandatory emission trading programs such as the US State of California's mandatory cap-and trade program which came into force in January 2013. This initially shows showing strong interest in REDD+ credits, and other emerging regulatory carbon markets, such as those in China, South Korea, South Africa, Kazakhstan, Mexico and New Zealand which could potentially create a demand for REDD+ credits (Peters-Stanley et al., 2014). However, the development of the carbon markets for REDD+, both voluntary and regulatory, is highly influenced by progress made at the UNFCCC negotiations, and this includes whether or not REDD+ will be part of the new climate regime after the Kyoto protocol expires (Angelsen 2014).

6.1.1 Outcomes from the UNFCCC COP20 in Lima

The two main objectives of COP 20 in Lima which met in late 2014 were to, i) define a framework for 'intended nationally determined contributions' (INDCs) to climate change mitigation and ii) create a draft text for the post-Kyoto global climate agreement which will be decided at the 2015 COP 21 in Paris (Morel *et al.*, 2014). Although REDD+ attracted a number of high profile side-events, it was not formally discussed at the negotiations in Lima.

The INDCs aim to give parties a large flexibility to customize their own contributions towards climate change mitigation. The negotiation text specifies that INDCs "will represent a progression beyond the current undertaking" of every country; 'current undertakings' here refers to the Kyoto Protocol commitments, which are voluntary. Therefore INDCs take a bottom up approach to setting global emission reduction targets while at the same time adding an element of commitment to emission reduction. Parties are expected to submit their INDCs to the UNFCCC by March 2015 and it is unknown if countries will or will not include REDD+ as a mitigation option in their INDCs. However commenters are confident that many developing countries will rely on REDD+ as part of their INDC (REDD+SWG, 2014).

With regards to the text for the new climate agreement to be agreed in Paris at the end of 2015; the draft text presented in Lima was generally considered weak and many have expressed scepticism for REDD+ to be included as part of the new climate agreement (Morel *et al.*, 2014; REDD+SWG, 2014). In spite of the widespread criticism the Copenhagen Accord received in 2009 for not setting legally binding emission reduction targets for parties (Anderson & Bows, 2011); the draft climate agreement did not indicate if the future climate agreement will be legally binding or not. At Lima, there were advocates for both legally binding (e.g. the European Union) and non-legally binding (e.g. USA) limits on emissions (Morel *et al.*, 2014); outcomes indicated that there will likely be a mix of binding provisions (e.g. with regards to transparency in emission reduction) and non-binding provisions (e.g. targets in national contributions). The role of markets was also not clarified in the draft text.

However, significant progress was made at Lima with regards to climate financing with the Green Climate Fund taking shape as a mechanism for channelling mitigation and adaptation funds to countries. The Green Climate Fund was created in 2010 is now capitalized at the level of USD10.2 billion for the period of 2015-2018 (Decision 7/CP.20) (UNFCCC, 2015). The main contributions come from developed countries such as the United States of America (USD3 billion), the United Kingdom (USD 1.1 billion), Germany and France (USD 1 billion each). More unexpectedly perhaps, some non-Annex I countries (countries with no obligated greenhouse gas emission caps), such as Mexico, South Korea, and Indonesia also contributed (Morel *et al.*, 2014). Investment guidelines have also been created and there has been progress in accreditation policies for agencies that will channel funds (Decision 7/CP.20) (UNFCCC, 2015). All these has increased the confidence of developing countries that predictable and sustainable funding is likely, which can support REDD+, however long term funding beyond 2020 has not been resolved. Another positive outcome of the COP20 in Lima was the lack of differentiation between Annex-1 and non-Annex-1 countries in terms of commitment towards emission reduction; there is an emerging sense that all countries need to contribute and all countries will need to develop INDCs. This is a big step forward in meeting global climate mitigation goals (Morel *et al.*, 2014).

6.1.2 What progress has there been for biodiversity in REDD+ negotiations?

As discussed in Chapter 2, the potential biodiversity impacts of REDD+ first gained significant attention in 2010 at the COP16 in Cancun where concerns about the potential biodiversity and social impacts of REDD+ led to the development of the Cancun Safeguards. Countries which want to access the Green Climate Fund or any other potential source of climate funds at the UNFCCC level will need to demonstrate that they have set up national Safeguard Information Systems (SIS) and they must submit information on how the Cancun safeguards are being addressed and respected. Parties began submitting their SIS to the UNFCCC late 2014 which was assessed by the REDD+ Safeguards Working Group. Based on these assessment, the REDD+ safeguard working group submitted their recommendation to the UNFCCC at the COP20 in Lima which indicated that more guidance is should be given to countries for reporting about their safeguard information system (REDD+SWG, 2014). The gaps identified by the REDD+SWG were i) there should be a common framework for summary reports, ii) SISs should be more similar to systems for reporting to other international processes and based on multi-stakeholder participation and revision, and iii) there should be a mechanism to verify that safeguards have been addressed and respected in order to access results based finance. Besides the Cancun safeguards, the Green Climate Fund has also indicated that it will develop its own environment and social safeguards. This is to not only ensure that the Green Climate Fund’s landings are in line with environment and social principles, it also acts as an oversight mechanism to ensure that financial intermediaries such as commercial banks associated with the Fund also comply with the environmental policies and social safeguards of the Green Climate Fund (UNFCCC, 2015).

6.2 The progress with REDD+ in Indonesia

> "With international support, we are confident that we can reduce emissions by as much as 41%. This target is entirely achievable because most of our emissions come from forest related issues, such as forest fires and deforestation."
> - President Susilo Bambang Yudhoyono - Pittsburgh G20, 2009

Indonesia has made strong commitments to implement REDD+ (see quote from the former President above). It has been an enthusiastic participant since the conception of REDD+ and created over two dozen REDD+ specific agencies and policies, more than any other REDD+ country in the tropics (Brockhaus *et al.*, 2014). For example, in 2013 Indonesia established a REDD+ agency as a cabinet level ministry reporting directly to the president, the first such agency operating at such a high level in the world. However despite the political will expressed by the Government of Indonesia, and the strong financial backing from big donors such as the Norway government, progress with REDD+ in Indonesia has been slow (see Chapter 5). Since the issuance of the Ministry of Forestry Regulation (No.P.30/Menhut-II/2009) on the procedures to establish REDD+ projects on the ground in 2009, the Indonesian government has only officially approved two REDD+ initiatives both in 2013 and both having gone through a tedious and highly bureaucratic process to obtain their REDD+ permit (see Chapters 3 and 4). Discussions on deforestation and forest degradation in Indonesia are inseparable from Indonesia's political economic context and this is an important reason why REDD+ has progressed so slowly in Indonesia (Brockhaus *et al.*, 2012; Luttrell *et al.*, 2014). Implementation of REDD+ policies and the allocation of land for REDD+ in Indonesia involves coordination between the various layers of governance (national, province, and district) as well as between the various ministries. Policies for forest land allocation and forest governance in Indonesia are also heavily influenced by vested interests predominantly related to oil palm and to industrial plantations for pulp and paper (Irawan *et al.*, 2013) which offer fast and more lucrative (although short term) gains when compared to REDD+.

6.2.1 Recent political changes in Indonesia and implications for REDD+

In October 2014 Indonesia elected a new President Joko 'Jokowi' Widodo. In the few months since he took office, massive government restructuring has taken place in the interest of streamlining the government and to reduce overlap between government agencies. In January 2015, the new President issued a Presidential Regulation to merge the Ministry of

Forestry and the Ministry of Environment, and revoke previous presidential decrees on the REDD+ agency and the National Council on Climate Change (Presidential Decree No. 16/2015). The new decree also mandates a new division under the Minister of Environment and Forest called the Directorate General of Climate Change Oversight, replacing the function of the REDD+ agency and the National Council on Climate Change with the intention to improve coordination in climate change issues.

Despite the disruption, there are potential benefits to progress with REDD+ in Indonesia with this decree. Firstly, the REDD+ agency had not been particularly effective. The USD1 billion agreement with Norway required the establishment of this high level agency reporting directly to the president (Government of Indonesia & Government of Norway, 2010). However the process of establishing this REDD+ agency was long (3 years) and difficult as the agency was seen as lacking the legitimacy needed to coordinate various ministries in order to progress with REDD+ and was resented by several ministries because reported directly to the President and therefore it overlooked the existing ministries' authority (Wibowo & Giessen, 2014). Under the new decree, both the REDD+ agency and the National Council on Climate Change will be 'integrated' into the Directorate General of Climate Change Control under the authority of the minister of environment and forest. This bold move by the new President has been somewhat positively received my many hoping for more progress with REDD+(Gokkon & Putri, 2015). The decision to integrate the REDD+ agency and the National Council on Climate Change into a larger and more powerful ministry may be the most effective way to deal with the lack of legitimacy and authority the REDD+ agency had and to gain cooperation from other ministries. This integration also has the potential to make REDD+ more efficient as the slow progress of REDD+ in Indonesia is often linked to bureaucracy, a lack of coordination, weak law enforcement, unclear spatial planning and bad forest governance(Widiaryanto, 2015). Synergies and coherence between other international process have been promoted by the UNFCCC; with regards to the delivery of biodiversity benefits, synergies between the Convention on Biological Diversity's Aichi Targets and REDD+ have been explored and promoted (Miles *et al.*, 2013; Latham *et al.*, 2014). At least for Indonesia, under the new MoEF, these synergies can be easily enhanced with minimal conflict as compared to when these were under separate ministries. For example, elements reporting to the Convention of Biological Diversity can be submitted as part of its REDD+ SIS reporting requirements where the new MoEF will have more capacity to report on the biodiversity of biodiversity safeguards and co-benefits.

However, there are also disadvantages associated with this new decree. In order to effectively reduce emissions from deforestation and forest degradation, REDD+ policies will need to be implemented in areas outside the jurisdiction of the Ministry of Environment and Forest (MoEF). Integrating the REDD+ agency into the MoEF confines it’s authority to the 40% of forest which is under the MoEF’s jurisdiction. The vast majority of land designated for conversion to oil palm plantations for example are not located within the production forest estate under the authority of the MoEF. Another potential effect of this new decree is directly on REDD+ implementation on the ground. In the one year of existence, the REDD+ agency signed Memorandum of Understandings with at least eight local governments. There are concerns that these will become invalid with the new move. This new decree may seem to side-line the urgency of climate change and Indonesia’s emission reduction commitments because what was previously a key political agenda of under the direct authority of the President is now integrated as part of a minister’s portfolio.

There are also potential negative implications for biodiversity arising from the newly merged MoEF. There is a risk that environmental objectives or forest conservation will be diluted by forest production objectives considering that the Ministry of Environment is cost generating and the MoF generates income for the economy. There are also concerns that the Ministry of Environment will have a smaller or limited authority under the portfolio of the Ministry of Forestry and environmental issues will be marginalized. Also, as separate ministries, a system of ‘check and balance’ was in place, especially since the MoF main business is forest exploitation while the Ministry of Environment’s is to protect the environment. With regards to implication for biodiversity concerns in REDD+, there is a chance that the role of biodiversity and other forest ecosystem services could be overlooked in the attempt to deliver highest carbon sequestration potential.

6.3 Contributions of this thesis

In this thesis, I aimed to assess the potential for the REDD+ climate mechanism to deliver biodiversity benefits, as well as maximize the potential positive impacts on biodiversity while reducing the potential for harm. Below, I discuss the findings from each chapter and how these could be used to inform the design and implementation of future REDD+ initiatives as well as advice future policy development on biodiversity benefits in REDD+.

