Carbon Finance Schemes in Indonesia - Empirical Evidence of their Impact and Institutional Requirements

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D 7

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To my great friend Silke

ABSTRACT

Solutions are sought throughout the world to counter land and forest conversion processes, as well as strategies for climate change mitigation. Payments for Environmental Service (PES) schemes, which are market-based incentives, are promoted as a possibility to enforce or support sustainable forest management and conservation activities. Using empirical evidence from the island of Sulawesi in Indonesia, this study provides a contribution to ongoing research to determine strategies to actively sequester and conserve remaining stocks of carbon. Farming households in the vicinity of the Lore Lindu National Park contribute to conversion processes at the forest margin as a result of their agricultural practices and specifically the expansion of their cacao plantations. The objective is to investigate the impact of payments for carbon sequestration on the households and their land-use systems, as well as the institutional framework of such a PES scheme. A comparative static linear programming model was used to analyse the household behaviour and changes observed due to the introduction of the policy option of carbon payments. In addition, we discussed and evaluated the impact of the institutional arrangement of the existing natural resource management schemes in focus groups in four villages, using participatory rural appraisal tools. If the carbon credits are specifically targeted towards more sustainable agroforestry systems, increased environmental benefits in terms of higher carbon sequestration rates, as well as higher income benefits for the poorer households can be obtained. A PES scheme could build upon the community conservation agreements, which are in place already, as they provide an initial basis to reduce transaction costs and integrate the local communities. However, the participation structures for the villagers, as well as monitoring and enforcement need to be improved to safeguard the stability of the rainforest margin in the Lore Lindu region.

SUMMARY

On the global scale the forest cover is constantly decreasing and developing countries, especially those in tropical areas, continue to experience high rates of deforestation. A variety of contributing factors exist, one of which is agricultural expansion. In turn, deforestation causes about a quarter of human induced carbon dioxide emissions. Thus, solutions are sought to counter these land and forest conversion processes, as well as strategies to actively sequester and conserve the remaining stocks of carbon. Payments for Environmental Service (PES) schemes are regarded as a possibility to promote the conservation of natural resources, and are used as market-based incentives to enforce or support sustainable forest management and conservation activities.

Using empirical evidence from the island of Sulawesi, Indonesia, this study provides a contribution to ongoing research to determine strategies for climate change mitigation. Farming households in the vicinity of the Lore Lindu National Park contribute to conversion processes at the forest margin as a result of their agricultural practices. In this region the area dedicated to cacao plantations has increased from zero to nearly 18,000 hectares between 1979 and 2001. A reasonable share of these plots has been established inside the 220,000 hectares of the National Park. The objective is therefore, to investigate the impact of payments for carbon sequestration on the households and their land-use systems, as well as the institutional framework of such a scheme. At the household level, we explore the potential of payments as an incentive for the adoption of more environmentally beneficial land-use systems, and their ability to offer a mechanism for the protection of the rainforest. At the institutional level, we investigate the structures of the existing community conservation agreements, and whether they can be used as a platform for a potential payment for carbon sequestration scheme.

We selected a quantitative and qualitative research design for the analysis. In combining the different methods, we were able to concentrate on the two levels associated with the PES schemes and allow for their complementation. We adopted a comparative static linear programming model to analyse the household behaviour and changes observed due to the introduction of the policy option of carbon payments. Four cacao agroforestry systems (AFS) can be distinguished whereby AFS D exhibits a high degree of shading and a low management intensity, while at the other hand of the spectrum AFS G involves intensive management and fully sun grown cacao. Cacao gross margins increase when moving along the cacao AFS intensification gradient from D towards G. An intensification process is observed with a consequent reduction of the shade tree density. The input data for the model was obtained in a household survey using a sample of 46 households in six villages. The households were categorised according to the dominant AFS among their cacao plots into four classes (HH_D – HH_G). At the institutional level, we discuss and evaluate the impact of the institutional arrangement of the community conservation agreements in focus groups in four villages, using participatory rural appraisal tools. These tools allow for an in-depth insight into the participation processes and the institutional framework for the agreements, as perceived by two different social groups, farmers and decision makers.

Results indicate that at the plot level, payments for carbon sequestration are the largest for the full shade cacao agroforestry system as it has the highest total carbon sequestration potential. Focusing on the household level, with the introduction of the payments, household D experiences the most pronounced relative impact on its TGM, ranging from 4 percent with a low (€5 per tCO_2e) to 18 percent with a high (€25 pro tCO_2e) carbon credit price. The corresponding impacts for household G are extremely small. At this range of carbon prices, none of the households realises any shift in their land-use practices. Economic incentives, such as price premiums offered through carbon certificates for shade intensive cacao could be a solution to slow down the intensification process. With differentiated carbon prices of up to €32 per tCO_2e, an incentive is provided for the first three household types to grow the more shaded cacao AFS. If the current deforestation rate is reduced and prices paid for every ton of CO_2e avoided are €23, the incentive is sufficiently high enough for the household types D, E and F to stop forest conversion activities. A win-win situation seems to appear, whereby, when targeting only the shade intensive agroforestry systems with carbon payments, the poorest households economically benefit the most, the vicious circle of deforestation can be interrupted and land-use systems with high environmental benefits are promoted. If one would want to implement such a payment scheme for carbon sequestration in the region, the present institutional arrangement of the community conservation agreements could be used as a starting point. The agreements provide a regulatory framework and an entity has been established with the aim of monitoring activities. It addresses illegal activities and the rules enforcement. Extractive activities have declined and environmental awareness has increased since the establishment of the institution. Yet, this newly formed institution is not very strong, due to financial limitations and unclear definitions of responsibilities. Additionally, the participation of the villagers in the agreement negotiation and formation was restricted, making the acceptance and compliance with the regulations difficult. Thus, for a potential PES project the institutional framework needs to be strengthened and community participation in the conservation activities fostered.

The policy implications derived from this study focus on the applicability of PES schemes as a strategy for climate change mitigation, their strength and limitations, and institutional arrangements for their implementation. Depending on the local context, these programmes provide an improved environmental service with higher carbon sequestration rates. At the same time they offer stable income sources for the local population and can break the vicious cycle of poverty and deforestation. Avoided deforestation, among agricultural practices, also provides a cost-efficient solution for the abatement of greenhouse gases. Local institutional frameworks used for natural resource management processes should be used as a starting point for such schemes, as they provide a good basis to reduce transaction costs and integrate the local communities. However, for PES schemes to be implemented, their applicability to a specific region needs to be assessed on a case-by-case basis.

ZUSAMMENFASSUNG

Auf globaler Ebene gehen jährlich 0,2 Prozent der Waldfläche verloren und in Entwicklungsländern, insbesondere in den Tropen, sind Entwaldungsraten von bis zu 3 Prozent im Jahr vorzufinden. Die Erweiterung landwirtschaftlicher Nutzflächen gehört zu den wichtigsten Auslösern für die Umwandlung von Naturwaldflächen zusammen mit kommerziellem Holzeinschlag und der Ausdehnung der Infrastruktur. Die globale Entwaldung trägt 25 Prozent zu den menschlich verursachten Kohlenstoffemissionen bei. Dementsprechend werden Lösungen gesucht, um großflächige Entwaldungen gerade in tropischen Regionen zu stoppen, und um Maßnahmen zu entwickeln, durch die Kohlenstoff festgelegt werden kann. So genannte „Zahlungen für Umweltdienstleistungen“ (PES) bieten die Möglichkeit, Anreizstrukturen für den Schutz natürlicher Ressourcen zu schaffen und werden als ein marktbasierter Ansatz für Ausgleichszahlungen zur Unterstützung von nachhaltigem Forstmanagement sowie Naturschutzaktivitäten eingesetzt.

Die vorliegende Studie trägt mit Hilfe einer empirischen Datenerhebung auf der indonesischen Insel Sulawesi zur Forschung für Klimaschutzstrategien bei. In der Umgebung des Lore Lindu Nationalparks in Zentral-Sulawesi wird die Abholzung von Regenwald in erster Linie von ländlichen Haushalten vorangetrieben. Eine besonders expansive Form der Landnutzung ist in dieser Region der Anbau von Kakao in Agroforstsystemen. Die Anbaufläche wurde in den letzten 20 Jahren von 0 auf 18.000 Hektar ausgedehnt und neue Plantagen wurden im Randzonengebiet und teilweise auch innerhalb des 220.000 Hektar großen Nationalparks angelegt. Das Hauptanliegen dieser Studie ist es, die Auswirkungen von Ausgleichszahlungen für Kohlenstofffestlegung, so genannte Emissionszertifikate, auf die lokalen Haushalte und ihre Landnutzungssysteme zu beschreiben und die institutionellen Rahmenbedingungen für die mögliche Ausführung eines PES Programms zu prüfen. Zum

einen wurde auf der Haushaltsebene wurde untersucht, ob Emissionszertifikate als Anreizmechanismus für a) eine nachhaltige Bewirtschaftung von Agroforstsystemen und b) einen wirksamen Schutz noch bestehender Regenwaldflächen eingesetzt werden können. Zum anderen wurden auf der Institutionen-Ebene Naturschutzabkommen (*Kesepakatan Konservasi Masyarakat* - KKM), die bereits auf Gemeindeebene bestehen, auf ihr Potential als Ausgangsbasis für ein PES-Programm für Zahlungen für Kohlenstofffestlegung geprüft.

Die Analysen setzen sich aus einer quantitativen und eine qualitativen Studie zusammen. Durch die Kombination und Ergänzung der unterschiedlichen Methoden konnten die unterschiedlichen Ebenen der Haushalte und der Institutionen in PES-Programmen untersucht werden. Mit Hilfe eines komparativen statischen linearen Programmierungsmodels wurde das Haushaltsverhalten hinsichtlich möglicher Veränderungen in den Landnutzungsaktivitäten durch die Einführung der Politikoption der Emissionszertifikate analysiert. Die untersuchten Kakao-Agroforstsysteme (AFS) wurden in vier Intensivierungskategorien eingeteilt. Dabei weist das AFS D eine hohe Anzahl von Schattenbäumen und einen geringen Aufwand- und Materialeinsatz auf, wohingegen das AFS G am anderen Ende des Spektrums sehr intensiv bewirtschaftet wird und Schattenbäume weitgehend entfernt wurden. Entlang des Kakao-Intensivierungsgradienten vom AFS D zum AFS G steigen die Deckungsbeiträge der Kakaoproduktion, was für die Kleinbauern einen ökonomischen Anreiz zur weiteren Schattenbaumentnahme und Intensivierung der Produktion bietet. Die Datengrundlage dieser Studie bildet eine Haushaltsumfrage in einer Stichprobe von 46 Haushalten in 6 Dörfern. Hierfür wurden die Haushalte anhand ihres dominanten Kakao-AFS in vier Typen unterteilt (HH_D-HH_G). Zur Auswertung der institutionellen Rahmenbedingungen für PES Programme wurden in vier Dörfern die Auswirkungen der Naturschutzabkommen in Fokusgruppen diskutiert. Mit Hilfe partizipativer Methoden konnte die Wahrnehmung bezüglich der Partizipationsprozesse und institutionellen Rahmenbedingungen in zwei verschiedenen sozialen Gruppen, den Entscheidungsträgern und den Bauern, herausgearbeitet werden.

Die erforderlichen Zahlungen für Kohlenstofffestlegung sind für das AFS D mit der dichtesten Schattenkrone am höchsten, da es das größte Kohlenstoffspeicherungspotential hat. Auf Haushaltsebene sind die relativen Auswirkungen durch die Zahlung auf den Gesamtdeckungsbeitrag für den Haushalt D am stärksten ausgeprägt und variieren zwischen 4 Prozent (€5 pro tCO_2e) bis 18 Prozent mit Preisen von €25 pro tCO_2e. Hingegen sind die Auswirkungen für den Haushalt G sehr gering. Mit den Zertifikatspreisen, die zurzeit auf den Märkten gehandelt werden, kann kein ausreichender finanzieller Anreiz für Landnutzungsveränderungen sichergestellt werden. Preisaufschläge durch

Kohlenstoffzertifikate für den schattenintensiven Kakao bieten Lösungsansätze, um den Intensivierungsprozess zu reduzieren. Die Ergebnisse zeigen, dass durch differenzierte Emissionszertifikatspreise bis €32 pro tCO_2e Anreize für die Haushaltstypen D, E und F geschaffen werden, so dass diese zu den jeweils schattenreicheren AFS wechseln. Damit die Haushaltstypen D, E und F ihre Abholzungsaktivitäten einstellen und um die momentane Entwaldungsrate von 0,3 Prozent zu reduzieren, müssten die Zertifikate einen Preis bis maximal 23€ pro vermiedene Tonne CO_2e aufweisen. Die dem schattenintensiven AFS D beigeordneten Haushalte gehören gleichzeitig zu dem einkommensschwächsten Drittel der Bevölkerung. Durch zielgerichtete kohlenstoffbasierte Ausgleichszahlungen für die schattenreichen AFS bieten sich Lösungen an, insbesondere für diese ärmeren Haushalte den Teufelskreis von Entwaldung und Armut unterbrechen, sowie ihr Einkommen zu verbessern und gleichzeitig die AFS Typen, die den größten Umweltnutzen bieten, zu fördern. Wenn man ein CO_2-Speicherungsprojekt in der Region implementieren wollte, können die institutionellen Gefüge der regional existenten Naturschutzabkommen als Ausgangspunkt genutzt werden. Diese lokalen Institutionen bieten neben einem Regelwerk auch eine Instanz, die Kontrollaktivitäten durchführt. Die KKM befassen sich mit der Kontrolle illegaler Landnutzungsaktivitäten und der Einhaltung der Gesetze zum Schutz des Waldes. Rodungsaktivitäten sind zurückgegangen und das Umweltbewusstsein der Dorfbewohner hat zugenommen, seitdem die Abkommen etabliert wurden. Die Umsetzung der KKM ist jedoch finanziell nicht gut abgesichert und die Verantwortlichkeiten wurden auf Dorfebene zwischen den verschiedenen Institutionen nicht klar festgelegt. Zudem war die Beteiligung der Dorfbewohner bei den Verhandlungen und der Etablierung der Abkommen sehr gering, was eine schlechte Akzeptanz unter der Bevölkerung und damit auch eine unzureichende Einhaltung der Gesetze zur Folge hatte. Für ein potentielles PES-Projekt müssen die institutionellen Rahmenbedingungen gestärkt und die Partizipation der Bevölkerung in den Naturschutzaktivitäten unterstützt werden.

Die Politikempfehlungen, die aus den Ergebnissen dieser Studie abzuleiten sind, beziehen sich auf die Anwendbarkeit der PES-Programme als eine mögliche Klimaschutzstrategie, ihre Stärken, Schwächen und ihre institutionelle Gestaltung. Abhängig vom lokalen Kontext können erhöhte Kohlenstofffestlegungsraten durch PES-Programme gefördert werden. Zudem werden stabile Einkommensstrukturen für die lokale Bevölkerung ermöglicht und der Teufelskreis von Armut und Abholzung kann unterbrochen werden. Im Vergleich zu anderen landwirtschaftlichen Aktivitäten bietet die verhinderte Abholzung eine kosteneffiziente Möglichkeit, um den Ausstoß von Treibhausgasen zu mindern. Lokale Institutionen, die für das Management von natürlichen Ressourcen genutzt werden, bieten eine gute Basis für potentielle PES-Programme, da durch die Nutzung vorhandener Strukturen Transaktionskosten reduziert und die lokale Bevölkerung eingebunden werden können.

RINGKASAN

Negara-negara berkembang khususnya yang terletak di daerah tropis menghadapi tingkat penebangan hutan (*deforestasi*) yang tinggi. Demikian juga di tingkat global, wilayah hutan secara konstan semakin mengalami penurunan. Berbagai faktor melatar-belakangi hal ini, yang salah satunya dikarenakan oleh peningkatan penggunaan lahan pertanian. Di sisi lain, seperempat dari karbon emisi yang dihasilkan oleh manusia diakibatkan oleh kegiatan deforestasi tersebut. Berdasarkan hal-hal di atas, diupayakan untuk mencari solusi dalam mengatasi masalah proses peralihan lahan dan hutan dan juga dibutuhkan strategi-strategi aktif untuk mengamankan cadangan karbon yang masih tersedia. Program atau skema pembayaran atas jasa lingkungan adalah salah satu cara yang berpotensi untuk mempromosikan perlindungan terhadap sumber daya alam, yang didasari atas insentif pasar dalam mencanangkan atau mendukung kelestarian perlindungan hutan dan alam.

Penelitian ini adalah hasil dari pengamatan empirik di wilayah Sulawesi Tengah Indonesia, yang hasil penelitiannya menyumbangkan strategi-strategi untuk mengurangi dampak dari perubahan cuaca global pada suatu proyek penelitian yang saat ini masih berlangsung. Keluarga-keluarga petani yang berada di sekitar wilayah taman Nasional Lore Lindu berperan dalam proses peralihan lahan dari hasil kegiatan pertanian mereka. Dalam kurun waktu 20 tahun, wilayah yang diperuntukan bagi perkebunan cokelat bertambah dari 0 hektar menjadi 18.000 hektar. Dimana kebun-kebun cokelat yang berada di dalam wilayah taman nasional mempunyai bagian jumlah yang cukup penting. Tujuan dari penelitian ini adalah untuk menganalisa pengaruh dari pembayaran atas pemisahan (*sequestrasi*) karbon dan sistem penggunaan lahan oleh keluarga petani, dan juga untuk meneliti kerangka kerja satu instutitusi atau badan dari program kegiatan tersebut. Di tingkat petani kami meneliti jumlah pembayaran potensial untuk mengadopsi sistem pengunaan lahan yang ramah lingkungan

yang mampu menawarkan mekanisme perlindungan hutan. Di tingkat badan atau institusi, kami meneliti struktur yang ada dalam masyarakat tentang kesepakatan konservasi atau perlindungan alam.

Untuk tujuan penelitian, kami melaksanakan penelitian berdasarkan metode kuantitatif dan kualitafif. Dengan mengkombinasikan berbagai metode kami dapat mengkonsentrasikan pada dua tingkatan yang dihubungkan dengan program pembayaran jasa lingkungan, dan dapat memungkinkan metode tersebut untuk saling melengkapi. Untuk menganalisa perilaku rumah tangga dan perubahan yang terjadi dikarenakan oleh pengenalan akan pilihan kebijakan dari pembayaran karbon, kami menerapkan suatu perbandingan dengan menggunakan program linier statis. Sistem agroforestri cokelat dikelompokan atas empat tipe. Tipe D menggambarkan tingkat tanaman peneduh yang tinggi dan intensitas manajemen yang rendah. Sebaliknya, tipe G melibatkan intensitas manajemen yang tinggi dengan pencahayaan matahari penuh dalam penanaman cokelat. Besar margin kotor dari cokelat akan bertambah dengan intensitas gradien dari sistem agroforestri cokelat dari tipe D ke tipe G. Proses intensitas tersebut dipantau dari runtutan menurunnya densitas tanaman pelindung atau naungan. Data untuk pemodelan bersumber dari survei di tingkat rumah tangga yang dihasilkan dari empat puluh enam keluarga yang berlokasi di enam desa. Rumahtangga tersebut dikelompokkan berdasarkan atas sistem agroforestri yang paling dominan pada kebun cokelat mereka yang terbagi dalam empat kelompok yaitu dari kelompok HH_D sampai HH_G. Di tingkat institusi, kami membahas dan mengevaluasi dampak dari pembentukan institusi dalam kesepakatan konsevasi masyarakat dalam satu wadah kelompok khusus yang bersumber dari empat desa. Dengan menggunakan cara ini, memungkinkan pemahaman yang lebih mendalam tetang proses partisipasi dan kerangka kerja dari kesepakatan-kesepakatan yang terdiri dari dua kelompok sosial yang berbeda.

Hasil penelitian menggambarkan bahwa di tingkat area penanaman, pembayaran untuk sequestrasi karbon lebih tinggi untuk sistem agroforestri dengan naungan penuh karena memiliki nilai tertinggi untuk total karbon yang disequestrasi. Dengan memfokuskan pada tingkat rumah tangga sebagai hasil pengenalan sistem pembayaran tersebut, kelompok HH_D adalah yang paling menunjukkan dampak relatif atas total margin kotor mereka, yang bernilai empat persen saat harga yang ditawarkan rendah sampai dengan nilai margin delapan belas persen untuk tawaran pembayaran harga karbon yang tinggi. Sedangkan dampak dari kelompok HH_G menunjukan nilai yang sangat rendah. Pada skala besaran ini, tidak satupun dari rumah tangga menyadari adanya perubahan dalam kegiatan penggunaan lahan mereka. Insentif ekonomi seperti pembayaran harga premium ditawarkan melalui pemberian sertifikasi atas intensitas naungan dapat menjadi salah satu cara untuk menurunkan proses intensitas. Insentif disediakan bagi tiga kelompok rumah tangga dengan membedakan harga karbon sampai dengan nilai tiga puluh dua Euro per ton karbondioksida equivalen, agar mereka menanam lebih banyak tanaman naungan untuk cokelat. Misalkan tingkat deforestasi yang sekarang ada menjadi menurun dan harga yang dibayarkan untuk setiap ton karbondioksida equivalen adalah dua puluh tiga Euro, insentif yang diberikan masih cukup tinggi untuk kelompok rumah tangga D, E dan F untuk menghentikan kegiatan peralihan hutan. Situasi *win-win* akan didapatkan dengan hanya mentargetkan intensitas naungan dalam sistem agroforestri melalui pembayaran karbon. Rumahtangga-rumahtangga miskin adalah yang paling memperoleh keuntungan ekonomi, sehingga lingkaran setan dari kegiatan deforestasi dapat dihentikan dan sistem penggunaan lahan yang menguntungkan bagi lingkungan dapat dipromosikan. Jika program pembayaran atas sequestrasi kabon hendak diimplementasikan di suatu wilayah, maka bentuk institusi yang sudah ada seperti kelompok kesepakatan konservasi dapat dijadikan sebagai titik awal pelaksanaan kegiatan. Kelompok ini mewadahi kerangka kerja aturan dan kepemilikan yang sudah terbentuk didasarkan atas kesepakatan, yang dapat digunakan sebagai landasan untuk kegiatan monitoring. Dimana telah mencakup aktifitas kegiata-kegiatan illegal dan penegakkan aturan atas tindakan pelanggaran tersebut. Disebabkan oleh pembentukan badan ini, kegiatan ekstrasi menjadi menurun dan kesadaran lingkungan meningkat. Akan tetapi, pembentukan badan baru ini belum kuat dikarenakan terbatasnya ketersediaan dana dan definisi tanggungjawab yang belum jelas. Di samping itu, keterlibatan masyarakat desa dalam negosiasi kesepakatan dan proses pembentukan sangat terbatas, membuat penerimaan dan pemenuhan aturan-aturan menjadi sulit. Berdasarkan hal tersebut, untuk satu proyek pembayaran karbon yang potensial dibutuhkan kerangka kerja institusi yang kuat dan juga penerapan partisipasi komunitas atas kegiatan konservasi.

Implikasi kebijakan yang dihasilkan dari studi ini dikhususkan pada penerapan program pembayaran karbon sebagai strategi untuk mengurangi dampak buruk dari perubahan cuaca global, dan juga mencakup kekuatan dan keterbatasan pembentukan institusi untuk penerapan pelaksanaanya. Berdasarkan atas konteks daerah, program-program ini menyediakan jasa lingkungan yang lebih baik dengan tingkat sequestrasi karbon yang tinggi. Bersamaan dengan itu, program jasa pembayaran lingkungan menawarkan sumber pendapatan yang stabil bagi masyarakat setempat dan dapat mematahkan lingkaran setan dari kemiskinan dan deforestasi. Selain itu, deforestasi dalam kegiatan pertanian dapat dihindarkan dengan menyediakan solusi dengan biaya efisien untuk mengurangi dampak efek rumah kaca. Kerangka kerja institusi lokal digunakan untuk proses manajemen sumberdaya alam sebaiknya dimanfaatkan untuk program kegiatan tersebut, didasarkan atas ketersediaan basis yang baik untuk mengurangi biaya transaksi dan juga untuk mengintegrasikan komunitas lokal. Akan tetapi, untuk mengimplementasikan sistem pembayaran karbon, kemampuan aplikasi program di setiap wilayah lokal perlu dikaji berdasarkan setiap kasus.

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Christina Seeberg-Elverfeldt

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A/R	Afforestation and Reforestation
BPD	*Badan Perwakilan Desa* (Village Representative Body)
BTNLL	*Balai Taman Nasional Lore Lindu* (Lore Lindu National Park Administration)
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
CIFOR	Centre for International Forestry Research
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalents
COP	Conference of the Parties
CSIADCP	Central Sulawesi Integrated Area Development and Conservation Project
dbh	Diameter at Breast Height
DNA	Designated National Authority
EU ETS	European Union Emission Trading Scheme
EUA	European Emissions Allowances
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GHG	Greenhouse Gas
ha	hectare
IDR	Indonesian Rupiah
KKM	*Kesepakatan Konservasi Masyarakat* (Community Conservation Agreement)
LA	*Lembaga Adat* (Customary Village Council)

LKD	*Lembaga Konservasi Desa* (Village Conservation Council)
LULUCF	Land-Use, Land-Use Change and Forestry
m.a.s.l.	meters above sea level
MPB	Marginal Private Benefit
MPC	Marginal Private Cost
MSB	Marginal Social Benefit
MSC	Marginal Social Cost
NGO	Non-Governmental Organisation
NPV	Net Present Value
NSW GGAS	New South Wales Greenhouse Gas Abatement Scheme
NTFP	Non-Timber Forest Products
OECD	Organisation for Economic Co-operation and Development
OTC	Over-The Counter Market
PEI	*Persatuan Evergreen Indonesia* (Association of Evergreen Indonesia)
REDD	Reduced Emissions from Deforestation and Degradation
RUPES	Rewarding the Upland Poor for Ecosystem Services
STORMA	STability Of Rainforest MArgins
t	ton
TGM	Total Gross Margin
TNC	The Nature Conservancy
TNLL	*Taman Nasional Lore Lindu* (Lore Lindu National Park)
UNFCCC	United Nations Framework Convention on Climate Change
VER	Verified Emission Reductions
yr	year
YTM	*Yayasahn Tanah Merdeka* (Free Land Foundation)

1. INTRODUCTION

1.1. Meeting Challenges posed through Climate Change

In recent years scientific evidence has been growing that climate change presents a serious risk to humanity, and requires action to mitigate its effects. Investigations demonstrate that a 70 percent increase in atmospheric carbon dioxide (CO_2) and other greenhouse gas (GHG) emissions can be attributed to human activities between 1970 and 2004 (IPCC 2007). The major sources of these anthropogenic CO_2 emissions are fossil fuel combustion and cement production (75 percent) and land-use changes (approximately 25 percent) (IPCC 2007). The major factors of these land-use change emissions are deforestation, as well as changing agricultural practices. Developing countries, especially those in tropical areas, continue to experience high rates of deforestation, but also on a global scale the forest cover is constantly decreasing. Between 1990 and 2005, the world lost three percent of its total forest area, an average decrease of 0.2 percent annually (FAO 2007). Primary forests, of which a high proportion are located in tropical countries, are lost or modified at a rate of six million hectares per year because of selective logging or deforestation, and there is no indication that the rate is slowing (FAO 2006). Some of the highest deforestation rates in absolute numbers are shown in the following Table 1.1.

The drivers of deforestation are very complex, making it a difficult issue to tackle on a national scale. Five broad categories can be determined as underlying driving forces of deforestation. These are demographic, economic, technological, policy and institutional and cultural factors. In general, at the proximate level, infrastructure extension, agricultural expansion, as well as wood extraction are the main causes of tropical deforestation and land-use change (Geist and Lambin 2002). The majority of deforestation incidences are connected to agricultural expansion. The incentive for forest conversion for many smallholders can be attributed to the fact that other land-uses such as permanent cropping, cattle ranching, shifting cultivation, and colonization agriculture yield higher revenues than forestry. Smallholders can contribute to deforestation processes with their land-use practices, especially if they are driven by short-term economic profits. Hence, local emissions of carbon are affected and carbon stocks and associated fluxes are often negatively influenced.

Table 1.1. Deforestation Rates of Selected Tropical Countries

	1990-2000		2000-2005	
	1,000 ha	**%**	**1,000 ha**	**%**
Brazil	-2,681	-0.5	-3,103	-0.6
Indonesia	-1,872	-1.7	-1,871	-2.0
Philippines	-262	-2.8	-157	-2.1
Nigeria	-410	-2.7	-410	-3.3
Sudan	-589	-0.8	-589	-0.8
Ecuador	-198	-1.5	-198	-1.7

Source: FAO 2007

In the framework of the Kyoto Protocol, forests are recognized as playing a role in mitigating greenhouse gas emissions, since carbon dioxide is removed through photosynthesis (UNFCCC 2001). Different mechanisms exist which enable countries to meet their greenhouse gas emission limitations by purchasing emission reductions elsewhere. The generated carbon credits can be derived amongst other project types from forestry activities.

Indonesia is endowed with some of the most extensive and biologically diverse tropical forests in the world. However, Indonesia, after Brazil, is the country with second highest loss of forest in absolute values. Furthermore, forest conversion in Indonesia is progressing at a higher rate in the 2000s than in the 1990s (see Table 1.1.). Widespread deforestation processes occurred after the 1950s and the forest cover has decreased from 162 million ha to 98 million ha. Illegal logging has been a major cause of this loss, as well legal logging and industrial timber plantations. Small-scale farmers have been contributing significantly to this forest clearance but they have not been a dominant factor (FWI/GFW 2002). These high rates of deforestation are also one of the main contributing factors resulting in Indonesia being the third largest greenhouse gas emitter (World Bank 2007).

Thus, strategies are needed which provide incentives on the one hand to counteract degradation and deforestation processes and on the other hand to offer climate change mitigation options.

1.2. Objectives of the Investigation

This study was conducted in the Lore Lindu region in Central Sulawesi, Indonesia. It is part of the sub-project A4 of the research programme "Stability of Rainforest Margins in Indonesia" (STORMA) carried out by two Indonesian Universities (Institut Pertanian Bogor and Universitas Tadulako, Palu) and two German Universities (Universität Kassel and Georg-August Universität Göttingen). The project is supported by the German Research Foundation (DFG) as a Collaborative Research Centre (SFB 552).

The population living in the vicinity of the Lore Lindu National Park (*Taman Nasional Lore Lindu* - TNLL) is predominantly engaged in agricultural activities. The most important crops are paddy rice for subsistence, as well as cacao, the dominant cash crop in the region. A "cacao boom" has taken place in the region, and its cultivation has risen by 230 percent over the last two decades (Steffan-Dewenter et al. 2007). The primary and secondary forest margin of the 220.000 hectares of the National Park forest has been encroached by smallholders in their pursuit of agricultural land (Burkard 2002). In addition, an intensification process among the cacao agroforestry systems, whereby farmers gradually remove the shade tree cover and adopt more input-intensive practices, can be observed. As a measure to resolve conflicts between peoples' needs and conservation demands of the National Park, in several villages community conservation agreements (*Kesepakatan Konservasi Masyarakat* - KKM) have been established. These are a co-management strategy and have been negotiated between the village community and the TNLL authority (*Balai Taman Nasional Lore Lindu* - BTNLL) in co-operation with several non-governmental organisations (NGOs).

The objective of the study is twofold and assesses distinct components at two different levels. We are evaluating the market-based instrument of payments for environmental services (PES) and its impact at the household level, as well as the requirements for its institutional arrangement. Specifically, we explore at the household level:

I. The impact of payments for carbon sequestration activities on the land-use systems of smallholders in the regions bordering the TNLL in Indonesia.

II. Furthermore, we assess whether such payments can provide an incentive for the adoption of more sustainable and shade tree covered land-use practices.

III. Finally, whether the payments for avoiding deforestation can contribute to the conservation of the rainforest margin.

At the institutional level, we aim to explore the necessary conditions and institutional settings for a PES scheme. Therefore, using the example of the KKMs, we assess:

IV. Whether they provide the institutional arrangement and linkages for a carbon sequestration project.

V. If they allow for the participation of the local community, as well as for monitoring and enforcing the performance of such a project.

VI. Finally, we evaluate their impact on the status of the environment.

In order to make policy recommendations, a profound understanding is necessary of the incentive mechanism and the impact it has on land-use changes. In this study we investigate the payments for carbon sequestration and their adequacy and applicability for rural land-use systems. Since most of the households in the research region are considered to be poor, our aim is to determine whether these payments could contribute, not only to their primary goal of improving an environmental service, but also to raise the rural poors' income. Based on the knowledge gained of the institutional framework of the KKMs, suggestions can be made with respect to the negotiation and management of community natural resource projects. The insights and results gained are specific for the Lore Lindu region but certain conclusions and recommendations can be generalised for PES schemes in developing countries.

1.3. Structure of the Study

Chapter 2 provides background information on the politics of climate change and specifically of carbon finance. It gives an overview of the carbon markets, the compliance and the voluntary market and then explains in more detail the regulatory context of the Kyoto Protocol. Consequently, it turns towards the forestry sector and the implications and limitations of the Clean Development Mechanism for the development of carbon sequestration projects. This leads to a review of voluntary initiatives, specifically in light of their importance for promoting projects to reduce emissions from degradation and deforestation. The Chapter concludes with a summary of the present situation of climate mitigation activities in the forestry sector in Indonesia and a general outlook.

The theoretical framework for the analysis of PES schemes is introduced in Chapter 3. We begin with an explanation of the theory and concept of externalities and their application to PES schemes as a market-based incentive mechanism for positive externalities. The different environmental services are described and the experience up-to-date with these types of projects. Then we review the literature with respect to the proposed link between PES schemes and poverty reduction and its potential for win-win situations. The institutional frameworks for natural resource management projects are discussed, as well as the implications of transaction costs and barriers-to-entry in PES projects for smallholders. Finally, we derive the conceptual framework for the empirical research.

In Chapter 4 we introduce the research region, focusing first on its geographical and biophysical characteristics, followed by an outline of the socio-economic background and the prevailing land-use dynamics. This allows the reader to understand the factors contributing to the encroachment at the forest margin of the National Park and to put the subsequent analysis into the specific context of the Lore Lindu region.

Consequently, we explain the methodologies employed in the research design in the next two chapters. As we have used a quantitative and a qualitative approach based on the twofold objective of the study, they have been respectively separated into Chapter 5 and 6. By means of a household survey we collected quantitative data on the agricultural activities using a standardised questionnaire. To calculate the carbon sequestration rates of the agroforestry systems, as well as of the TNLL forest, we used a carbon accounting technique. The household data, as well as the carbon sequestration rates of the (agro) forest systems provide important inputs for the subsequent analysis. Finally, we turn to the methodology used for the farm household modelling. Different approaches and model types are appraised, guiding towards the choice of a linear programming model. Its structure is explained, which will be used and adjusted in the ensuing analysis to the specific local characteristics and requirements.

Then we continue in Chapter 6 with the qualitative research design chosen for the second part of the investigation to evaluate an appropriate institutional arrangement for community natural resource management projects. We start out with an introduction to qualitative research methods and the reasons for selecting these. Then we first illustrate our procedure and consequently underpin this with the theoretical background of the selected methodologies. Thus, we begin by outlining the criteria for the selection of the research villages, as well as the participatory tools employed for the data collection. Based on this approach, we explain the methodology for focus groups, as well as the content analysis method, which we used for the interpretation of the subject matters of the discussions.

In the next two chapters we display the results from the quantitative - Chapter 7 - and qualitative - Chapter 8 - study. After discussing the household model, the inputs used and the assumptions made, the baseline results of the model are presented. Subsequently, the payments for carbon sequestration are introduced and different scenarios developed. In these scenarios we assess the impact of changing carbon credit prices and consequences for the households and their income, as well as their potential to stimulate a change in land-use. Additionally, a scenario of reducing deforestation in the TNLL is developed. Finally, the discussion draws conclusions with respect to carbon payments offering solution to the vicious cycle of deforestation and poverty.

In Chapter 8 the requirements for an institutional arrangement of carbon sequestration projects are developed. These are the results we obtained from the analysis of the KKMs, which were used as an example of a natural resource management project. The analysis focused on the institutional and participation structures of the agreements, its monitoring and enforcement arrangements and the impact on the environment due to their establishment. Finally, conclusions are drawn with respect to the adequacy of using the agreements as a platform for a carbon sequestration project.

Finally, in Chapter 9 we point out the answers to the research questions entailed in the objectives and summarise the main results of the study. Some limitations of the study are pointed out which guide towards potential fields of further research. We conclude with relevant policy implications and recommendations for PES programmes, avoided deforestation initiatives, as well as the institutional implementation of such schemes.

2. CARBON FINANCE – POLITICAL BACKGROUND AND DISCUSSION

2.1. Regulatory Context and Markets

The economic impacts of climate change have been discussed among scientists for a long time, yet they have become much more a focus of attention since the publication of the Stern Review (Stern 2006) in October 2006. The stand out message of the report was that the benefits of strong, early actions considerably outweigh the incurred costs. By investing one percent of the global gross domestic product (GDP) per year in its reduction, the worst effects of climate change can be avoided. The consequence of not taking action and investing in climate change mitigation activities will eventually damage economic growth and could result in a 20 percent lower global GDP than there would otherwise be.

National governments as well as intergovernmental institutions have become active in promoting various climate change policies. Carbon finance has emerged, with the objective of finding the lowest cost emission reduction possibilities. Carbon has become a valuable economic commodity, resulting in carbon dioxide (CO_2) and other greenhouse gases (GHG) carrying prices and being traded on carbon markets. Over the last few years several financial instruments and mechanisms to regulate this trade have emerged, as well as numerous voluntary initiatives.

The present study is oriented towards the regulated market of the Kyoto Protocol (KP), specifically the Clean Development Mechanism (CDM). The next section presents a short overview of the carbon market in general, followed up by the regulatory context of the compliance market.

2.1.1. Market Overview

The carbon market can be divided into two segments; the *regulatory compliance* and the *voluntary* markets. The compliance market consists of companies and governments that by law must surrender emission allowances or credits and it is regulated by mandatory national, regional or international carbon reduction regimes. The voluntary market includes the generation and transaction of carbon credits in non-compliance markets. The credits are produced for the purpose of selling them to voluntary end users and not to compliance buyers. The World Bank (2008) estimates that the total traded volume in the global carbon market was 2.9 Gt CO_2e in 2007 (see Table 2.1.), an increase of 42 percent compared to the previous year. The value of the carbon traded grew by 100 percent in the same period to €47 billion. The largest carbon market is the EU Emissions Trading Scheme (EU ETS, explained in 2.1.2) with a share of 69 and 78 percent of the physical and financial markets respectively. The second largest market is the CDM, which has been growing considerably in 2007 and constitutes 27 percent of the physical and 20 percent of the financial market. The voluntary market has also been increasing and was up by 66 percent in 2007. However, the traded volumes are only a small proportion of the total traded volume, with 65 Mt CO_2e in 2007 compared to 43 Mt in 2006 and a share of under one percent of the total financial value (Capoor and Ambrosi 2008).

Table 2.1. Overview of the Carbon Market in 2007

	Volume (Mt CO_2e)	**Value (Million €)**	**Certificate type**
Compliance Market			
EU ETS	2,061	36,836	EA
JI	41	367	PBA
CDM	791	9,468	PBA
NSW GGAS	25	165	EA
Voluntary Market			
CCX	23	53	EA
Other voluntary transactions	42	195	PBA
Total	2,983	47,000	

EA: emission allowances, PBA: project-based activity emission reduction,

JI: Joint implementation

Source: Capoor and Ambrosi (2008), Hamilton et al. (2008)

The worldwide carbon emission market can additionally be divided according to the types of emission reduction certificates: The first type of *emission reductions* are generated through *project-based activities* when a buyer purchases emission reductions from a project that produces measurable reductions in GHGs. Some project-based transactions are conducted to meet voluntary targets, but most are ultimately intended for compliance with the KP or other regulatory regimes. The second type of emission reduction is the trading of GHG *emission allowances,* allocated under existing, or upcoming, cap-and-trade regime of different states. Examples are the EU Allowances, the Chicago Climate Exchange (CCX) and the Australian New South Wales Greenhouse Gas Abatement Scheme (NSW GGAS).

The voluntary market can be divided into two categories, the voluntary, but legally binding, cap-and-trade Chicago Climate Exchange (CCX) and the "Over-the-Counter" (OTC) market, which is characterised by bilateral deals and is not based on an exchange (Hamilton et al. 2008).

The CCX is *"North America's only and the world's first global marketplace for integrating voluntary legally binding emissions reductions with emissions trading and offsets for all six GHGs, with offset projects worldwide*" (CCX 2008). Membership is voluntarily, but is subject to a legally binding reduction policy. It is owned by the holding company Climate Change PLC. The OTC market is not part of a cap-and-trade system with an emission allowance trade; the carbon offsets originate from project-based transactions and the buyers are motivated to offset their own emissions. The traded credits are often referred to as Verified Emission Reductions (VER), or carbon offsets. Voluntary buyers can also purchase credits from the compliance markets or the CCX (Hamilton et al. 2008). Concerns about individual air travel and a growing sense of corporate social responsibility have had a considerable impact on the growth of this market as organisations and companies are increasingly trying to become "carbon neutral" (Neff et al. 2007).

A number of government voluntary purchasing programmes also exist, such as Japan's Keidanren Voluntary Action Plan on the Environment, with voluntary purchases of carbon offsets. In Australia the Greenhouse Challenge Plus Programme was created by the government to improve the energy efficiency and reduce GHG emissions of companies.

Some of the voluntary carbon initiatives in the OTC market have an additional impact on the forestry market - these will be addressed in more detail in 2.3.

2.1.2. *Kyoto Protocol and the Compliance Market*

The overall framework for intergovernmental efforts to tackle the challenge posed by climate change was established by the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The Kyoto Protocol, adopted in 1997 at the third Conference of the Parties (COP), complements the UNFCCC and was eventually enacted in 2005. It was ratified by 180 countries as of May 2008 (UNFCCC 2008). It is the first time that an enforceable agreement with quantitative targets for climate change mitigation has been taken. All Annex I Parties[1] that are party to the Convention have committed themselves to reduce their GHG emissions by 5.4 percent of their 1990 levels by 2012. Non-Annex I Parties (mostly developing countries) are recognized by the Convention as being especially vulnerable to the adverse effects of climate change, and investment, insurance and technology transfer activities are emphasized to assist these countries in their efforts to adapt to and mitigate climate change. The world's largest GHG markets have evolved[2] under the Kyoto regime. These markets are based on a cap-and-trade model. For fulfilling the reduction obligations, the KP offers three flexible mechanisms, namely Emissions Trading, Joint Implementation and the CDM.

Emissions Trading is an allowance-based transaction system that enables Annex I countries to purchase carbon credits from other Annex I countries to fulfil their emission reductions commitments. The mechanism has resulted in the European Union Emission Trading Scheme (EU ETS), which involves all EU member states and is currently the world's largest multinational GHG emissions trading scheme. The Scheme makes use of the credits called European Union Allowances (EUAs). According to the World Bank, in 2007 the EU ETS market traded 2,061 Mt CO_2e, and the market was valued at €36,836 million (Capoor and Ambrosi 2008).

Joint Implementation (JI) allows emitters in Annex I countries to purchase carbon credits via project-based transactions implemented in another Annex I country. Emissions from these JI projects are referred to as Emission Reduction Units (ERUs). The World Bank estimates that in 2007 there were 41 MtCO_2e of ERU credits transacted, and the market was valued at €367 million (Capoor and Ambrosi 2008).

[1] Annex I or Annex B parties include 36 countries, these are mostly OECD countries and economies in transition. They are listed in http://unfccc.int/parties_and_observers/parties/annex_i/items/2774.php.
Non Annex I countries are mostly developing countries, a list can be found under http://unfccc.int/parties_and_observers/parties/non_annex_i/items/2833.php

[2] Six GHGs are listed under the Kyoto Protocol: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons, and perfluorocarbons.

The Clean Development Mechanism (CDM), like the JI, is a project-based system. It allows industrialised countries to obtain carbon credits by implementing projects that reduce emissions in non-Annex I countries, essentially assisting the host Parties in achieving sustainable development and contributing to the ultimate objective of the UNFCCC to act against global warming and cope with temperature increases. The carbon offsets originating from registered or approved CDM projects are called Certified Emission Reductions (CER). Not only can the generated CERs can be used by Annex I countries to help meet their emission targets (FAO 2004), but the accepted CDM offset projects have an important impact on developing countries. In 2007, 551 Mt CO_2e of primary CDM credits were transacted, and the CDM market was valued at €5,460 million. Some of these credits were further sold into a burgeoning secondary market which traded 240 Mt CO_2e of secondary CDM credits, valued at €4,008 million (Capoor and Ambrosi 2008).

In some countries which have not ratified the Kyoto Protocol additional legally binding state and regional GHG reduction initiatives exist or are planned. The Federal government in the USA does not currently regulate GHG emissions. However, several states have initiated regulations on their own or in conjunction with other countries.

At the moment there are six markets operating or are in the planning stage:

- the first GHG regulation in the USA is the Oregon Standard which was enacted in 1997
- the Regional Greenhouse Gas Initiative (RGGI) is a regional strategy involving ten states from the East coast
- California's Global Warming Solutions Act (AB 32) is the first US state-wide programme to reduce GHGs from industries
- the Western Climate Initiative (WCI) is a collaboration of 11 partner states in the US and Canada developing a market-based mechanism to reduce GHG emissions
- the Midwestern Regional GHG Reduction Programme includes six US states and one Canadian state; and the Climate Registry. The Climate Registry is not yet a cap-and-trade system, but could be of importance for any future federal initiative, since thirty-nine US states, six Mexican states and six Canadian provinces have signed on to it (Hamilton et al. 2008).

In Australia the NSW GGAS is a mandatory state-level programme aiming at "*reducing GHG emissions associated with the production and use of electricity; and to develop and encourage* *activities to offset the production of GHG emissions*" (NSW GGAS 2008). It started in 2003 and trades the New South Wales Greenhouse Gas Abatement Certificates (NGACs). Outside the KP this is the world's largest, regulated cap-and-trade GHG market with about 25 Mt CO_2 traded in 2007 and an estimated value of €165 million (Capoor and Ambrosi 2008).

2.2. Forestry Sector

Land-use changes, which are dominated by deforestation, with contributions from changing agricultural practices, are responsible for about 20-25 percent of human-caused CO_2 emissions (IPCC 2007). It is the second largest source globally after fossil fuel use and contributes more than the entire global transport sector. Therefore, when deforestation and land-use change decrease and natural systems are restored, opportunities are provided to decrease carbon emissions. Some of these activities can have the additional benefit of increasing the CO_2 uptake, protecting biodiversity, as well as restoring and reconnecting natural systems. Forestry activities, so-called sink projects[3], are an important means of mitigating GHG emissions because CO_2 is removed through photosynthesis. Under the agreements reached at the COP7 in Marrakesh in 2001, the rules for sink projects in the CDM were established and in non-Annex I countries only projects implemented for afforestation and reforestation (A/R) activities are considered. The exchange units are carbon credits or CER, which is a measure of the amount of CO_2 kept from the atmosphere either by avoiding an emission or creating a sink[4]. On the Kyoto market, and under the rules of the CDM, the forestry sector is quite restricted. Among all CDM projects the forestry sector provides 0.5 percent of all activities, as can be seen in Figure 2.1. By June 2008 only one project had achieved registration under the CDM and eighteen projects had been submitted for validation[5] (UNEP Risoe, June 2008).

Some of the reasons why so few forestry projects have been validated, according to the experience of auditors of CDM projects, are; the lack of experience with forestry CDM, the broad variety of project types, the characteristics and the particularly demanding data requirements for forestry CDM such as spatial data management. Additionally, forestry projects often entail rural development issues, which complicate the validation processes. The

[3] Uptake and loss of carbon from terrestrial vegetation and soils.
[4] The terms carbon credits, certificates and CER are used interchangeably. One credit is considered equivalent to one tonne of CO_2 emissions.
[5] www.cdmpipeline.org/cdm-projects-type.htm

complexity of the auditing process and of the methodologies requires a considerable degree of specialisation[6] (Neff et al. 2007).

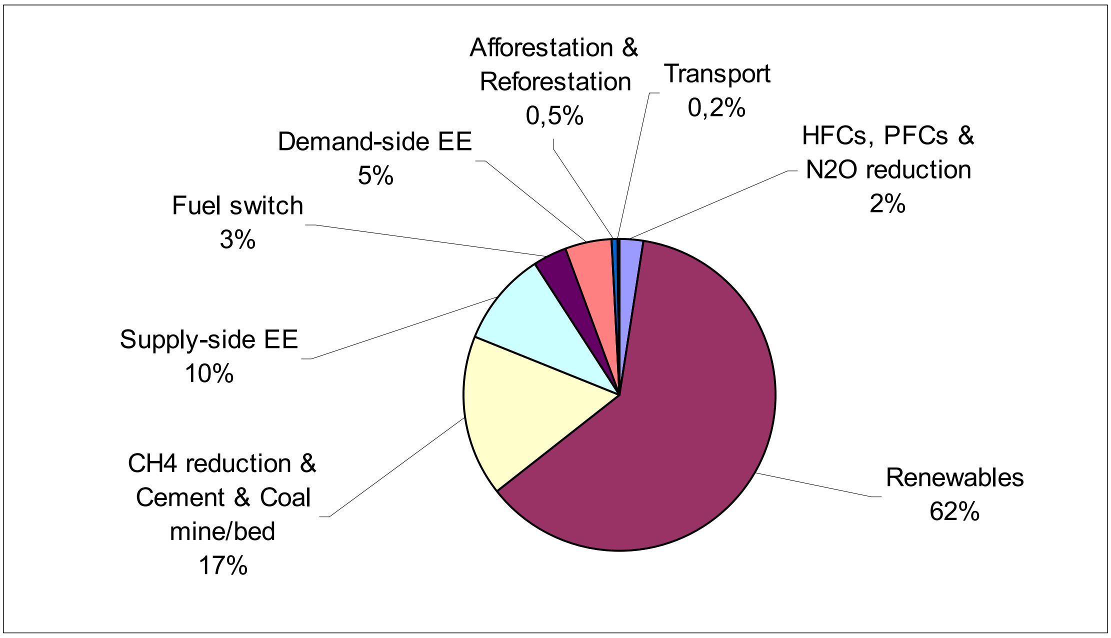

Figure 2.1. Number (%) of CDM Projects in each Category

Source: (UNEP Risoe 2008)

The voluntary markets have become the primary source of demand for forestry related sequestration credits. A growing number of project developers, mainly in developing countries, are implementing projects to create offset credits for the non-Kyoto markets. Forestry has the additional comparative advantage in the OTC market of being a "charismatic" project type as it has public appeal (Hamilton et al. 2008). Corporate responsibility and public relations are the most common motivations behind carbon offset purchases, together with considerations such as additionality, certification, reputation and environmental and social benefits.

2.2.1. Main Criteria, Relevant Rules and Decisions

All CDM forestry projects have to pass certain criteria to assess whether the project activity creates real reductions of GHG emissions compared to what would have occurred otherwise. There are also concerns with respect to the quality of the carbon credits in the voluntary sector. The important criteria are the same, regardless of whether projects are targeted towards CDM or the voluntary market:

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[6] For example, the CDM methodology AR-AM0007 entails 134 equations on 103 pages.

- Baseline

"*The baseline for a proposed A/R project activity under the CDM is the scenario that reasonably represents the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the proposed project activity*" (UNFCCC 2003). The baseline is therefore a hypothetical reference case, representing the volume of GHGs that would have been sequestered if the project activity had not been implemented. Hence, the carbon benefits can be calculated by deducting the baseline carbon storage and emissions from the carbon storage and emissions resulting from the project activities.

- Additionality

"*An A/R project activity under the CDM is additional if the actual net greenhouse gas removals by sinks are increased above the sum of the changes in carbon stocks in the carbon pools within the project boundary that would have occurred in the absence of the registered CDM A/R project activity*" (UNFCCC 2003). It is not necessary that the project is happening solely because of the carbon credits it produces, but the anticipated benefits of the carbon offsets have to be a decisive factor for pursuing the project. Thus, the question which needs to be asked is whether this project would have occurred anyway or are the project activities dependent on the sale of carbon credits?

- Leakage

"*Leakage is the increase in greenhouse gas emissions by sources which occur outside the boundary of an A/R project activity under the CDM which is measurable and attributable to the A/R project activity*" (UNFCCC 2003). Leakage can happen if activities are shifted or changes in supply and demand take place. It is a negative external impact caused by the project activity. In some cases the terms slippage or migration of benefits are used instead of leakage.

- Permanence of carbon storage and accountability

Especially forest projects are subject to permanence difficulty, as the length of the carbon storage and the risk of loss are a very important issue when accounting for the credits. Carbon is not stored indefinitely in forest biomass, therefore, a separate temporary crediting system was developed for A/R projects in which credits expire roughly between five and thirty years and can be renewed and resold (see Chapter 5.2. for specifics on carbon accounting methodology). In addition, there is an inherent risk of loss resulting from natural or human disturbances, such as fire, flood or pest outbreak. This can be managed by creation of buffer reserves of emission reductions or pooling of projects to share the risk (Kant 2007).

The quality of the CDM carbon emission reductions is determined by applying standards. An accredited independent verification board must approve the project design before it can generate CDM compliant emission reduction credits. Furthermore, approved methodologies will be used in the verification process. In 2007, there were seven large-scale methodologies available for forestry CDM which cover the above mentioned criteria. Recently two further methodologies were approved, which also allow agricultural intercropping between the planted trees and the use of the produced crops as livestock forage, as well as providing a tool for dynamic baseline estimation when planting on lands with vivid land-use dynamics, rather than restricting to abandoned and degraded land (Neff et al. 2007).

2.2.2. Voluntary Initiatives

The voluntary sector, as mentioned above, has become very important for forestry projects. Credits from Land-use, Land-use Change and Forestry (LULUCF) projects provided 36 percent of the OTC transactions, making them the most traded credit type on the market in 2006 according to Ecosystem Marketplace & New Carbon Finance (2008). There are two main reasons for this relatively high proportion of forestry projects: Avoided deforestation or reduced emissions from deforestation and degradation (REDD) projects have been excluded from CDM for the current commitment period and very few A/R projects have been registered and validated under the CDM due to the complex procedures and methodologies of project registration. Forest emission reduction projects are only accepted under the NSW GGAS credits, and these must be located in Australia. Additionally, on the voluntary markets the forest projects are often valued more highly for their social and environmental benefits. Among the LULUCF projects the native restoration projects accounted for 42 percent, avoided deforestation for 28 percent, agricultural soil projects for 16 percent, plantations/monoculture for 13 percent and other biological sequestration schemes for 0.1 percent (Hamilton et al. 2008).

The debate with respect to REDD has recently gained momentum, having been one of the key topics at the COP 13 in Bali, Indonesia in 2007. The idea behind REDD is that developing countries that succeed in reducing emissions from deforestation should be financially compensated, for example with emission credits (Laurance 2007). The Bali Action Plan encouraged voluntary action and REDD was included among other mitigation activities as a potential mechanism to reach emission reduction targets. By reducing deforestation a significant cutback of GHG emissions can be attained which could lead to a substantial growth on the carbon markets for REDD credits. Ebeling and Yasue (2008) calculate that if 10 percent of the deforestation rate is reduced, for a range of carbon prices of €5-30 tCO_2^{-1} between €1.5-9.1 billion per year could be generated globally.

Nevertheless, there is a lot of discussion with respect to the implementation of the REDD mechanism regarding a variety of issues that need to be solved. These are briefly outlined. Realistic baselines need to be set, as carbon credits are computed on the basis of comparing current deforestation rates and a business-as-usual (BAU) or baseline scenario. Obviously, determining the baseline year will considerably influence the monetary incentives for individual countries. Depending on their historical deforestation rates, countries can gain very little or be a beneficiary of REDD credits, and hence affect their political support for REDD. Accounting for emissions caused from degradation is a further challenge. Changes in the forest area can be monitored quite easily with existing technology, however estimating carbon stock changes from forest degradation is still difficult (DeFries et al. 2007). As already mentioned, permanence is one of the controversial issues associated with emission reductions from forestry projects. For example, a fire or drought can cause a decrease in forest cover, which poses a risk for the protected carbon stocks. International leakage can become problematic, especially if only some countries participated in a regime for reducing deforestation. Impacts could be caused for global markets shifting supply and demand patterns for timber or agricultural commodities across borders and leading to greater deforestation rates in non-participating countries (Ebeling and Yasue 2008). Finally, the success of REDD also depends on how well countries can actually decrease their deforestation rates. Therefore, national governance factors, such as enforcing land-use regulations, implementing payments for environmental service schemes and restructuring incentives for agriculture, play a vital role. Previous research has found that countries with lower governance scores tend to have higher deforestation rates and less success in conservation (Smith et al. 2003). Furthermore, the economic benefits from compensation schemes are often not passed on to rural populations if the governance structures are weak, and corrupt government agencies may have little interest in sharing the financial retributions.

The problem for projects on the voluntary markets, therefore, is that in comparison to the CDM with its established quality standards and methodologies, offsets on voluntary markets are less well defined, making standards for this sector crucially important. These standards are important to safeguard the quality of the offset credit and the project should undergo a quality control and audit.

A variety of standards have been developed in the forestry sector and the following are of interest:

- the California Climate Action Registry, which provides detailed protocols for forest carbon sequestration projects
- the CarbonFix Standard emphasizes sustainable forest management
- the Climate, Community, and Biodiversity Standards (CCB) are a set of project-design criteria for evaluating land-based carbon mitigation projects and their community and biodiversity co-benefits
- VER + Standard developed by TÜV SÜD, a Designated Operational Entity (DOE) for the validation and verification of CDM projects accepts LULUCF projects, including REDD, if they are implemented with a buffer approach to address the risk of potential non-permanence
- the CCX standards also include uniform rules for forestry projects.

2.2.3 Carbon Credit Prices

Prices for carbon credits differ between the markets. In 2007 in the EU ETS the allowances traded in a range between €12.25 and €25.28 tCO_2e^{-1}. During July 2005 they even reached a peak level of \$37.7 tCO_2e^{-1} (Henders 2005). In the primary CER market prices were between €9-11 tCO_2e^{-1}, registered projects attained prices of €12/tCO_2e and issued CER between €14 and €17 tCO_2e^{-1} (Point Carbon 2008). Secondary CER have been continually rising on the European Climate Exchange and reached €20.30 tCO_2e^{-1} in June 2008 (Carbon Positive 2008).

On the US voluntary markets credit prices varied between \$2 and \$15 tCO_2e^{-1}, depending on the project type (Point Carbon 2008). In general on the voluntary markets a huge variation can be observed in prices between \$1.8 to \$300 tCO_2e^{-1}. This high price was charged for wind farm credits in New Zealand, an anomaly in the marketplace (Hamilton et al. 2008). The usual range was between €3-30 tCO_2e^{-1}. However, lower prices prevail and the most frequently paid prices by end users among retailers were between €5-10 tCO_2e^{-1} (Neff et al. 2007). The most expensive credits on the voluntary markets are the LULUCF ones, with prices averaging between \$6.80 for native species reforestation and \$8.20 tCO_2e^{-1} for monoculture plantations, avoided deforestation prices averaged \$4.80 tCO_2e^{-1} (Hamilton et al. 2008). The problem with mentioning these prices is also whether they are actually the ones which reach the project. Kollmuss and Bowen (2007) discovered that in the air travel offset market between 25 and 93 percent (on average 70 percent) of the funds went to the respective project. On the voluntary market, the "story" which a project has to tell is quite important and there are a considerable number of "charismatic" projects where the credit buyers are searching for a way to remedy a social obligation they feel and promote environmental and social responsibility. Due to this huge variety of different forest carbon project types and motivations guiding buyers, it is difficult to make any real predictions for the development of carbon credits for this market segment.

2.3. Situation in Indonesia

About 88 million hectares (49 percent) of Indonesia's land area is covered by forest, storing a carbon stock of about 6,095 million tons. The remaining forest area, however, is under constant threat, as Indonesia has the second highest annual net loss in forest worldwide. Between 1990 and 2000 the annual loss of forest was 1.7 percent, which has risen to two percent per year between 2000 and 2005 (FAO 2006). Indonesia is among the top three GHG emitters in the world with 3 billion tCO_2e annually. The main factor for this high rate is the emissions from the LULUCF sector, especially deforestation and land conversion caused through forest fires; this accounts for 83 percent of the annual GHG emissions in Indonesia, and 34 percent of global LULUCF emissions (World Bank 2007). There are a variety of reasons for the forest conversion processes, such as wood processing, but also the accelerated demand for palm oil has been a key driving force. Approximately 27 percent of the concessions for new palm oil plantations are on peatland tropical rainforests, covering 2.8 million hectares (Fargione et al. 2008).

Indonesia signed the Kyoto Protocol in 1998 and ratified it in 2004. The National Commission for CDM is the Indonesian Designated National Authority (DNA) which is in charge of issuing approval letters for CDM project proposals that fulfil Indonesia's sustainable development criteria. The DNA was created through the Ministry of Environment in 2005 and consists of representatives from nine government agencies, one of whom is the Ministry of Forestry that is responsible for the A/R CDM projects. According to the World Bank (2007), Indonesia also has a number of forestry policies and legislation that favour sustainable forest management. However, the capacity of the government to implement and enforce laws is weak and there is an urgent need for detailed planning, budgets, international information sharing agreements and standard protocols (Chomitz 2007). In June 2008 there were 14 projects registered with the CDM Executive Board, 47 had been approved by the Indonesian DNA and 81 CDM projects were at or after the validation stage, however, none of these are in the forestry sector (UNEP Risoe 2008). In comparison to other Asian countries, Indonesia has a reduced number of CDM projects in general. Several reasons have been put forward, such as the difficulty to arranging for the project finance, as well as a lack of awareness of CDM. A variety of national and international NGOs have been critical of the fact that, apart from the Ministry of Environment, none of the Ministries such as the Forestry or Energy and Mineral Resources Ministry has shown much interest in the Kyoto Protocol (Sauermost and Wiekert 2008). Awareness with respect to climate change has however, been increasing since the UNFCCC conference in Bali at the end of 2007, which has pushed climate protection on the political agenda in Indonesia. With respect to non-existing forestry CDM projects, barriers have been identified as the complex CDM regulations and the existing limitations in the forestry sector only for A/R projects.

As a result of these restrictions in the CDM, several initiatives are under way in Indonesia for forestry carbon projects in the voluntary sector. Before the Bali conference the majority of projects focused on afforestation, reforestation or agroforestry projects, however, the interest in REDD has increased considerably. The World Agroforestry Centre (ICRAF) has been assisting a variety of carbon mitigation initiatives and identifying priority areas, applying criteria for sustainable development, as well as data on land cover, fire frequency and the human development index (Murdiyarso et al. 2008). Several projects have been supported by ICRAF, such as the RUPES (Rewarding the Upland Poor for Ecosystem Services) project in Singkarak, Sumatra; which focuses on bundling carbon sequestration and watershed protection activities and aims at an involvement of the community in the global carbon market. In two projects in Sidenreng Rappang in South Sulawesi and in Way Tenong in Sumatra the plausible effects of the reforestation activities on farmer income and terrestrial C-stocks were analysed (van Noordwijk et al. 2008). Another forestry project in Loksado in South Kalimantan looked at grassland reforestation, converting these to more productive tree-based systems (rubber, cinnamon, gmelina and mahogany), and also addressed capacity training for the local population. A further project is located in Bomanan district, Southeast Sulawesi, and focuses on the conversion of *Imperata cylindrical* grasslands to more productive fruit trees - cashew- and timber-based - teak- systems (Iskandar et al. 2006). There many more projects, a lot of them concentrating on peatland adaptation and management in

Kalimantan and Sumatra because peat swamp forests are an important carbon store and are increasingly cleared and converted to other uses, mainly agriculture (Noor et al. 2005).

Furthermore, a global increase in interest in avoided deforestation projects can be observed, e.g. US investment bank Merrill Lynch which joined a REDD project in Sumatra, expected to generate 100 million tonnes of VERs over 30 years. The project in the 750,000 hectares Ulu Masen forest, one of the last rainforests in this region, is implemented by the Aceh government, the British NGO Flora and Fauna International and Carbon Conservation. It has already been certified by the CBBA, giving the generated VERs credibility. Current funding from the World Bank Multi-Donor Fund's Aceh Environment and Forest project is to be joined in future by carbon credit sales under the REDD model, as well as from the recently established World Bank Forest Carbon Partnership Facility (Carbon Finance 2008).