6.3.1 Moving beyond safeguards to deliver additional benefits

There has been much discussion in the literature about the potential of REDD+ to contribute to biodiversity conservation and a sometimes parallel discussion about the potential for harm to biodiversity from the mechanism. In chapter 2 of this thesis I developed a conceptual framework laying out the features of REDD+ at the national level most likely to influence the delivery of benefits for biodiversity (both opportunities and risks). These key features are: the location of intervention, financing, the scope of REDD+, the actors and their interests and the design of REDD+ initiatives. ‘Safeguards’ and ‘co-benefits’ have become important buzz words at the UNFCCC negotiations (Arhin, 2014); I bring together the disparate literature on biodiversity safeguards and co-benefits in REDD+ to show that the Cancun Safeguards in its current form is inadequate to deal with many of the risks posed by REDD+ for biodiversity and for REDD+ to provide deliver biodiversity co-benefits, additional investment will be needed. These findings are important because they effect the overall implementation of REDD+ from where projects should be located, to how they are funded, and the choice of forest management options on the ground.

Findings from this chapter were synthesized into a briefing paper which was widely circulated (in English, and Spanish) among participants at the UNFCCC’s COP20 in Lima in December 2014 (Murray & Jones, 2014)(See Appendix 6). This was one of six briefs covering various aspects of REDD+ safeguards targeted at governments, policy makers, practitioners, and other key stakeholders interested in operationalizing safeguards. My briefing paper focused on biodiversity safeguards emphasizing that REDD+ actors will need to do more than the safeguarded minimum if REDD+ is to realize opportunities for biodiversity conservation.

6.3.2 The incorporation of biodiversity consideration in early REDD+ initiatives

Many countries are coming to the end of the early implementation phase of REDD+ (phase 2), which includes piloting REDD+ on the ground and the implementation of REDD+ policies and strategies developed in phase 1. Over 300 REDD+ pilot projects in 47 countries are being implemented globally (Simonet *et al.*, 2014). These early initiatives are important testing grounds for REDD+ (Arhin, 2014) and the long term success of REDD+ will require that lessons learned from these activities to be integrated systematically into national and global architecture for REDD+ (Bernard *et al.*, 2014). Reviews looking at livelihood impacts (Caplow *et al.*, 2011; Marion Suiseeya & Caplow, 2013), challenges in securing tenure (Awono *et al.*, 2014; Resosudarmo *et al.*, 2014; Sunderlin *et al.*, 2014b), and monitoring, reporting and verification capacities (Romijn *et al.*, 2012; Joseph *et al.*, 2013) have been considered in early REDD+ initiatives, but I found no evidence of published information about how biodiversity concerns have been considered in these initiatives.

In Chapter 3, I use the conceptual framework developed previously to investigate how biodiversity is considered in a range of sub-national REDD+ pilot projects and likely impacts on biodiversity. I found that many of the REDD+ initiatives were extensions of a past conservation initiative and/or were led by conservation NGO; therefore their high consideration for biodiversity is not surprising, but this also meant that projects were not necessarily located in forests most threatened with deforestation. In spite of concerns in the literature about the potential negative impacts of carbon markets on biodiversity, Chapter 3 highlights the role of external pressures such as, market pressure in creating a demand for the delivery of biodiversity benefits thus forcing projects to design their projects in accordance to non-carbon certification standards such as the CCBA. This chapter also provides valuable insights on the challenges faced by REDD+ project developers in delivery of biodiversity benefits-highlighting a general lack of capacity to design and implement robust biodiversity programs.

6.3.3 Patterns of carbon, biodiversity and deforestation threat in Indonesia

As a climate mechanism, REDD+ proposes to incentivize the reduction in emissions from deforestation and forest degradation (compared with a reference level). While REDD+ has the opportunity to simultaneously deliver biodiversity benefits, it is unlikely that this will be formally incentivised via REDD+ (UNFCCC, 2013). Therefore understanding the spatial congruence between carbon and biodiversity is important to determine where there are synergies and where trade-offs need to be made. While it has been reported that there is a strong congruence between carbon and biodiversity at the global scale (Strassburg *et al.*, 2010), this may not hold true at the national scale, and this was reflected on our findings. Chapter 4 of this thesis demonstrates how robust national scale carbon-biodiversity analysis can be carried out using readily available datasets. The study stresses on the importance of scale when carrying out such analyses based on the variability we observed at the national and sub national scale. We found that patterns of biodiversity distribution is highly variable depending on taxa and measure used (total species, threatened species or restricted range species), which also effected congruence patterns with carbon. These findings therefore suggests that it is not possible to locate REDD+ projects in a way that is good for all measures of biodiversity; in order to maximise conservation outcomes from REDD+, pro-biodiversity

REDD+ initiatives will need to strategically locate their REDD+ initiatives in order to meet their conservation goals. These may include seeking out forests most important for species specific conservation or forests with the highest potential to protect the highest number of threatened species or threatened habitat type.

6.3.4 The location of REDD+ initiatives relative to deforestation threat

Benefits for biodiversity from REDD+ will depend on whether or not projects are located in areas important for biodiversity but additional gains for biodiversity (and carbon) are only possibly achieved if these forests are threatened by deforestation. Our study found that REDD+ initiatives in Indonesia are not located in forests most threatened to future deforestation which is somewhat disappointing. This rings an important alarm bell for future REDD+ initiatives in Indonesia and globally because if REDD+ projects continue to be located in forests with the lowest threat to deforestation (which is likely to be the case such forests will tend to be lower cost per unit of carbon due to the lower opportunity cost of conserving them) then the benefits for both biodiversity and climate will be low. Findings from Chapter 4 also show that in Indonesia, there is a lot of opportunity for REDD+ expansion in forest at very high risk to future deforestation which are not protected by PAs or existing REDD+ initiatives. Therefore, strategically locating future REDD+ initiatives in forests with high deforestation threat via a robust nationwide spatial planning process will have high benefits climate and biodiversity.

Chapter 4 (Part 1 and 2) was initially planned as two separate chapters; one to explore the congruence pattern between carbon and biodiversity in Indonesia and the other to assess the location of REDD+ projects in Indonesia relative to the distribution of carbon, biodiversity and deforestation threat. However, these chapters were merged in order to produce one high impact paper which has been accepted for publication in Conservation Biology (Murray *et al.*, 2015). A large majority of the underlying data I used and analysis I carried out was not included in the manuscript which I have captured in the thesis as Chapter 4 (Part 2). A summary of the findings from this chapter was also developed into a box (Appendix 7 - Box L: Can REDD+ deliver biodiversity co-benefits in Indonesia?) which contributed to the book chapter (Sassi *et al.*, 2014) in an important book about REDD+ implementation on the ground developed by CIFOR which was launched at the UNFCCC COP20 in Lima (Sills *et al.*, 2014).

6.3.5 The challenges of implementing pro-biodiversity REDD+ in Indonesia

The Indonesian government has made ambitious voluntary emission reduction targets and REDD+ has always been a key mechanism in realizing these targets. Indonesia has also received strong donor support to meet their emission reduction targets via REDD+, including support from the Norwegian government which pledged USD1 billion towards performance based emission reductions (Angelsen, 2013). However, there has been scepticism over Indonesia's ability to meet its commitments largely based on poor track records in meeting its conservation commitments (Clements *et al.*, 2010a). The concern is that corruption in the natural resources sectors and other political-economy related bureaucracies could undermine efforts to reduce carbon emissions (Luttrell *et al.*, 2014). Chapter 5, provides insights into two of the challenges faced by REDD+ proponents when implementing REDD+ in Indonesia and its implications forest and species conservation. There was hope that REDD+ would incentivise land allocation policies in Indonesia away from economic activities that promote the exploitation of forest assets (Brockhaus *et al.*, 2012). However, the results from chapter 5 show that at least at the two REDD+ initiatives in my study, this has not happen in favour of REDD+ but instead there is a general lack of political will to approve REDD+ permits and REDD+ application seems to fight a losing battle with other more lucrative land uses. Chapter 5 provides valuable lessons about REDD+ implementation in Indonesia and clearly demonstrates that protecting forests via REDD+ alone will not be enough to safe the imperilled orangutan. I provide species specific recommendations for a pro-orangutan REDD+ implementation in Indonesia these include; optimizing project size and location, pro-orangutan forest management practices and policy interventions.

Another contribution of this thesis is on the development of a spatially explicit orangutan density map which was welcomed by leading orangutan conservation experts in Borneo because to date, fine scale orangutan density maps are not available in spite of its importance in orangutan conservation planning. In my communication with orangutan experts when acquiring data needed to build the density database, I was informed that experts in Borneo such as Serge Wich and Erik Meijaard are currently pulling together a Borneo-wide orangutan density dataset in order to develop a consolidated orangutan density distribution map for the whole Borneo. The orangutan density map I developed for Katingan, Kotawaringan Timur and Ketapang districts will be an important contribution towards this effort.

6.4 Limitations and areas for further research

The disappointing progress of REDD+ policy globally, and the impacts of this on national and sub-national initiatives, has affected progress for REDD+ on the ground and therefore what was possible in this study. Here, I express some of the limitations in my study and my recommendations for further research.

6.4.1 Assessing true biodiversity impacts of REDD+

Insights from REDD+ proponents informs us about the extent to which biodiversity considerations are being incorporated into the design of early REDD+ initiatives and the challenges proponents face in doing so (Chapter 3). Such information provides an overview about the potential outcomes for biodiversity conservation, especially useful at this early stage of REDD+ implementation. My study shows that many REDD+ initiatives have good intentions for biodiversity conservation; however, little is known about how these good intentions are being realized on the ground and what the true impacts on biodiversity are. For impacts to be measurable and used for adaptive management purposes, biodiversity monitoring programs are needed to accompany REDD+ (Harrison *et al.*, 2012; Latham *et al.*, 2014). There is also no information about the robustness of biodiversity monitoring programs being implemented as part of the requirements of third party certification standards and how the results are able to detect change in the state of biodiversity. Instead, project developers have expressed difficulty in designing such robust monitoring programs (Chapter 3). I did not explore this in my thesis partly because such information coming from pilot REDD+ projects have only recently been available. Assessments of biodiversity monitoring programs at existing REDD+ initiatives will be important to understand their robustness and ability to deliver additional benefits for biodiversity. Future assessments could include assessing biodiversity monitoring programmes on their ability to deliver biodiversity conservation goals at the project level as well as on its robustness and scientific integrity.

6.4.2 Cost implications associated with low carbon-biodiversity co-location

One of the options to deliver additional biodiversity benefits is for REDD+ initiatives to be explicitly located in forests important for biodiversity (Chapter 2). This is especially important when there is a lack of congruence between carbon and biodiversity in the landscape such as demonstrated in Indonesia (in Chapter 4) and in other countries (Wendland *et al.*, 2010; Sangermano *et al.*, 2012) Ultimately, the highest benefits for climate or conservation will be when REDD+ is targeted at forests most threatened to deforestation. However, such forests tend to be on land with higher opportunity cost for conservation. I found that in Indonesia, forests with the highest species richness have on average lower carbon densities and have high threat for conversion to agriculture (i.e. high agriculture) rent (Chapter 4). This would make REDD+ in such areas more costly (though not necessarily per unit of truly additional carbon emissions avoided). Therefore, there are likely to be costs associated with locating REDD+ projects in forests most important for biodiversity and this would need to be funded through some sort of additional funding not directly from climate change mitigation funds (see Chapter 2). The cost of targeting REDD+ at high biodiversity forests in Indonesia was not assessed in my thesis but further research in this area is needed and it would be valuable in informing future REDD+ implementation especially since future implementation is likely to focus on cost-effective delivery of carbon (Busch, 2013).