2.4. Outlook

The policies and economic framework of the member countries of the Kyoto Protocol are driving the dynamics of this compliance market. Prices are obviously an important determinant for the demand and supply. Forestry as a project activity has a comparatively important advantage in providing competitive credit prices on the CDM market (Capoor and Ambrosi 2007). The CDM market is also more transparent than the emerging non-Kyoto markets.

There seems to be an increase in the momentum of voluntary carbon mitigation projects, and suppliers estimate that the volume of credits traded on the CCX and OTC markets in 2020 will be larger than the trade volume of the EU ETS in 2005 by 428 $MtCO_2e$. Complex methodologies and standards in the compliance markets, as well as the growing demand of companies, governments and consumers to become carbon neutral and reduce their carbon footprint has also pushed this market segment. Many forestry projects, especially REDD projects seem to have gained more acceptance as a climate mitigation option, and have been additionally incentivised through the UNFCCC conference in 2007. In turn, project developers responded to the hype over numerous success stories of commercialising forestry credits on the market. Many believe it will save costs to opt for non-Kyoto schemes and therefore do so. However, forestry projects are also required to be certified in these voluntary segments and the transaction costs for the high-quality voluntary schemes resemble those of the CDM, since these schemes increasingly use the CDM as a benchmark (Neff et al. 2007). Thus, it could potentially be better for project developers to be cautious and maintain all commercialisation options and eligibility for various schemes. To maximise flexibility in selling carbon credits, the certification and registration procedures of several schemes should be accounted for.

2.5. Summary

This Chapter provides an overview of the political background of climate change and specifically of the carbon finance activities. The global carbon market is growing rapidly, with an increase of nearly 50 percent was observed during the last two years. The compliance market is very dominant and outstretches the voluntary market by far, both in value and volume. The EU Emissions Trading Scheme has become the largest carbon market with a share of around 70 percent of the entire market, followed by the Clean Development Mechanism. Forest carbon projects are currently still quite restricted under this mechanism. Yet the voluntary market offers several possibilities for forestry offset schemes, especially since many credit buyers aim at neutralising their carbon footprint and these “charismatic” projects will offer an opportunity to recompense their debts. Avoided deforestation projects are increasingly implemented, also partly due to the encouragement they received during the Climate Conference in Bali in 2007. In Indonesia, all forest carbon projects are in the voluntary sector. Since it is one of the main greenhouse gas emitters on a global level due to land-use change and deforestation, projects addressing the reduction of emissions from deforestation and degradation are en vogue. The concepts of climate change regulations, specifically in the forestry sector and in Indonesia, enable the reader to put the analysis, results and recommendations in the subsequent chapters into its political context.

3. A THEORETICAL FRAMEWORK TO ANALYSE PAYMENTS FOR ENVIRONMENTAL SERVICE SCHEMES

3.1. Introduction

Externalities are among the most important class of market failures in the field of environmental and resource economics (Kahn 2005). In most cases they can be attributed to human activities, sometimes they are caused consciously, whereas other times they are unintentional side-effects. For economic analysis values can be attached to the environmental impacts. A variety of different policy instruments are available, such as taxation, subsidies, tradable permits or charges, to take these environmental impacts into account and regulate them. Among the incentive-based mechanisms are the payments for environmental services (PES). Incentive-based mechanisms, also called market-based mechanisms, rely on price signals, like those in private markets, to convey incentives for behavioural change. These changes in incentives can increase or maintain the delivery of publicly valuable ecosystem services (Jack et al. 2007). The focus of this study is the instrument of payments for carbon sequestration, a market-based mechanism for environmental policy that has been promoted as a tool for climate change mitigation. Frequently, institutions of society exist, which shape the use and the regulations of environmental services. In PES schemes these institutions often provide a framework for management and the associated regulatory parameters. The schemes entail the participation of various stakeholders, especially those who pay for the project and those who deliver the service. However, factors such as transaction costs might provide a barrier to entry for some of the stakeholders. This is reflected in the theory of institutions of which the transaction cost theory constitutes an important component, which North (1990) has focused on. Therefore, this Chapter gives an outline of the topic of externalities, addresses the different types of benefits of environmental services, and points towards the importance of accounting for their values in natural resource management projects. Consequently, it focuses on PES programmes as a policy involving market-based incentives for positive externalities. Finally, since these schemes often entail high transaction costs, the nature of institutional arrangements will be highlighted and their implications for the management of natural resources.

3.2. Externalities as a Source of Market Failure

When the allocation of goods and services by a free market is not efficient we talk about market failure. It can be viewed as a scenario in which the individuals' pursuit of profit maximisation leads to negative results for the society as a whole. Hence, market clearing forces do not maximise social net benefits by equating marginal social benefits with marginal social costs and a divergence between private and social costs is created. Externalities are an example when an individual makes a decision and does not bear the consequences of his or her action. Thus, the activity of one agent has an impact on another agent and this action is uncompensated. A negative externality causes a loss in welfare, whereas a positive externality implies a situation where one agent generates a positive level of welfare for a third party (Pearce and Turner 1990). Usually externalities caused by farm households are associated with negative effects from production. Examples are the pollution of drinking water through the run-off from pesticides applied in agricultural activities, as well as uncontrolled forest conversion resulting in erosion or increased flooding. Most people think of externalities as detrimental, but it is also possible for externalities to be beneficial. There are a variety of activities carried out by farmers which have positive spill-over effects. Carbon sequestration is a typical positive externality, as it is an unplanned side effect of sustainable forest management and conservation within a specific area, where the benefits are not confined locally, but accrue to all of humanity. The beneficiaries of conservation actions designed to sequester carbon are in general separated spatially and temporally from the costs of the actions undertaken (Arrow et al. 1999). Furthermore, non-excludability is one of the characteristics of positive externalities. The absence of externalities is one of the conditions required so that competitive markets will achieve an efficient resource allocation (Carlson et al. 1993).

Pigou (1950) was the first to identify the potential market failure due to the presence of externalities and started the discussion of whether governments should intervene to correct market failures when negative externalities exist. He argued that the externality cannot be mitigated by contractual negotiation between the affected parties and recommended to either apply coercion or taxes. By imposing a tax, the producer can be induced to supply the socially optimal amount of the good on each unit of production so that the private marginal cost (MPC) is increased to the point where it equals the marginal social cost (MSC) of the production of the good to correct for this divergence. This can happen when the property rights are not assigned or transaction costs do not allow for negotiation between the producer, i.e. the supplier, and the demander. The tax implies that the producer of the externality has to bear the full cost of his action (Carlson et al. 1993). This is depicted graphically in Figure 3.1.

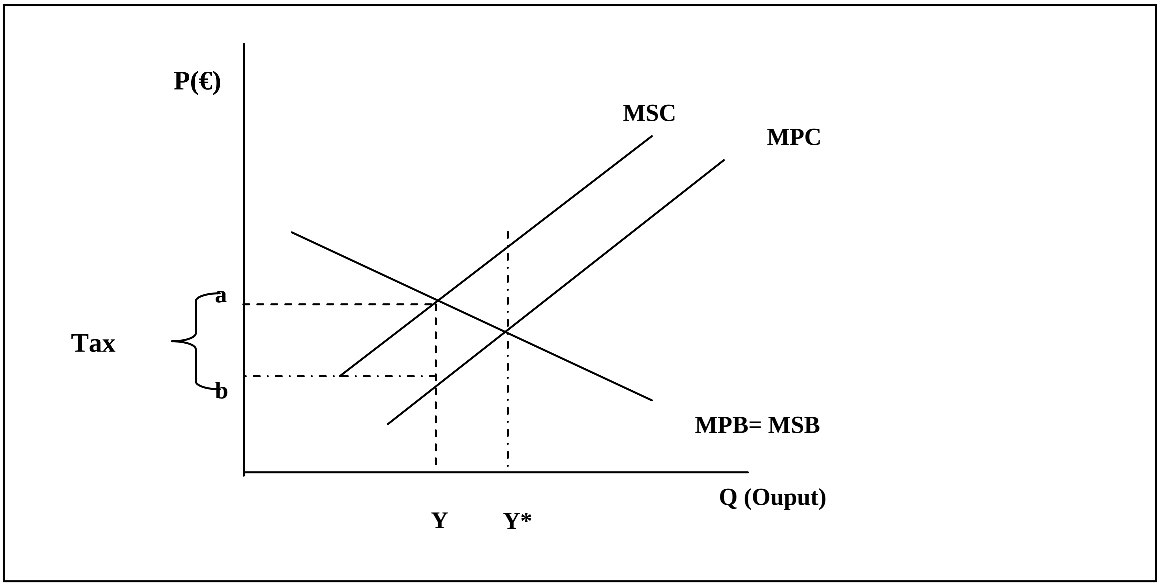

Figure 3.1. A Tax on a Negative Externality

Source: adapted from Carlson et al (1993)

The farmer produces his crops where his MPC equals the marginal private benefit (MPB), thus, his individual optimal output is Y*. However, the optimal level of output is Y from a social point of view, where MSC equals marginal social benefit (MSB). For example, this is due to the fact that he does not take into account the spill-over effect from fertiliser application in his production, which has a negative impact on the watersheds. If an externality tax equal to the divergence (a-b) between MPC and MSC were charged, then it would raise the farmers' private costs, because he would have to pay the tax on each unit of output. This will lead to the production of the socially optimal output Y and the externality is internalised. Recent discussions have been evolving around the fact that the tax should not be placed on the output production, but on the externality itself. As the output generates benefits, the production should not be discouraged, but it is the externality which causes social costs and should be taxed (Kahn 2005).

Another classical solution for the problem of externalities is proposed by the Coase Theorem. The affected party (the individual whose drinking water has been polluted) and the party causing the external effect (the farmer whose fertiliser application from his agricultural production pollutes the watershed) should bargain between themselves. Coase (1960) showed that the socially efficient allocation of resources will be obtained regardless of the allocation of property rights among the different parties with voluntary bargaining. Property rights refer to whether the generator of the externality has the legal right to generate the externality or whether the victim of the externality has the legal right to be free from exposure to the externality (Kahn 2005). Thus, does the farmer have the right to discharge his fertiliser application into the river or do the individuals using the river have the right to clean drinking water? According to Coase, voluntary bargaining between agents will lead to an efficient outcome, if property rights are fully specified, no transaction costs arise and distributional aspects do not matter. If this situation occurs, there is no need for government intervention to correct market failures due to externalities. The major insights from his paper were to show that transaction costs are extremely important in real life situations, as for environmental problems it is likely for a large numbers of agents to be involved and bargaining between the parties not to be costless. Furthermore, the initial assignment of property rights is relevant for designing efficient solutions to externality problems, as well as for distributional concerns. The existence of high transaction costs might explain why government interventions occur, as it is sometimes cheaper and can achieve optimality.

3.3. Payments for Environmental Services as an Incentive-Based Mechanism

Meade (1952) recommended to generalise the Pigouvian welfare theory to find a market solution for a positive externality situation when private production results in additional social benefits, using a subsidy. This situation is graphically indicated in Figure 3.2., where less of the environmental service (Y) is supplied by the farmer than is socially optimal.

For example, the farmer plants trees, which generate private benefits, such as timber, but also social benefits by reducing erosion and increasing air quality. He equates his MPC with his MPB and plants Y amount of trees. Introducing a subsidy to the farmer equal to the vertical distance a to b, he is willing to supply the socially optimal amount of the service (Y*), i.e. he will plant additional trees. The subsidy can also be translated into a payment for the environmental service, which induces a movement along the MPC curve and a change in the price.

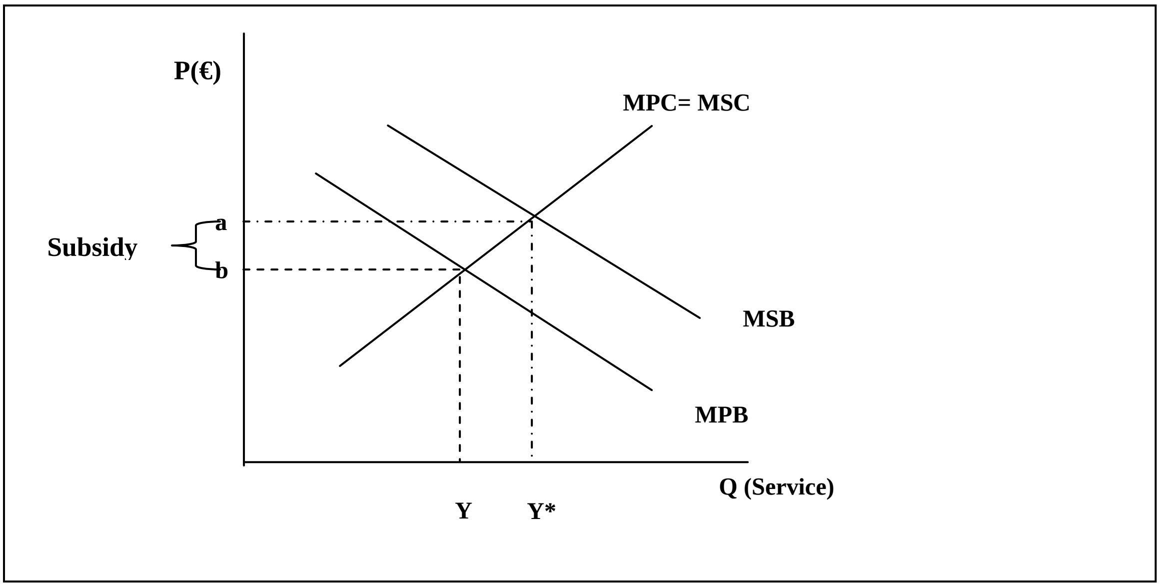

Figure 3.2. A Pigouvian Subsidy on a Positive Externality

Source: adapted from Kahn (2005)

Recently, PES schemes have emerged as a potential policy for aligning private and social benefits, serving as a type of subsidy to increase the supply of the desired environmental service. The notion behind the PES approach is that those who provide environmental services should be compensated for doing so. Additionally, an incentive is created for the providers to undertake conservation measures for services which do not have a private monetary return, but a benefit for society, and that those who receive the services should pay for their provision (Pagiola et al. 2005; Wunder 2005; Máñez Costa 2004). The most commonly used definition for PES, developed by the Centre for International Forestry Research (CIFOR), is that they are a 1) voluntary transaction where 2) a well-defined environmental service (or corresponding land-use) is 3) being bought by a (minimum one) environmental service buyer 4) from a (minimum one) environmental service provider 5) if and only if environmental service provision is secured (conditionality) (Wunder 2008). It is a very restricted definition and in reality there are many PES-like schemes that satisfy only some of the criteria but usually not all. A global review by Landell-Mills and Porras (2002) identified a list of 287 cases, of which some were in planning stages. By now there are most likely to be many more initiatives, as they have been widely promoted to provide a tool to finance conservation in developing countries (Wunder 2005). Through the development of markets for forest environmental services efficient mechanisms for promoting and financing forest protection and sustainable forest management can be created, as values are generated by the services and their costs and benefits can be quantified and accounted for.

3.3.1. Typology of Environmental Services

The main environmental services are classified into four different types – watershed protection, preservation of landscape beauty, carbon sequestration and biodiversity protection (Landell-Mills and Porras 2002). Forests are among the most important providers of these environmental – sometimes also called ecosystem – services and have been claimed to be of great economic value (Costanza et al. 1997). Environmental services are the by-product of ecosystem functions, which are the biophysical processes taking place within the ecosystems, and are of benefit for humanity (Nasi et al. 2002). According to the global review of forest environmental services 27 percent are carbon sequestration projects, closely followed by biodiversity conservation projects, constituting 25 percent (see Figure 3.3).

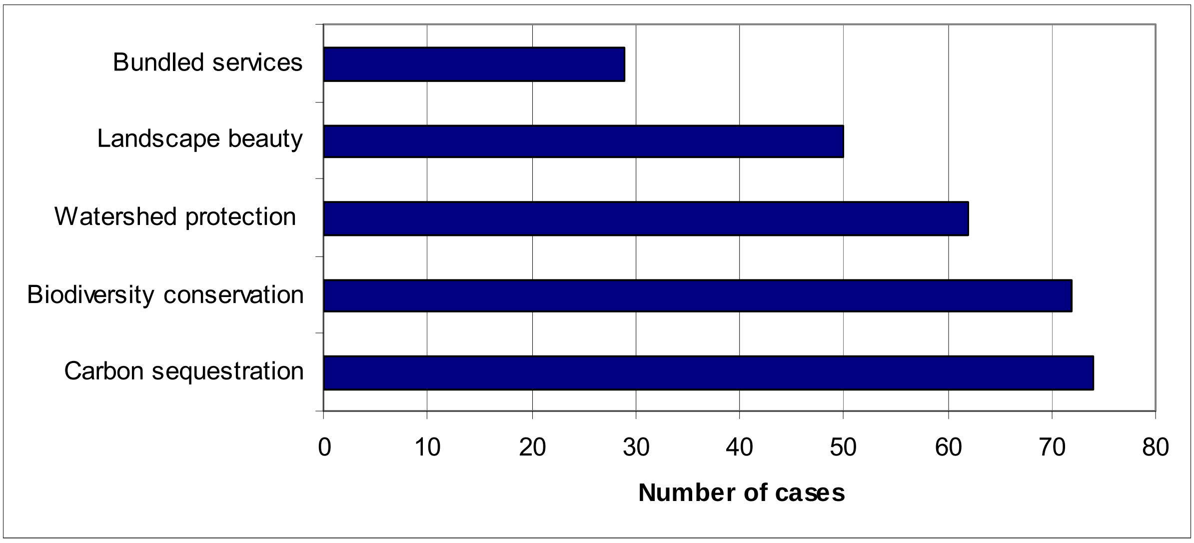

Figure 3.3. Breakdown of PES Programmes in the Forest Sector
Source: Landell-Mills and Porras (2002)

To distinguish the provided benefits of the environmental services, they are differentiated according to their direct or indirect contribution to human welfare and whether they entail a consumptive or non-consumptive use of natural resources. This framework typically includes four categories of value: direct use, indirect use, option, and non-use values. Non-use values in turn are divided into existence and bequest values. The total economic value of any given land-use is defined as the sum of its component values, provided they are mutually exclusive (Pearce and Turner 1990; Munasinghe and Schwab 1993). Apart from the direct use products forests provide, such as timber, fuelwood and non-timber forest products (NTFP), they also supply services, which are the less tangible benefits. Many of these environmental services are typically classified as indirect use values, as they support and protect economic activity and property. Examples are the protection and cleaning of watersheds, nutrient cycling provision and storage for carbon dioxide. Biodiversity is considered to have an option value, as forests also contain important genetic resources which can potentially offer valuable information for agricultural, pharmaceutical and industrial uses, but its exact use is still unknown. In addition, some people argue that animals, habitats and ecosystems have an intrinsic value, in that the value resides in something and can be captured by peoples' preferences in the form of a non-use value. There is the existence value which people attach for example to a rare bird species, a value which is unrelated to its use but to the knowledge of its continued existence. Furthermore, people want to safeguard the use and non-use values of the forest for future generations, which is the bequest value (Hartwick and Olewiler 1986; Pearce et al. 1989).

Usually, environmental services entail indirect use values, such as biodiversity, that is not sold directly, but it is specific land-uses that are protecting species, ecosystem or genetic diversity. Yet, sometimes the services also provide direct uses, such as the protection of landscape beauty, since it is associated with a cultural or ecological value given to that site. Usually, protected areas benefit through this important attribute, and in various countries spontaneous markets for private land conservation have developed.

Environmental service programmes have already existed for a considerable time, even though they might not have been named as such. In OECD countries experience dates back to the 1980s and many schemes were a response to environmental degradation from intensive farming practices (FAO 2007). Usually farmers were compensated for foregoing more intensive and profitable farming practices. In developing countries the first forest conservation activities begun in the 1990s, mainly in Latin America. By now, several countries have implemented very elaborate programmes. In Costa Rica the National Fund for Forest Financing (FONAFIFO) started a scheme in 1996, where land users can receive payments for specified land-uses through multiyear contracts, such as new plantations, sustainable logging, and conservation of natural forests (FONAFIFO 2005). Finance for these schemes is derived from a mixture of funds from fossil fuel sales taxes, revenues from hydroelectric companies, loans from the World Bank and a grant from the Global Environmental Facility (GEF). In Mexico, a payment for a hydrological environmental services programme is carried out. Other examples are to be found in Colombia, Ecuador and El Salvador (Pagiola et al. 2005). Also, in Asia PES schemes are on the rise, one of the most prominent programmes being RUPES coordinated by ICRAF. Projects are carried out in six sites in the Philippines, Indonesia and Nepal. For example farmers in Indonesia are assisted to obtain conditional land tenure in exchange for adopting mixed agroforestry systems that increase erosion control and foster biodiversity (Jack et al. 2007).

3.3.2. Payments for Forest Carbon Sequestration

Forest PES schemes aim at changing the incentives of managers and/or at generating resources to finance conservation efforts through cash or in-kind payments, carbon credits or tax incentives in turn for the sales of carbon sequestration services (Pagiola et al. 2002). As graphically shown above in Figure 3.2., the discrepancy between the private marginal costs for the provision of sustainable forest management systems and the social marginal cost of such measures can be reduced through the introduction of payments for external benefits of management measures. PES, being market-based mechanisms, can render forests to be a competitive land-use and farmers and loggers might decide to change their land-use practices to retain or replant trees if compensation is obtained.

Forestry-based carbon sequestration is based on two approaches: the active carbon absorption in vegetation, as well as avoiding emissions by conserving existing vegetation. Planting new trees, such as reforestation, afforestation and agroforestry, as well as increasing growth rates of existing forest stands like improved silvicultural practices belong to the first approach. The second approach entails activities such as the prevention or reduction of deforestation and land-use change, or the reduction in damage to existing forests. Thus, direct forest conservation measures, as well as indirect methods such as increasing the production efficiency of swidden agricultural systems, or improving the end-use efficiency of fuelwood resources can reduce the pressure on standing forests. Additionally, improved logging practices and forest fire prevention are also activities to complement the protection of existing carbon stocks (Bishop and Landell-Mills 2002). As mentioned in Chapter 2, the CDM of the Kyoto Protocol includes afforestation and reforestation projects in developing countries as emission trading schemes. Therefore, this mechanism is a type of PES aiming at active carbon sequestration. The rationale in simple terms is that companies causing GHG emissions in industrial countries pay farmers in developing countries to plant trees or improve the growth stands of an existing forest. Other forest carbon sequestration activities, however, are currently not eligible under the CDM rules, but only on the voluntary markets. As explained in the previous Chapter, some of these activities like forest management are accepted and financial incentives through carbon credits are rewarded. In the case of deforestation avoidance, farmers can receive a compensation payment as an incentive not to cut down the forest and use the timber or put the land to agricultural use. This is in line with the "compensated reduction proposal", which entails that countries electing to reduce their national emissions from deforestation would be authorized to issue carbon certificates, similar to the CERs of the CDM. These could be sold to governments or private investors and hence receive a compensation payment (Santilli et al. 2005).

3.3.3. Linkages between Payments for Environmental Services and Poverty

A short overview will be given with respect to the connection between PES and poverty, a topic which recently received wide attention in the academic world (e.g. Special Editions of the Environment and Development Economics Journal and the Ecological Economics Journal in 2008; State of Food and Agriculture FAO 2007; as well as the Quarterly Journal of International Agriculture in 2006). When PES schemes emerged, it was thought that they could provide a prospective sustainable additional income for rural households. According to a study by the World Bank (2003), very often the rural poor tend to live in areas featuring one or more environmental susceptibilities, such as being fragile or degraded, exhibiting low soil fertility and limited access to water. The estimation is that over one billion people in developing countries live in fragile ecosystems covering more than 70 percent of the Earth's land surface. These people very often depend on the natural resources, such as forests, which are found in their immediate surroundings.

> "*Some 350 million people who live within or adjacent to dense forests depend on them to a high degree for subsistence and income. In developing countries about 1.2 billion people rely on agroforestry farming systems that help to sustain agricultural productivity and generate income* (World Bank 2004 p.16).*"*

Forest environmental incomes are particularly important for poor people, since these activities are often more easily accessed and they require fewer levels of labour and purchased inputs. Thus, forests often serve as a safety net for people who depend on the environmental resources provided by these ecosystems (Vedeld et al. 2004). The environmental income derived from this natural capital is threatened by environmental degradation. This can be caused by an excessive use of the resource and results in a reduction in the natural capital stock, in turn having a disproportional negative effect on the poor. Fragile areas which are used for agricultural activities exhibit very low agricultural productivity, creating a constraint for people living in these regions who need to raise their income. However, if measures are adopted to improve soil fertility and its carbon sequestration potential, environmental and agricultural benefits can be reaped. If forests are protected, environmental services such as carbon sequestration or biodiversity conservation can be provided. Thus, the expectation was raised that farmers in remote areas who provide an environmental service can increase their earnings through compensation payments by allegedly richer buyers of these services. This results in “win-win” situations whereby environmental degradation can be constrained and poverty reduced (Pagiola et al. 2005; Wunder 2008). However, concern has been voiced and a considerable amount of investigation is concentrating on the issue whether the poor can benefit from markets for environmental services, while at the same time achieving its primary goal of an efficient environmental protection (Zbinden and Lee 2005; Engel et al. 2006; Zilberman et al. 2008; Bulte et al. 2008). The issue at stake is that poor smallholders in developing countries face serious constraints in accessing market opportunities in general, and specifically markets for environmental services. Thus, the discussion evolves around the participation possibilities for poor smallholders in PES programmes, the limiting factors, as well as enabling ones, and furthermore on the impact of these incentive-based mechanisms on the poor. A considerable amount of research shows that institutional factors play an important role for the involvement of poor people and their benefit of these programmes. Rural incomes and natural resource management can improve, however, it is of crucial importance to provide an adequate economic and institutional environment to support the participation of poor and marginalized farmers (Antle and Stoorvogel 2008). For example in a case study in the Sahel in Senegal of carbon sequestration payment possibilities for smallholders, Tschakert (2007) recommends flexible management plans and payment mechanisms, as well as supporting institutional structures to be integrated into pro-poor market-based mechanisms to enable their participation. A very important competitive factor are the transaction costs involved in PES schemes (Wunder 2008). In a recent study Jack et al. (forthcoming) concluded with respect to poverty alleviation, that when the poorest providers are also those with the lowest opportunity costs and the highest service provision potential, PES policies are most likely to alleviate poverty. Yet, if many smallholders are involved in PES schemes, transaction costs are higher, which implies a trade-off between cost-effectiveness and poverty alleviation. Thus, the experience seems to be mixed and depends very much on the local settings, the institutional framework, as well as the number of service providers and it is difficult to draw all-encompassing conclusions. However, one should bear in mind that the primary goal of the PES programmes is to deliver an improved environmental service, and obviously poverty reducing impacts are desirable, but pro-poor interventions should not be squeezed into these schemes if the result is less efficient.

3.4. New Institutional Economics, Institutions and Transaction Costs

The use and management of natural resources is often shaped through institutions. This is also the case for PES schemes, as different parties are involved, some of which have a right to use a certain resource and a transaction takes places in a market, where the rights for the resource at hand are exchanged. Neoclassical economics has little interest in the economic processes through which transactions are carried out. Its focus is on the end results of economic activities. In neoclassical economics an objective of markets is to whether they ensure welfare maximisation (Roth 1999). The aim is to achieve Pareto efficiency, such that the conditions for perfect competition are fulfilled for market exchanges. Markets are priced for their ability to achieve allocative and productive efficiency. New Institutional Economics builds on the neo-classical theory and tries to challenge it by linking economic theory to reality, especially with respect to its three main assumptions:

1. all economic actors are acting perfectly economically rationally,
2. people act independently on the basis of full and relevant information,
3. market exchanges are costless, so there are no transaction costs (North 1990).

Humans often have different motivations which are not always economically, but also socially, culturally and personally determined. When facing complex choices, they often lack the ability to evaluate these systematically. This is linked to the fact that the actors are not fully informed, and thus make the best decisions based on their limited knowledge and their capacity to analyse this information. Due to incomplete and asymmetric information, people need to invest in obtaining adequate information, as well as protecting their property rights, policing and enforcing decisions. These activities are pricey and result in transaction costs. New Institutional Economists therefore reject the three assumptions mentioned above and this has implications for markets. These are no longer the optimal solutions to allocate resources and there are now a multitude of institutional arrangements guiding decision-making and resource allocation. There are situations when centralised hierarchical systems, relying on planning, rules and stratification authority can be effective. Similarly, cooperative arrangements involving voluntary participation guided by informal rules prove to be optimal in certain cases when hierarchies or markets fail (Thompson et al. 1991). Often markets, cooperative arrangements and hierarchies evolve together, complementing and supporting each other. Hence, institutions are likely to be a mix of complementary and competing arrangements, tailored to specific historical, economic, social and environmental features.

Institutions and organisations are often understood as being the same however, they have different meanings. Organisations are material entities and include political, economic, social and educational bodies, such as political parties, firms, churches or schools. Institutions are the "rules of the game" and consist both of formal legal rules, as well as the informal social norms which govern the individuals' behaviour and also structure social interactions, and therefore provide an institutional framework (North 1990). Usually they include any form of constraint that human beings devise to shape human interaction. There might be formal written rules, such as political and economic rules, as well as contracts, or informal codes of conduct, which are often even written and underlie and supplement formal rules. Sometimes these formal and informal rules are violated, resulting in punishment to be enacted. Therefore, an essential part of the functioning of institutions is the costliness of ascertaining violations and the severity of punishment (North 1990). New Institutional Economics holds that the way institutions provide facilitation is through the reduction of transaction costs (Hubbard 1997).

As mentioned above, in order to tackle the source of market failures, Pigou proposed to involve governments to try to "internalise" externalities by introducing taxes, thus aligning the private costs of individual economic agents with the collective or social costs attributable to their activities. Coase, one of the pioneers of the New Institutional Economists', introduced the concept of transaction costs in his seminal paper on "The Nature of the Firm" (1937) and highlighted that exchanges in all markets are themselves costly, which was taken up and further developed by many other authors like Williamson (1985), North (1990) and Challen (2000). With respect to the application of transaction cost economics to environmental issues, Coase' paper on "The Problem of Social Cost" (1960) demonstrated, that the Pigovian logic of associating market failure with Pareto inefficiency is inconsistent, as it assumes that all exchanges in all markets are costless. His purpose was to persuade his colleagues to leave the world of neoclassical economics and concentrate on a better understanding of the one we live in:

> "*The reason why economists went wrong was that their theoretical system did not take into account a factor which is essential if one wishes to analyse the effect of a change in the law on the allocation of resources. This missing factor is the existence of transaction costs* (Coase 1988 p. 175)."

He pointed out that all market exchanges involve transaction costs and markets do not only exist to trade goods but also to trade property rights in relation to these goods. To a large part transaction costs are costs of relations between people and the fundamental idea is that they consist of "*arranging a contract to exchange property rights ex ante and monitoring and enforcing the contract ex post, as opposed to production costs, which are the costs of executing a contract*" (Matthews 1986). In natural resource management projects the major transactions costs are with respect to gathering information, designing regulations, coordinating participants, monitoring conditions, and enforcing regulations.

Coase (1960) proposed that interventions in markets should be assessed according to a comparative institutions approach which would attempt to assess which alternative real institutional arrangement seems best able to cope with the economic problem. Its objective is to identify the institutional framework, or governance structure, that minimises the transaction costs of resolving particular property-rights allocation problems (Williamson 1985). Therefore, an adequate institutional framework can enable the minimisation of transaction costs of natural resource management and specifically PES projects. Additionally, the participation of local communities in these markets for environmental services can be promoted. This is in line with experience from natural resource management systems, which suggests that in order to ensure the sustainability of forest projects, all stakeholders must be transparently involved, their customary rights need to be recognized (Ostrom 1990), and there must be a direct linkage between the environmental service and development activities (Asquith et al. 2002). Local communities need to have a voice in the implementation of such natural resource management projects (Smith and Scherr 2002). Also Hanna (1995) argues that user participation can contribute positively to the cost-effectiveness of natural resource management processes. The participation of local communities can lead to a reduction in transaction costs and specifically of monitoring and compliance:

> "*Compliance with regulations increases and, hence, management costs decline when regulations are acceptable and considered legitimate by those whose interests are being regulated. To be legitimate, the content of a regulation, the process by which it is made, the way it is implemented, and the effects of its distribution must be perceived as fair by resource users. To be equitable, a resource management process must represent the range of user group interests and have a clear purpose and a transparent operation. In addition, an equitable process must address explicitly the distributional changes embedded in options under consideration* (Hanna 1995, p.61)."