6.4.3 Filling the knowledge gap on degraded land in Indonesia

> We've spent 50 years developing this economy, and if we simply stop producing palm oil, we will be taking a massive economic hit, and production will just go elsewhere. So we have to engineer a land-swap. This means identifying degraded land that could be used for palm oil and trying to see if there is a way to persuade the people who have palm-oil concessions to switch over. I see REDD+ as a tool for helping us execute this land swap, but it's not easy – Heru Prasetyo, Head of the former REDD+ Agency of Indonesia

National land use planning is a complex task and in Indonesia this is made more complex because it is influenced by political agendas, ruled by conflicting policies and carried out under weak governance (Brockhaus *et al.*, 2012; Luttrell *et al.*, 2014). In Chapter 5, I show how this weak land allocation process had effected my two case studies in Central and West Kalimantan. Within the scope of my study, I did not explore policy options to avoid or minimise impacts of poor land allocation on biodiversity in REDD+. Understanding such options will be important to advise land use planning in Indonesia and to ensure that trade-offs between REDD+ implementation and economic development do not happen at the expense of biodiversity. The land swap mechanisms (i.e. swapping land important for conservation with an equivalent area of degraded land) have been proposed as a legal and feasible option in Indonesia (Sahide & Giessen, 2015). An estimated 40 million hectares of Indonesia's forest estate consist of degraded land which the Indonesian government has acknowledged as having potential for such land swaps. Activities to enhance forest carbon stocks in the REDD+ mechanism have the potential to restore a lot of these degraded forests, thus creating carbon sinks and protecting biodiversity in these forests which would be reduced if they were logged again or cleared for oil palm or pulpwood plantations (Edwards *et al.*, 2012a). A large body of evidence shows that degraded forests, such as these in Indonesia especially lowland forests contain some of the most species rich and threatened wildlife (Sheil *et al.*, 2005; Meijaard & Sheil, 2007; Edwards *et al.*, 2010b; Budiharta *et al.*, 2014; Law *et al.*, 2014). While land swaps have the potential to retain some of the more critical forests for conservation while diverting development to highly degraded / non-forest areas, there is a risk that if not properly planned for this could have negative conservation impacts (Sasaki *et al.*, 2011). This is especially risky in Indonesia where the land agency, the Ministry of Forestry, and the Ministry of Agriculture all have different definitions for 'degraded land'. Further research is therefore needed to explore the potential for land swap mechanisms or similar mechanisms which would allow REDD+ project developers to contest high biodiversity forests excluded from their proposed area. The first step will require the classification of degraded land (i.e. based on the degree of degradation)(Sasaki *et al.*, 2011).

6.5 Conclusions

The idea of REDD+ was intended as a straightforward solution to climate change – paying landowners to keep the forest standing. However, in practice, REDD+ is much more complex because it deals with forests which have highly complex social, economic and biological realities. In spite of the slow progress of REDD+ at the international negotiations, forest remains a key sector contributing towards climate mitigation with REDD+ an important mechanism in which this will be achieved. REDD+ has the potential to deliver benefits for terrestrial biodiversity based on the fact that it reduces forest loss which is a leading cause of global biodiversity loss. But as a climate mechanism, REDD+ has huge benefits for biodiversity because of the amplified and irreversible negative impacts climate change is predicted to have on biodiversity.

There are concerns that REDD+ could negatively impact biodiversity, however if properly planned, these risks can be minimised. There are governance tools such as international safeguards, national biodiversity policies and third party certification standards which can be applied to ensure that harm to biodiversity is minimised. However, with additional effort, REDD+ has the potential to do more than simply avoid harm and contribute towards biodiversity conservation efforts in the tropics; given the limited funds of REDD+ this will require additional funding. Understanding how biodiversity is co-located in the landscape is an important first step in ensuring that national and sub-national REDD+ initiatives do not assume that REDD+ will automatically deliver opportunities for biodiversity. Understanding the spatial location of carbon and biodiversity at the landscape level also allow for more effective REDD+ planning. Ultimately, the highest gains for both climate and biodiversity will depend on how well REDD+ activities are able to target REDD+ implementation in forests most threatened to deforestation.

Pilot and demonstration projects have been important testing grounds in the readiness phase of REDD+, many of which have advanced ahead of their nations progress in REDD+. Biodiversity considerations have been a key feature of early REDD+ initiatives and many adoption of third party biodiversity certifications standards to demonstrate delivery of biodiversity benefits however, true impacts of REDD+ on biodiversity will require long term monitoring using robust methods which would allow for the detection of change. Outcomes at the international negotiations remain important and have a strong influence on how REDD+ plays out on the ground. Outcomes at the international negotiations have reported to effect the voluntary carbon market where REDD+ credit volume and prices fluctuate depending on key decisions made. While it is still uncertain if the REDD+ mechanism will be included as part of the global climate regime which will be decided in Paris at the end of 2015, however, its inclusion will definitely provide the much needed boost and financing needed to implement reduce emissions from deforestation and forest degradation in the tropics.

GLOSSARY

terms used in the text	definition
Aichi Targets	A set of 20, time-bound, measureable biodiversity targets agreed by the Parties to the Convention on Biological Diversity in Nagoya, Japan, in October 2010 to reducing, and eventually halting, the loss of biodiversity at a global level by the middle of the twenty-first century.
Annex-I countries	Include the industrialized countries that were members of the OECD (Organization for Economic Co-operation and Development) in 1992, plus countries with economies in transition (the Russian Federation, the Baltic States, and several Central and Eastern European States) with obligations to greenhouse gas emission caps. By default, the other countries are referred to as **Non-Annex I countries**.
Cap-and-trade	A market-based approach used to control greenhouse gas emission by providing economic incentives for achieving reductions in the emissions; a limit (or 'cap') is set on emissions, and the unused portion of the limits can be sold (or 'trade') the to buyers who are struggling to comply
Green Climate Fund	A fund within the framework of the UNFCCC founded as a mechanism to redistribute money from the developed to the developing world, in order to assist the developing countries in adaptation and mitigation practices to counter climate change.
High Conservation Value (HCV)	The HCV approach was developed in 1999 by the Forest Stewardship Council (FSC) for use in forest management certification. The 6 HCVs are biological, ecological, social or cultural values which are considered outstandingly significant or critically important, at the national, regional or global level.
Kyoto Protocol	An international treaty linked to the United Nations Framework Convention on Climate Change (UNFCCC), which commits its Parties to reduce greenhouse gas emissions by setting internationally binding emission reduction targets compared to the year 1990. The Kyoto Protocol was negotiated in December 1997 at the city of Kyoto, Japan and came into force February 16th, 2005.
Subsidiary Body for Scientific and Technological Advice (SBSTA)	The SBSTA is one of two permanent subsidiary bodies to the Convention established by the Conference of Parties (COP). It supports the work of the COP through the provision of timely information and advice on scientific and technological matters as they relate to the Convention or its Kyoto Protocol.

Sustainable Forest Management (SFM)	Management of forests according to the principles of sustainable development which uses social, economic and environmental goals (different from Sustainable Management of Forest)

Indonesian terms used in the text	Definitions
Areal penggunaan lain (APL)	Forest for other uses - Forest land outside State forestland which is designated for non-forestry purposes.
Hutan desa (HD)	Village Forest - state forest managed by a village institution and utilized for the welfare of that community which takes take place in either protected forest or production forest. Forest should that could be designated should not bear any license.
Hutan Konservasi (HK)	Conservation forest - Forestland designated for conservation purposes. In this class include national park, nature reserved, wildlife reserved, other protected areas
Hutan lindung(HL)	Protection forest - Forestland designated for protecting soil and hydrology
Hutan Produksi (HP)	Production forest - State Forestland designated for production purposes
Hutan Produksi Konversi (HPK)	Convertible production forest - Forestland designated for production purposes and reserved for non-forestry development
Hutan Produksi Terhad (HPT)	Limited production forest - State Forestland designated for limited production purposes due to the topographic and soil condition
Perubahan fungsi	Land swap - A provision under the Indonesian Minister of Forestry Decree number 34/2010 which allows land swaps within production forests group. Head of district governments (*Bupati*) can approved this without the needing to go through parliament.

ABBREVIATION

abbreviations used in the text	definition
AGB	Above Ground Biomass
AOO	Area of Occupancy
CCBA	Climate, Community and Biodiversity Alliance
CDF	Corrected Degrees of Freedom
CIFOR	Center for International Forestry Research
COP	Conference of Parties
EOO	Extent of Occurrence
ERC	Ecosystem Restoration Concession
FFI	Flora and Fauna International
FSC	Forest Stewardship Council
GCS-REDD+	Global Comparative Study on REDD+
GIS	Geographic Information System
HCVF	High Conservation Value Forest
INDC	Intended nationally determined contributions
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KFCP	Kalimantan Forest and Climate Partnership
MoEF	Ministry of Environment and Forest
MoF	Ministry of Forestry
MRV	Monitoring Reporting and Verification
NGO	Non-Governmental Organisation
OHU	Orangutan Habitat Units
OSIRIS	Open Source Impacts of REDD+ Incentives Spreadsheet
PA	Protected Areas
REDD+	Reduce Emissions from Deforestation and forest Degradation
RIL	Reduced Impact Logging
SDM	Species Distribution Models
SIS	Safeguard Information System
SOC	Soil Organic Carbon
TaTEDO	Tanzania Traditional Energy Development & Environment Organization
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standards

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APPENDICES

Appendix 1: The 22 REDD+ projects in this study

Table S1: Additional information about the projects and their current status

Country	Abbreviated name	Project name	Lead proponent	Deforestation rate (2000 – 2012)		Status (Dec 2014)
				%	Level	
Brazil	Acre	Acre State Program of Incentives for Environmental Services – Carbon	Acre State Secretariat for the Environment	4.7	Med	Ongoing REDD+ initiative
Brazil	Cotriguaçu	Northwest Mato Grosso REDD Pilot Project	Instituto Centro de Vida	15.4	High	Ongoing but not using REDD+ label
Brazil	Transmazonica	Sustainable Settlements in the Amazon: The challenge of family production in a low carbon economy	IPAM – Amazon Environmental Research Institute	19.2	High	Ongoing REDD+ initiative
Brazil	Sao Felix de Xingu	REDD+ Pilot Program in São Félix do Xingu	The Nature Conservancy	12.6	High	Ongoing but not using REDD+ label
Brazil	Jari / Amapa	The Jari/Amapá REDD+ project	Biofílica Environmental Investments	6.5	High	Ongoing REDD+ initiative
Peru	Madre de Dios	Brazil nut REDD concession	Bosques Amazonicos	0.3	low	Ongoing REDD+ initiative
Peru	Ucayali	REDD in three certified community forest in the Ucayali Region	Aider	0.7	low	Ongoing REDD+ initiative
Cameroon	SE Cameroon	PES project in Cameroon South and East Region	Centre pour l'Environement et le Development (CED)	1.0	low	Ongoing but not using REDD+ label
Cameroon	Mt. Cameroon	Mt. Cameroon REDD Project	GFA-Envest	0.6	low	Ongoing REDD+ initiative

Cameroon	Shinyanga	Community Based REDD Mechanisms for Sustainable Forest Management in Semi-Arid Areas	Tanzania Traditional Energy Development and Environment Organization (TaTEDO)	1.0	low	Ceased operation as a REDD+ initiative in early 2013
Tanzania	Lindi	Making REDD work for Communities and Forest Conservation in Tanzania	Tanzania Forest Conservation Group	5.0	Med	Ongoing REDD+ initiative
Tanzania	Kilosa	Making REDD work for Communities and Forest Conservation in Tanzania	Tanzania Forest Conservation Group	2.6	Med	Ongoing REDD+ initiative
Tanzania	Zanzibar	HIMA – Piloting REDD in Zanzibar through Community Forest Management	CARE International in Tanzania	10.3	High	Ceased operation in December 2014
Tanzania	Kigoma	Building REDD Readiness in the Masito Ugalla Ecosystem Pilot Area in Support of Tanzania's National REDD Strategy	the Jane Goodall Institute	0.4	low	Ceased operation in June 2013
Tanzania	Mpingo	Mpingo Conservation Project	Mpingo Conservation and Development Initiative	3.0	Med	Ongoing REDD+ initiative
Indonesia	Ulu Masen	REDD+ in the Ulu Masen Ecosystem	Task Force REDD Aceh	1.4	Med	Operation on pause pending future decisions
Indonesia	Ketapang	REDD Pilot Project Development, Community Carbon Pools	Fauna Flora International (FFI)	4.6	Med	Ongoing REDD+ initiative
Indonesia	KFCP	Kalimantan Forests and Carbon Partnership (KFCP)	Indonesia-Australia Forest Carbon Partnership (IAFCP) & CARE	11.7	High	Ceased operation in 2014
Indonesia	Rimba Raya	The Rimba Raya Biodiversity Reserve Project	PT. Rimba Raya Conservation (Infinite Earth)	8.2	High	Ongoing REDD+ initiative
Indonesia	Katingan	Katingan Conservation Area: A Global Peatland Capstone Project	Starling Resources / PT. RMU	2.6	Med	Ongoing REDD+ initiative
Indonesia	Berau	Berau Forest Carbon Program (BFCP)	The Nature Conservancy	1.4	Med	Ongoing REDD+ initiative
Vietnam	Cat Tien	SNV Site, Cat Tien, Lam Dong District	SNV The Netherlands Development Organisation	5.3	High	Ongoing REDD+ initiative

Table S2: REDD+ financing options and progress with carbon and non-carbon verification or certification

Country	Project	REDD+ financing options			Fund	Current selling credits	CCBA validation	CCBA Gold - biodiversity	Others
		Voluntary market	Regulated market						
			national	international					
Brazil	Acre	✔	✔	✔					
Brazil	Cotriguaçu		✔	✔					
Brazil	Transmazonica				✔				
Brazil	Sao Felix de Xingu			✔					
Brazil	Jari / Amapa	✔		✔		✔			FSC
Peru	Madre de Dios	✔				✔	✔	✔	
Peru	Ucayali	✔							FSC
Cameroon	SE Cameroon	✔							
Cameroon	Mt. Cameroon	✔							
Tanzania	Shinyanga	✔							
Tanzania	Lindi	✔		✔					
Tanzania	Kilosa	✔		✔					
Tanzania	Zanzibar	✔							
Tanzania	Kigoma	✔							
Tanzania	Mpingo	✔							FSC
Indonesia	Ulu Masen	✔							
Indonesia	Ketapang	✔							
Indonesia	KFCP*	-	-	-	-	-	-	-	-
Indonesia	Rimba Raya	✔				✔	✔	✔	
Indonesia	Katingan	✔							
Indonesia	Berau	✔	✔						
Vietnam	Cat Tien	✔							

Note: * a demonstration project

Table S3: Complete list of funders (donors or investors) for the 22 REDD+ initiatives in this study

Country	Project	Donor 1	Donor 2	Donor 3	Donor 4	Donor 5	Donor 6 (plus)
Brazil	Acre	Amazon Fund	KfW Development Bank				
Brazil	Cotriguaçu	Amazon Fund	Packard Foundation				
Brazil	Transmazonica	Amazon Fund					
Brazil	Sao Felix de Xingu	Amazon Fund	USAID	British Embassy	Moore Foundation		
Brazil	Jari / Amapa	Biofílica	Jari Group				
Peru	Madre de Dios	Bosques Amazonicos	Asterix	BioCarbon	Land Economics Management Consultants (LEMCO)	Peruvian and Chilean investors	
Peru	Ucayali	AIDER	ITTO	REDDES	Initiative for Conservation in the Andean Amazon (ICAA)	Consortium of The Nature Conservancy Peru	CI, WWF and Banco Interamericano de Desarrollo (BID)
Cameroon	SE Cameroon	Department for International Development (DFID)					
Cameroon	Mt. Cameroon	KfW Development Bank					
Tanzania	Shinyanga	Royal Norwegian Embassy					
Tanzania	Lindi	Royal Norwegian Embassy					
Tanzania	Kilosa	Royal Norwegian Embassy					
Tanzania	Zanzibar	Royal Norwegian Embassy					
Tanzania	Kigoma	Royal Norwegian Embassy					
Tanzania	Mpingo	Royal Norwegian Embassy					
Indonesia	Ulu Masen	Funded through provincial budgets					
Indonesia	Ketapang	The David & Lucille Packard Foundation	Australian Aid	Climate and Land Use Alliance (CLUA)	European Union (EU)		
Indonesia	KFCP	Australian Aid					
Indonesia	Rimba Raya	Gazprom	Allianz				
Indonesia	Katingan	PT. Rimba Makmur Utama (RMU)	Clinton Foundation				
Indonesia	Berau	Govt. of Indonesia	NORAD	USAID	Australian Department of Agriculture	Fisheries and Food (DAFF)	Tropical Forest Conservation Act (TFCA)
Vietnam	Cat Tien	Darwin Initiative (funded by DEFRA)	DFID	FCO			

Appendix 2: Land use change analysis

Table S4: 2001 Land cover classification system (22 Classifications)

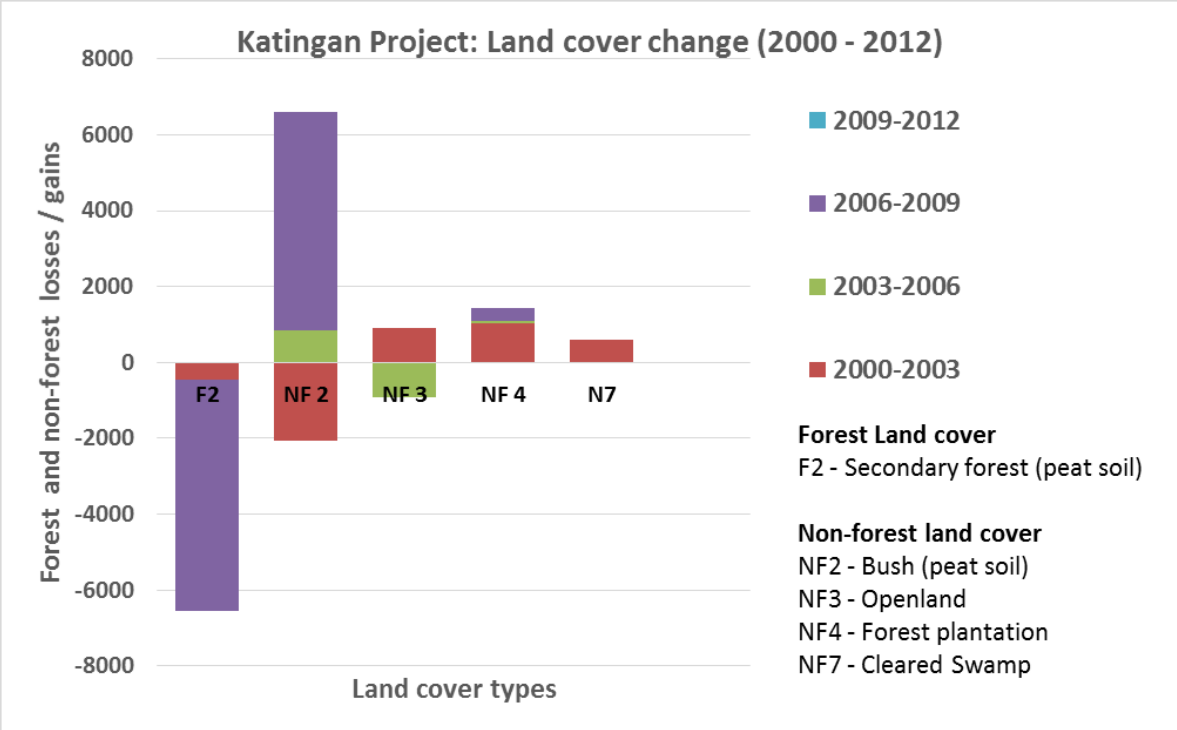
	Natural Forest Land Use Classes	
No.	Classification	Definition
1	Primary Upland Forest	The entire scene of lowland, high land, mountainous area that shows no traces of logging, including stunted/small forest, heap forest, hutan di atas batuan kapur, hutan di atas batuan ultra basa, hutan daun jarum, hutan luruh daun, moss forest
2	Secondary Upland Forest/Logged Forest	The entire area of lowland and high land forest, and mountainous that have shown traces of logging (the visibility of logging traces and spots), included in this group is stunted/small forest, heap forest, hutan di atas batuan kapur, hutan di atas tra basa, hutan daun jarum, hutan luruh daun, and moss forest, which show indications of being encroached/logged. Traces of slash and burn, forest fire, or vegetation that start to grow out of the degraded soil. They all belong to this classification.
3	Primary Swamp Forest	The entire scene of swampy/marshy area, including turbid-water swamp, and peat swamp, which has not indicated signs or traces of logging, included in this category is sago forest.
4	Secondary Swamp Forest/Logged Area	The entire scene of forest in marshy area, including turbid-water swamp, and peat swamp that shows traces of logging, including sago forest and a swamp forest that was once burned. The logged area is classified as open land when the heavily logged area is not inundated. However, if such area is flooded, it is classified into a body of water (swamp).
5	Primary Mangrove Forest	The entire scene of mangrove forest, nipah, and bamboo (nibung) available around the coast, which has not yet indicated traces of logging. In several location, mangrove forest stretches deeper into the hinterland.
6	Secondary Mangrove Forest/ Logged	The entire scene of mangrove forest, nipah, and bamboo (nibung) available around the coast, which suggests traces of logging in a strip mode (pola alur), spots, inundated, or burned. Particularly for a logged area that has turned into fish pond/rice field is categorized as fish pond/rice field, while an area that does not display a specific pattern and remain inundated will be classified as a body of water (swamp).
7	Crop Forest	The entire scene of crop forest landscape that has been planted, including crop forest for the purpose of regreening/afforestation and industry. Identification of location may be obtained through Crop Forest Distribution Map. On the other hand, it will be difficult to identify, through satellite imaging or distribution map, smallholder plantation, due to the small size. This necessitates other information, such as field data.