Thus, an institutional arrangement for a natural resource management project, allowing for the participation of the users, affects the cost-effectiveness of management processes. Information costs can be lowered through the provision of supplemental non-technical knowledge, monitoring costs reduced if the compliance is increased through management legitimacy and finally enforcement costs are lowered due to regulations that are appropriate in the specific context.

3.5. Conceptual Framework for the Analysis

Based on the discussion presented in the previous sections, as well as the objectives outlined in Chapter 1, we derive the following conceptual framework to guide the empirical research. In Figure 3.4. the crucial points and linkages for the subsequent analysis are highlighted.

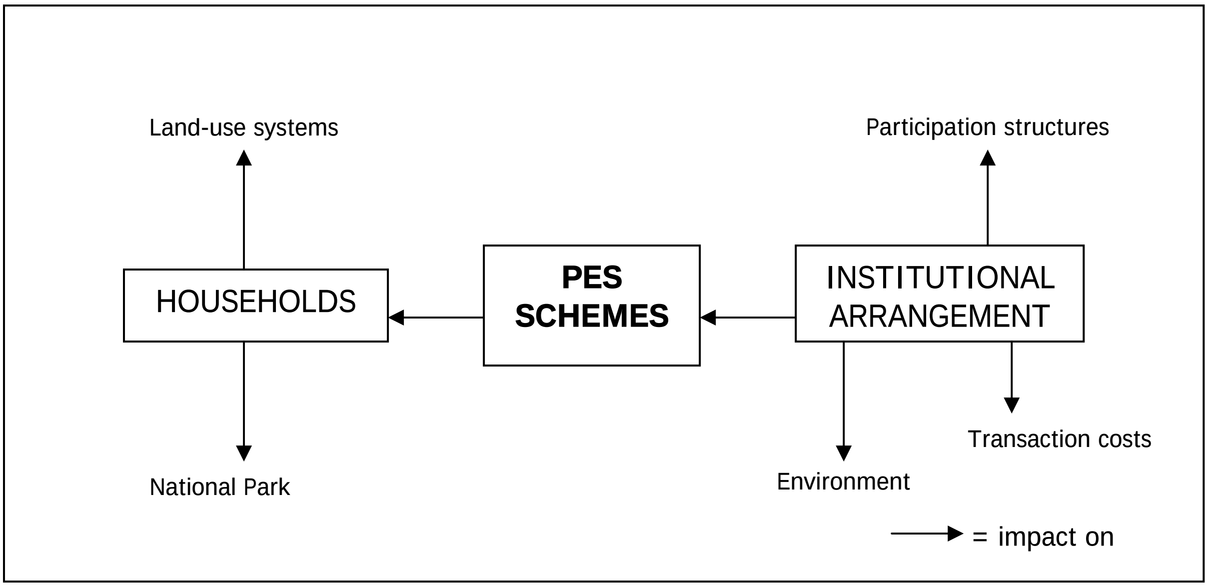

Figure 3.4. Framework for the Twofold Analysis of PES Schemes
Source: own elaboration

The present research focuses on the PES schemes and the impact they have on the households, as well as the requirements for the institutional arrangement for their implementation. On the one hand we are assessing the impact of the payments from carbon sequestration on the land-use systems of the smallholders, and whether the cultivation of the more sustainable land-use systems can be specifically stimulated by the financial compensation. Additionally, we explore if the payments can provide a solution to stop deforestation processes at the National Park margin. On the other hand we have seen that for a natural resource management project, such as a PES scheme, the participation of the stakeholders is essential to safeguard its accomplishment. Experience has demonstrated that certain transaction costs can be lowered by involving local communities and institutions, and specifically monitoring and enforcement can be easily integrated into community processes and the costs for these activities minimised. Finally, we look at the impact these arrangements have on the status of the environment, whether through their introduction and its associated rules illegal extractive activities have been affected.

The second part of the research uses as an example the community conservation agreements in Indonesia and whether these can provide the institutional structure for a PES scheme. For this purpose we developed an additional, more detailed analytical framework. This is based on four focal points displayed in Figure 3.5., institution, participation, monitoring & enforcement and status of the environment.

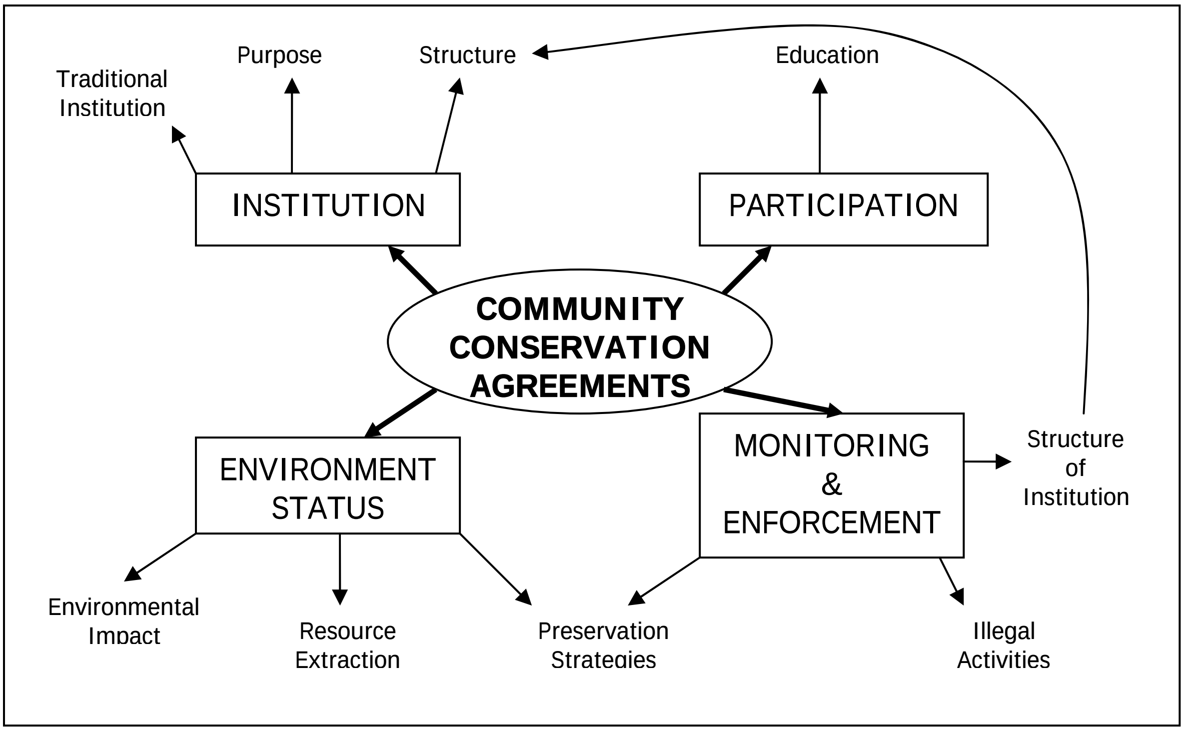

Figure 3.5. Framework for Analysis of the KKM Institution

Source: own elaboration

These main topics have been selected based on the literature review above and because they are crucial elements in an analysis of a community natural resource management process. We are interested in the institutional structure of the agreements, which role the traditional institution plays and if the purpose of the agreements is understood by the community. Furthermore, we assessed whether the institution represents all village households and whether they are involved and participate in the process of designing and implementing the agreement and its associated interventions. Educational activities are seen as a possibility to provide the community members with information on the functions of the forest and usage rules. The interventions are specifically assessed with respect to the monitoring and enforcement of the forest regulations. Therefore, the structure of the monitoring entity is explored and what impact its regulatory framework has on illegal activities in the forest.

Traditional forest and land zones are investigated whether they can provide preservation strategies. A good indicator for the success of the monitoring activities is the status of the environment and to what degree resource extraction and environmental impacts are observed.

3.6. Summary

This Chapter develops a conceptual framework, as well as the theoretical foundations for this research. The concept of externalities is reviewed, focusing on the positive side-effects of human actions and environmental attributes. As an example of a market-based mechanism for environmental policy, the payments for environmental service programmes are introduced, that rely on incentives to induce behavioural change. In due course it is demonstrated which services exist, how payment systems can be established, what experience has been gained up to date, their effectiveness in securing forest environmental benefits, and finally their contribution towards reducing rural poverty. Usually, natural resource management schemes entail a variety of stakeholders with different roles and responsibilities. The schemes are shaped by institutions, which provide a regulatory framework, consisting of formal and informal rules, in order to assure their performance. Yet, institutions always involve transaction costs, an important point to consider when one wants to assess the participation of users and providers. Typically, these are local communities and smallholders in natural resource management projects in rural settings. The following empirical chapters proceed on the basis of the presented conceptual framework.

4. RESEARCH AREA

4.1. Geographical and Biophysical Conditions

Indonesia comprises 17,500 islands, making it the World's largest archipelago state. With a population of over 200 million inhabitants it is the world's fourth largest nation and the most populous Muslim-majority country (Berié 2007). The country consists of 30 provinces. The research region of the STORMA project is located on the island of Sulawesi in the province of Central Sulawesi and embraces 750,000 ha. Sulawesi is embedded between the island of Borneo to the West and the islands of Maluku to the East (Figure 4.1.). The region is characterized by high biodiversity and socio-cultural heterogeneity. Situated near the equator, the climate of Sulawesi is dominated by high precipitation rates throughout the year as is typical for the inner tropics.

Figure 4.1. Location of Lore Lindu National Park in Sulawesi, Indonesia

The Lore Lindu National Park (*Taman Nasional Lore Lindu* - TNLL) embraces 220,000 ha and is positioned in the centre of the research region (see Figure 4.2.) towards the south of the provincial capital Palu. It borders the sub-districts (*kecamatan*) Sigi Biromaru, Kulawi, Lore Selatan, Lore Tengah, Lore Utara and Palolo. These sub-districts comprise 119 villages and belong to the Donggala and Poso district. Lore Lindu was declared a UNESCO Man and Biosphere Reserve in 1978 and has been nominated as a World Heritage site for its cultural heritage of ancient stone megaliths. The National Park was founded in 1982 by the Ministry of Agriculture and officially recognised by the Ministry of Forestry in October 1993 (ANZDEC 1997). Its formation was the result of joining three nature reserves: Lore Kalamanta Wildlife Sanctuary, funded in 1973; Danau Lindu Recreational and Protection Forest, established in 1978; and Sungai Sopu and Gumbasa Wildlife Sanctuary, declared in 1981 (Mappatoba 2004). The BTNLL manages the National Park from its administrative office in Palu and directly reports to the Ministry of Forestry at the national level.

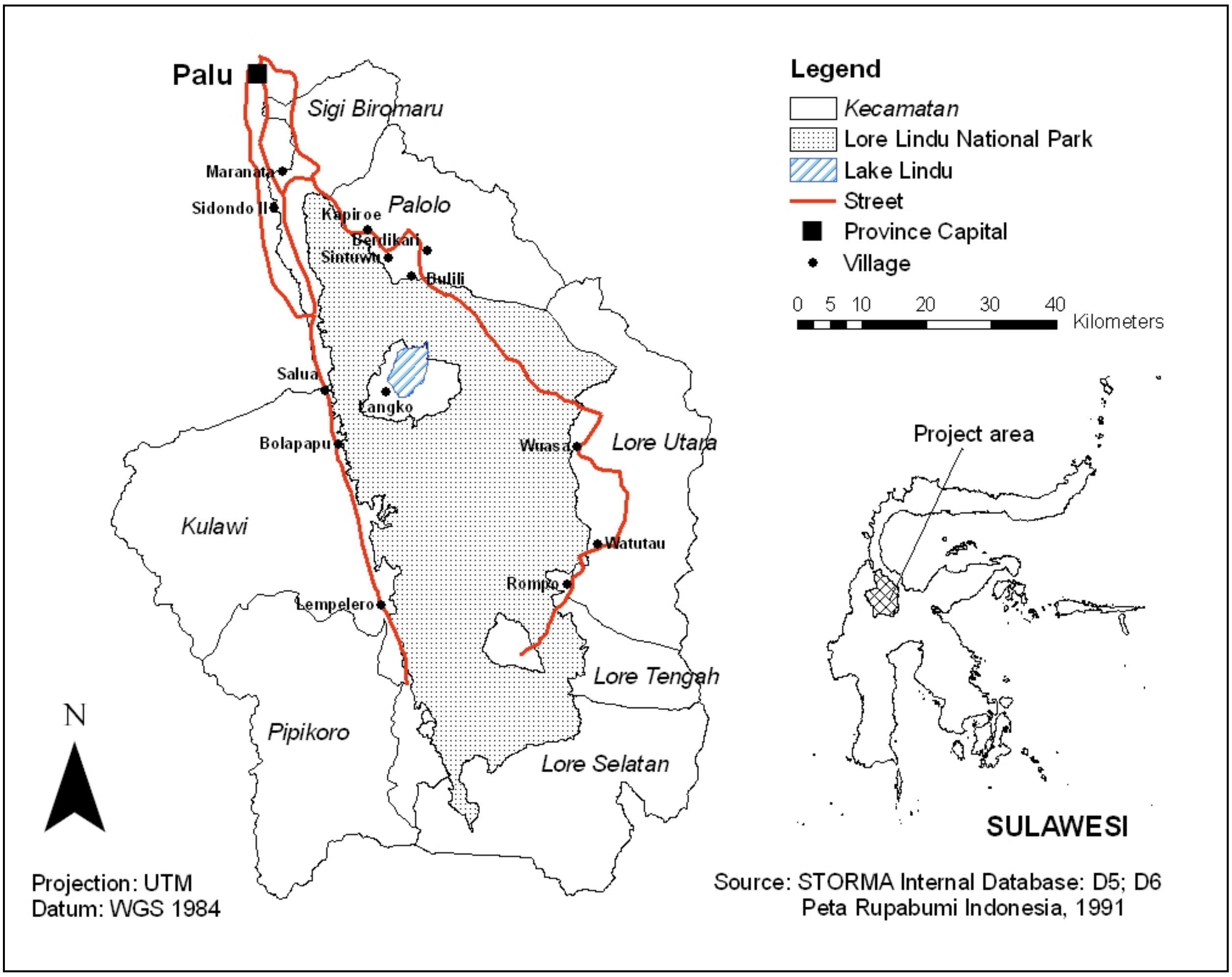

Figure 4.2. Research Region

The TNLL is regarded as especially important because of its important ecological values and high socio-cultural diversity in its surroundings. Ethnically, the mixture of people is diverse due to a complex demographic history. The island of Sulawesi is located along the Wallace line, which means it contains a mix of both Asian and Austronesian species, making it one of the most important centres of endemism in the world. Many of the islands' endemic mammals are found in the National Park and it is also home to about 230 bird species (Waltert et al. 2003). With respect to its ecological value, it provides important water catchment area, of which 16 percent are covered by the major land-use systems (Leemhuis 2005). It is a very topographically diverse region, containing mountainous rainforest, with peaks up to 2,610 m.a.s.l. (Mount Nokilalaki), interspersed with narrow and outstretched valleys at different elevations and expositions (Erasmi et al. 2004).

4.2. Socio-economic Background

Agriculture is an important land-use in the area, covering 15 percent of the total research area - excluding the National Park. About half of the agricultural land is used for perennial crops, mainly cacao and coffee, one third is allocated to paddy rice production, and annual crops and home gardens are found on the remaining land. 87 percent of the households are farmers and rice is the most important staple food, whereas coffee and cacao are predominantly cash crops (Maertens et al. 2006).

About 20 percent of the households in the research region live on less than US$ 1 per capita per day (purchasing power parity) and almost half of the population falls below the international poverty line of US$ 2 (purchasing power parity) (van Edig 2005). Poorer households have significantly less access to formal credit markets (Nuryartono 2005), and live in locations with poorer markets and road infrastructure. Usually, the prices for cacao are lower in these markets and also face a higher variability (Anggraenie 2005). The poorest households depend more on agricultural activities and the sale of forest products, whereas the better-off households derive a substantial proportion of their income from perennial crops and non-agricultural activities (Schwarze et al. 2006).

The population size in the region is estimated to be 136,000 people, with a population density of 18.7 people per km^2 - excluding the TNLL area, 27.4 people per km^2. The two northern sub-districts, Sigi Biromaru and Palolo, are much more densely populated, with 86 and 43 people per km^2 respectively, in comparison to the remaining sub-districts with 10 people per km^2. Because of different migration occurrences a considerable population increase has been observed. According to a survey in 2001 conducted by Maertens (2006) the population has risen by 60 percent over the last twenty years. In Palolo and Lore Utara migrants constitute about 21 percent of all households (Maertens 2003).

The local ethnic groups, the Kaili, Kulawi and Lore, are descendents from ancient kingdoms and lived primarily in Kulawi, Lore Utara and Lore Selatan. It was not until the 1950s that Palolo became inhabited through spontaneous migrants from Kulawi (Faust et al. 2003). Through the Indonesian transmigration programmes in the 1960s and 1990s Javanese, Sundanese and Balinese people were resettled mainly to Palolo and Lore Utara. Yet, the main change in the cultural landscape has been caused by the Bugis from South Sulawesi in the 1990s, who settled dominantly in Palolo and Lore Utara. This influx of newcomers was additionally encouraged through the road construction between Palu and these two sub-districts in 1982 (Weber 2005).

4.3. Land-use Dynamics in the Lore Lindu Region

An implication of this rapid population growth has been the conflict over natural resources, which can be observed along the borders of the TNLL forest where encroachment takes place. The main changes to be observed are an expansion of the area dedicated to agricultural activities by 20 percent during the last two decades, the tripling of the perennial crop plantation area associated with an expansion of cropping land into former forest areas, as well as selective and clear-cut logging. Maertens' village survey revealed that 70 percent of the villages bordering the TNLL have agricultural land inside (2003). The clearing of forested areas causes ecological and economic problems such as erosion and a higher risk of flash floods. For example in Dongi-Dongi, in the north-east of the research region, in 2001 extensive illegal logging took place and approximately 2200 ha of forest belonging to the TNLL have been converted (Erasmi et al. 2004). The effect of this was higher sedimentation load in the rivers, and the exposed logged areas in the valley probably also caused flash floods, which consequently destroyed bridges, streets, and agricultural fields in the region (Leemhuis 2005). These large forest clearings inside the National Park show that the forest frontier in the research region is by no means secured (Weber 2005). Analysis of satellite imagery detected a mean annual deforestation rate of 0.3 percent in the research region between 1983 and 2002 (Erasmi and Priess 2007). In contrast, the annual forest loss rate for the island of Sulawesi is estimated by the Forest Watch Institute / Global Forest Watch (2002) to amount to 1.6 to 2.4 percent between the years 1985-1997 and for the whole Indonesian Archipelago, 2 percent per year between 2000 and 2005 (FAO 2007). Erasmi et al. (2004) attribute the differences in the regional deforestation estimates to the diverse data sources which were used as the basis for the estimates at the national level. Furthermore, cacao plantations under shade trees cannot be detected by optical satellite instruments, thus, the encroachment process at the forest margin is not fully reflected by the first figure. In the vicinity of the TNLL a great spatial heterogeneity of agricultural production can be observed. In general, human activities are much more concentrated in the northern and eastern part of the National Park than in the south. For example in Palolo, one of the four main valleys embracing the TNLL in the north-east, the closed forest decreased by 35 percent between 2001 and 2004 due to logging, whereas the area covered by cacao plantations increased by 11 percent (Rohwer 2006).

In the region around the TNLL four cacao agroforestry systems (AFS) can be distinguished according to the degree of shading and shade tree species, as well as the management intensity: AFS D exhibits a high degree of shading with natural forest trees and a low management intensity, while at the other end of the spectrum AFS G involves intensive management and fully sun grown cacao[7]. The gross margins of cacao consistently increase along the cacao AFS gradient from D towards G (Steffan-Dewenter et al. 2007). There seems to be a trade-off situation between an intensification of the cacao cultivation with shade free plantations and higher economic returns and shade-grown, low intensity management cacao with lower returns and biodiversity conservation. Even though the cacao grown in full sun has higher mean yields and obtains substantially higher gross margin values in comparison with shade grown cacao, in the long run the intensification is likely to be unsustainable. Anticipated consequences are agronomic risks, such as declining soil nutrient levels (Belsky and Siebert 2003). Experience shows that the dependency on single crops can pose serious risks for farmers and local food security, as cacao price volatility and cacao diseases are recurring phenomena (Neilson 2007).

The AFS D provides high biodiversity values and habitat for the native fauna, whereas the establishment of unshaded cacao plantations reduces the landscape level diversity by eliminating secondary forests on fallow land which may adversely affect the soil fertility and cause biodiversity loss (Siebert 2002). It is widely accepted that biodiversity benefits are higher for cacao grown under shade cover and more specifically under the shade of native forest species. However, in most cacao growing regions full-sun cacao is replacing the shade produced cacao (Franzen and Mulder 2007). In the research region the species-richness of plants and animals and ecosystem functioning was assessed by Steffan-Dewenter et al. (2007). This study did not discover a linear gradient of biodiversity loss in the four AFS, but

[7] The differences between the systems are explained in more detail in Chapter 5.2.1.

deduced that only small quantitative changes in biodiversity and ecosystem functioning occurred when changing from AFS D to E and F. However, the complete removal of shade trees removal is an unsustainable path due to the disproportional loss of biodiversity and ecological functioning. Unfortunately, this process already takes place in the region. A willingness-to-pay study, which suggests a higher preference for low shade AFS among the local farmers, supports these results (Glenk et al. 2006).

Another important phenomenon in the region is that many of the Bugi households, who constitute the biggest migrant group in the region, started to buy land from the local ethnic groups, the Kailis' and Kulawis'. In many cases the local ethnic households had originally obtained this land by clearing primary forest on the border of the National Park (Sitorius 2002; Faust et al. 2003). They consider themselves to be the owner's of the village territory and do not see the necessity to buy land, but in turn realised the opportunity to generate additional income by selling parts of their land. This money is usually used for buying status symbols or for ceremonial purposes, which require substantial amounts of cash (Weber et al. 2007). In due course they are often in need for further land for their own cropping activities, since the majority of them are at least to some extent subsistence farmers, leading to additional encroachment at the forest margin of the National Park.

4.4. Summary

This Chapter presents an overview of the research region, which is the surrounding area of the Lore Lindu National Park in Central Sulawesi, Indonesia. The households in the villages are predominantly farmers and carry out different agricultural activities with cacao and paddy rice being the most important crops. In such a geographically diverse region a variety of important ecological attributes contribute towards its importance from a conservation point of view. Additionally, the ethnic diversity is very high, both due to existing local groups, as well as migrants. Rapid population growth has been a major factor for land-use dynamics in the region, causing encroachment at the forest margin, an intensification process of the agroforestry systems, as well a change in ownership of land taking place from locals to migrants. A foundation is provided in this Chapter for a better understanding of the setting and situation when we explain the research design and the selection of the villages

5. QUANTITATIVE RESEARCH DESIGN

5.1. Data Collection

This Chapter focuses on the quantitative research design, and accounts first for the inputs to the model, which is the data collected in the household survey, as well as the carbon sequestration data from the agroforestry systems, and finally explains the methodological approach of the model employed for the data analysis and its specifications.

The research at hand employed an explorative research design, which is based on two household surveys in 2000 and 2004 carried out by the STORMA A4 subproject with a random selection of 325 households in 13 villages. For the specific sampling procedure see Zeller et al. (2002). Three criteria were used to distinguish the sampling strata and the village selection as they are hypothesised to have a strong influence on land-use practices in the research region:

- proximity of the villages to the TNLL
- population density of the village
- ethnic composition of the village population.

Building on the already existing sampling frame and the retrieved data, only those six villages (out of the above mentioned 13 villages) were selected which include households of all four AFS types or at least households of the infrequent land-use types D and G to economise on time and costs. The following villages were identified: Sintuwu, Maranata, Lempelero, Bulili, Wuasa, and Berdikari. A random sample of 46 households from the initial sample was taken across the six villages.

The data was collected between March and June 2006 by means of structured interviews using standardised, formal questionnaires (see Appendix I). Even though some data existed from the previous surveys on the land-use practices, for each individual household all the necessary data for the modelling was collected in this survey in order to have data from one point in time. The survey at hand focused on general aspects of the household and farm characteristics, availability of land resources and their use, agricultural production activities, forest use, as well as the households' perception of the TNLL, the forest and its functions. The questionnaire was translated into Indonesian language and a pre-test was carried out in the two villages Sidondo II and Kapiroe. This pre-test served on the one hand to test for the understanding of the questions among the household respondents and help improve it, as well as on the other hand as a training for the enumerators who carried out the interviews. Three enumerators had been selected who had been trained previously with respect to the content of the questionnaires, as well as interviewer techniques. A research assistant helped with the organisation of the survey, the supervision of the enumerators, as well as the translation of the questionnaire. The data was entered and checked by the researcher either directly in the field or shortly afterwards in Palu which enabled the clarification of doubts, inconsistencies or missing data. A first descriptive analysis was carried out in July 2006 in Palu and compiled in a short report as a feedback for all those who had been helping in the design of the survey, as well as the interviewed households. See Appendix II for some pictures taken during the interviews.

5.2. Carbon Accounting Methodology

As a second step for the analysis, the payments for carbon sequestration are needed as an input for the model. Therefore, this section outlines the carbon accounting methodology, which allows for a calculation of the carbon sequestration rates of the agroforestry and forest (eco)systems.

The Kyoto Protocol is the first agreement to commit countries with legally-binding quantitative targets to limit or reduce their GHG emissions. As explained in Chapter 2, the CDM allows a country with an emission-limitation commitment under the Kyoto Protocol (Annex I Parties) to implement an emission-reduction project in developing countries (non-Annex I Parties). These projects can earn saleable certified emission reduction (CER) credits, which can be counted towards meeting their Kyoto targets (UNFCCC 2008).

The term carbon sinks is applied to pools or reservoirs, such as forests, oceans and soils, which are absorbing carbon, the carbon storage exceeds the carbon release. The process of capturing carbon from the atmosphere and storing it in vegetation biomass is referred to as sequestration. Therefore, forestry activities which result in additional GHGs being actively sequestered from the atmosphere and stored in sinks can generate carbon credits or CER. On the different types of carbon markets these credits may be used to offset GHG emissions (Moura Costa and Wilson 2000). The amount of carbon sequestration which can be claimed as a carbon credit is limited to the net amount of change in the total forest carbon pool from one period to the next. For this reason for a carbon sequestration project a baseline needs to be defined for the start of the project and a fixed project cycle period.

Two certified emissions reduction schemes are available – the *temporary* CER (tCER) and the *long-term* CER (lCER) (UNFCCC 2003). The tCERs are limited to five years and can only be used in the commitment period during which they were certified. After this they need to be re-certified, therefore transaction costs will be raised. This possibly decreases their economic attractiveness; however, if compliance is sought for only one period, they are easier to handle on the market. On the other hand the validity of lCERs can be up to 60 years, but re-verification is due every five years. Both types entail the deficiency of the possible carbon loss during the certification period. Finally, if the buyer needs further emission allowances once the tCER or lCER cannot be re-certified, he needs to bear their replacement costs in mind (Manguiat et al. 2005).

Five main *carbon pools* have been identified and are used in the relevant UNFCCC decisions for afforestation and reforestation activities. They include living biomass (above and belowground), dead biomass (dead wood and litter), and soil carbon (soil organic matter). A project should account for all significant changes in carbon pools and/or emissions of the GHGs that are increased as a result of the implementation of the activities, while avoiding double counting (UNFCCC 2003). Commonly forestry-offset projects need not attempt to assemble the full carbon budget to accurately estimate a minimum increase or maximum decrease in net ecosystem carbon stocks, whichever applies. It is central to the economic viability of forestry-offset projects to distinguish between full carbon accounting and viable-carbon accounting for carbon management. Usually the carbon pool of the living biomass can be monitored cost-effectively. These projects should not overestimate increases in carbon stocks, but they need not accurately reflect the changes in carbon stocks, as long as they do not overestimate any change in carbon stocks that are reported (Hamburg 2000).

Estimates for *aboveground biomass* can be obtained by using biomass regression equations. These regression equations are mathematical functions that relate oven-dry biomass per tree as a function of a single or a combination of tree dimensions. They are applied to measurements of a single or individual trees in stands or in a line (Brown 1997). These so-called allometric equations exist for certain forest types in specific climates. However in many cases the equations do not exist for specific species and need to be generated based on data from field inventories.

Several studies exist with respect to the approximation of *belowground biomass*, i.e. root biomass, however, it is quite expensive to obtain exact measurements for this carbon pool. For tropical forests it is estimated that the percentage of root biomass contributes between 3 and 49 percent to total biomass (MacDicken 1997). To determine total above- and belowground biomass, it is suggested that the oven-dry weight of the tree is correlated to size variables of the trees such as height, diameter, basal area and volume (Brown 1997). According to Ortiz and Riascos (2006) the most recommended procedure to estimate biomass in tropical forests consists of relating theses variables in a linear regression with logarithmic scalars. This simplifies the calculations and increases the statistical validation when homogenising the variance over the data range.

One of the most important pools is the *soil organic carbon* but it is one of the least understood aspects by scientists, particularly carbon cycling processes in soils. It has been proven knowledge that the organic matter and litter production of forest soils is higher compared to other ecosystems, although when it comes to organic matter recycling, grasslands have a faster rate (Nilsson and Schopfhauser 1995). To obtain an estimation of the change in soil carbon it is recommended to measure at least the top 1 meter of soil. The carbon pool in the upper 1 meter of the world's soils is assumed to be about 1.5 times higher than that in the above-ground biomass (Hamburg 2000). The soil carbon pool is enlarged due to reforestation and in temperate ecosystems soil carbon increased on average by 0.5 t ha^{-1} yr^{-1}. For tropical ecosystems similar results have been obtained, but more research is necessary to validate these outcomes (Hamburg 2000).

The forest type, as well as the disturbance history can have an impact on *dead biomas*s quantities. However, Hamburg (2000) states that it is acceptable not to consider this component if there has not been a recent disturbance, natural or anthropogenic. Usually, it is the rate of change which is important and not so much the size of the dead biomass pool.

To determine the carbon quantity present in the total biomass, a conversion factor is used. This factor it is widely assumed to be 0.5 g of carbon respectively for 1 g of biomass. In order to create a homogenous tradable commodity, emission reductions of any GHG are traded in the form of tonnes of carbon dioxide equivalent (CO_2e), which means that the climate change potential of each GHG is expressed as an equivalent of the climate change potential of CO_2 (UNFCCC 1997). For carbon the conversion factor to CO_2e is 3.667.

The term accumulated or *stored carbon* refers to the carbon quantity which is present in an ecosystem at a certain point in time before it is released in to the soil or the atmosphere. It is usually accounted for as tonnes of carbon per hectare (t ha^{-1}). On the other hand the term fixed or *sequestered carbon* is attributed to the carbon flux of a certain area during a specific time. This depends on the species characteristics, the growth and longevity rate, as well as the site conditions such as location, climate and rotation. Generally it is expressed in tonnes of carbon per hectare per year (t ha^{-1} yr^{-1}).

5.2.1. Carbon Fixation Rates of Agroforestry Systems

For the comparison of the different agroforestry systems (AFS) in the research region the carbon sequestration rates, based on the species-specific biomass growth rates, were calculated. In the STORMA research area, four AFS have been distinguished which all contain cacao trees (*Theobroma cacao* L.). They are differentiated according to the species type of shade trees and their canopy cover proportion, as well as the management intensity: AFS D contains a high density of remaining forest trees as shade trees, the canopy cover is approximately above 86 percent and they are managed with very few agricultural inputs; AFS E is shaded by a diverse spectrum of planted trees and naturally grown after clear-cutting, it has a shade cover of approximately 66-85 percent; AFS F exhibits a low density of a shade tree layer, which is dominated by the non-indigenous leguminous trees *Gliricida sepium* and *Erythrina subumbrans*, with a canopy cover between 36-65 percent; finally, the AFS G has very few to no shade trees (5-35 percent shade canopy cover) and is intensively managed (see Annex III for a graphical presentation of the four systems. These pictures were used during the survey for the farmers to categorise their own plot).

Observing the standing biomass rates for the four different cacao AFS (Table 5.1), there is a decline in biomass and respectively in the carbon and CO_2e content from the AFS D to the AFS G, which contains on average only 21 percent biomass of the D plot.

Table 5.1. Characteristics of the Four Cacao Agroforestry Systems

	Agroforestry System				Source:
	D	E	F	G	
Standing Biomass t ha^{-1} (Shade & cacao trees)	33	21	13	7	Kessler (pers.comm.), Ortiz & Riascos (2006), Zuidema et al. (2005)
Basal area of shade trees m² ha^{-1}	21 (100%)	15 (71%)	12 (57%)		Kessler (pers.comm.)