Non forest Land Use Classes		
8	Plantation/Garden	The entire scene of plantation with crops. The identification of plantation or garden sited can be obtained through Plantation Distribution Map. On the other hand, it will be difficult to identify, through satellite imaging or distribution map, smallholder plantation, due to the small size. This necessitates other information, such as field data.
9	Bushes/Shrubland	The entire scene of former upland forest that re--grows (undergoing a succession) but not yet optimum. Or, an upland area with sparse natural trees, or a low natural vegetation-dominated upland area. This type of scene usually does not show traces of logging.
10	Swampy Bush	The entire scene of what was once a swamp/mangrove forest, which undergoes a succession but not yet in an optimum stage. Or, a former swamp/mangrove forest filled with naturally sparse trees, or a former swamp/mangrove forest dominated with natural low vegetation. Usually, this type of scene no longer shows traces of logging.
11	Savanna	The entire scene of natural non-forest grassland and, occasionally, insignificant number of bush or trees can be found in this area. This scene is commonplace in some part of South East Sulawesi, East Nusa Tenggara and southern Papua. This form can also be found in an upland area or swamp (grassy swamp). The scene of grass and blade-grass land (padang alang-alang) are also classified into this group.
12	Upland Farming	The entire scene of farming activities on an upland, such as tegalan and farmland (ladang). In this classification, upland farming activities (seasonal crops) are more dominant than plantation or bush.
13	Upland Farming Mixed with Bush	An entire scene of upland farming and plantation, which muddles up with shrub, bush, and logged forest. It is frequently found in shifting cultivation area, and karst land planting rotation. This classification also includes mixed plantation, dominated by tree crops (plantation trees) in between the shrub.
14	Rice field	The entire scene of wetland farming activities, characterized by pematang pattern. Pay attention on the planting rotation phases, which consist of inundated phase, young crop phase, ripened crop, and fallowed phase. This category also includes seasonal rice field, rain fed rice field, and irrigated rice field. Additional field information is needed for seasonal rice field in swampy area.
15	Cultured Fisheries/Fishpond	The entire scene of land fishery activities (fish/shrimp) or salination, characterized by pematang pattern (in general), and it is usually inundated and located around the coastal area.

16	Settlement/Developed Land	The entire scene of settlement, including the urban area, rural region, industrial zone, public facility, etc., definite shapes and compact strip pattern (pola alur rapat).
17	Transmigration	The entire scene of rural settlement area (transmigration) and its surrounding house yard. If the agricultural, plantation, and settlement areas can be clearly identified, then it is possible to delineate them separately as agricultural, plantation, or settlement. However, if the transmigration area has developed and the pattern has become less regular and difficult to separate, then it is classified as transmigration category.
18	Open Land	The entire scene of open land without vegetation (mountain top singkapan batuan, snowed tops, volcanic crater, gosong pasir, coastal sand, river sediment), and open land where fire once took place. Open land scene for mining is classified into mines, while an open land where land clearing formerly took place is classified as open land. An open land in the frame of rice field/cultured fishery planting rotation remains in rice field/cultured fishery group.
19	Mining/mines	The entire scene of open land used for open pit mining (such as coal, lead, bronze, etc.), as well as large scale underground pit, which can be identified from the satellite image according to the association of its objective scene, including tailing ground. Small scale underground pit or the one that cannot be identified is grouped according to its surface scene.
20	Water Body	The entire scene of waters, including sea, river, lake, dam, coral reef, padang lamun, etc. The scene of fishery pond, rice field, and swamps ahs been separately classified.
21	Swamp	The entire scene of swamp land, which is no longer filled with vegetation (forest).
22	Airport/Harbor	The entire scene of large-sized airport and harbor, which is possible to be delineated separately.

Table S5: Limits of land cover change data

Bush:	Vegetation coverage dominated by trees, of which crown does not respectively entangled, with 25-60% canopy.
Forest:	Vegetation cover dominated by intertwined tree crowns (pohon dengan tajuk saling menutup), of which canopy is ≥ 60%; following the UNESCO terminology.
Moss Field:	This is moss-dominated area. Occasionally surrounded by bush or trees that grow on plains or highland (*permafrost*)
Grassland:	An area dominated by grass or other tundra (terna) plants. It may consist of imperata cylindrica, or other type grasses.
Trees:	Wooden plant, which generally has one main trunk with either wide of narrow tajuk.
Savanna:	An area dominated by grass or other terna plants, which exists in certain climate and soil conditions, which form typical ecosystem. Usually, it is surrounded with bush and trees.
Shrubland:	An area dominated by shrub, of which height extends more than 0,5m, with an average cover of more than 25%.
Stunted/small bush:	An area dominated by shrub, of which height extends less than 0,5m, with an average cover more than 25%.
Tundra:	Moss-dominated area, occasionally surrounded by shrub.



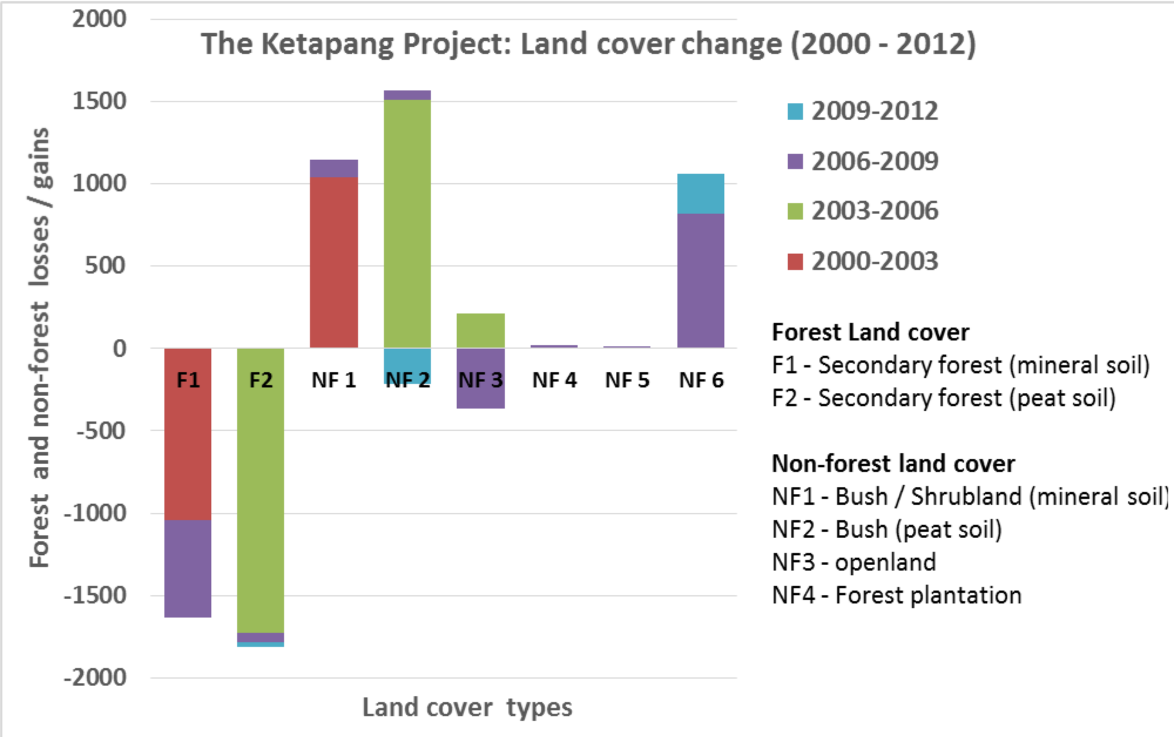


Figure S1: Land cover change analysis for the Ketapang and Katingan projects (2000 – 2012)

Note: Land cover change from 2000 – 2012 for the area proposed as the Katingan and Ketapang projects. The graphs show natural forest loss (F1 and F2) during four time period (2000 – 2003, 2003 – 2006, 2006 – 2009, 2009 – 2012) and its subsequent land cover type (NFs 1 – 7).

Appendix 3: Additional information about the Ketapang and Katingan REDD+ Project

Table S6: Area proposed, verified and excluded from REDD+ for the Ketapang project.

Village Forest	Area Proposed (ha)	Area Verified (ha)	Area Not Eligible for REDD+ (Ha)	% of area not eligible
Sungai Besar	10566	6825	3,741	35.41
Sungai Pelang	2152	610	1,542	71.65
Beringin Rayo	4406	1645	2,761	62.66
Sebadak Raya	14246	2425	11,821	82.98
Laman Satong	1084	1070	14	1.29
Tanjung Berulang	2470	1750	720	29.15
Pematang Gadung	14377	On going	14,377	100.00
Serengkah Kanan	3260	Declined by MoF	3,359	100.00
Rangga Intan	3140	Declined by MoF	3,140	100.00
Petebang Jaya	1734	Declined by MoF	1,734	100.00
TOTAL:	57,534	14,325	43,209	75.10

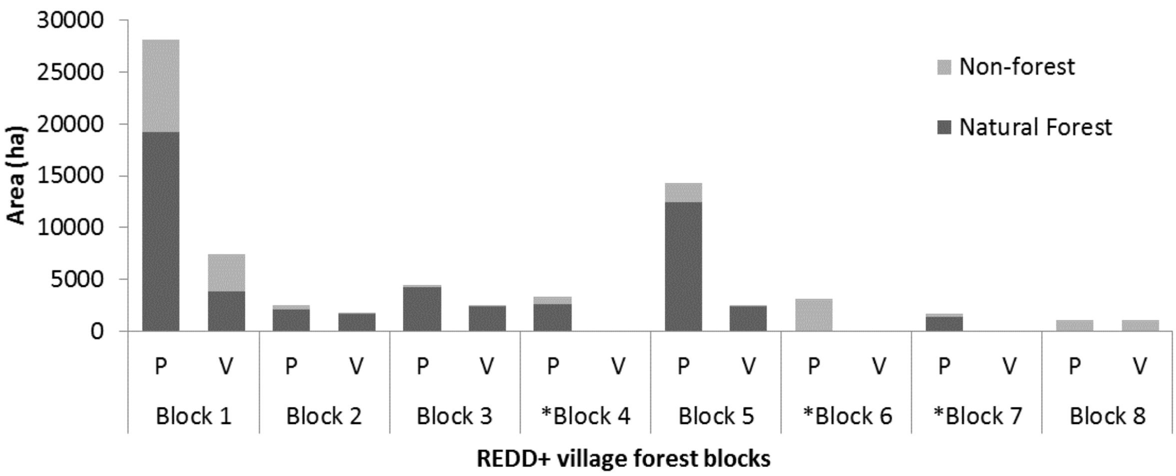


Figure S2: Distribution of forest and non-forest classes in the 8 proposed and / or verified blocks

Note: * = rejected right after application; Block 1 compose of three proposed village forest (2 have been verified); P = proposed; V = verified