In order to obtain the site-specific above-ground biomass (AGB) amounts for the cacao trees, the data from Nicklas (2006) was used. He sampled 12 plots of the AFS G in Nopu[8] and measured diameter at breast height (dbh), number of trees per ha, height and age of the cacao trees. As no site-specific allometric equation for cacao exists, the following equation for cacao by Ortiz and Riascos (2006) from Costa Rica was used, where, as the diameter at 30cm above the soil was not available for the research region, the dbh was used[9].

$$AGB = 10^{(-1,625 + 2,626 * LOG (dbh))}$$

Based on this model, the total above-ground biomass for cacao was estimated, and using the specific root:shoot ratio for the project region of 0.28 by Smiley (2006), the root biomass was included in the carbon budget. In Smileys' allometric modelling of the cacao biomass he attained a value of 9.74 kg tree^{-1}, which is slightly more than in Costa Rica where an average biomass of 6.7 kg tree^{-1} was obtained.

After running various models, a logarithmic regression model was adopted to estimate the total biomass, with a R^2 value of 0.76.

$$TB= - 4,2874 + (9,6312 * \ln (a))$$

where TB= total biomass (above- and below ground biomass) in kg and a= age.

A cacao tree contains on average 16.10 kg of biomass, storing on average 8.05 kg of carbon in a time span of 20 years. This is in line with the results from the Costa Rican study, where an average of 14.42 kg of total biomass, and 6.61 kg of carbon fixation in a 20 year period was calculated (Ortiz Guerrero and Riascos Chalapud 2006).

[8] Nopu used to be a sub-unit (*dusun*) of the village Rahmat in the sub-district Palolo. After Nopu became an independent village, its name was changed to Bulili.
[9] It is acceptable to exchange these parameters, according to Andrade C. (2007)

The next step was to upscale this measurement from the tree to the hectare basis. In the study by Nicklas (2006), who has been working on G plots, he counted on average 1,333 trees ha^{-1}, whereas according to the A4 survey in 2004, farmers planted on the D, E and F plots the cacao trees at a spacing of 3 x 3 metres on average, adding up to 1,111 trees ha^{-1}. Additionally, 0.5 t ha^{-1} yr^{-1} of soil organic carbon was added, a figure from the literature (Hamburg 2000), as no site-specific data exists. This figure also coincides with the assumption of Nilsson and Schopfhausers' study (1995) which estimates the amount of soil carbon sequestered under fairly fast-growing tropical hardwood species to be 0.5 tC ha^{-1} yr^{-1}. Due to lack of data, we calculate the carbon accumulation in soils to occur linearly in time.[10] All carbon measurements for above-, below-ground and soil carbon were added up to obtain an estimation of the total carbon per hectare of the cacao trees. Finally, this amount was converted to CO_2e, the basis for calculating the amount of certificates which are to be obtained for the different AFS.

For the three AFS with shade trees the carbon sequestration and consequently the CER have been calculated in two ways. According to the Kyoto Protocol, a baseline is established for the launch of the project, as well as the crediting period and the certificates can only be assigned for the trees which are planted at the beginning. However, in the AFS D-F, in addition to the carbon fixation of the cacao trees, the shade trees also sequester carbon. If this supplementary shade tree carbon fixation is ignored, the fully sun grown AFS G would automatically be assigned more CER than the other three AFS, as these are more densely planted. This could even foster further cutting down of the shading trees. Hence, the carbon fixation of the shade trees has also been calculated and included in the carbon budget for the AFS D, E and F. So far no studies have been conducted for the carbon fixation rates of the shade trees in this region. The study by Brown et al. (1996) has been taken as a basis, as they determine the sequestration potential of different forest types. They indicate selectively logged evergreen rainforests to have an average net annual rate of carbon accumulation of 2.9 tC ha^{-1} yr^{-1}. Thus, a net rate of 2.8 tC ha^{-1} yr^{-1} for AFS D has been assumed. The basal area tends to be a good predictor of total biomass, since diameter, basal area, and sapwood area all have a similar functional relationship to the quantity of live foliage and branches in the crown (MacDicken 1997). We used the average basal area proportions for the AFS D-F (Kessler, pers. comm., 15. October 2005; calculated for 4 plots of each AFS, see Table 5.1.) to determine the annual carbon accumulation rates for the shade trees in the E and F systems.

[10] For comparison, the total carbon pool has also been calculated excluding soil carbon. As the difference is quite small (3 percent decrease in annuity payment), it is assumed that it is acceptable to include the soil carbon.

Consequently, the carbon fixation of the shade trees in the AFS E is assumed to be 2 tC ha^{-1} yr^{-1} and respectively for AFS F it is 1.6 tC ha^{-1} yr^{-1}.

An accounting scheme with temporary CER[11] for a project period of 25 years was used which is depicted in Figure 5.1. for the fully shaded AFS. To make things straightforward we assumed that the credits are synchronous with the commitment periods, so that they are issued at the end of the first commitment period and expire five years later at the end of the next commitment period (Dutschke and Schlamadinger 2003; Olschewski and Benitez 2005). After the commencement of the project and during the first five years of growth, the cumulative carbon storage is 35 tCO_2e ha^{-1}, for which the first 35 temporary CER are issued. These expire after five years, but can be reissued in year 10 together with the newly accumulated CER for the additional 14 tCO_2e ha^{-1}, adding up to 49 tCO_2e ha^{-1}. In year 15 another 8 CER will be issued which are available together with the reissued 49 CER until year 20. Finally for the last five-year period ending in year 25 another 6 CER are generated. Therefore, in the last period a total of 62 CER can be provided. Over the entire project period of 25 years 202 CER are issued (Table 5.2.).

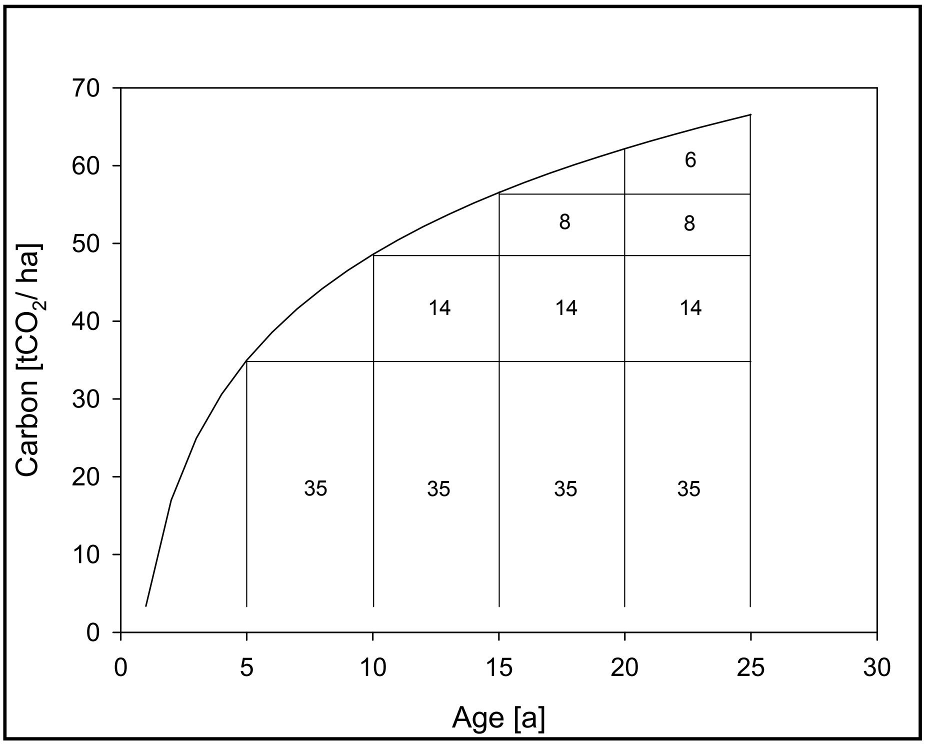

Figure 5.1. Cumulative Carbon Storage of the AFS D and Temporary CER
Source: own data

[11] The calculated credits are all temporary CER (tCER). From this section onwards, if the credits are denoted as CER, we are referring to the tCER.

The total carbon fixation potential of the AFS D for both the cacao and shade trees in the project period of 25 years amounts to 67 tCO_2e ha^{-1}, as it can be seen in Table 5.2. There is a gradual decline in the total sequestration potential from the AFS D towards F. However, AFS G has the same carbon sequestration potential as AFS D, because of the higher cacao tree density. The carbon sequestration of the shade trees is not sufficient to outplay the higher cacao tree density. When we exclude shade tree carbon sequestration, the carbon budget decreases by between 11 and 6 tCO_2e. These results refer to the net carbon accumulation, where the baseline is defined by a zero carbon stock.

Table 5.2. Total Cumulative Carbon Sequestration Potential for a 25 year Project

	Agroforestry System				
	D	**E**	**F**	**G**	**D-F without shade trees**
Total CER issued	202	191	185	192	161
Total tCO_2e ha^{-1} fixation	67	64	62	67	56

Source: own data

Before calculating the net present value (NPV) and annuity payments of the certificates accumulated over time, the non-permanent credits of forestry projects need to be converted to permanent CER. The prices for tCERs and lCERs represent only a fraction of the prices for regular CERs from other project categories such as energy projects, as the non-permanent certificates must be replaced by permanent ones at some point in the future. Bird et al. (2005) indicate that the price of CERs plus the net present value of the replacement cost should be less (respectively equal) than the current price of CERs. The same authors estimate the tCER price with approximately 10 percent of the current market value for CERs. Olschewski and Benítez (2005) determined the relative value of non-permanent credits with respect to permanent ones, and depending on the discount rate used and the expiring period the value ranges between 14 percent (discount rate 3 percent, five years expiring period) to 88 percent (discount rate 9 percent, expiring period 25 years). The value of the temporary credits can be seen as the difference between the current permanent credit price and the discounted value of the future permanent credit price. Using equation (1) the difference between permanence and non-permanence can be accounted for (Olschewski and Benitez 2005):

$$P_{tCER_0} = P_{CER_0} - \frac{P_{CER_T}}{(1 + d^*)^T} \qquad (1)$$

where CER_0 is the price of the CERs today and CER_T the price of permanent CERs discounted at rate d* found in Annex I-countries and T is the expiring time of tCER (Subak 2003).

For the conversion, the CER prices are assumed to be constant over time ($p_{CER\ 0} = p_{CER\ T}$), and a three percent discount rate (d*) is taken, which reflects the current low interest rates in Annex I countries (Deutsche Bundesbank 2007). As a tCER has a duration of five years, its value according to the equivalence relation in (1), is only about 14 percent of that of a permanent credit.

The annual remuneration to the farmer was obtained for each land-use system through the calculation of the NPV, using equation (2), where d represents the discount rate in Indonesia and T the 5 year periods from year 5 until 25. The calculations refer to the net carbon accumulation.

$$\Sigma tCER \cdot (1+d)^{-t} = \frac{(\text{net } CO_2 \text{ storage})_5}{(1+d)^5} + \frac{(\text{net } CO_2 \text{ storage})_{10}}{(1+d)^{10}} + \ldots + \frac{(\text{net } CO_2 \text{ storage})_{25}}{(1+d)^{25}} \qquad (2)$$

For the linear programming model the NPV are converted to annuities, in order to show the annual payments which the farmer would be receiving from a 25 year sequestration project. The equivalent annuity method expresses the NPV as an annualised cash flow by dividing it by the present value of the annuity factor. The annuity factor is calculated according to formula (3), where i= interest rate, n= number of years. The real interest rate of 10 percent is taken, which is the rate to be found in Indonesia in 2006 (Bank Indonesia 2006) and the time span is 25 years.

$$AF_{n,i} = \frac{i \times (1+i)^n}{(1+i)^n - 1} \qquad (3)$$

Finally the annuity factor is multiplied by the NPV to obtain the annuity. In Table 5.3. the resulting annual payments for a range of different CER is indicated. €5 tCO_2e^{-1} is comparable to the lowest traded medium-risk CER price, whereas €25 tCO_2e^{-1} at the other end represents the trading prices in the European Climate Exchange for 2008-10 carbon allowances in May 2007 (Capoor and Ambrosi 2007). Additionally, for comparison we use two discount rates;

10 percent which the interest rate observed in Indonesia, as well as 3 percent, to indicate the impact of low discount rates[12].

Table 5.3. Annuity Payments for Different Discount Rates and CER Prices

Annuity payments € ha^{-1}	Agroforestry System				
	D	E	F	G	D-F without shade trees
d 10%, CER €5 tCO_2e^{-1}	5.54	5.18	5.00	5.09	4.28
d 10%, CER €12 tCO_2e^{-1}	13.30	12.40	12.00	12.20	10.30
d 10%, CER €25 tCO_2e^{-1}	27.70	25.90	25.00	25.50	21.40
d 3%, CER €12 tCO_2e^{-1}	28.80	27.10	26.20	27.10	22.80
d 3%, CER €25 tCO_2e^{-1}	60.00	56.40	54.60	56.40	47.40

Source: own data

When the CER price is €5 tCO_2e^{-1}, the evolving payments per hectare for the AFS are around €5. Taking high credit prices of €25 tCO_2e^{-1}, and using a normal discount rate of 10 percent the annuity payments per hectare are around €25-27. Once the discount rate is lowered to three percent, the per hectare payments increases up to €60 tCO_2e^{-1}. The variation between the four different AFS is not very pronounced, as the net carbon accumulation is similar between all four systems. However, the highest annuity payments from carbon sequestration are always obtained for the fully shaded AFS and decline towards the AFS F. Very similar payments are achieved by the AFS type E and G, and those for AFS F are lower. Once the carbon sequestration for the shade trees for AFS D-F is excluded, the remuneration is 15 percent lower than the payments for the intensively managed fully-sun grown cacao plots. These obtain payments in the mid-range, because the cacao trees are more densely planted in comparison to the other three shaded systems.

In a survey conducted in 80 of the 119 villages in the research area approximately 20,590 ha were used for cacao plantations in 2007. Approximately 1 percent of this area was planted with the AFS type D, 31 percent with AFS E, 60 percent with AFS F and 8 percent with AFS G (Reetz, pers. comm, 16. April 2008). Thus, if a carbon sequestration project were to be implemented in this region, the approximate carbon offset potential of the cacao agroforestry

[12] Different discount rates imply altered time preferences and natural resource usage. The higher the discount rate the higher will be the discrimination against future generations. A lower discount rate implies a less rapid development and usage of exhaustible resources, longer rotation periods and higher stocks of renewable resources. However, there is not a clear cut relationship between low discount rates and an improved preservation of natural resources. For further discussion see Pearce and Kerry (1990).

systems would be 1,300,000 tCO_2e^{-1}, summing up to 3,855,699 CER in 25 years. At low carbon prices of €5 tCO_2e^{-1} this would amount to an annuity payment of €104,000, at a price of €12 tCO_2e^{-1} to €250,000 and at €25 tCO_2e^{-1} to €522,000 for a 25 year project.

5.2.2. Carbon Sequestration Rates for Avoided Deforestation

Accounting for the preserved carbon from avoided forest conversion is not a simple issue. However, it is an important one because although tropical deforestation is not the main source of GHG emissions, it makes a significant contribution to the global budget comparable to the emissions reductions to be gained by implementing the Kyoto Protocol in its first commitment period (Santilli et al. 2005). As mentioned in Chapter 2.2.2. avoiding deforestation has been increasingly discussed on the political agenda. At the 11th COP of the UNFCCC in Montreal in 2005, Papua New Guinea and Costa Rica, on behalf of the Coalition for Rainforest Nations, put forward a submission to further consider whether and how incentives to reduce tropical deforestation could be included in a future climate regime under the UNFCCC. Consequently, several proposals have been made for different approaches to account for avoided deforestation. For example Achard et al. (2005) presented a proposal to assess the reduction of the conversion rates below a baseline for each potential change at the global and country level. The proposed carbon accounting system would mainly rely on forest area and forest area changes, and for greater accuracy additional data on biomass and carbon stocks and changes in specific forest types would be needed. Other authors argue that it is difficult to assess deforestation baselines, as depending on the region and time, these differ within every country. Therefore, Prior et al. (2006) propose a cap-and-trade stock based methodology. Carbon credits are allocated to countries based on an approximation of the amount of carbon currently held in that country’s forest carbon reservoirs. Those countries than have the opportunity to either sell credits and at the same time transfer equivalent areas of forest to protected reserves, or carry out deforestation activities, or a combination of both. If a country decides to sell some of the credits allocated to its carbon pool, it could make use of the so-called Carbon Reservoir Mechanism, which would be modelled after the Joint Implementation. This mechanism can be used to financially reward conservation and protection of tropical forests. It creates an incentive for protecting those parts of the carbon pool under danger of being lost as it makes carbon credits generated through the protection available for trading. An additional problem of the measurement or monitoring of forest area changes can be attributed to the remaining challenge of estimating carbon stock changes from forest degradation (DeFries et al. 2007).

For the present study a simplified approach of the land-use simulation model by Soares-Filho et al. (2006) has been used. They estimated the effect of recent protected areas created since 2004 in reducing future carbon emissions from deforestation in the Amazon. An empirically based, policy-sensitive model of Amazon deforestation was developed and several deforestation-conservation scenarios were run. The present deforestation trends are hypothesised to continue in the 'business-as-usual' (BAU) scenario, whereas on the other hand in the 'governance' scenario, Brazilian environmental legislation is assumed to be implemented across the Amazon basin and the protected area network to expand. The carbon emissions expected for each scenario were estimated by supposing that 85 percent of the carbon contained in forest trees is released in to the atmosphere after deforestation.

Deforestation and land conversion processes in Central Sulawesi have been analysed in the STORMA project. The observed land-use changes have been associated with different factors, such as an expansion of the agricultural area by 56 percent between 1980 and 2001, sometimes at the expense of the forest margin of the National Park. Specifically the area dedicated to cacao plantations has increased from zero in 1979 to nearly 18,000 hectares in 2001. Furthermore, selective and clear-cut logging takes place. Another important factor is the population growth of 60 percent in the last two decades causing massive land cover transformations and infrastructure expansion (Maertens et al. 2006). A satellite image analysis detected a mean annual deforestation rate of 0.3 percent in the research region between 1983 and 2002 (Erasmi and Priess 2007). For the TNLL area of 221,412 hectares, the annual forest loss has been 0.3 percent between 1999 and 2002 (Erasmi 2007). As we have seen in Chapter 4 this rate is rather small in comparison to the estimation of the deforestation rate for the entire island. However, even though the conversion rates for TNLL and the wider research region are relatively low, the intensity of land-use activities differs around the National Park. The region towards the south is less populated in comparison to the northern and eastern parts which exhibit concentrated agricultural activities. In this region a tremendous loss of 2,200 ha of National Park forest occurred in 2001 (Erasmi et al. 2004).

The TNLL had a closed forest cover in 1972 of 207,708 ha. In 2002 the closed forest cover had decreased to 193,720 ha (Erasmi 2007). Hence, if the annual forest loss rate of 0.3 percent remains stable, in the BAU scenario annually 581 ha of closed forest will be deforested. For the natural forest type with traditional use of rattan extraction but no timber extraction with a closed canopy the standing biomass is estimated to be 140 t ha^{-1}. The estimates for the virgin rainforest of the TNLL are up to 240 t C ha^{-1} or 435 tCO_2e ha^{-1} (Kessler 2008). As mentioned above, assuming that 85 percent of carbon contained in forest trees is released to the atmosphere after deforestation, in the ‘total preservation scenario’ reducing the deforestation rate from the BAU scenario to 0 percent, annually 215,500 t CO_2e are not released through deforestation. As the conversion rates in the vicinity of the National Park vary greatly depending on the location and the logging activities are more concentrated close to the border, an extreme ‘Sulawesi scenario’ will be assessed. An island wide annual deforestation rate of 2.4 percent is used, leading to an annual forest loss of 4,649 ha for the TNLL. If this was reduced to 0 percent, annual carbon emissions of 1,719,000 t could be saved for the entire National Park.

5.3. Methodology for Data Modelling

5.3.1 Potential Methodological Approaches and Model Types

In order to determine the appropriate methodology for the study at hand, several methodological approaches were appraised and evaluated. Several considerations had to be accounted for, such as the objective of evaluating new policy options of carbon payments at the farm level and the impact it might have on land-use decisions, as well as the diversity of households in the research region. Additionally, we had to integrate financial and time constraints.

A great variety of models and methodologies exist, they can be static or dynamic, mathematical or physical, stochastic or deterministic. Economic models can be most easily classified into optimisation or simulation models. Usually two different branches of models are applied in economics and agricultural sciences, being econometric/simulation models, optimisation models, or a combination of both.

Econometric models are employed to statistically estimate system parameters (the coefficients relating changes in one variable to changes in another) from empirical observations to describe the system behaviour based on theoretical assumptions. The advantage of econometric models is that they represent the best possible guess of the true relationships between the variables (Börner 2005). Three steps are to be carried out for econometric modelling: the structure of the system is specified using a set of equations. Consequently, the values of the parameters are estimated. Finally the resulting output is used to make forecasts for the future performance of the system. In general econometric models require the availability of large degrees of freedom both in terms of cross section and time series data.

Optimisation or mathematical programming models are not used for predicting what will happen in a certain situation. Instead they explain what to do in order to make the best of the situation; they are normative or prescriptive models (Sterman 1991). They consist of three components: the goal or objective is specified by the objective function, the decision variables are the choices to be made and the constraints restrict the choices of the decision variables to those that are acceptable and possible. Hence, given the assumptions of the model, the model aims at achieving the best – optimal – solution as its output.

5.3.2. Linear Programming Models

According to Hazell and Norton (1986) "*mathematical programming in agriculture had its origins in attempts to model the economics of agricultural production*". If it is used for whole-farm planning, it can assist farmers in efficiently adapting to a changing economic and technological environment, or as a tool for policy analysis. With the help of these models farmers' reaction to interventions can be simulated indicating their adaptation with respect to the allocation of their resources. Specifically linear programming, which is amongst the most common optimisation models, is regularly mentioned as the method of choice to model the effects of interventions on farm households (Upton and Dixon 1994). It is a very useful technique to assess technology changes or adoption potentials *ex ante*, so that careful planning for new policies or strategies can be undertaken. Generally, given the objective function of the farm household, the solution procedure maximises the total gross margin of the farm by finding the optimal set of activities for the household type or it minimises costs of the activities under the respective restrictions. These are the availability of certain technical constraints, such as usually the land, labour and capital endowments. Mathematically, the optimal values of unknown variables within a system of equations are examined. When these values are combined, they define the alternative decisions. To determine the optimal feasible strategy, an algorithm (such as the simplex method) is used (Teufel 2005). At the farm level the programming model is explicitly a normative or prescriptive tool.

Linear programming has been applied to farm household research for several decades. Its advantages are the structured data requirements, which provide a good insight into the studied systems, the flexibility of model structures and the ease with which model runs can be replicated with various data sets (McCarl and Nuthall 1982). Disadvantages are several fundamental assumptions which underlie linear programming models, such as linearity, additivity, divisibility, certainty and non-negativity (Paris 1991). These need to be kept in mind, when using the tool. A brief overview is given of the limitations and problems. Specifying the *objective function* involves assuming certain values and preferences, making it important to critically assess whose goals are incorporated. It is a challenge to incorporate intangibles, which can be roughly quantified to integrate measurable components or proxies need to be sought for these. In developing countries particularly, when the model attempts to depict the land-use systems of smallholder households, a variety of objectives need to be accounted for, such as cash income, subsistence requirements and leisure time. Hence the food security necessities for these households can be included in the model by using constraints, resembling satisficing rules (Schreinemachers and Berger 2006). In reality *linear relationships* between the variables, an assumption of linear programming model is almost always not true. Over small ranges in the variables a linear relationship might be a good approximation, but when the linearity assumption cannot be justified, non linear programming can be used. Furthermore complex systems usually exhibit a high degree of *feedback* between sectors. When models ignore feedback effects they have to rely on exogenous variables and are said to have a narrow boundary. Theoretically, feedback can be incorporated into optimisation models, but the resulting complexity and non-linearity usually render the problem insoluble. Often these effects are not acknowledged, as they present irresolvable problems because of their complexity and non-linearity (Sterman 1991). With respect to the *dynamics* of optimisation models, some are static and determine the optimal solution for a particular moment in time not taking into account how the optimal state is reached or how the systems will evolve in the future. This can be considered by dynamic models which are designed for longer time horizons and link time periods. Delays are a crucial component of the dynamic behaviour of systems, but – like non-linearity – they can be incorporated into optimisation models, however it involves a great deal of effort. Therefore one has to be aware of these restrictions when constructing a model. Despite all these limitations optimisation techniques can be extremely useful, when they are planned and applied properly. Optimisation models can be considered whenever the problem is one of choosing the best from among a well-defined set of alternatives. If the meaning of best is also well defined, and if the system to be optimised is relatively static and free of feedback, optimisation may be the best technique to use. As mentioned above, to make prescriptive statements it is legitimate to use optimisation models, however, they can be employed for forecasting only if the farm household in fact optimises and makes the best possible decisions. To model how systems actually behave, simulation techniques are more useful. Optimisation models can approximate how a system or people ought to behave and simulate policy changes (Sterman 1991).

Several studies exist, employing *linear programming models*, which assess the adoption of new technologies or the introduction of policy options. Mudhara and Hildebrand (2004) for example used a linear programming model to simulate the livelihoods of smallholder farmers and assess the potential adoption of improved fallows in Zimbabwe. The authors indicate the contribution linear programming models can make towards an *ex ante* evaluation of new technologies before their dissemination. Hence, it allows for the precise identification of target farmers for this new technology. The study emphasises the fact that household linear programming models have to accommodate household resource levels. Since the objective function was to maximise discretionary household income, several constraints were included to reflect specific household characteristics such as food security, household composition and available arable land. They perceive the advantage of household linear programming models in their sensitivity towards diverse household characteristics. Thus, households and technologies can be matched by determining the technology that is both compatible to the resources of the specific household and satisfies its stated objective function. Various authors have employed linear programming models to simulate technology changes, for example Teufel (2005) who analysed the introduction of potential technical improvements for milk production of smallholder households in Pakistan. As the households were poorly integrated into markets and household decisions could not be sufficiently explained by maximising only household income, he chose a multi-criteria decision making approach to integrate further objectives into the model. Usually, when herd dynamics are included, long-term effects are an important consideration. This is also true for forestry projects, where a time lag between the investment period and the returns are observed, as well as fallow periods which might be a part of the system (Mudhara and Hildebrand 2004). However, as the considered interventions did not represent large investments with long time-lags between investment and return, Teufel (2005) developed a single year static model. In South Sulawesi in Indonesia, a study was conducted by Taher (1996) regarding smallholder cacao farmers' technology adoption and application and an optimisation of their activities. A static linear programming model focused on the farm level activities based on different technologies. As the farm condition was assumed to be stable, no risk and time dimensions were included in the model. The main objective of farmers was to achieve an optimal farm gross margin by optimising the gross margin of several crops and off-farm activities subject to labour and land constraints. Different scenarios were run with respect to the most favourable mix of activities, and the outcome indicates that it may well be the best solution for the farmers to diversify their activities. Thus, policy recommendations to improve the farmers' practices were made.

So-called *bio-economic farm household models* have been widely applied to simulate farmers' behaviour. They are optimisation models which allow us to combine biophysical and socio-economic data at different scales with expert information and stylised facts and hence, are quite adapted to the scientific reality of farm household research in developing countries. For example, Barbier and Bergeron (2001) simulated the effect of population pressure, market integration, technological improvement, and policy interventions on economic decisions about natural resource management in the hillsides of Honduras. Therefore, they applied a dynamic linear programming model to a microwatershed, focusing on the sustainability of changing farm production with a 20 year time horizon. For a study to evaluate the effects of particular policy and technological changes on deforestation, land-use, and farm household income in the Brazilian Amazon, Vosti et al. (2002) focused on smallholders' decision making. They explored land-use determinants with a multivariate regression analysis, and used a linear programming model that explicitly incorporates biophysical constraints on production to simulate household responses' to policy and technology changes. The model does not account for risk, as the farmer has information about alternative production activities, the impact of the agricultural activities on the soil and nutrient availability and input and output prices. In the same region Börner (2005) assessed policy options to target rural poverty and environmental degradation under technological and economic changes. His linear and non-linear mathematical programming model also included a biophysical component of a set of crop specific yield damage functions. A 25-year simulation horizon was chosen because of inter-temporal decision making due to fallow periods forming part of the farming system. All these bio-economic studies examine issues involving the interplay between economic and particular biophysical variables. They investigate how individuals manage multiple biophysical processes to generate human welfare, with consequent changes in stocks and qualities of the natural resources. These models all account explicitly for changes in biophysical input availability (e.g. soil nutrients, climate), their impact on crop growth, and their effect on economic decisions about land-use management, which in turn alters input stocks for the next period (Vosti et al. 2002). All these studies integrated two different types of data sets on the economic and biophysical components, as they were part of bigger research projects. None of these studies have been considering *payments for environmental services* provided by the farmers through their land-use systems. Máñez Costa (2004) developed a linear programming model to calculate the income of farming systems in Guatemala which can be differentiated according to the provision of environmental services. The farmers incur income losses due to the adoption of systems, which generate these services. Therefore, she calculated the extent of payments necessary as a compensation based on existing environmental measures. These measures are all based on changes in the farming techniques or specific conservation approaches, however, no payments are considered for the intangible services provided by the farming systems themselves, such as biodiversity conservation or carbon sequestration.

5.3.3. Models of Carbon Sequestration Economics

As all the reviewed optimisation models above have not addressed carbon sequestration, a brief appraisal will be done on studies and methodologies which were conducted to assess economic impacts of carbon sequestration. However, very few of these use optimisation techniques. De Koning et al. (2002) investigated the carbon sequestration potential of afforestation projects and secondary forests in Ecuador and Argentina and conducted an economic analysis of different land-use systems. The net present value was determined of these systems and compensation payments for the landowners calculated to induce a change from agricultural activities to forestry, assuming timber production and carbon sequestration. The compensations reflected the opportunity cost of land-use change. The income per hectare for the landowners from compensations for carbon sequestration was obtained, indicating that forestry projects are not competitive without these payments compared to cattle ranching. Also Santos and Bauer (2006) conducted a cost-benefit analysis, using the net present value and internal rate of return as criteria to evaluate forestry-carbon activities for a region in the Brazilian Amazon. The authors of a study in northern Sweden also employed a linear programming model which maximises the net present value of wood production and carbon sequestration for a 3.2 million hectare region (Backeus et al. 2006). For a management programme they determined the maximised objective function for wood harvesting, biofuel production and carbon storage. The approach of this study differed in comparison to the research at hand as the optimal harvest levels were determined for the entire region using different carbon prices. Focusing on the household level, Antle et al. (2007) assessed the economic impacts of agricultural carbon sequestration for terraces and agroforestry in Peru. They employed an econometric-process simulation model to simulate farmers' land-use and management decisions with respect to carbon contracts. The impact of carbon contracts on the adoption rate of terraces and agroforestry practices was assessed and provided input to the regional policy analysis with the aggregated results of various models. Additionally, they investigated the potential of the contracts to alleviate poverty.

5.3.4. Present Model Specifications

The present study aims at better understanding the land-use systems and determinants for land-use decisions in the vicinity of the TNLL, as well as the impact of different policy options for payment scenarios for environmental services. We are looking at smallholder farming systems with a mixture of paddy rice, maize and cacao agroforestry systems. Hence, we selected a model approach, which is appropriate for the present circumstances, from the reviewed types of models. In order to portray the different options that a farm system has, we chose a static single year linear programming model for several reasons. It proves to be a flexible tool for modelling farm decisions and allows for the inclusion of adjustments in the resource allocation due to changes in the attractiveness of the different activities, as well as taking into account the simultaneous decision-making on consumption and production. Stochastic or econometric models such as the study by Antle et al. (2007) with sufficient detail in the production activities would have far greater data requirements. Long-term considerations are an important component in forestry projects, as investments at the beginning are followed by a period of low income, hence time lags between investment and return are to be observed. Also in some agroforestry projects different timings for improved fallows are taken into account and hence, longer time horizons are brought into the model, such as the four year planning period in Mudhara and Hildebrands' study (2004). In the research region most of the agroforestry plots contain trees of mixed age, and there is no clearly defined investment period and time of returns. Hence, the time lag between investment and returns has been ignored, as there are always some trees which can already be harvested whilst the others still mature. The initial investment costs are very low and the additional labour in the first three unproductive years cannot be clearly separated from other activities necessary for the already productive trees on the cacao plots. Therefore, for the study at hand a single year model seemed to be sufficient in regards to the study objectives. Because of the already mentioned time and financial constraints, no biophysical crop simulation for the agroforestry plots was carried out in the model. Crop production is assumed to be constant, and changes in soil carbon over time are not considered, which was mentioned already in 5.2.1. As the farm condition is assumed to be stable and the farmer has information about alternative production activities, and input and output prices, no risk is included in the model.

To determine the values to be incorporated into the objective function, in the survey the respondents were asked about their daily activities pursued during an average day and had to rank these in the order of importance to them. Activities such as agricultural production for sales, as well as religious activities were of highest importance to them, followed by agricultural production for home consumption, spending time with their family, resting and watching television. Thus, given the objective function, the solution procedure in the model aims at maximising total gross margin of the farm by finding the optimal set of the different agricultural activities for the household type. We included home consumption requirements as food security constraints for maize and rice.

The model therefore enables us to obtain an estimation of the farmers' reaction to changes in their environment and the output can indicate the optimal allocation of the available resources. Additionally, when introducing hypothetical activities, such as in this case payments for carbon sequestration, linear programming proves to be a reliable method to incorporate these into the analysed system. The aim of the presented linear programming model is to maximise the farm level gross margin (Y) of a linear function of a certain number of activities (X_j) (4) given a set of m linear constraints for these variables (5) and does not involve any negative activity levels (6).[13]

In a simplified form the model can be written as follows:

$$\max Y = \sum_{j=1}^{n} c_j X_j \qquad (4)$$

such that

$$\sum_{j=1}^{n} a_{ij} X_j \leq b_i, \qquad \text{all } i = 1 \text{ to } m \qquad (5)$$

and

$$X_j \geq 0, \qquad \text{all } j = 1 \text{ to } n \qquad (6)$$

where

X_j= the level of the *j*th farm activity (i.e. hectares), *n* is the number of possible activities.

c_j= the gross margin of a unit of the *j*th activity.

a_{ij} = the technical conversion factors or quantity of the *i*th resource required to produce one unit of the *j*th activity. *m* is the number of resources.

b_i = the amount of the *i*th resource constraint available.

This structure of the model will be used in the following Chapter to develop a site specific smallholder model with its specific characteristics and requirements.

[13] The model at hand is based upon Hazell and Norton (1986) and Teufel (2005).

5.4. Summary

This Chapter provides an overview of the methodology used to obtain the required input for the analysis of the farm households and their behaviour when offering them market-based incentives for carbon sequestration. The data for the analysis of the prevailing land-use systems was collected in a household survey in six villages, using a standardised questionnaire. The villages, as well as the households had been selected on the basis of existing data from previous surveys in the research region. Using the carbon accounting technique we calculated the carbon sequestration rates of the agroforestry systems and the evolving payments to be obtained. Additionally, the amount of carbon saved when avoiding deforestation in the TNLL was determined. Finally, different methodological approaches for farm household modelling were evaluated, leading to the choice of the linear programming model. It allows for an estimation of the farmers' reaction to changes in their environment, as well as to policies and the output can indicate the optimal allocation of the available resources. The structure of the model provides the basis for the analysis in Chapter 7.

6. QUALITATIVE RESEARCH DESIGN

6.1. Methodology for Analysis of Institutional Framework

This Chapter describes the methods which were employed for the analysis of the second part of the study. It starts out with an explanation of the qualitative research approach and the reasons for its adequacy for the present investigation; this includes an outline of the criteria used for the selection of the research villages, as well as the participatory rural appraisal tools used in the data collection. Some socio-economic background information on these villages is also provided. Finally, we will explain the method of the focus group more in-depth and outline the selected content analysis methodology for the systematic text investigation.

The analysis of the second part of the research concentrates on the institutional setting for natural resource management processes. We will therefore be assessing whether the KKMs could provide the institutional structure for a carbon sequestration project, and allow for an active involvement of local stakeholders, as well as for monitoring and enforcing the project performance. A qualitative research design was adopted in order to assess this institutional arrangement and the four topics outlined in the objectives in the conceptual framework in Chapter 3 (institution, participation, monitoring & enforcement and status of the environment). The main motivation to opt for this approach was to obtain information on the impact the agreements had in the village. Through the analysis of changes in the vegetation cover, one can assess whether or not the forest margin has remained stable since the introduction of the agreements. Surveys allow for obtaining data on the number of rules associated with the agreements and how often the regulations had been violated. However, it is also essential to examine what is happening within the village; whether the institutional arrangement has allowed for the participation of the community, which structures have been established and if the villagers observe changes in the impact on the environment associated with the new institution. The perceptions, thoughts and evaluations of the people living in these villages are therefore considered important. The discussions we carried out were aimed at acquiring an in-depth insight into the participation processes in the formation of the agreements and the perceived impact on the status of the environment, as well as their regulatory structure.

Qualitative methods typically refer to a range of data collection and analysis techniques which employ purposive sampling, participant observation and semi-structured, open-ended interviews. Sampling is guided by the search for contrast to clarify the analysis and achieve optimum identification of emergent categories. Thus, particular samples are selected to identify and illustrate specific phenomena (Glaser and Strauss 1967). The aim is to capture and understand individual definitions, descriptions and meanings of events. Qualitative techniques, which we have used to both produce and analyse textual data, allow for an in-depth analysis of social, political, and economic processes (Dudwick et al. 2006).

Open-ended questioning and focus group discussions are particularly appropriate in community settings to allow respondents to identify and articulate their priorities and concerns free from researchers' restrictions and assumptions. One of the key issues related to qualitative research is whose voices and opinions are heard and communicated to outsiders as a consequence of the research (Chambers 1997). In a village community different groups may have overlapping or contrasting experiences of social norms, networks and management processes. With the help of qualitative methods researchers can explore the different views of homogeneous as well as very diverse groups of people in order to help reveal the variety of perspectives within a community. Furthermore, the integration of non-scientific knowledge, values and preferences through social discourse will improve the quality of research by giving access to practical knowledge and experience and to a wider range of perspectives and options (Asselt Marjolein and Rijkens-Klomp 2002). We therefore were interested in the perspectives of the community members where the agreements have been established, to help enrich the discussion on arrangements for natural resource management processes.

There are obviously disadvantages and shortcomings associated with qualitative research which need to be acknowledged and kept in mind. As Abercrombie (1988) points out, social science research in general can never be objective because of the subjective perceptions of both the researcher as well as the respondent. Usually, all propositions will be limited to their meaning to a particular language context as well as social groups. Additionally, the researcher will often unintentionally impose his own value judgements and finally all observations are theory laden.

Four main limitations of qualitative research can be put forward (Dudwick et al. 2006). The first shortcoming is the ability to extrapolate the findings to a wider population, due the selected sample size being usually quite small and not randomly selected. Secondly, because groups may be selected by the researcher himself or on recommendation of others, a difficulty arises in replicating, and independently verifying the results of qualitative research. Thirdly, when it comes to analysing the collected data, typically in the form of interview transcripts or observation accounts, interpretation is necessary. In such a situation two researchers looking at the same data may arrive at somewhat different conclusions. Finally, it is difficult to control for external mitigating factors in the research, which makes it sometimes complicated -but again, not impossible- to make compelling claims regarding causality on the basis of qualitative data alone.

In order to ensure the quality of the research and overcome these limitations as much as possible, *reliability* and *validity* are essential criteria for qualitative research. For the conduct of research one needs to be methodical with consistency and comprehensiveness of analytic procedures being exercised at all times. Based upon the more general considerations, as well as specific criteria, certain procedures have been elaborated which should be followed and satisfied to secure the quality of the results (Gropengießer 2001; Bortz and Döring 2006).

To guarantee *selection validity* and overcome the critique of presenting results on extreme cases, an emphasis is made to select "normal" interview partners. The *technique validity* should be ensured, taking into account six quality factors (Mayring 2002).

1. *Technique documentation* – detailed documentation of the procedures of the collection, preparation and analysis of the data.
2. *Argumentative interpretation validation* – the interpretation has to be justified in an argumentative style and needs to be coherent. Certain criteria can be used, such as an adequate pre-understanding of the interpretation, which allows for a more theory-derived analysis.
3. *Rule-guided working method* – qualitative research needs to be open towards the subject of research, but must also pursue certain pre-arranged steps of analysis in order to assess it.

4. *Closeness to the object* – the researcher needs to be as close as possible to the normal course of life of the subject of research.
5. *Communicative validation* – the validity of the research can be verified by confronting the respondent with the results.
6. *Triangulation* – different analysis paths should be considered to try and find different solution approaches for the same question and the results should be compared.

Even if the *selection* and *technique validity* criteria have been fulfilled, the results could still be extreme outliers and only apply to a specific sample. Therefore, the *correlative validity* of the results should be ensured, whereby the obtained results need to be compared with other research findings.

To conclude, it is important to be aware of the problems associated with qualitative research and to conduct careful planning, methodology and execution of the research. However, when the guidelines are followed, the limits of the chosen specific research design are acknowledged, and a good-faith effort is made to minimise the shortcomings, qualitative research can provide well-founded and rounded results which are of practical relevance for social science research.

6.1.1. Data Collection

For the research we chose four villages in the surroundings of the National Park. The main selection criterion for the villages was that they had to have a Community Conservation Agreement (*Kesepakatan Konservasi Masyarakat* - KKM)[14]. According to a survey on community forest use and the conservation agreements in the surroundings of the TNLL conducted in 2006 by Palmer, 49 out of the total sample of 72 villages reported that they had negotiated or were in the process of establishing a KKM (2007). Through discussions in June 2006 with different NGOs - The Nature Conservancy (TNC), Association of Evergreen Indonesia (*Persatuan Evergreen Indonesia* -PEI), Jambata Foundation and Free Earth Foundation (*Yayasan Tanah Merdeka* -YTM), we obtained important information on the agreements and their status. Each organisation has carried out substantive work in the majority of the villages in the research region and have been involved in the establishment of the KKMs. TNC is an international NGO and Jambata and PEI are Indonesian NGOs and they all focus on environmental issues, whereas the Indonesian organisation YTM is traditionally

[14] The agreements are explained in more detail in Chapter 8.1.1.

involved in indigenous rights advocacy projects.[15] The agreements were established as a co-management strategy between the local communities and the National Park Authority. Its purpose was to negotiate an arrangement to resolve the conflicts between peoples' needs and conservation demands with respect to the use of natural resources. The negotiations were usually conducted by the village elders and the *Lembaga Adat* (LA), the traditional customary council which is in charge of the village law. The LA typically signed the agreement and established the village conservation council (*Lembaga Konservasi Desa* -LKD) to look after the KKM and monitoring activities.

The selected villages are: Kapiroe in the Palolo sub-district, Wuasa in the Lore Utara sub-district, and Salua and Langko in the Kulawi sub-district. Langko exhibits special features. It is located in the Lindu enclave inside the National Park at an elevation of approximately 1,000 m.a.s.l.. Access to Langko is quite difficult, as it can only be reached by motorbike or on foot using a trail traversing the forest. Some of the characteristics of the case study villages are displayed in Table 6.1.

Table 6.1. Characteristics of Case Study Villages

	Salua	Langko	Wuasa	Kapiroe
Village established in	1984	1900	1892	1900
No. of households	307	184	648	279
Population	1,244	704	2,644	1,026
Village size (ha)	6,632	7,500	2,839	10,680
Population density (pop/km^2)	19	9	93	10
Ethnic composition	mixed	local	local	mixed
Paddy land (ha)	0	208	330	75
Cacao land (ha)	900	30	430	445
Forest (ha)	5,589	6,738	489	10,015

Source: A4 village survey 2007 by Reetz (2008) and own data

Wuasa, Langko and Kapiroe are the oldest villages, of which Langko's and Kaipiroe's populations are predominantly constituted by the local ethnic groups. Wuasa is the most densely populated village. In Salua no paddy is grown, yet a lot of cacao. In Kapiroe and Wuasa the cacao cultivation is also quite important, whereas in Langko very small amounts of cacao are grown. The forest area indicated by the villages as belonging to their territory can be productive or protection forest, and was sometimes inclusive of National Park forest.

[15] The NGOs and their approaches are explained in more detail in Chapter 8.1.1.

According to these numbers Kapiroe has the largest forest resources, whereas Wuasa has the smallest amount.

Discussions with the NGOs provided us with important information on the villages, as well as their KKMs, and we used three main criteria for the selection of these villages. These were; the negotiation stage of agreement, the location of the village and the ethnic composition.

1. The main criteria for selection are that the four villages are at different stages of negotiation or execution of the KKM (Table 6.2.). In Wuasa the negotiation process first commenced in 1999 and the agreement was signed between the village headman and the head of the sub-district Lore Utara in 2002. The National Park Director recognised the agreement shortly afterwards and the community conservation agreement became legal and was implemented.

   Similarly, in Langko, the negotiations started in 2004 and they have already been signed by the head of the TNLL. The customary council and TNC began negotiations in Kapiroe in 2005 but the agreement is yet to be signed. In Salua different institutions have been working with KKMs. CARE carried out a programme called "Biodiversity Conservation for the National Park" between 1995 and 2000. Its purpose was sustainable agricultural development to support the conservation and management of the National Park. CARE initially promoted the agreements as an accompanying measure to their development programme. However, after completing their first phase of project activities in the area in 2000, they stopped any further support for them (Mappatoba and Birner 2004).

   The Central Sulawesi Integrated Area Development and Conservation Project (CSIADCP), which was established in 1998 and lasted until 2005, focused on supporting community welfare in the villages in the bufferzone of the TNLL (ANZDEC 1997). They also promoted KKMs, called traditional KKM (*Kesapakatan Konservasi Masyarakat Adat* -KKMA). Thus, in Salua the first KKM negotiation process was initiated by CARE in 1996 but never finalised, then taken up by CSIADCP in 2004. The process was eventually finalised by 2006. This range of dates for the start of the negotiation process is in line with Palmers' survey (2007). The first negotiations started in 1995 and only 38 of 49 villages had their agreements recognised or acknowledged by TNLL in 2006.

2. All four villages are located in different points around the TNLL, one towards the north-east, one in the east, one in the west and one in the centre of the National Park

(see Figure 4.2.). We cover three different sub-districts. In Sigi Biromaru no village with an agreement was found and the distance to reach Lore Selatan and Lore Tengah was too far, so that to reduce overall costs we concentrated on Kulawi, Palolo and Lore Utara.

3. The villages have diverse ethnic compositions: Salua has a very mixed ethnic situation with many outsiders who have arrived and settled in the village. It was established in 1984 as an extension of a sub-section (*dusun*) of a neighbouring village and is connected by road with Palu. Thus, the migrants do not only come from villages close-by, but also from distant villages and other provinces. The same is true for Kapiroe, which has experienced an influx from Bugis, as the access to Palu is very good. In contrast, Langko is geographically more isolated than other villages and it has very few migrants. In Wuasa, the original ethnic group Napu constitutes about 70 percent of the population and the remaining 30 percent are mainly Bugis, with a minor part originating from other ethnicities such as Poso, Manado, Toraja, Kaeli and Java.

Table 6.2. Characteristics of Community Conservation Agreements

	Salua	**Langko**	**Wuasa**	**Kapiroe**
Agreement name	KKM/KKMA	KKM	KKM	KKM
Start of negotiation process	1996 /December 2004	March 2004	1999	March 2005
Signed by BTNLL	Not signed / Not signed in 2006	March 2005	August 2002	Not signed in 2006
Facilitator	CARE /CSIADCP	TNC	TNC	TNC
Local organization looking after KKM	*Lembaga Adat*	LKD	LKD	*Lembaga Adat*

Source: own data

Data collection was carried out in all villages through conducting focus groups with two respondent groups to assess the impact of these agreements. Before describing the focus group methodology, the tools we used for the data collection are explained.

6.1.2. Participatory Rural Appraisal Tools

This section serves to present the instruments which have been employed to carry out the assessment of the KKM. The focus group discussions were carried out using participatory rural appraisal tools. These are particularly adequate when one aims at enhancing the participation of community members in assessments. On the basis of an extensive literature review Asselt Marjolein and Rijkens-Klomp (2002) define participatory methods as "*methods to structure group processes in which non-experts play an active role in order to articulate their knowledge, values and preferences*". These methods usually entail group methods.

As explained in 6.1.1, we selected the four villages of Kapiroe, Wuasa, Salua and Langko in the vicinity of the National Park. In every village two focus group meetings were held in June and July 2006. One group was purposively selected and consisted of the local village authorities, such as the village headman or the village secretary, as well as members of the LA and the LKD. The second group comprised villagers, which we randomly selected by walking through the village and asking farmers whether they wanted to participate in the meeting. We separated the respondents into these two groups to avoid the domination of the discussion by the authorities, as well as to ensure that the farmers did not feel inhibited in front of their leaders and could speak freely.

In each meeting around five people assisted and the discussions lasted approximately two and a half to three hours. As my knowledge of the Indonesian language was not sufficient to conduct a group discussion by myself, the workshops were facilitated by two Indonesian assistants under my supervision. The structure of the discussion and the different topics to be covered had been elaborated by me beforehand, and with the team we discussed this outline for them to feel comfortable to guide the meeting (see Appendix IV for the outline). During the gatherings I was present and could intervene or provide additional comments which were integrated into the discussion. All focus groups were recorded and later transcribed and translated into English. It should be noted that a translation will usually imply some loss of information. Yet, the workshops were always followed up by an evaluation session of our small team where all in attendance wrote down the main points, impressions, as well as the atmosphere during the discussions - these working notes helped to complete the transcripts of the discussions. Additionally, all labelled cards from the evaluation session were photographed, in order to keep an extra record of the assessment of the participants. Whilst analysing the contents of the discussion, if there were ambiguous parts in the translations, I usually discussed these with one of the assistants in order to clarify the doubts. The methodology ensured that the transcribed and translated interview material was as thoroughly checked for possible misunderstandings as was feasible. See Appendix V for some pictures taken during the focus groups.

The meetings started with a warm-up session during which the participants had to draw a map of their village and the adjacent forest. This served to indicate which area was part of the KKM, as well as the location of the different types of forest, such as the National Park forest, or adjacent protection forest (*hutan lindung*) or productive forest (*hutan produksi*). Furthermore, in some villages traditional land and forest zones exist, which were outlined and their specific uses or functions explained, as well as the areas monitored by the LKD. On the maps it was observed where illegal logging or rattan collection had taken place in the past or still occurred. In the initial session we therefore obtained some general information about the KKMs and the different involved organisations, as well as an impression of the familiarity of the group with the agreements. This first part was followed by a brainstorming session, giving the participants the chance to propose different themes they associated with the agreements. They could contribute their opinions and ideas by writing them on cards which were all displayed on a board. This allowed for the participation and feedback of all respondents, as it was a free, interactive and non-committal way to explore options and views; all the participants were encouraged that "all ideas are good ideas" (Borrini-Feyerabend et al. 2000). The topics were ideas which could be positive or negative, impacts, results, consequences, causes; any idea associated with KKM was seen as a contribution to the discussion. Afterwards these cards were assigned to different topics. These were institution, participation, education, monitoring, preservation, status of the environment, illegal resource extraction, environmental impact and economic impact. Consequently, the participants were given a range of scores from +3 (very good) to -3 (very bad), and asked to allocate them to each topic. Through this method the participants could, as a group, determine how every topic scored "Before KKM" and "After KKM". This was then used to evaluate whether there was any positive or negative impact caused by the KKM so far. As the agreements had not been signed before the survey was conducted in the villages of Salua and Kapiroe, the participants evaluated "Before the start of the KKM process" and "After the start of the KKM process".

At the end of each session the facilitators presented a short introduction to the topic of compensation payments and carbon sequestration in forestry ecosystems. Initial feedback from participants was noted with regard to the possibilities of implementing conservation agreements in all villages in the entire surrounding of the TNLL, and the necessary monitoring efforts this would require. Furthermore, the issue of compensation payments was discussed in terms of past experience and associated doubts and problems.

6.2. Focus Groups

For the purpose of the research at hand we wanted to obtain an evaluation of the KKMs, and specifically their institutional structure and purpose, the participation and involvement of the village stakeholders and the agreement's impact on the status of the environment, as well as the monitoring and enforcement structures. We were interested in various people's opinions and evaluations with respect to these topics. We therefore gathered the village members in discussion or so-called focus groups to appraise and evaluate the agreements.

The qualitative research method of focus groups[16] is usually employed in research designs with the objective to gain an insight to opinions, attitudes and awareness of a group of people with respect to a specific topic. It entails the explorative virtues of being a communicative and open technique (Krüger 1983). There are various definitions for this method, but we selected one which gave a good all-encompassing description: "*The focus group is a special type of group in terms of purpose, size, composition, and procedures […] In summary, a focus group is a carefully planned discussion designed to obtain perceptions on a defined area of interest in a permissive, non-threatening environment* (Krueger 1994 p.6)".

Group discussions are a relatively young method in comparison to other techniques in empirical social research. In the USA they were employed by Lewin in the field of psychology as early as the 1930s. He was essentially working with experimental small groups, and did not focus so much on the factual result of the discussion but more on the group, the participants and its dynamics. His particular interests were leadership styles and behaviour and responses by the group members. Similarly, the sociologist Bales (1950) placed his emphasis on the interaction processes in the groups. In the USA focus group discussions have been used mainly for market and opinion research in order to prepare consumer surveys or investigate motivation structures among consumers. Merton and Kendall (1946) developed a fairly standardised set of procedures for interviewing groups, but it was covered in oblivion and it was not until the late 1960s that the technique began to be used regularly. It has subsequently grown in popularity (Greenbaum 1998). In Germany the Frankfurt Institute for Social Research started to work with group discussions in the 1950s. Their focus was on accounting for the comprehensive group process discussion results. Thus, their discussions were primarily used to obtain the content-thematic issues of the discussed topics.

[16] The terms "focus groups" and "group discussions" are used interchangeably, as there is no uniformity with respect to the terminology. In the English language area various names are used, such as *nominal group technique*, *brainstorming techniques*, *Delphi technique*, *focussed interview*, *group interview*, *focus group*, *group discussion*, etc. Specifically the last two are used synonymously (Lamnek 2005).

Four methodological approaches can be identified. According to Pollock (1955) group discussions are used in order to determine the *individual non-public opinion*. The group is seen as an important determinant to express personal attitudes and opinions in communication processes, to indicate the non-public conviction with respect to a certain theme. Mangold (1959, 1967) was interested in using group discussions as a method to obtain the *informal group opinion*. He concentrates on the collective opinion which emerges during the process of mutual interaction. The *situation dependent group opinion* is the main focus of Niessen (1977). The social reality is only reflected by a group situation, which has an influence on the generation of group opinions. Bohnsack (2003) points his attention towards investigating the *collective orientation patterns* when aiming at explaining collective phenomena.

The main interest of all four concepts is the content findings of the discussion, whereas the group processes and dynamics are not considered. Focus groups are considered to be more realistic and close to daily life than the individual interview and hence can lead to more viable and reliable results. This is in line with the purpose of the research at hand, since the present research interests lay in the content of the informal group opinion, and not so much in the individuals' views or in the group processes or dynamics.

There are a variety of advantages associated with the focus group methodology in empirical research designs (Mangold 1967; Wittenberg 2007). It proves to be an appropriate method to explore the variation breadth with respect to a specific topic. The variety of participants in a discussion can be a stimulation and encouragement for the individual to express his own thoughts and opinion. Additionally, a focus group can stimulate the activation and expression of deeper awareness contents and provoke spontaneous, uncontrolled reactions; this allows us to draw conclusions on the latent content of the expressed opinions (Mangold 1967). The final advantage is that when the research objective is to explore a new field of investigation, this can be done with reduced effort, personnel, time and cost. Clearly, there are also disadvantages which need to be kept in mind: Irregular participation of the respondents in the discussion can arise due to social and language barriers and sometimes opinions may be suppressed in order to conform to the group opinion. Furthermore, a bias can be introduced due to the prevailing group dynamic trends, as well as the erratic contributions of participants, e.g. opinion leaders or silent participants can make a standardisation impossible. Finally, as with all qualitative research, reliability and validity are an issue. However, when certain quality criteria are met and specific procedures are implemented, these concerns can be overcome.

In order to assure the validity and quality of the research, we adhered to the quality criteria as outlined in section 6.1. We specifically chose to discuss the research topics in two groups, and since the individual participants of one group were purposively selected, the members of the other group were chosen randomly to guarantee a selection of average, "normal" respondents (*selection validity*). The advantage of focus groups is that the structured discussion gives the space to express individual opinions in a permissive, non-threatening environment. This was additionally supported by the separation of the respondents into two discussion groups to give them the space to articulate their views. We acknowledge the importance of the participation of these groups, as it allows to "*involve those affected by, knowledgeable of, or having relevant expertise or experience on the issue at stake in knowledge production and/or decision-making*" (van Asselt and Rijkens-Klomp 2002). It is most likely that the perceptions with respect to the development of the agreement negotiation and establishment differ between the groups and therefore it is relevant for this research to include these different dimensions. To ensure the *technique validity* we settled on the focus group interview methodology and carefully documented the different stages (see 6.1.2.). This also holds true for the analysis technique (see 6.3.).

The theoretical framework, which underlies the present research and has also been used as a foundation for the interpretation of the contents of the group discussions, has been delineated in Chapter 3. Similarly, the necessary steps for setting up and organising a focus group have been followed during the field research, as well as the rules and guidelines for the analysis of the material collected during the meetings. We conducted the discussions directly in the villages, usually at some public place such as the school or a villager's home, thus providing the advantage of respondents staying in their familiar environment. The results of the interpretation of the discussion have been presented in three of the villages in workshops carried out in February 2008. Thus, the findings have been mirrored by the same group discussion participants, who participated in 2006. We discussed the results, as well as changes which have been taking place since 2006, to allow us to assure the validity of the results. We also conducted a further workshop in March 2008 with BTNLL, TNC and other organisations working in the Lore Lindu region and presented and discussed the research results and the feedback from the villages. Again, the findings were corroborated by the different institutions. Finally, to ensure for *correlative validity*, the existing literature on KKMs and its research findings (Mappatoba and Birner 2004; Burkard 2007; Palmer 2007; Thamrin 2007) have been compared with the present research and similar patterns emerge.

6.3. Content Analysis

For the systematic text analysis of the group discussions we chose a deductive, logical approach, as we were interested in specific issues of the KKM. Thus, we used the *qualitative content analysis* following Mayrings' (2007) approach order to apply a rule-guided, reproducible assessment of the group discussion interview material. This involves the transcription of the data for the analysis of the substantive content (Bloor 2001) and consequently data indexing, data storage and retrieval, and interpretation.

We will first present an overview of the method and then explain the steps taken for the data analysis for this research.

The qualitative content analysis is the longest established method for examining a text among the empirical methods of social investigation (Titscher et al. 2000) and can be defined as "*the use of a replicable and valid method for making specific inferences from the text to other states or properties of its source*" (Krippendorff 1980). Its aim is to analyse recorded or documented material derived from any kind of human communication. A systematic, as well as rule- and theory-guided procedure is pursued and allows for conclusions and inferences to be made based on specific aspects of the communication (Mayring 2007). The development of content analysis is fundamentally connected to the analysis of mass media and has gained importance during the first half of the twentieth century in communication sciences. Other areas of application are in hermeneutics (the process of communication and understanding), as well as in the study of literature to allow for a systematic text analysis. Finally, in qualitative social research it is used for interpretation.

For the analysis of text material an elaborate *category system* is developed which is adopted in due course as a basis for the summarising interpretation of the data. Some authors also talk about indexing the data in order to bring together all extracts of data that are pertinent to a particular theme, topic or hypothesis (Coffey and Atkinson 1996). The *categories*, sometimes also called *index codes*, are perceived as the more-or-less operational definitions of a variable (Titscher et al. 2000). Thus, in an interview, the entire text will be searched for sections, expressions, or words, which are relating to or expressed by this category (or code) and consequently assigned to it. At the beginning these categories are likely to be quite broad, but usually there is an entire set of categories – a category system – which develops and becomes more narrow and focused as we work on the text material and follow a theory-guided procedure. The main categories are further divided into subcategories in order to specify certain aspects more in detail. The development of this coding system is crucial to the analysis.

For indexing the data, a method is required which collects all extracts of text which have been allocated to the same category, so that they can be retrieved for comparison with other extracts of the same category. Nowadays, there are a variety of different softwares available to facilitate the analysis of qualitative data, each allowing for the data storage and retrieval of text by the given codes (Bloor 2001).

Another important differentiation is whether one chooses an *inductive* or *deductive* approach. Qualitative research often uses a process of analytic induction. This involves the data collection and a formulation of hypotheses based on the data, consequently testing the hypotheses using the data and attempting to develop the theory. The theory is developed during the investigation. It is called grounded theory because it arises out of and is directly relevant to the particular setting under the study (Frankfort-Nachmias and Nachmias 1996). Similarly, if the categories are derived when going through the interviews, an inductive approach for developing the categories is taken, whereas, if the categories have been developed by a theory-driven procedure, a deductive approach is followed. In this case the research questions and hypothesis guide the structure of the coding system. In reality usually a mixture between both approaches is carried out; one applies an a priori developed category system to the interview text and then refines and amends it. Once the category system is developed and all relevant text sections have been assigned, the data needs to be interpreted.

Mayring (2007) developed three different procedures in his content analysis technique which give guidance for the category development, as well as the data interpretation. The three procedures underpinning the content analysis are *Summary*, *Explication* and *Structuring*. The first approach reduces the material but preserves the main content. Using abstraction one needs to create a summary which still reflects the initial material. Explication involves explaining, clarifying and annotating the material. Thus, additional material is used to explicate the specific text sections. The last approach aims at filtering specific aspects from the material, using pre-formulated criteria. These techniques should not be blindly applied to the text, but Mayring argues that one needs to adjust and modify them according to the material at hand. When required, techniques can be mixed, but should keep as close as possible to the initial form of interpretation. Thus, for the analysis of the interview material from the focus groups on KKM, we selected the *structuring content approach*. It was appropriate for our research needs, as only the text sections with respect to specific topics and content realms were extracted and summarised.

Having explained the method, we now turn to the actual data analysis, which consisted of four steps, following a deductive and theory-driven approach. The first analytical step was the development of a category system based on the research objectives (Chapter 1) and the analytical framework (Chapter 3). We obtained the main structure of the category system which was additionally guided by the four focus points of the analysis (Chapter 1 & 3). This category system was a requirement for the second step during which we conducted a deductive analysis of the entire text material of one group interview and assigned sections, quotes or words to the codes. This served to expand and reformulate the category system as several codes had to be revised, renamed or some had to be divided into subcategories in order to account for the richness of the interview texts and the data. Finally, we derived a final version of the coding system. In the third step of the analysis we carried out the main run-through of the text and the final category system was applied to all eight group interviews. The entire coding analysis was carried out with the MaxQDA 2007 Software[17]. The fourth step involved the data retrieval for each index code. The extracted material belonging to this category was paraphrased and summarised according to whether it was a quote from the decision maker or the farmer group. This served not only to check for differences between the two groups, but also between the different villages. Consequently, the data was interpreted using the research questions in order to falsify or verify them.

We ensured for the inter-coder reliability carrying out check coding as described by Miles and Huberman (2004). Hence, coding is conducted separately by two independent coders. Another researcher and myself performed the coding of the group interview and discussed the derived categories. Disagreements about the assignment of sections to certain codes were examined and the respective text sections recoded in consensus. The final inter-coder reliability was calculated to be 90 percent across all categories and was considered to be a satisfactory value.

6.4. Summary

In order to address the conflicts which have been arising on the one hand through the households' needs to use the forest and its resources and on the other hand through the conservation demands from a recognized National Park, conservation agreements have been negotiated and established. Several NGOs participated in the negotiation between the villages

[17] See www.maxqda.de

and the National Park Authority. Four villages, which are at different stages of negotiation or execution for these agreements have been selected for an in-depth case study on the impact of these institutional arrangements on natural resource management processes. This Chapter reviews the qualitative research design chosen for the analysis, illustrating the participatory tools we used to work with the community members. Furthermore, the focus group method employed for the data collection, as well as the content analysis method for the data interpretation and both their theoretical founding are explained.