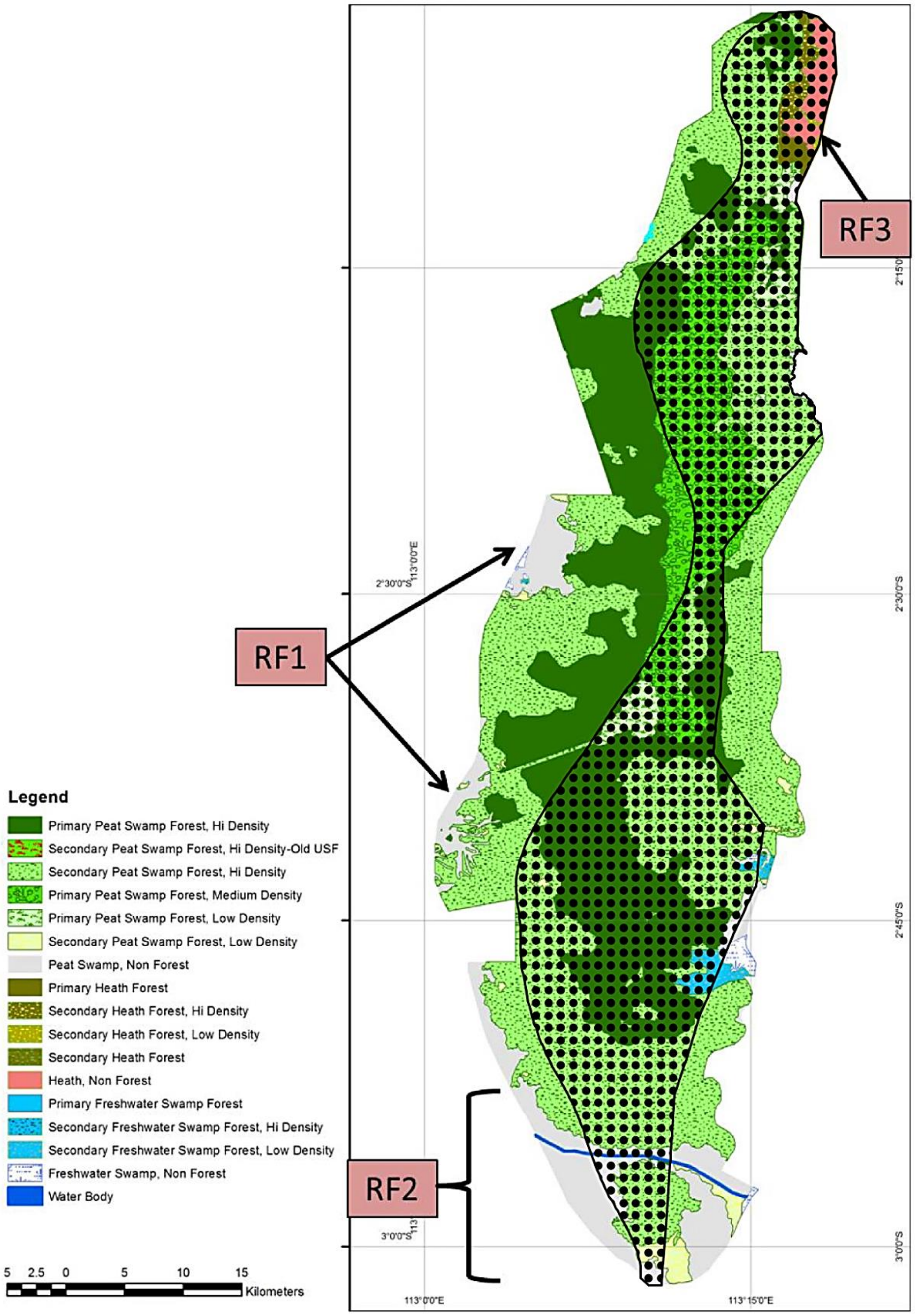


Figure S3: Map showing the Katingan project's proposed project boundary, reforestation priority areas (RF 1, RF2 & RF3) and area approved for REDD+ implementation (shaded)

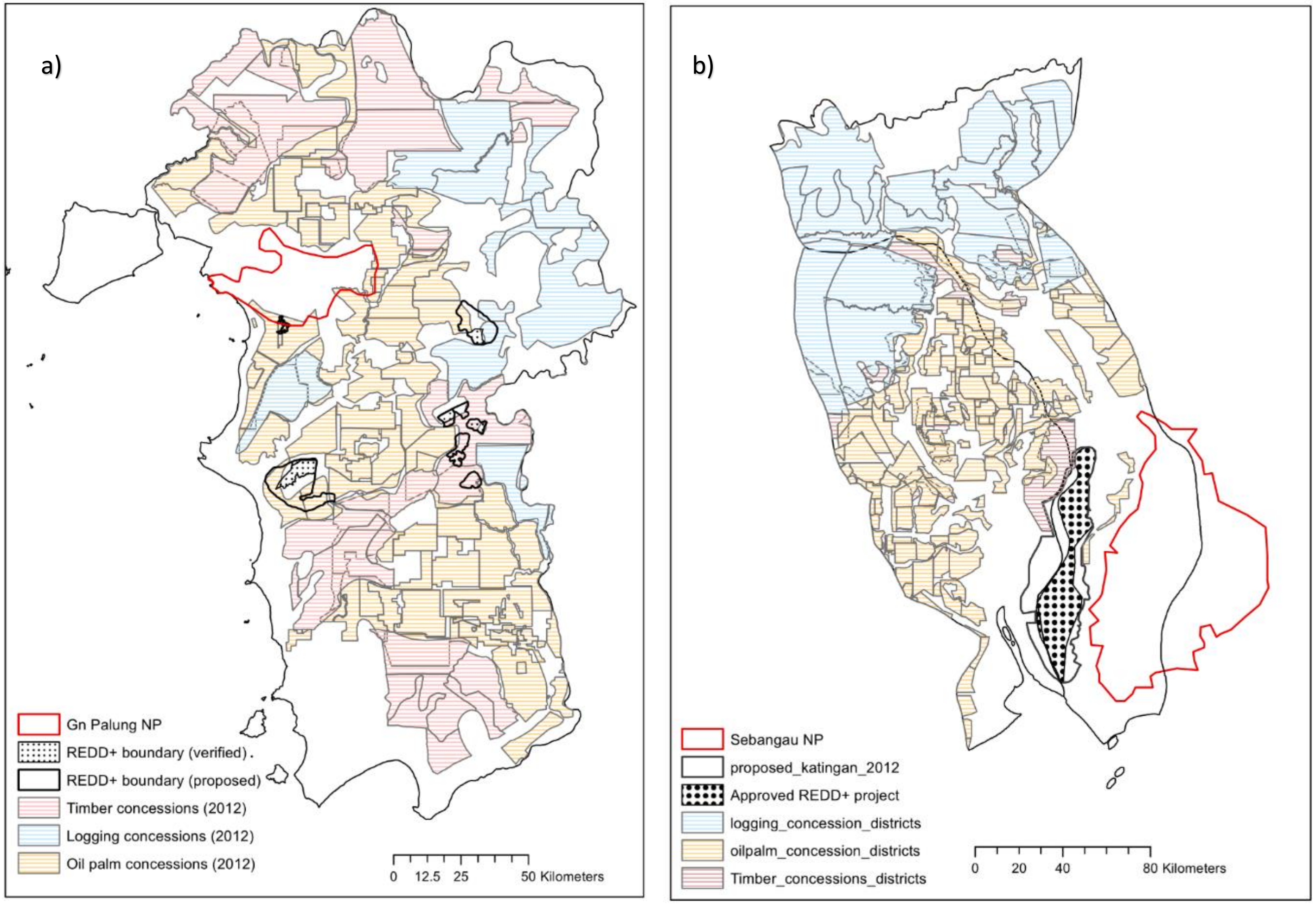


Figure S4: The maps show the location of the REDD+ projects and the timber, logging and oil palm concession in the Ketapang district (a) and the Katingan and Kotawaringan Timur districts (b)

Appendix 4: Underlying orangutan density data

Table S7: Ketapang district: orangutan density, data source and density notes for all forested blocks

BLOCKS	Mean Density	Source	Density_Note	Other_notes
BLOCK 1	1.94	Husson et al 2009	Part of the Arut-Belantikan Forest Block	Used Arut secondary density because block contained secondary forest with signs of clearing around the buffer
BLOCK 2	0.46	Singleton et al 2004	OUTrop 2003 Survey in Schwaner Foothills	Moderate sized isolated patch of forest occupaid by two logging concessions i) PT Duaja Corp, ii) PT Karunia Hutan Lestari
BLOCK 3	3.8	Animal Rescue International 2013	Pematang Gadung Block	Cited in Mering (2013)
BLOCK 4	0	Density unknown		Big Block of forest North of Gn Palung Block
BLOCK 5a	3.0	Johnson et al 2005	GPNP Secondary upland	
BLOCK 5b	3.2	Johnson et al 2005	GPNP Primary upland	
BLOCK 5c	3.2	Johnson et al 2005	GPNP Secondary Peat	
BLOCK 6	0	Non-forest	Non-forest	
BLOCK 7	0	Non-forest	Non-forest	
BLOCK 8	0	Non-forest	Non-forest	
BLOCK 9	0	Non-forest	Non-forest	
BLOCK 10	0	Density unknown	Hutan Lindung located to the East of Gn Tarak	Possibly no OU because it is a small patch of forest surrounded by oil palm concessions
BLOCK 11	0	Non-forest	Non-forest	Non-forest
BLOCK 12	0	Density unknown		Possibly no OU because it is a small patch of forest surrounded by oil palm concessions
BLOCK 13	1.71	Andi Erman 2007 (unpub)	Used Harapan sawit Lestari's density (connected to HSL)	RAPID ASSESSMENT HABITAT DAN SENSUS SARANG ORANGUTAN HUTAN KONSERVASI PT. HARAPAN SAWIT LESTARI (HSL) BERNILAI KONSERVASI TINGGI (HCV)
BLOCK 14	0	Density unknown		Possibly no OU because it is a small patch of forest surrounded by oil palm concessions and timber concessions
BLOCK 15	0	Non-forest	Non-forest	
BLOCK 16	0	Non-forest	Non-forest	

BLOCK 17	1.93	FFI 2010	Sungai Putri Block + Kuala Totak	HCV assessment site by FFI. Block of forest overlaps with 6 oilplam concessions
BLOCK 18	0	Density unknown	Small isolated patch of forest	Overlap with a big timber concession and surrounded by oil palm concessions
BLOCK 19	0	Non-forest	Non-forest	
BLOCK 20	0	Non-forest	Non-forest	
BLOCK 21	0	Non-forest	Non-forest	
BLOCK 22	0	Non-forest	Non-forest	
BLOCK 23	0	Non-forest	Non-forest	
BLOCK 24	0	Non-forest	Non-forest	
BLOCK 25	0	Non-forest	Non-forest	
BLOCK 26	0	Density unknown	Mederately large patch of forest to the north of GPNP.	Overlap with a big timber concession and surrounded by oil palm concessions
BLOCK 27	0	Non-forest	Non-forest	
BLOCK 28	0	Non-forest	Non-forest	
BLOCK 29	2.74	FFI 2008	PT. SUKA JAYA MAKMUR (PT. SJM) South	From the Eddi Erman Report for FFI in PT. SUKA JAYA MAKMUR (PT. SJM)
BLOCK 30	1.9	Andi Erman 2007 (unpub)	Gunung Tarak Protection forest	RAPID ASSESSMENT HABITAT DAN SENSUS SARANG ORANGUTAN HUTAN LINDUNG GUNUNG TARAK
BLOCK 31	0	Non-forest	Non-forest	
BLOCK 32	0.46	Singleton et al 2004	OUTrop 2003 Survey in Schwaner Foothills (same density as Block 2 is used)	Small sized isolated patch of forest occupaid by logging concessions PT Duaja Corp with a tiny protection forest enclosed; possibly connected to the large Block 25 & Arut Belantikan block.
BLOCK 33	1.64	Singleton et al 2004	OUTrop 2003 Survey in Schwaner Foothills	Very small block connected to the south of Block 2; legal status = protection forest; enclosed by the oil palm concession PT Agra Jaya Bhaktitama
BLOCK 34	0	Density unknown		Small isolated patch of forest on legally classified as non-forest land; half the area ov erlaps with two palm oil concessions i.e. PT Sawit Murni and PT Sepanjang Inti Surya Mulia
BLOCK 35	3.34	Husson et al 2009	Part of the Arut-Belantikan Forest Block	Used Belantikan unlogged density because block contained primary forests and is part of a large contogious block
BLOCK 36	4.35	FFI 2010	Kuala Satong	HCV asseassment site by FFI. Half occupaid by oil palm PT Kayong Agro Lestari

Table S8: Katingan and Kotawaringan Timur districts: orangutan density, data source and density notes for all forested blocks