7. CARBON PAYMENTS FOR AGROFORESTRY SYSTEMS

7.1. Farm Household Modelling

In this section the farm households of the research region will be portrayed with their different agricultural enterprises, as well as their forest conversion activities using a linear programming model. Three components are vital for the model, which need to be well defined: the objective function and the resource constraints of the farmers, and the environmental services offered through the agroforestry systems. Therefore, we briefly characterise the production environment in the region and the farm households. The structure of the modelling process and inputs are explained, which are built upon the review of linear programming and carbon sequestration methodologies in Chapter 5.3., and the model structure with equations (4) to (6). A static comparative model is developed maximising the objective function of farm level gross margin subject to specific local requirements, such as the food security constraint, and we then develop the baseline – status-quo – situation of the farmers. In the second part of this Chapter several scenarios will be introduced, which assess different payment options for carbon sequestration. The impacts on the land-use systems of variations in carbon credit prices and discount rates is assessed, as well as at which level of credit prices households have an incentive to keep or switch towards the shade grown cacao AFS. In the last scenario, payments for avoiding further deforestation, i.e. for the carbon saved by not clearing forest, are introduced into the model.

7.1.1. Farm Households in the Lore Lindu Region

As discussed in Chapter 4.2. Lore Lindu is predominantly a rural region. 87 percent of the farmers depend on agricultural activities as their main income source (Maertens et al. 2006).

According to the STORMA A3 village survey in 2001 about half of the agricultural area is allotted to perennial crops, mainly cacao and coffee, and to a lesser degree coconut, vanilla, pepper, and clove. Approximately one third is allocated to paddy rice, the principal food crop. Other annual crops, such as maize, upland rice, peanuts, cassava vegetables and soybeans as well as homegardens are found on the remaining land. Rice is above all produced for home consumption, while cacao and coffee are cash crops and mainly destined for export. As mentioned previously, during the last 20 years the paddy rice area increased by 20 percent, and the area dedicated to perennial crops tripled. Because of its specific cultivation requirements paddy rice production is found in the lowland areas, and upland rice and maize are cultivated in the more hilly parts. Also coffee and cacao are usually grown in the upland regions where new land was acquired often by expanding into the forest margin. 38 of 80 villages reported that they have agricultural land inside the National Park and on average the households have acquired 30 percent of their land by clearing forest (STORMA 2003).

With the help of a poverty assessment tool based on principle component analysis (Zeller et al. 2006) the households in the region were classified into poverty groups according to their relative welfare. The N (0.1)-normally distributed poverty index allows the grouping of households into terciles and makes it possible to draw comparisons between the poorest, poor and better off households. The poorest and local households were found to have acquired on average 7.9 ha of land by clearing primary forest, whereas better-off and migrant households obtained on average 18.1 ha by purchase (Nuryartono 2005). The observed pattern is that because the local population has sufficient labour available, they can clear the plots in the first place, establish ownership rights, and then sell these plots to migrants who lack the access to the informal land-use rights (Ebersberger and Weber 2005). Among the poorest households a higher percentage have been clearing forest since 1999 than among the less-poor (28 percent versus 11 percent respectively). There is no significant difference between the mean area cleared, but the better-off households convert less forest (0.6 ha during five years) than the poor households (1.17 ha) (Schwarze et al. 2006). The same authors determined with a probit model that the probability for a household to engage in deforestation declines with increasing wealth, the share of irrigated land in total land owned and non-agricultural income-earning activities.

7.1.2. Model Inputs

The linear programming model developed for the Lore Lindu region is based on empirical household data. The major agricultural activities of the farming households are annual crops, such as paddy rice, upland rice, maize; perennial crops such as cacao, coffee, bananas, coconut and fruit trees, as well as livestock activities. Animal husbandry is of minor importance in the area and does not absorb a lot of land or labour. Schwarze (2004) derived in his study that only 8 percent of the total household income is contributed by livestock in this region. Similar results are obtained by Keil (2004), who concluded that only 29 percent of the households own 2.4 heads of cattle and 2.2 percent own 3 heads of buffalo on average. Therefore animal husbandry has not been included in the model.

As explained in Chapter 5.2.1., the agroforestry systems (AFS) in the region are characterised by different shade tree density and management intensity and are subsequently divided into four types: D (natural forest trees as shade trees), E (shaded by a diverse spectrum of planted trees and trees naturally grown after clear-cutting), F (shaded by planted trees), and type G (no shade trees). These AFS constitute the basis to characterise the four household categories which are the focal point for the analysis. We categorised the households according to the dominant AFS among their cacao plots, and determined four corresponding household types (HH_D - HH_G). For example, the household type G (HH_G) has a total of 1.1 hectares of cacao plots, of which the major area is made up by the G type AFS plots (0.79 hectares), but he also has a small plot of E type cacao (0.33 hectares). Apart from the cacao plots, all household categories also have paddy rice and upland rice, as well as maize plots. Consequently, for all four household types a separate linear programming model was developed and the four annual and perennial crops constitute the different activities. The general structure of the modelling approach is shown in Figure 7.1. The data collected at the farm level provides the basic set of descriptive data, and enables the calculation of the gross margin for the agricultural activities. Given the objective function, the solution procedure maximises total gross margin by finding the optimal set of activities for the household type, under the given restrictions such as farm size, suitability of the land for various crops, family work force, and the seasonal peak requirement of labour for each activity. Additionally, the solution procedure also maximises the returns from the sales of timber, which the household obtains when they convert forest. Various economic-political-environmental parameters from the research region form the basis for the calculation of deforestation activities and carbon payments for the AFS. New production techniques and packages can easily be incorporated by adding further activities to the model. The farm condition is assumed to be stable, and risk and time dimensions are not included in the model as explained in section 5.3.4.

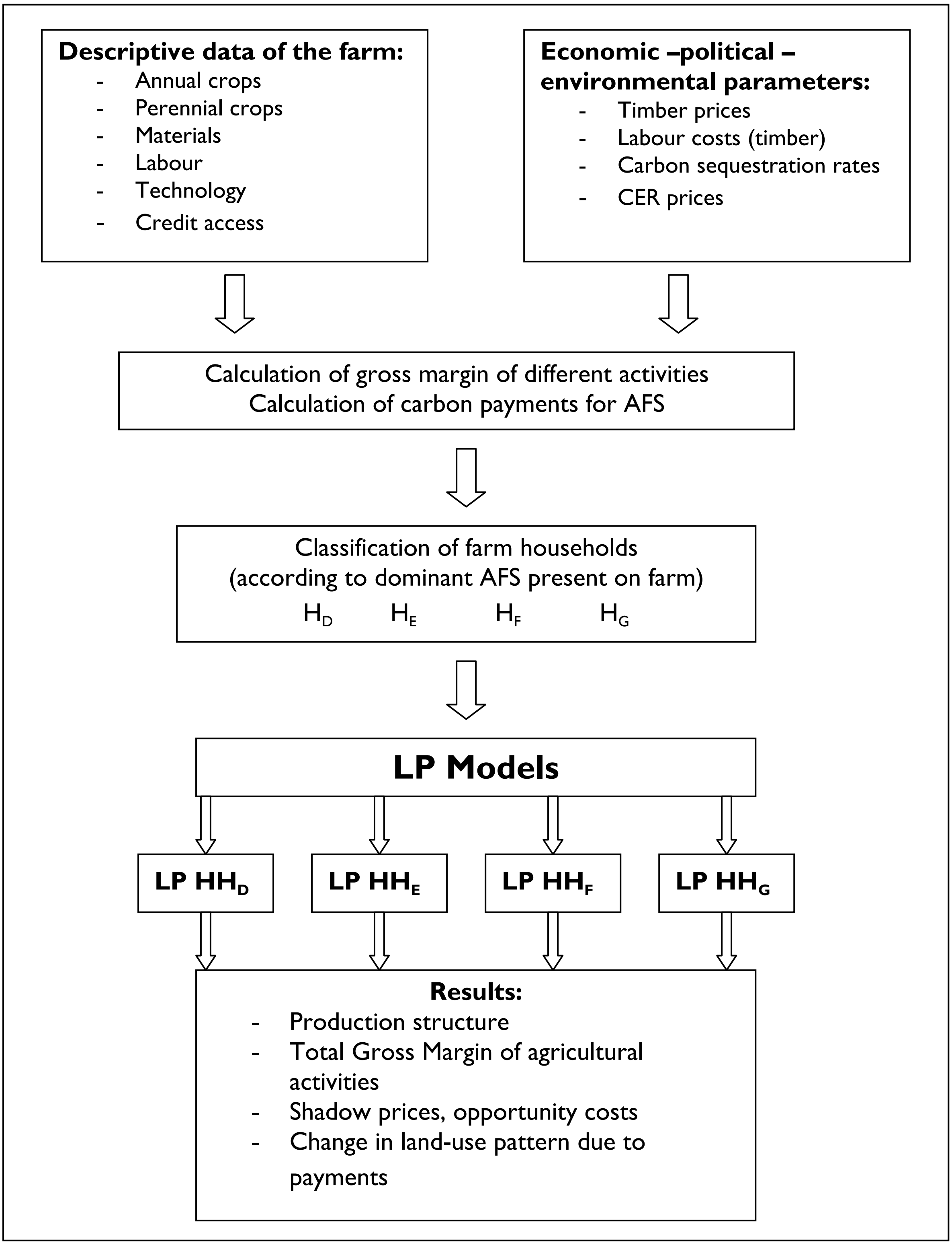

Figure 7.1. The Modelling Approach

Source: adapted from Acs et al. (2000)

The *main input activities* of smallholder farm households are the use of their land, the use of labour and capital (either own or borrowed). As a simplification, the input ratios are taken as given and are not to be optimised. Hence, the model seeks to find the best combination of activities (output-output relations), but assumes input-output and input-input relationships as given by empirical evidence. Since the model is based on the household level, it does not attempt to simulate decisions on the input mix for individual crops. Therefore, technical inputs such as seed, fertiliser, herbicides and pesticides are considered with regard to their costs and are included in the variable costs.

The *main constraints* which limit the household decisions in the model correspond to the main activities and thus also refer to the availability of land, labour and capital.

Each model household may freely use the *land* of the respective household class, some of this land is only used for the cacao plantations (see Table 7.1.). The amount of land available for each model household is based on the mean of the respective household class of their cultivated land. The land used for cropping activities cannot exceed the available land types – annual crop land and cacao plantation.

Table 7.1. Characteristics of Different Household Classes

	Household class			
	D	**E**	**F**	**G**
Total cultivated land (ha)	2.5	2.8	2.8	2.4
Cacao AFS I (ha)	0.60	0.23	0	0
Cacao AFS II (ha)	0	0.30	0.45	0.33
Cacao AFS III (ha)	0.49	0.23	0.58	0
Cacao AFS IV (ha)	0	0	0	0.79
Family labour days per month (Wage +other labour + 10% deducted for other activities)	32.4	29.5	34.4	31.6
Credit limit (IDR)[18]	380,000	8,295,625	11,682,222	6,568,750
Ethnicity (% migrant households)	0	19	22	80

Source: own data

Most households use the forest for their agricultural activities. Either the forest is directly converted into maize fields or some cacao seedlings are planted and hence, the fully shaded AFS D is created. Therefore, in the model the household can convert forest land to cacao plots, for which they incur costs for hired labour and material. Based on empirical evidence (Schwarze et al. (2006) as mentioned in 7.1.1), the household cannot convert more than 0.2 hectares per year in the model. Apart from this conversion possibility the land area available

[18] In 2006 the exchange rate was €1 = 11,500 Indonesian Rupiah (IDR)

to each household is fixed; no trading or renting of land is included in the model. It has been observed in most villages that the land is limited and additional purchases are very difficult, as there is no more non-forest land available. Within the model time horizon of one year, only one crop can be grown per land unit. Requirements for crop rotation are not implemented as they are not important within the cropping systems of the study region.

For the agricultural activities two types of *labour* are available which are family labour and hired labour. The total labour capacity of the household represents a constraint in the model. If additional labour is required it may be hired according to the recorded daily wage rate on a monthly basis. In general there is no limit to the use of *hired labour*, the only restriction is capital availability. The rate for hired labour of IDR 19,000 per day is based on values found in the survey area in 2006. Assuming 23 working days per month, the monthly wage rate is IDR 437,000.

The cacao plantations need labour all year around, however paddy rice, upland rice and maize are usually harvested twice a year, in some regions even three times. However, in some regions only one harvest took place once a year. In general there is a great regional variation in the time of the year in the cropping pattern to be found, as the microclimatic conditions fluctuate strongly. The recall period for the farmers was the last year (see Appendix VI for monthly labour requirements for each household class and activity for one year).

In order to obtain the *family labour capacity* for the four household categories the OECD modified equivalence scales[19] were used. The figure of 23 working days per month is taken to calculate the family labour availability. Family labour is also used for off-farm employment (wage labour and other labour). In the survey we also obtained data on the amount of time spent on wage labour employment and off-farm labour employment and consequently deducted this time from the family labour capacity. In addition to the cropping activities included in the model, family members have to perform various other activities, such as other perennial and annual crops not considered in the model. Therefore, 10 percent of the family labour is deducted for these activities (see Table 7.1.). The total family labour capacity is equally distributed over twelve months.

Capital is required for a variety of activities, such as covering the costs of the inputs for the crop activities, such as fertilizer, herbicides, hiring additional labour and also for the forest

[19] Equivalence scales are used to assign each household type in the population a value in proportion to its needs. The factors commonly taken into account are size of the household and age of its members (adults or children). A wide range of equivalence scales exist, the OECD modified equivalence scales assigns a value of 1 to the household head, of 0.5 to each additional adult member and of 0.3 to each child (OECD Social Policy Division 2006).

conversion activities. In the survey households were asked about their monetary savings and cash, however no answers were provided by the respondents. Therefore, a proxy is used for the limiting cash constraint, the credit limit (see Table 7.1.), which is the maximum amount of credit the household expects to be able to borrow from formal and informal sources (Diagne and Zeller 2001). As the formal and informal credit market in the research region have been investigated by Nuryartono (2005) already, this proved to be a reliable method.

Rice is a staple food in Indonesia and in the project region it is produced for sales but also for home consumption. According to Glenk et al. (2006), who obtained a constant marginal willingness to pay for the consumption value component, it can be suggested that rice cultivation is perceived as a necessity for the households in the research region regardless of their poverty level. Therefore, a *rice food security constraint* has been included for the households' rice requirements, which is based on the household expenditure data for rice consumption. The expenditure data for rice consumption, consisting of purchases, gifts and home consumption (STORMA A4 survey 2005) allowed us to derive for each household class the proportion of expenditure for rice consumption covered by home production. Using the market prices for paddy and upland rice, the necessary quantities of rice home production are obtained and than converted to minimum land requirements using the per hectare productivity figures. On average all households retain for home consumption 222 kg rice from their own production. For paddy rice 0.08 ha are needed and 0.07 ha for upland rice. These figures are included as a restriction in the model, indicating the households' minimum land requirements for rice to fulfil their home consumption needs. Similarly in the model by Keil et al. (2007), developed for the same research region, the households' rice requirements were included as a constraint. The gross margin for maize proves to have a very low value, increasing the likelihood for this activity to be forced out of the model. Hence, as maize is an important crop production activity observed throughout the research region, a *maize food security constraint* for minimum maize production, calculated specifically for each household class, has been included. On average all households use 442 kg per year. Again, the respective home consumption figures were converted into minimum land requirements using the per hectare productivity figures for maize.

7.1.3. Objective Function Coefficients

The objective function is maximising the total gross margin of the cropping activities, as well as the returns from timber sales from the forest conversion activities. The values of these activities enter the equation as objective function coefficients and are discussed in turn.

We calculated the gross margin values for the three main annual crops, paddy rice, upland rice, and maize, as well as for cacao, but we differentiated between the four AFS, which are grown under distinct shade regimes on the plot. Other crops such as peanuts, cassava, beans and other vegetables were left out, as only very small quantities are planted and harvested. Similarly coffee, coconut, kemiri and other perennial crops were omitted, since only few farmers were engaged in these activities. The gross margin (GM) was calculated as follows:

Gross Income (GI) – Variable Cost (VC) = GM

where **GI/ha** = $Q_{sales} * P_{sales} + Q_{home\ consumed} * P_{market} - Q_{seeds} * P_{seeds}$

and **VC/ha** = $C_{Material}$ [20] + $C_{Hired\ Labour}$ [21]

(Q= quantity, P= price, C= cost)

For the four household types, as well as for the annual and perennial crops, we derived different gross margin values (in Indonesian Rupiah (IDR)), as indicated in Table 7.2.

Table 7.2. Gross Margins for Agricultural Activities and Households

	Household Class			
(IDR ha^{-1})	**D**	**E**	**F**	**G**
Paddy rice	2,114,115	4,309,772	5,669,864	2,735,000
Upland rice	831,600	1,446,256	2,537,778	0
Maize	0	1,188,298	3,371,167	1,116,000
D Cacao	**1,034,195**	1,300,000	0	0
E Cacao	0	**4,344,886**	4,030,471	6,475,421
F Cacao	2,031,915	8,558,012	**4,273,694**	0
G Cacao	0	0	0	**16,807,098**
Total	**6,011,825**	**22,335,521**	**23,254,139**	**28,249,519**

Source: own data

As it can be seen the gross margin values for the shade free cacao production is much higher than for the shade intensive cacao AFS D. These results exhibit a similar cacao intensification gradient between AFS D and G as has been observed in the data collected in the STORMA A4 survey in 2001. However, the average gross margin obtained in the A4 survey for AFS G was much lower (6.8 million IDR) in comparison to the present one (16.8 million IDR), but

[20] land preparation + seeds + fertiliser +fertiliser transport + herbicides+ pesticides +pesticide equipment +harvest equipment hire +harvest costs

[21] land preparation, fertiliser, herbicide and pesticide application + plantation maintenance

the maximum observation was 14 million IDR which is closer. The high value obtained within this survey reflects a typical household G, who concentrates on intensively managed cacao production.

When the farmer converts forest to agroforestry plots, he can sell some of the timber, even though the extractable timber which is suitable for sales is quite limited. An estimation can been made on revenues from timber sales according to data collected in the field on prices for timber, timber harvest rates in cacao plots, and data on the number of trees counted in the agroforestry plots. We applied the planning horizon of 25 years which we used for the calculation of the carbon credits, and calculated the NPV of the timber revenue. Consequently, as an input for the linear programming model, we derived the annuities by applying the same annuity factor as determined by equation (3) for the carbon payments in Chapter 5.2.1 to the NPV. These annual payments and hence objective function coefficients range from 95,000 IDR for the conversion activity of forest to the AFS D, over 130,000 IDR for the conversion to AFS E, 225,000 IDR to AFS F and 290,000 IDR to AFS G.

7.1.4. Model Formulation

The simplified model for the farm household has been described in Chapter 5.3.4. On the basis of this structure we formulated the Lore Lindu household model which aims at maximising farm-level gross margin (equation 7) of a linear function of a certain number of activities (X_j). For this specific model two types of variables (activities (X)) have been defined:

- *free variables* without any restrictions, which are optimised by the model at different stages of the programming procedure, and
- *positive variables*, which can only assume non-negative values. These represent the actual farm activities.

The model equations are shown in Table 7.3., differentiating between two types of equations:

- Objective function (7); the variable on the right side of the objective function is optimised (maximised) during the solving process. This equation includes the free variables.
- Constraints (8) - (17); all other model equations represent the conditions, which have to be fulfilled in the model solution. These ensure the logical, physical and economic restrictions of the household.

The model contains four production activities, maize, upland and paddy rice, and cacao, which is sub-divided into the four activities according to the management intensity of the AFS. Another activity is forest conversion for which limited labour is needed and costs are incurred for hiring labour, but it also produces revenues from the timber and firewood sales.

Table 7.3. Equations of the Linear Programming Model

Farm income			
Annual farm level gross margin			(7)
Gross margin from crop production activities (including value of home consumption and minus variable costs for crop production) (c_j) + revenue from timber sales (T) - costs of hired labour (Chl)	=	Farm level gross margin (Y)	
Introduction of new activities (Scenarios 1-7)			
+ revenue from cacao production including carbon payments (PC)			(7a)
+ compensation payments from avoided deforestation (AD)			(7b)
$\sum_{j=1}^{n} c_j X_j + T_j - Chl$	=	max Y (X_j= the level (hectares) of the *j*th farm activity, *n* are the number of possible activities)	
Land			
Monthly land-use			
Monthly sum of crop area requirements	≤	Farm size (A)	(8)
$\sum_{j=1}^{n} X_j$	≤	A	
Forest conversion	≤	Forest conversion limit	(9)
Sum of paddy and upland rice area requirement	≥	Minimum rice area	(10)
Total maize area requirement	≥	Minimum maize area	(11)
Cacao D area requirement	≥	Minimum cacao plantation D	(12)
Cacao E area requirement	≥	Minimum cacao plantation E	(13)
Cacao F area requirement	≥	Minimum cacao plantation F	(14)
Cacao G area requirement	≥	Minimum cacao plantation G	(15)

Labour			
Monthly sum of household labour requirements for crop production (Lcp) - hired labour for crop production (HL) + monthly labour requirements for forest conversion (Lfc)	≤	Monthly household labour (L)	(16)
$\sum_{j=1}^{n} Lcp_j X_j - HL + Lfc$	≤	L	
Capital			
Annual sum of variable cost requirements for crop production (VC) + expenses for forest conversion (Cfc) + expenses for hired labour (Chl)	≤	Annual credit limit (M)	(17)
$\sum_{j=1}^{n} VC_j X_j + Cfc + Chl$	≤	M	

Source: own data; Equations 12-15 only in baseline model 1 (B1)

7.1.5. Assumptions of the Linear Programming Model

A model tries to represent a system, however, the system needs to be simplified and the essential features need to be documented. Therefore assumptions are made about certain processes and activities. Some of these have already been mentioned in Chapter 5.3.4. and the model inputs section 7.1.2., but will be summarised in this section with additional ones.

- Crop rotation constraint

Most models with cropping activities use a crop rotation constraint, when different crops are planted on the same plot at different times of the year. In the research area no crop rotation activities have been observed for the crops considered by this model. Yet, some intercropping, such as of maize and cacao, as well as upland rice and maize, is practised in the region, but it was not considered in the model because very few of the interviewed households reported these practices.

- Perennial cacao production

Cacao trees are perennial crops, but in this model they are treated like annual crops. As explained beforehand, the investment costs in this region are very low, and for the calculation of their gross margin, only the productive trees from year four onwards have been included. It is assumed that the agroforestry systems are in place. The static model is looking at one point in time, which is an average point in their productive life span between year four and year twenty-five. In the carbon payment scenarios the farmer can choose between the "old" AFS activities (without payments) and the "new" activities which include the carbon payments. In the "new" activities the additional labour and costs for hired labour for the conversion to a system with fewer shade trees are included.

- Gross margin calculation

We assume the gross margins of the different activities to be constant over the planning horizon of 25 years, because we are not sure about variations of market prices for the different crops. Supply and demand can change market prices and predictions of these underlying conditions are difficult to obtain. Furthermore, we do not have the analytical tools to predict inflation far into the future, which also affects prices. Therefore, as it is also done in project analysis (Belli 2001), we work with constant prices.

- Land constraint

As mentioned above, the land area available to the households is fixed, as practically no further sales and rental of land takes place. However, the forest conversion restriction allows the farmer to convert annually 0.2 ha of forest and use it for his cacao production (equation 8). In reality, usually once the forest is cleared, maize is planted and only in subsequent years cacao seedlings are planted. In some cases farmers start to plant some cacao seedlings directly in forest patches, thus moving towards a fully shaded agroforestry system D. For simplification, since we use a static model and calculated the total gross margin for one year, a direct conversion from forest to cacao plantations is assumed for which capital and labour are necessary.

- Land quality differences

The quality differences for land used for perennial and for annual crops is taken into account in the baseline model with the rice and maize food security constraints (equation 10 and 11). For the model to reflect the real situation special land suitability constraints had to be included, which determine the area shares of the different cacao AFS for the household types (equations 12-15). For a second baseline model, as well as the scenarios, the cacao land suitability constraint is removed, in order to obtain the impact due to the payments only. Additionally, in scenario 6 we introduce complete flexibility for a hypothetical case of free crop distribution. More detailed differences in soils and soil quality, their improvement or deterioration are not considered in the model.

- Risk

The farm condition is assumed to be stable, risk and time dimensions are not included in the model. Prices for crops and timber are assumed to be constant, and that certainty with respect to prices and input-output relationships exists.

- Transaction Costs

For the calculation of carbon payments no transaction costs are considered, which usually entail considerable pre-implementation transactions for developing a carbon sequestration project. It is widely accepted that these can be quite substantial and especially for small farmers can reduce the payments. Transaction costs are discussed in detail in Chapter 3.4. and 8.1.

- Time horizon

The time horizon of the carbon sequestration project is 25 years, which is also the life span of the cacao trees in the region. The model itself looks at only one year, hence for the cacao gross margin calculations an average point in their productive lifespan is used, whereas for the carbon sequestration payments, as well as the revenues from timber sales, the annuities are considered.

7.1.6. Baseline Results

On the basis of the model specifications four models have been developed for the four household types taking into account their particular activities and resource endowments. The results of the baseline model are summarised in the following Table 7.4. The annual Total Gross Margin (TGM), as well as the different shares of the crops of the total cultivated area for paddy rice, upland rice, maize and cacao is listed for the four household types in the model baseline (B1) situation. In brackets, the actually observed shares are indicated and it can be seen that the area shares for paddy and upland rice, as well as maize are much lower in the model, whereas the shares of cacao are much higher in comparison to the actually observed shares. A calibration of the baseline has been repeated various times, still the differences cannot be reduced any more. The encountered difficulty was that the very low prices for maize and rice and the favourable producer prices for cacao, which in the model induced all household types to cultivate only very small areas of rice and maize. The minimum farmgate price indicated in the interviews was 8,000 up to 13,000 IDR kg^{-1} for cacao, in comparison to paddy and upland rice of 3,000 IDR kg^{-1} and maize of 750 IDR kg^{-1}. Hence, an economically rational farmer would probably switch completely to cacao, a phenomenon which has also been observed in the research region in the last years. In the survey at hand, 40% of the farmers declared to have switched to cacao from another crop on their land and the main reason was due to the very high cacao prices which can be obtained in comparison to the other crops. However, even though it might not seem profitable, most farmers will maintain some rice and maize production for food security reasons. An additional reason for not switching from paddy fields to cacao mentioned by a few farmers was that the customary law (*adat*) did not allow them to convert the fields.

Table 7.4. Baseline Model 1 and Optimal Mix of Activities

	Household Class							
	D		E		F		G	
Baseline 1 TGM (IDR yr^{-1})	4,256,000		10,459,000		12,661,000		28,592,000	
Area Share per crop (%age of cultivated area)								
Paddy rice	0.03	(0.26)	0.02	(0.25)	0.02	(0.23)	0.05	(0.10)
Upland rice	0.05	(0.4)	0.04	(0.28)	0.01	(0.32)		
Maize			0.04	(0.22)	0.12	(0.18)	0.15	(0.21)
Cacao D	0.47	(0.19)	0.08	(0.08)				
Cacao E			0.43	(0.09)	0.36	(0.15)	0.13	(0.14)
Cacao F	0.44	(0.16)	0.39	(0.07)	0.57	(0.19)		
Cacao G							0.67	(0.34)
Total Cacao	0.91	(0.34)	0.90	(0.24)	0.93	(0.34)	0.80	(0.48)

Source: own data

As mentioned briefly above, baseline 1 (B1) indicates the TGMs of the four household types as it can be observed also in the real world (Table 7.4. and 7.5.). For the model to reflect this reality, special land suitability constraints (equations 12-15) had to be included, which determine the area shares of the different cacao AFS for the household types. As shown in Table 7.2., the cacao gross margins increase in profitability when moving along the cacao AFS intensification gradient from D towards G. However, the farmers in the region do not only employ the AFS with the highest gross margin, even if this would be rational from an economic point. There are a variety of complex factors and circumstances, which are not reflected in the model, such as the distance of the plot to the forest, traditional land-use practices and cultural preferences, which play important roles in the households' decisions with respect to cultivating a specific cacao system. The farmers who predominantly grow the fully shaded cacao might not just be restricted because of labour, land and credit constraints to this land-use system, but also because their cacao plot borders the forest and they also grow a variety of other tree crops in the same plot. Some farmers also believe that the shade trees prevent diseases from spreading. In order to establish the impact of the payments on the farm TGMs and consequently on the optimal mix of activities we need to determine the TGM without these special constraints. Baseline 2 (B2) in Table 7.5. thus indicates the TGM for all four household classes free of cacao land suitability restrictions. Once the constraints are released, as expected, an intensification of the cacao AFS takes place. Household type E, who grows in the first baseline model apart from dominantly AFS E also AFS D and F, completely stops to grow the fully shaded cacao and adopts more of the unshaded AFS G. Similarly, household type F starts to grow more of the fully sun grown cacao and gives up the AFS E in the baseline situation free of restrictions. This intensification phenomenon is also taking place in reality in this region (Steffan-Dewenter et al. 2007).

Table 7.5. Baseline Models for Four Household Classes

	Household Class							
	D		**E**		**F**		**G**	
Baseline 1 (B1) TGM ($IDR\ yr^{-1}$)	4,256,000		10,459,000		12,661,000		28,592,000	
Baseline 2 (B2) TGM ($IDR\ yr^{-1}$)	4,314,000		12,220,000		15,312,000		31,105,000	
Crop Areas (ha)	**B1**	**B2**	**B1**	**B2**	**B1**	**B2**	**B1**	**B2**
Paddy rice	0.07	0.07	0.07	0.07	0.06	0.13	0.13	0.13
Upland rice	0.11	0.11	0.11	0.11	0.04	0.04	0	0
Maize	0	0	0.12	0.12	0.12	0.25	0.38	0.38
Cacao D	1.49	1.56	0.24	0	0	0	0	0
Cacao E	0.77	0.94	1.31	0.06	1.09	0	0.33	0
Cacao F	0.25	0	1.16	0.77	1.73	1.05	0	0
Cacao G	0.02	0.04	0	1.74	0	1.38	1.72	2.00
Total Cacao	2.53	2.53	2.71	2.57	2.82	2.42	2.05	2.00

Source: own data

The results mirror the poverty gradient, which we obtained when we categorised the households according to their relative welfare. A cross-tabulation calculation was implemented for all households of their poverty index (see Chapter 7.1.1. for an explanation on the properties of the index) and the type of AFS of the cacao plots (Table 7.6.). This analysis includes all households in the research region from the 2004 STORMA A4 survey who grow cacao. All cacao plots from all households were included in the analysis. A trend can be observed that the majority of the plots with fully shaded cacao are owned by the poorest households (67 percent), whereas the majority of the shade free cacao plots are owned by the better off households (63 percent). Thus, it corroborates the fact that there is a wealth gradient to be found from household type D towards household type G.

Table 7.6. Cross-tabulation between Poverty Index and AFS of Cacao Plots

AFS type	Households		
	The poorest	Poor	Better-off
D	67%	22%	11%
E	45%	19%	36%
F	22%	38%	40%
G	13%	25%	63%
Total	28%	33%	39%

Source: STORMA survey 2004 (n=348 (plots of 202 households))

7.2. Linear Programming Model Scenarios

In the previous section the baseline model developed for the four household categories indicated an intensification as well as a poverty gradient from household type D towards G. To assess which impact carbon payments have on the pursuit of activities, whether a change or shift can be observed, and which impact is exerted from lower or higher carbon and cacao prices, we tested various scenarios. In these scenarios new activities are introduced into the baseline model B2. These new activities have a higher gross margin compared to the one of the original cacao activities, as they consist of the gross margin of the original cacao activities plus the annuity payment for carbon sequestration to be received for the AFS. An overview of the annuity payments is displayed in Table 5.3. for a range of discount rates and carbon certificate prices. These payments are administered as per hectare payments. The models of Scenario 2 are displayed in Appendix VII for all four household classes.

Looking at equation 7 of the model, the payments for carbon sequestration are added:

$$\sum_{j=1}^{n} c_j X_j + T_j - ChI + PC = \max Y \qquad (7a)$$

where PC = revenue from cacao production including carbon payments.

As a definition and for the better understanding of the following analysis, the objective function coefficient of the "old" cacao activities is the original gross margin of cacao. The objective function coefficient of the "new" cacao activities is the original gross margin plus the carbon annuity payment.