BLOCKS	Mean Density	Source	Density Note	Other notes
BLOCK 1	2.57	Morrogh-Bernard et al 2003	Use Sebangau NP's density	Mean density based on tall interior which appeared to be preferd and highest population
BLOCK 2	2.3	Marchant et al. 2014	Use Katingan Project's density	
BLOCK 3	0	NON-FOREST	NON-FOREST	
BLOCK 4	1.5	Singleton et al 2004	Use OU range FID 201	Part of a larger block known as the Seruyan – Sampit – Katingan uplands.
BLOCK 5	0.6	Singleton et al 2004	Use Bukit Baka-Bukit Raya's density	Part of the Bukit-Baka- Bukit Raya block therefore I used the same density value for this contigous block of forest
BLOCK 6	0.6	Singleton et al 2005	Use Bukit Raya Perluasan's density information	
BLOCK 7	1.59	Husson et al 2009	Consider this the Samba-Kahayan block	
BLOCK 8	0	NON-FOREST	NON-FOREST	
BLOCK 9	0	NON-FOREST	NON-FOREST	
BLOCK 10	0	Density Unknown	A tiny isolated block just above the Katingan project	
BLOCK 11	0	NON-FOREST	NON-FOREST	
BLOCK 12	0.6	Singleton 2004	Can say it is part of the contigous Bukit Baka-Bukit Raya area	
BLOCK 13	0.6	Singleton et al 2004	I also used Bukit Baka Bukit Raya density for this one	It is an isolated patch in the wider forested patch that is BKBR
BLOCK 14	0	Density Unknown	Isolated patch	
BLOCK 15	0	NON-FOREST	NON-FOREST	
BLOCK 16	0	Density Unknown	Isolated patch	
BLOCK 17	0	NON-FOREST	NON-FOREST	
BLOCK 18	0	NON-FOREST	NON-FOREST	
BLOCK 19	1.5	Singleton et al 2004		Visibly connected (a little) to the larger Seruyan-Sampit-Katingan block

BLOCK 20	0	Density Unknown		A very Isolated block (small) of psf on the west of the Katingan project
BLOCK 21	0	Density Unknown		A very small and patch of; if any ou at all, we could use density estimate similar to Block 5 because it is in the same block of forest
BLOCK 22	0	Density Unknown		Another very small patch of forest sandwich by forest plantation and non-forest land use. Possible no OU
BLOCK 23	0	NON-FOREST	NON-FOREST	
BLOCK 24	0	NON-FOREST	NON-FOREST	
BLOCK 25	1.9	Singleton et al 2004	Use Tanjung Puting NP's density	Look in Husson et al 2009 for density
BLOCK 26	1.7	FFI 2008	PT. Sari Bumi Kasuma logging concession	From the Eddi Erman Report for FFI in PT. Sari Bumi Kasuma

Appendix 5: Predicted deforestation in Orangutan Habitat Units

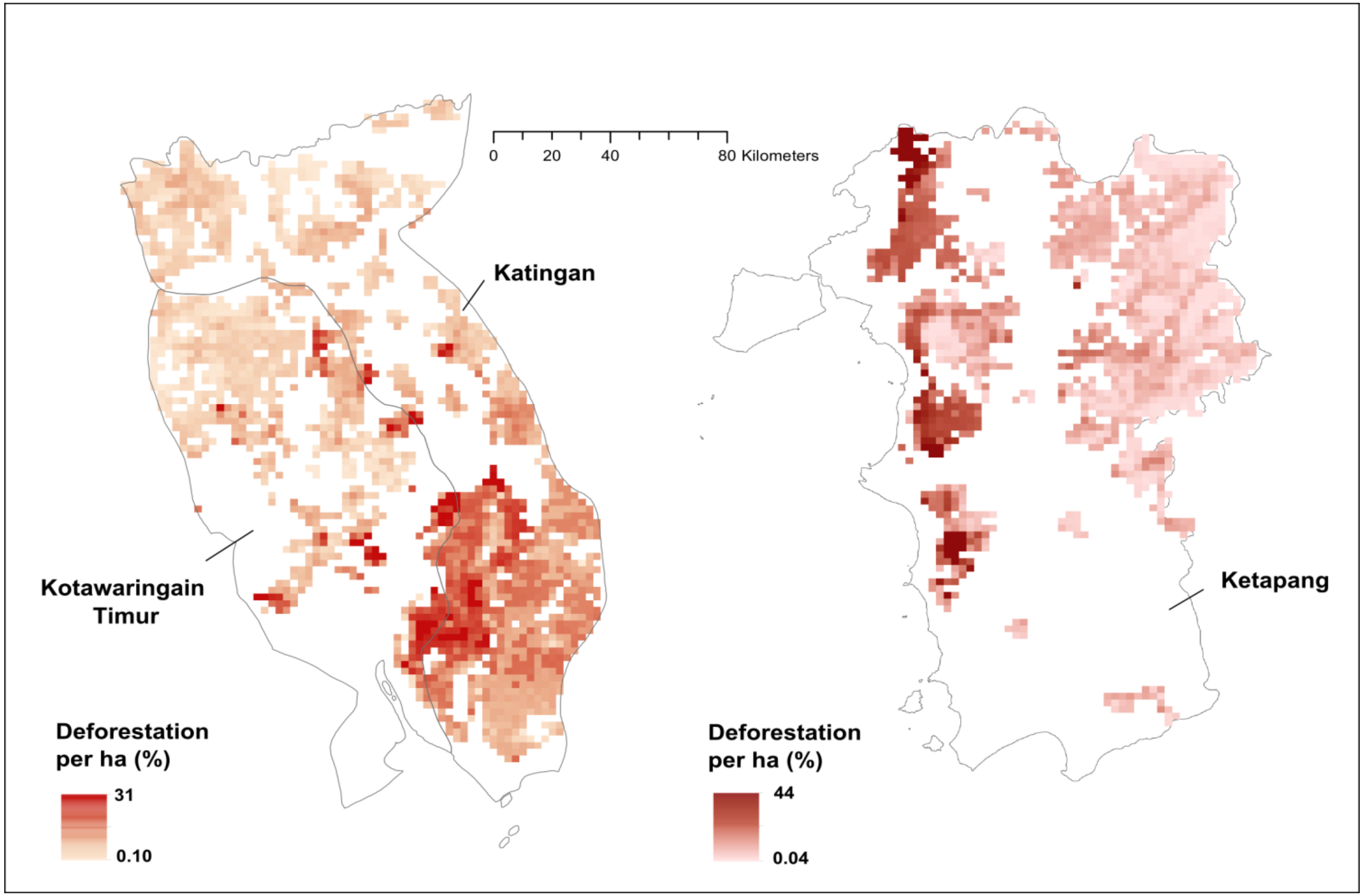


Figure S5: Predicted deforestation througout the *P. p. wurmbii* range in the Ketapang district (a) and the Kotanwaringan Timur and Katingan districts (b

Appendix 6: Publication contribution from thesis Chapter 2

Briefing paper on biodiversity safeguard developed for the 2014 COP 20 in Lima, Peru (Murray & Jones, 2014)

REDD+ Safeguard Brief 5

Safeguarding Biodiversity in REDD+

Necessary but not sufficient to help slow global biodiversity loss

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Biodiversity safeguards were introduced into the REDD+ mechanism to avoid potential harm to biodiversity. However, for REDD+ to truly contribute to biodiversity conservation, initiatives must go much further.

“Biodiversity benefits from REDD+ must not be confined to isolated projects but integrated across larger areas.”

READ THIS BRIEF IF…

- You are interested in the potential of REDD+ to contribute to biodiversity conservation in the tropics.
- You want to know how REDD+ could deliver biodiversity benefits beyond the safeguarded minimum.
- You are planning to design a REDD+ initiative that delivers biodiversity conservation benefits.

KEY MESSAGES

- REDD+ provides the opportunity to deliver biodiversity conservation in the tropics.
- Safeguards are vital, but alone do not guarantee delivery of biodiversity co-benefits in REDD+.
- The delivery of biodiversity co-benefits will require additional effort.
- A landscape approach will offer better opportunities for REDD+ to contribute to biodiversity conservation.

OPPORTUNITIES AND RISKS FOR BIODIVERSITY IN REDD+

Land-use change and climate change are predicted to be the two most important drivers of biodiversity loss in the terrestrial realm in the 21st century (Pereira et al. 2010). REDD+ has the potential to tackle these two major challenges simultaneously. As deforestation and forest degradation directly affect natural habitats (Sangermano et al. 2012), then if REDD+ can slow deforestation and forest degradation, it should, in theory, benefit biodiversity conservation in tropical forests (Gardner et al. 2012). Future REDD+ financing could offer an opportunity to supplement the current shortfall in conservation funding (Waldron et al. 2013) or fund forest conservation at a scale that could potentially dwarf current investment (Busch et al. 2011; Venter et al. 2013).

However, if REDD+ is not properly planned, it could negatively affect biodiversity (Harvey et al. 2010). A key concern is that preferential targeting of REDD+ in high-carbon areas could lead to the displacement of land-use pressure (leakage) into high-biodiversity but low-carbon areas (Parr et al. 2014) or divert funds for conservation away from high-biodiversity areas with lower carbon (Phelps et al. 2012a; Venter et al. 2013). This is because carbon markets seeking low-cost REDD+ credits would not incentivize the delivery of non-carbon benefits (Phelps et al. 2012b). The expanded scope of REDD+, which includes the conservation and enhancement of forest carbon stocks and sustainable management of forests, has also led to further concerns. Activities to enhance forest carbon stocks could encourage the expansion of carbon plantations at the expense of high-biodiversity non-forest ecosystems (Griscom and Cortez 2013; Parr et al. 2014). Furthermore, improved forest management, even if under principles of sustainable forest management, could compromise old-growth forest and pristine natural forests (Huettner 2012; Lindenmayer et al. 2012).

SAFEGUARDS FOR BIODIVERSITY AT THE INTERNATIONAL NEGOTIATIONS

In response to the concerns for biodiversity in the REDD+ mechanism, safeguards were introduced at the UNFCCC Conference of the Parties in Cancun to ensure that REDD+ does no unintended harm to biodiversity (Pistorius and Reineck 2013). The Cancun Agreement provided guidance for safeguarding biodiversity by requiring that REDD+ actions do not result in the conversion of natural forests to plantations, but instead be used to incentivize the conservation of natural forests and their ecosystem services, and enhance environmental benefits (UNFCCC 2011). Although a step in the right direction, the wording was considered too general and not operational (Gardner et al. 2012; Grussu et al. 2014). Despite the evolution of international safeguard discussions since Cancun, safeguards for biodiversity and other non-carbon benefits remain vague (Pistorius and Reinecke 2013). This is generally true of international standards, which need to be flexible and adaptable to different national and local contexts (Roe et al. 2013). It seems highly unlikely, however, that UNFCCC will set aside carbon payments for delivery of biodiversity benefits within the REDD+ mechanism (Busch 2013).

MOVING FROM SAFEGUARDS TO CO-BENEFITS

REDD+ biodiversity safeguards have been defined as the "minimum requirement for all countries participating in REDD+ in order to avoid perverse and unintended harm to forest biodiversity" (Phelps et al. 2012b). However, from early in the discussions about REDD+, there has been excitement that REDD+ could deliver additional benefits for biodiversity (known as 'co-benefits'). Biodiversity co-benefits can be defined as "ancillary benefits in addition to carbon benefits obtained through the improved state of biodiversity from an agreed upon baseline through the activities implemented under REDD+" (Phelps et al. 2012b). Based on these definitions and the way in which safeguards and co-benefits have been discussed in international negotiations, safeguards can be viewed at one end of the spectrum as a 'risk management approach' to protecting biodiversity, i.e. ensuring that REDD+ does no harm to biodiversity. At the other end of the spectrum, co-benefits can be viewed as an 'opportunity realization approach', i.e. REDD+ is designed to deliver additional benefits for biodiversity (Figure 1).

Delivering additional conservation benefits for biodiversity will require developing explicit 'biodiversity-friendly' methods, such as spatial targeting of REDD+ interventions (Jantz et al. 2014; Venter 2014), supplementary financing focused on biodiversity delivery (Phelps et al. 2012b; Dinerstein et al. 2013) or biodiversity-specific management strategies (Martin et al. 2013; Nghiem, 2014), because safeguards alone will not guarantee the delivery of biodiversity benefits.

Figure 1. Biodiversity safeguards and co-benefits on the biodiversity spectrum

REALIZING THE DELIVERY OF BIODIVERSITY CO-BENEFITS IN REDD+

Spatial targeting has been increasingly recognized as an important strategy for achieving additional gains for biodiversity (Busch and Grantham 2013; Locatelli et al. 2013; Venter et al. 2013). Studies in Tanzania (Lin et al. 2014) and Brazil (De Barros et al. 2014) show evidence of REDD+ initiatives spatially targeting high-biodiversity areas instead of purely carbon-rich areas. There is also evidence that focusing REDD+ initiatives in high-biodiversity areas promotes more opportunities for bundling with other ecosystem services (e.g. biodiversity conservation, carbon storage, water regulation and scenic beauty) than when focusing on high-carbon areas alone (Locatelli et al. 2013).

REDD+ is a climate mechanism, and it is unlikely that a future regulatory mechanism would finance the delivery of non-carbon benefits, because diverting carbon funds to projects or locations that are good for biodiversity can increase costs and overburden initiatives (Venter 2014). That said, analyses show that spatially targeting areas that are good for both carbon and biodiversity can provide additional biodiversity benefits with only marginal cost increases in most cases (Phelps et al. 2012a; Busch and Grantham 2013). REDD+ could achieve carbon and biodiversity synergies through separate add-on incentive mechanisms that promote the delivery of biodiversity benefits (Phelps et al. 2012b). Options for supplementary financing include wildlife premiums (Dinerstein et al. 2013) or conservation funds to cover opportunity costs (Crossman et al. 2011). Alternatively, Venter et al. (2013) argue from a strict biodiversity perspective that it would be most cost efficient to use biodiversity funds to protect areas neglected by REDD+.

REDD+ initiatives that protect existing forest carbon stocks will not automatically protect other forest values (Huettner 2012);
if REDD+ is to go beyond doing no harm to actually realizing biodiversity conservation benefits, biodiversity-specific management will need to be incorporated in the planning, design and implementation of REDD+ on the ground. Martin et al. (2013) found that because carbon pools recover more quickly than biodiversity in degraded forests, REDD+ initiatives would need to carry out active restoration or reforestation in order to promote biodiversity conservation. If biodiversity conservation is factored into forest plantation design, a longer optimal rotation age will need to be applied compared to the period that maximizes the joint value from timber and carbon sequestration (Nghiem 2014). Persistent threats to biodiversity loss (such as hunting) could still take place in REDD+ protected forests if specific enforcement and monitoring activities (e.g. patrolling) are not put in place to address direct threats to biodiversity. Lastly, we emphasize the importance of a landscape approach to REDD+ planning, designing and implementation that ensures that biodiversity benefits from REDD+ are not confined to isolated REDD+ projects but instead are integrated across larger areas.

CONCLUSION

Safeguards to ensure that REDD+ does no harm to biodiversity are vital. However, additional planning at the landscape level, including other payment mechanisms such as markets for biodiversity, will be required to realize the potential of REDD+ to contribute to biodiversity conservation.

> **“Planning at the landscape level is needed to realize REDD+’s potential for biodiversity conservation.”**

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SEED

RESEARCH PROGRAM ON Forests, Trees and Agroforestry

This research was carried out by CIFOR as part of the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA). This collaborative program aims to enhance the management and use of forests, agroforestry and tree genetic resources across the landscape from forests to farms. CIFOR leads CRP-FTA in partnership with Bioversity International, CATIE, CIRAD, the International Center for Tropical Agriculture and the World Agroforestry Centre.

Appendix 7: Publication contribution from Chapter 4.

Published in: REDD+ on the ground: Global insights from local contexts (Sassi *et al.*, 2014).

Box L
Can REDD+ deliver biodiversity co-benefits in Indonesia?

Josil P Murray, Richard Grenyer, Sven Wunder, Niels Raes and Julia PG Jones

Loss of tropical forests is a major driver of biodiversity loss (Wilcove et al. 2013). The REDD+ mechanism can therefore, in principle, play an important role in tackling biodiversity loss by incentivizing the reduction of deforestation and forest degradation (Busch and Grantham 2013). However, concerns that REDD+ could potentially harm biodiversity if it is not properly regulated, led to the proposition of biodiversity safeguards and co-benefits at the UNFCCC negotiation in Copenhagen at COP15 in 2009 (Visseren-Hamakers et al. 2012). A key concern is that preferential targeting of REDD+ in high carbon areas could lead to the displacement of land-use pressure (leakage) into high biodiversity but low carbon areas (Harrison and Paoli 2012) or divert funds for conservation away from high biodiversity areas with lower carbon (Phelps et al. 2012). The degree to which carbon and biodiversity are co-located in the landscape will influence the potential for REDD+ to deliver biodiversity benefits (Strassburg et al. 2010). However, additional gains for both will depend on the degree to which REDD+ focuses on areas under the threat of deforestation and forest degradation (Busch and Grantham 2013; Venter 2014).

Here, we explore the spatial overlaps between carbon stocks (Baccini et al. 2012; Hiederer and Köchy 2012), biodiversity richness, deforestation pressure (Busch et al. 2010), and the location of REDD+ initiatives relative to protected areas (PAs) and nonprotected forest. We focused on Indonesia because it has the highest deforestation rate globally (Margono et al. 2014), and it is a mega-biodiversity country (Sodhi et al. 2004) and a key player in the international REDD+ arena (Brockhaus et al. 2012). For biodiversity, we assembled data on the distribution of terrestrial vertebrates (ranges of amphibians, mammals, birds, reptiles) (BirdLife International and NatureServe 2012; IUCN 2012) and plants (species distribution models for eight major plant families) (Raes et al. 2013). We investigated congruence between carbon and different measures of biodiversity richness at the national and subnational scales. We then mapped the location of active REDD+ initiatives, investigated their carbon density and potential biodiversity richness, and modeled deforestation pressures to investigate their potential to deliver win–win carbon-biodiversity outcomes.

The results show that congruence between carbon and biodiversity varies greatly, depending on scale and the measure of biodiversity used (total, threatened or restricted range species richness). A total of 37 active REDD+ initiatives were identified, half of which were led by conservation NGOs, 35% by private for-profit organizations and 16% were collaborations with the Indonesian government. REDD+ forests tend to have, on average, lower carbon densities (mean = 419.8 tCO_2/ha) than PAs (mean = 479.0 tCO_2/ha) and unprotected forests (mean = 447.4 tCO_2/ha) in Indonesia (Figure L.1). The mean carbon density differed significantly between groups (F = 16.17 on 2822 df, $p < 0.0001$). However, REDD+ initiatives have significantly higher potential total vertebrate species richness (F = 116.2 on 2836 df, $p = < 0.0001$) and threatened species richness (F = 181.8 on 2916 df, $p = < 0.0001$). This relationship is also true when plants are included as a measure of potential species richness (F = 13.5 on 1816 df, $p < 0.0001$). With regard to deforestation threats, we found that 23% (or 2.9 million ha) of REDD+ initiative areas fall within medium to very high deforestation threat forest; this compares to 11% (or 2 million ha) of PA and 21% (or 20 million ha) of non-protected forest. Forests currently not protected by REDD+ or PAs have a much larger area exposed to high threats to deforestation perhaps highlighting the potential for REDD+ expansion in Indonesia.

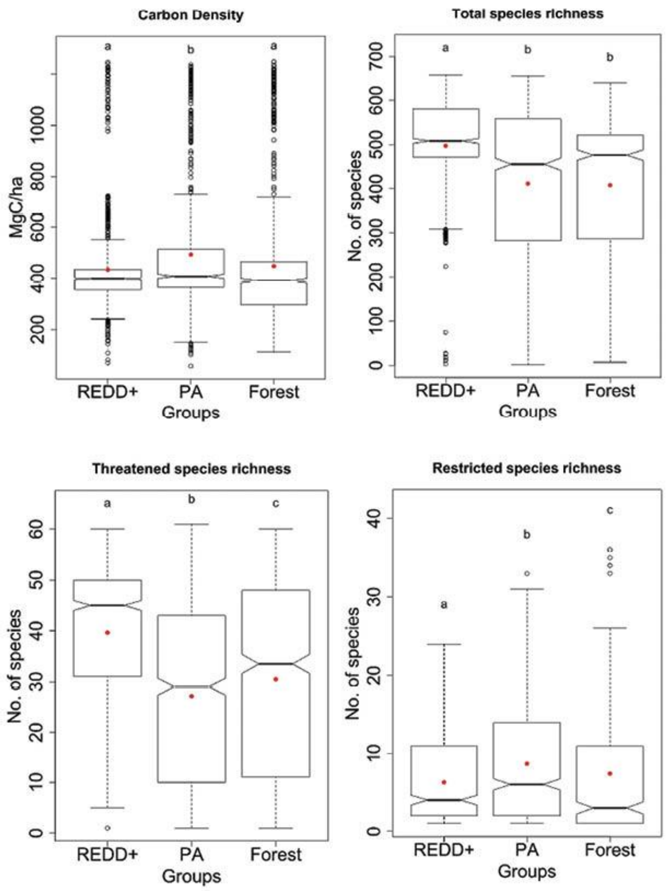

Figure L.1 Boxplots show the distribution of (a) carbon and three measures of vertebrate species richness: (b) total species, (c) threatened species and (d) restricted range species richness, in REDD+ initiatives (REDD), protected area (PA) and non-protected forests (Forest).

Note: notches approximate 95% confidence around the median value. Solid red dots represent the mean. The letters above each box indicate significant groupings after applying Tukey's HSD test.

The lack of a clear and consistent relationship between carbon and any of our proxy measures of biodiversity could be linked to the fundamental ecological differences between carbon and biodiversity (Potts et al. 2013), thus cautioning against overly simplistic assumptions of the biodiversity benefits associated with carbon. Our study also found that while REDD+ initiatives are not targeting areas with the highest carbon stocks, they seem well positioned to deliver additional biodiversity gains. Perhaps this is because remaining forests outside PAs are degraded (Margono et al. 2014), leaving those available for REDD+ development with lower than average carbon stock. This explains why we also found many REDD+ initiatives in our sample including reforestation and restoration as part of their key activities. High biodiversity in REDD+ initiatives could be attributed to the role of conservation NGOs in seeing REDD+ as a novel funding stream for their spatially prioritized actions.

This analysis suggests that biodiversity co-benefits could indeed be achieved through REDD+ in Indonesia – maybe in some cases more prominently so than those of carbon. National- and subnational-level REDD+ design could gain from including overlay analyses to inform site selection based on high deforestation threat and relations between carbon and biodiversity, to achieve win–win situations and minimize trade-offs.