In the scenarios the farmer can take up additional cacao activities, however if the new area exceeds the old area of that AFS type, he needs to convert land either from another cacao activity, forest or land occupied by an annual crop. This requires additional resources such as for the land preparation, hiring labour, etc. Thus, in the scenarios there are two cacao activities, both with the objective value inclusive of carbon payments, but one with the "old" labour and capital requirements and the other one with the higher resource requirements. For example, if he cultivates in the baseline model 1.2 hectares of the AFS D, but increases his AFS D area to 1.5 hectares, in the scenario he will cultivate 1.2 hectares of the AFS D with the original resource requirements and another 0.3 hectares of "new" AFS D with higher resource requirements.

In the next sections various scenarios will be analysed and presented. These include the following specifications and considered impacts:

	Specification	Purpose
Scenario 1	d 10%, CER €5 tCO_2e^{-1}	Changing carbon prices
Scenario 2	d 10%, CER €12 tCO_2e^{-1}	Changing carbon prices
Scenario 3	d 10%, CER €25 tCO_2e^{-1}	Changing carbon prices
Scenario 4	d 10%, CER €12 tCO_2e^{-1}	Depressed cacao prices
Scenario 5	d 10%	Incentives for shade grown cacao
Scenario 6	d 10%, CER €12 tCO_2e^{-1}	Cash crops first?
Scenario 7	d 10%	Payments for avoiding forest conversion

7.2.1. Impact of Changing Prices of Carbon and Cacao

To perform a sensitivity analysis, but also to detect which impact the variations in prices for carbon credits, as well for cacao have on the land-use systems, first of all various CER are considered. As explained in the previous Chapter and indicated in Table 5.3., the annuity payments for carbon sequestration can vary considerably, when using a range of credit prices from €5 to €25 tCO_2e^{-1}.

In the Table 7.7. the different total gross margins for the first three scenarios, as well as the baseline B2 as a comparison are indicated, reflecting the variation due to the change in the applied CER prices. The annuity payments for AFS D-F inclusive of the carbon sequestration of the shade trees are used for these calculations, as well as the following analysis.

Table 7.7. Total Gross Margin Calculations for Different CER Price Scenarios

	Household class			
IDR yr^{-1}	**D**	**E**	**F**	**G**
Baseline B2	4,314,000	12,220,000	15,312,000	31,105,000
Scenario 1 d 10%, CER €5	4,471,000	12,369,000	15,453,000	31,222,000
Scenario 2 d 10%, CER €12	4,691,000	12,578,000	15,650,000	31,386,000
Scenario 3 d 10%, CER €25	5,100,000	12,967,000	16,016,000	31,690,000

Source: own data

With the introduction of the payments, the HH_D experiences the most pronounced relative impact on its TGM. The rise in total gross margin, when comparing the baseline situation with the different payments is an increase of 4, 9 and 18 percent respectively for the price scenarios 1, 2 and 3. For household types E and F, the increase is smaller (between 1 and 6 (HH_E) and 1 and 5 percent (HH_F)), whereas for household type G the corresponding impact is almost negligible (between 0 and 2 percent). When looking at the absolute impact of the carbon payments on the TGM, household D receives the highest additional payments for all three CER prices, and the amounts gradually decline for HH_E, HH_F and HH_G.

If we look at the carbon sequestration rates of the four households, which are the environmental benefits provided, household E sequesters approximately 168 tCO_2e annually, closely followed by household D with 166 tCO_2e. Household F is in the medium range with 157 tCO_2e and household G provides the least benefits with an annual carbon sequestration of 134 tCO_2e.

Thus, with rising carbon certificate prices, generally seen, the households who obtain the lowest farm total gross margin from their crop activities and appear to belong to the poorest households benefit both in absolute and relative terms most from the payments. Additionally, they provide the second highest environmental benefits in terms of carbon sequestration.

Next, it is of interest to assess whether a change or shift in the land-use has occurred and in which direction. At the range of carbon prices which have been tested in the first three scenarios, none of the households are induced to shift their land-use management practices. Shifts in land-use are only observed if credit prices for carbon sequestration of cacao trees are set at higher levels (see Table 7.8.). The household type F starts to take up the AFS D once the carbon prices reach €55, and household type G needs a carbon price of €238 to induce a change in its land-use practices, also shifting towards AFS D. Household type E only starts to realise any shifts in land-use activity when CER prices are at €600, switching towards AFS D and E. Interestingly, household type D does not realise any further shifts in land-use activities, since its land, labour and capital constraints are binding.

Table 7.8. Impact of Rising CER Prices on Activities

	Household Class						
	D	**E**		**F**		**G**	
Crop Areas (ha)	B2	B2	€600	B2	€55	B2	€238
Paddy rice	0.07	0.07	0.07	0.13	0.10	0.13	0.13
Upland rice	0.11	0.11	0.11	0.04	0.04	0	0
Maize	0	0.12	0.12	0.25	0.21	0.38	0.38
Cacao D	1.56	0	**0.19**	0	**0.20**	0	**0.11**
Cacao E	0.94	0.06	**0.74**	0	0	0	0
Cacao F	0	0.77	0.77	1.05	1.14	0	0
Cacao G	0.04	1.74	1.01	1.38	1.35	2.00	1.97
Total Cacao	2.53	2.57	2.71	2.42	2.70	2.00	2.09

Source: own data

Additionally, the forest conversion rates of the households are changing with these prices, as you can see in the following Table 7.9. Once these higher CER prices are paid, all households start to convert forest to the AFS D. Beforehand the household E only converted forest to the AFS E, which he still does, but to a lesser degree (0.1 ha). However, he starts to grow some cacao in 0.19 ha of forest, which he did not do before. The household type F did not convert any forest in the baseline or in the first three scenarios, but now also uses 0.2 ha of forest to grow some cacao. And even the household type G, who only converted forest to AFS G beforehand (0.11ha), now switches, and converts 0.11 ha to the shade intensive agroforestry system and only in 0.9 ha he takes out all shade trees to convert it to AFS G. This can be attributed to the lower costs when converting forest to the AFS D in comparison to the other AFSs, as little additional labour is necessary.

Table 7.9. Forest Conversion Rates

	Household Class						
	D	E		F		G	
Crop Areas (ha)	B2	B2	€600	B2	€55	B2	€238
Cacao D	0.02	0	**0.19**	0	**0.20**	0	**0.11**
Cacao E	0	0.06	**0.01**	0	0.2	0	0
Cacao F	0	0	0	0	0	0	0
Cacao G	0	0	0	0	0	0.11	0.09

Source: own data

In January 2008, the world market FOB cacao prices were at 2,194 US$ per tonne (ICCO 2008). In general, there is a great price volatility to be observed on the cacao market, as it responds to supply and demand factors. In the 1970s prices experienced an important increase encouraging production in Indonesia and Malaysia, after very low prices in the 1960s. In the 1980s prices declined again and even though they modestly recovered in the mid 1990s, they were still low at the turn of the century and only started to increase again in the last few years. During the time of the survey in 2006, prices were about 1,550 US$ per tonne. The lowest price was observed in 2001, with prices of 960 US$ per tonne (ICCO 2008). This means there has been an increase of 38 percent in world market prices of cacao between 2001 and 2006. Thus, in scenario 4 we look at whether, with this low cacao price as observed in the past, the carbon payments would actually cause a difference and induce any shift in land-use activity or in the TGM. Considering the impact on land-use activity, for household types D, F and G no shift is to be observed, and the change in TGM ranges from 14, 3 to 2 percent respectively. However, HH_E shifts its land-use activities towards AFS D and E and realises an increase in its TGM of 93 percent.

Summarising, we observe an increase in the farm gross margin through the carbon payments, but for shifts in land-use activities to occur, when all AFS receive equal payments, very high carbon credits would be necessary. Thus, we next assess whether shifts occur if explicit land-use systems are targeted with payments.

7.2.2. Incentives for Environmentally Friendly Agroforestry Systems

In Chapter 4.3. we introduced the topic of the observed trade-off situation in the region between the shade-grown cacao with lower economic returns and biodiversity conservation and an intensification of the cacao cultivation with unshaded plantations and higher returns. Research in the region clearly indicates that the transition from AFS D to E has little effect on overall species richness, however completely shade free systems harbour significantly lower species numbers than shaded cacao systems (Schulze et al. 2004; Steffan-Dewenter et al. 2007). Similarly, studies with other perennial crops indicate that at the transition from shaded agroforestry systems to intensively managed shade free monocultures, a major loss of overall biodiversity occurs (Perfecto et al. 1996). Thus, the land-use transition from small scale subsistence plots to intensive agricultural systems results in disproportional losses of biodiversity and ecological functioning and less sustainable land-use systems.

To prevent the intensification of the cacao agroforestry systems to monocultures in the region, economic incentives are required. These could be price premiums, as they are already available for a long time for fair trade or organic coffee. Recently, premiums have also been introduced for fair trade cacao and organic cacao. The fair trade premium for standard quality cacao is €100 per tonne. The minimum price for fair trade standard quality cacao, including the premium, is €1,250 per tonne. Also for organic cacao, producers receive a higher price than for conventional cacao, ranging between €75 to 225 per tonne (ICCO 2007). Alternatives could also be price premiums offered through carbon certificates to offer an incentive for the shade grown, biodiversity rich and sustainable cacao agroforestry systems. Hence, using the reduced costs or opportunity costs of the different cacao AFS activities, the minimum prices for carbon certificates can be determined, which are needed for a specific activity to enter the farming plan. Therefore, in scenario 5 we assess at which minimum credit price the household types would adopt the full shade AFS D or the slightly less shaded AFS E, which both offer higher biodiversity values in comparison to the unshaded AFS, to decelerate the land-use transition process. The results indicate that household D needs a credit price of €14 tCO_2e^{-1} to adopt more (0.12ha) of the AFS D, household E is stimulated to shift more (0.34ha) towards the AFS E with credit prices of €27 and household F adopts more AFS D (0.08ha) with carbon credit prices of €32 tCO_2e^{-1}. These prices are in a range of carbon credits to be observed on markets currently and they are lower than the price premiums paid for organic cacao. However, household G would need very high credit prices of €185 tCO_2e^{-1} to induce him to adopt more of the less intensive cacao production practices.

To summarise, with carbon credit prices observed on carbon markets currently most household types have an incentive to either grow the full shade or slightly less shaded cacao.

7.2.3. "Cash Crop First?" Scenario

Another potential outcome in scenario 6 is investigated to see what happens if there were no food security restrictions in the model and the farmer could freely decide which crops to grow on his land (see Table 7.10.). Generally, in the region, a shift from a "food first" to a "cash crop first" strategy has been observed, as explained in 7.1.6. Thus, it is hypothesised that all household classes will shift towards cacao production and stop their rice and maize cultivation. Scenario 2 is compared with the new scenario 6 which does not contain the food security requirements.

Table 7.10. Impact of Release of Food Security Constraints

	Household Class							
	D		**E**		**F**		**G**	
Scenario 2 TGM IDR yr^{-1}	4,691,000		12,578,000		15,650,000		31,386,000	
Scenario 6 TGM IDR yr^{-1}	9,774,000		19,765,000		15,756,000		34,777,000	
Crop Areas (ha)								
Paddy rice	0.07	0	0.07	**0.04**	0.13	**0.11**	0.13	0
Upland rice	0.11	0	0.11	0	0.04	**0.02**	0	0
Maize	0	0	0.12	0	0.25	**0.24**	0.38	**0.10**
Cacao D	1.56	1.44	0	0	0	0	0	0
Cacao E	0.94	0.19	0.06	0	0	0	0	0
Cacao F	0	0	0.77	**1.59**	1.05	1.14	0	0
Cacao G	0.04	**1.08**	1.74	1.38	1.38	1.32	2.00	2.29
Total Cacao	2.53	2.72	2.57	2.97	2.42	2.46	2.00	2.29

Source: own data

The impact of a free crop distribution would mean that the household class D would not grow any more rice or maize and household E only keeps a very small amount of paddy rice production. This results in a considerable increase in their farm TGM for HH_D and HH_E, who would respectively more than double it and obtain a 60 percent growth in comparison to scenario 2. In this "cash crop first" scenario household type D shifts more towards the intensively managed cacao production, whereas household type E concentrates the majority of their cacao plots as type AFS F and G and retains no AFS E. On the other hand household classes F and G still retain some of the production of the staple food crops. These two household types do not see a sizeable increase in their total gross margin, which was much more pronounced for the other two household types.

7.2.4. Reducing Emissions from Deforestation and Forest Degradation

Nowadays avoided deforestation is increasingly discussed on the agenda of climate change policies, since it can provide an important strategy for avoiding greenhouse gas emissions in the first place. In a study by Jung (2005) the estimates for the global potential for carbon uptake[22] through avoided deforestation are 11 times higher than for plantations, regeneration and agroforestry together.

Therefore, we used the linear programming model and introduced scenario 7 to determine the necessary carbon prices at which households stop deforestation activities at the forest margin of the TNLL. Looking at equation (7), a new objective function coefficient is included:

$$\sum_{j=1}^{n} c_j X_j + T_j - ChI + PC + AD = \max Y \qquad (7b)$$

where AD = compensation payments for deforestation avoidance.

The prices we obtained show a huge range. Annual payments of €5 per hectare are necessary to stop conversion activities of household type D, whereas household type E would need annual payments of €125, household type F of €300 and household type G of even €700. However, these compensation payments do not necessarily have a positive impact on the farm TGM, which even decreases for household F by 17 percent. Household type D sees no change and the households E and G obtain an increase of 2 percent.

It depends on the future arrangements for payment modalities for emission reductions from avoided deforestation as to whether the above calculated payments can be made. Discussions are still on-going and evolve around up-front and annual payments, setting the year of the baseline etc. In addition, much discussion remains as to who should be receiving payments for avoided deforestation, the state, the community, the farmers? Thus, we appraised the feasibility of these compensation payments made to farmers for not converting further forest with a simple projection. As mentioned in Chapter 5.2.2., the current estimate for the carbon

[22] This does not represent the real carbon uptake but the one accounted for by the carbon accounting scheme used for forestry projects in the CDM.

content of the TNLL forest is 435 $tCO_2e\ ha^{-1}$ (Kessler, pers. comm., 9. April 2008). Assuming that the current deforestation rate of 0.3 percent is reduced to 0, every year emissions of 13 tCO2e ha^{-1} could be avoided. Depending on the prices paid for avoided emissions from deforestation, payments between €65 and €326 per hectare could arise[23] (see Table 7.11.). Different scenarios are calculated with a safety margin of a 25 percent lower and a 10 percent higher CO_2e content of the forest, as it is not homogeneous over the entire National Park area.

Table 7.11. Scenarios of Payments for Avoided Emissions

		Scenarios of different CO_2e contents		
		Low	**Middle**	**High**
Carbon content TNLL	$t\ CO_2e\ ha^{-1}$	326	435	479
Annual emissions (avoided deforestation rate reduced from 0.3% to 0)	$t\ CO_2e\ ha^{-1}$	10	13	14
Payments for different CER prices per tCO_2e avoided				
€5 tCO_2e^{-1}	€ ha^{-1}	49	65	72
€12 tCO_2e^{-1}	€ ha^{-1}	117	157	172
€25 tCO_2e^{-1}	€ ha^{-1}	245	326	359

Source: own data

If the CER prices paid for every ton of CO_2e avoided are €12, the evolving payments are sufficiently high enough to provide an incentive for the household types D and E to stop forest conversion activities, even using the lower scenario. If the prices were increased to €25 tCO_2e^{-1} avoided, even the household type F, who needs a compensation of €300 per hectare, could be stimulated to desist from further tree cutting. Household type D, who only cuts down a few original forest trees and sets seedlings under the remaining shade trees, obtains a much lower cacao gross margin and, hence, needs a much lower compensation payment to stop forest conversion. In comparison, the household type G receives a very high gross margin for the intensively managed cacao. The need for very high compensation payments arises through the opportunity costs of not converting forest which is the cacao gross margin.

Are the payments for avoiding emissions from deforestation therefore a cost-efficient solution for the abatement of greenhouse gases when focusing only on agricultural production activities? Currently, there is much debate regarding biofuels and whether they actually

[23] Transaction costs are not considered, their inclusion would reduce the evolving payments.

contribute towards the reduction of greenhouse gases. Therefore, there is a call to develop an accounting system which calculates the entire life cycle analysis of the biofuels, and takes into account the direct and indirect land-use changes and associated emissions, as well as air and toxic emissions, biodiversity, water and soil impacts. In addition, the discussion is now turning to the practical challenges of where and how emission reductions can best be achieved, at what costs, and over what periods of time. Therefore, it is worthwhile to also consider at a global scale, which options can provide a cost-efficient solution to reach the abatement targets established by now in most countries. We compare the abatement costs of alternative biofuels to the opportunity costs of not converting the TNLL forest into a cacao plantation. These are calculated by converting the net present values of the average cacao agroforestry system, as well as the AFS G to annuities, to derive the annual payments from a 100 year project horizon and divide these by the annually avoided tons of CO_2e per hectare when completely reducing deforestation.[24] Table 7.12. lists these different options of activities in the agricultural domain from different countries and one can see that bioethanol production from sugar cane in Brazil is the most cost-efficient solution with negative abatement costs of –27 € tCO_2e^{-1}. Still, as a second option comes the avoided deforestation of the TNLL ((AD TNLL) 23 or 55 € tCO_2e^{-1}), which is far more effectual than the remaining biofuel options.

Table 7.12. Abatement Costs of Biofuels and Avoided Deforestation

	Biofuel rapeseed (Germany)	Rapeseed oil (Germany)	Bioethanol sugar beet (Germany)	Bioethanol sugar cane (Brasil)	Bioethanol (USA)	AD TNLL Average AFS	AD TNLL Type G AFS
Abatement costs € tCO_2e^{-1}	154	83	291	-27[25]	290	23	53

Source: Schmitz (2006), Steenblick (2007) and own data

These numbers, however, do not take into account other environmental services provided by the forest, which obviously will raise its value even more. Also, the environmental costs associated with land-use changes related to diverting land from previous agricultural activities

[24] The biofuels displace fossil fuels forever, whereas in this calculation the carbon emissions which are avoided by reducing deforestation are only displaced for 100 years. However, in 100 years we should have hopefully encountered sufficient alternative energy sources to meet our needs.

[25] Abatement costs are negative, because of a very good greenhouse gas balance and the very low production costs. These are caused because Brazil has a long experience in developing sugar-growing and processing technology and its relatively low taxation of fossil fuels used in biofuel production (Henniges and Zeddies 2006).

or forest to biofuel production have not been considered. In Brazil the cerrado is converted for sugar cane or soybean production and the Amazon logged for producing soybeans, which increases the carbon debt of the obtained biofuels considerably. Bioethanol from sugar cane produced on converted cerrado land would take approximately 17 years to repay its carbon debt (Fargione et al. 2008). Yet, the transaction costs when implementing and carrying out a REDD project have also not been included in the calculation of the abatement costs for avoiding deforestation, which would lower its benefits. The costs can be quite considerable, and results from a study by Michaelowa and Jotzo (2005) indicate transaction costs for forestry carbon projects to range from US$ 1.48 per tCO_2 for large to US$ 14.78 per tCO_2 for small ones.

7.3. Discussion

First of all, we can observe that the baselines of the linear programming model exhibit a steady increase of the farm TGM from HH_D towards HH_G (Table 7.5.). At a first glance, the results, especially of the household type G seem to be extremely high, also if you compare them with results from Schwarze (2004) who obtained an average agricultural crop income for the households of 3.7 million IDR, and a range for the three poverty groups from 1.7 million IDR of the poorest group to 5 million IDR of the better-off group. However, in the linear programming model used by Keil et al. (2007), the medium-sized and strongly cacao-based households reached a total gross margin of 17.5 million IDR. By combining the linear programming model with a stochastic simulation the same household type can obtain, with a 15 percent probability, an income equal to or higher than 28 million IDR. It is important to keep in mind that the four household types at hand are all cacao-based households, who in general exhibit higher incomes than an average household.

Even though all the farmers in the sample are growing dominantly cacao, we can differentiate the four household types based on their characteristics and the preceding results. It was shown in Table 7.1. that household type D has the lowest credit limit and the least cultivated land. The main share of its land is dedicated to the most shade intensive agroforestry system. This household type also belongs dominantly to the poorest income group (Table 7.6.), and this is mirrored by the fact that it obtains the lowest farm total gross margin in comparison to the other household categories (Table 7.5.). Furthermore, it is mainly the households from the local ethnic groups - Kaili, Kulawi and Napu - who own these fully shaded agroforestry systems. Household types E and F have an increasing credit limit and most land available for cultivation, and they dedicate the majority of their land to AFS E and AFS F, respectively.

The household type E is not clearly a typically poor or better-off household, but is found in all poverty classes, whereas the household type F shows a clear tendency to belong to more to the richer farmers (Table 7.6.). In both household classes the share of migrants, such as Bugis, Toraja and Poso families, gets more frequent. Finally, the household type G predominantly grows the intensively managed AFS G. They can be classified as economically better-off, a result corroborated by the extremely high farm total gross margin obtained in the analysis. Mainly migrants belong to this household type. Interestingly, its credit limit is only the second highest and its land availability is the same as that of household type D. Yet, among the four household types it is the one who indicated the highest amount he can obtain from formal credit sources (rising from household type D towards G) and a smaller proportion from informal sources. This could be an indication that, even though he faces restricted land availability and has a lower credit limit, he feels it to be more secure due to its source being formal, and so he adopts a more intensive production system in comparison to the other household types.

The intensification gradient for the household types is quite evident from the results of the analysis, with the poorer, mainly local farmers growing the more shade intensive cacao and the richer migrants concentrating on the productive unshaded cacao monocultures. Therefore, the land cover transition observed in the Lore Lindu region is also induced by culturally influenced innovations and the Bugi migrants from southern Sulawesi, the major centre of cacao production in Indonesia (Neilson 2007), have been encouraging the intensified cacao farming practices. An increasing proportion of the indigenous households have been motivated to adopt these more intensive farming practices, as we have seen in the “cash crop first” scenario in Chapter 7.2.3. Once the rice and maize food security constraints are released, especially household types D and E concentrate their production on the unshaded cacao and shift away from the subsistence “food first” to the “cash crop first” strategy, a finding observed in other studies as well (Weber et al. 2007; Steffan-Dewenter et al. 2007). The results also suggest that the two household types F and G, who are both better off, can allow themselves some staple food production, since their monetary needs are covered already by having a considerable amount of their land dedicated to the intensively managed cacao production.

The ethnic affiliation, as well as poverty status plays an important role in the land-use changes in the Lore Lindu region. As mentioned previously in Chapter 4.3., many of the farmers from the local ethnic groups are the drivers of the encroachment processes at the National Park forest margin where they open up new land for cultivation. Consequently, they sell the land to the Bugi newcomers, who tend to be economically better endowed and practice a more intensive management of their cacao agroforestry systems. This provokes a vicious cycle, because after a while the local households spend the income gained through the land sales on ceremonial purposes or status symbols. In due course, when they are short of money again, they convert further forest to fulfil their subsistence needs (see Figure 7.2.).

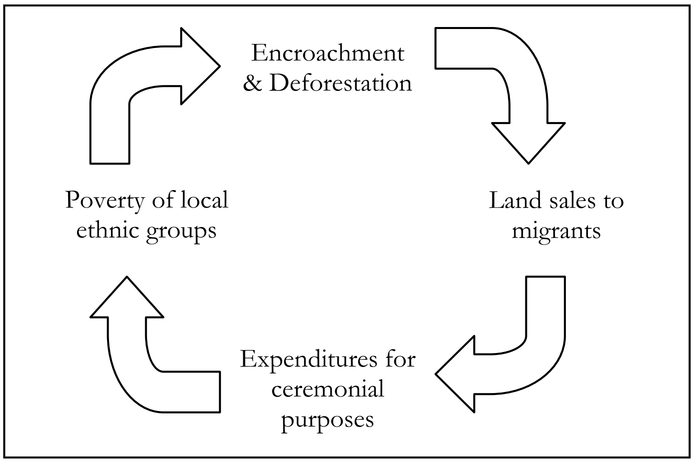

Figure 7.2. Vicious Cycle of Poverty and Deforestation

Source: own illustration

Therefore, the carbon compensation payments could provide a solution to break this vicious cycle of poverty and deforestation. Following the analysis of Chapter 7.2.2., the carbon credits would need to be specifically targeted towards the shade intensive AFS D and E, as these are mainly cultivated by the poorer local ethnic groups, who are contributing considerably towards the forest conversion process at the border of the TNLL. Therefore, a win-win situation is possible, whereby on the one hand the poorest households are given a chance to escape poverty due to the increase in income from the carbon payments and on the other hand with a stable income supply, their need to continue opening up the forest frontier to obtain additional land can be reduced. If we aggregate the results of the analysis of the avoided deforestation scenario, we can observe that if in addition to payments for carbon sequestration of the agroforestry systems, payments for reducing the deforestation of the Lore Lindu National Park are made to the local D and E households, their conversion activities can be stopped. A further benefit of targeting these households is that they provide the highest environmental benefit in terms of the annual carbon sequestration rate of their cacao agroforestry systems.

On a regional scale, for the research area there is a carbon offset potential of 1,300,000 tCO_2e from all cacao plantations which in comparison to the BioCarbon Fund Projects of the World

Bank would be in the upper range of their projects. This could lead to annual payments from €100,000 to €500,000 from the carbon sequestration of the AFS. However, the limits for a small-scale afforestation project under the CDM, which only allows for an annual average greenhouse gas removal by sinks of less than 16,000 tCO_2e, would be exceeded. Such a small-scale project could be an option for the AFS type D farmers, since the smallest area share among the cacao plantations is planted with the full shade cacao (264 hectares), and they would only need to gather a total area of their shade intensive cacao agroforestry systems of 240 hectares.

With respect to the discussion of payments for avoided deforestation providing potential solutions for climate change mitigation, we can see from the results that there is definitely a huge potential for saving carbon emissions when protecting forest resources. If the deforestation rate in the TNLL is reduced to zero percent, annual savings of approximately 215,500 – 1,719,000 t CO_2e can be made. This is a considerable amount in comparison to the annual emissions per capita of Germans (10 tCO_2e yr^{-1} per person in 2004), US Americans (20 tCO_2e) and the Qataris (70 tCO_2e) (Marland et al. 2007). Obviously, in comparison to the country-wide emissions of Indonesia of three billion tCO_2e annually, it is only a small contribution. Nonetheless, if similar REDD schemes are developed for further areas in the country, the combined effort of reducing forest loss and saving carbon could counteract the current process of deforestation and increasing carbon emissions, as well as provide a valuable income source. Indonesia has 88 million hectares of forest, of which 48 million are primary forest (FAO 2006), and projecting a reduction of the current country-wide deforestation rate of two percent, annual carbon savings of approximately 417 million t CO_2e are possible. Even if the price per t CO_2e would be only €5, this would amount to a potential income of €2 billion.

For the Lore Lindu region the results of the analysis indicate that with current carbon prices most households can be stimulated to stop the ongoing conversion processes. Currently, the debates are still ongoing with regard to the payment modalities for avoided deforestation schemes, and they are often suggested to be nationally based and directed to government agencies. The Indonesian government proposes that the funds should be directed towards protected area authorities, 'certified' logging companies engaged in sustainable forest management, initiatives to tackle illegal logging, PES schemes, and community-based forest management (Government of Indonesia 2007). We have assumed that the payments will be made directly to the households of the Lore Lindu villages. Such a scheme would involve probably high transaction costs, thus, it is argued to include intermediary bodies between the service providers and buyers. This issue is evaluated and discussed in the next Chapter. Additionally, we have also seen by comparing the costs for avoided deforestation in the TNLL with the abatement costs of biofuel options, if one searches for cost-efficient solutions on a global scale for the abatement of greenhouse gases among activities in the agricultural sector, it is reasonable to invest in the conservation of the TNLL before investing further in other biofuel options in Germany.

7.4. Summary

This Chapter shows that there is a transition from the household type D towards G with an increasing farm total gross margin to be observed both in the baseline model, as well as once the payments for carbon sequestration are introduced. This is in line with a poverty gradient observed among these farmers. With rising carbon certificate prices, the poorest households who attain the lowest total gross margin from their crop activities benefit in absolute and relative terms most from the payments. At this range of carbon prices none of the households is induced to shift its land-use management practices. If the farmers were free of any subsistence food requirements, especially the poorer farmers would opt for a “cash crop first” strategy. On the contrary, the already richer households maintain some land for the cultivation of the staple foods. Carbon certificates offer the possibility to give incentives for the majority of households to adopt more of the shade intensive and biodiversity richer agroforestry systems. However, current prices would only be sufficient for the poorer households to stop them from further forest conversion, whereas the better off households need extremely high carbon prices, due to the very high net-revenues of the fully sun grown cacao. Finally, win-win situations seem to be possible, whereby deforestation processes and poverty can be reduced with carbon payments.

8. INSTITUTIONAL ARRANGEMENTS FOR CARBON SEQUESTRATION PROJECTS

8.1. Analysis of Payments for Environmental Service Schemes

The first part of the research indicated which primarily impact a PES scheme, specifically a carbon sequestration project for agroforestry systems, has on the involved households. The financial, as well as the land-use impact has been derived and environmental benefits highlighted. Consequently, this part focuses on the requirements and enabling institutional conditions for the households to participate in a PES scheme. In particular, we are using the community conservation agreements in Central Sulawesi as a case study to assess their institutional arrangement and whether they can provide a framework for active involvement of the local stakeholders in a potential carbon sequestration project. As outlined in Chapter 3, institutions will be referred to as the "*systems of rules, decision-making procedures, and programs that give rise to social practices, and guide interactions among the occupants of relevant roles. Where they arise to deal explicitly with matters involving human/environment relations, it is normal to speak of institutions as environmental or resource regimes* (Young et al. 1999, p.6)." Unlike organizations, which are material entities that typically figure as actors in social practices, institutions may be thought of as the rules of the game that determine the character of these practices. Institutional arrangements are the rules and conventions which establish peoples' relationships with resources, translating interests into claims, and claims into property rights (Gibbs and Bromley 1989).

Many carbon sequestration projects are carried out by large-scale plantation forestry and the participation of smallholders is limited. One of the main reasons is the high transaction costs of forest carbon projects (Pfaff et al. 2007). Experience shows that communities benefit less from large-scale plantation projects, whereas small-scale projects allow small farmers to participate and offer the possibility to earn cash income through carbon credits as well as offering the broader socio-economic and cultural benefits (Murdiyarso 2005). The CDM provides the opportunity for smallholders to participate in carbon sequestration activities through selected small-scale afforestation and reforestation activities. This means that they can benefit from simplified modalities and procedures when preparing and implementing a small-scale forestry CDM project activity (UNFCCC 2005). The objective is to coordinate and consolidate the sequestration supply from smallholders in order to reduce transaction costs. There is wide support for the creation of institutions and financial intermediaries to bundle projects in a portfolio, such that investors are not tied to an individual project (Cacho et al. 2003). Among local communities, the technical skills for developing baselines and monitoring plans can be pooled and group contractual arrangements made. Intermediaries for these processes can be different institutions, such as local governments, NGOs, private sector entities and local community organisations. To enhance cost-effectiveness, a strategy is advocated to develop projects whereby smallholders participate in groups rather than individually e.g. being distinguished by local community boundaries. These projects are than managed as common-property rather than individual property. Local communities then act as service providers and obtain a share of the carbon revenues.

Experience shows that in many cases carbon smallholder projects were built upon some type of existing community project, particularly community forest plantations or farmers' groups. For example, in Mexico the Scolel Te carbon sequestration project was initiated by a group of interested farmers primarily originating from one farmers union (de Jong et al. 2002; Smith and Scherr 2003). According to McKean (2000), a common-property regime can be understood as "*a property-rights arrangement in which a group of resource users share rights and duties towards a resource*". Community-based natural resource management is advocated to be the mid-way between government administration and market-oriented management. Furthermore, collaborative management (co-management) of natural resources involves sharing the rights and responsibilities between state agencies and local populations. Such negotiated agreements are promoted to overcome problems of state-dominated natural resource management, since they are voluntary and provide the potential to take into account any development aspirations and the local knowledge of the communities (Borrini-Feyerabend et al. 2000). The involvement of different stakeholders, such as local communities, local associations, governments and industrial lobbies in natural resource management is seen as participative governance. All parties join in a common decisional pattern to achieve agreement. In the literature, local communities, as part of the civil society, are increasingly pointed out as the most efficient bottom organisations to minimise social costs and maximise social welfare (Ballet et al. 2007). Community participation is therefore considered to be an important component in natural resource management processes.

Supporting evidence from different case studies has confirmed that common-property arrangements can reduce the transaction costs of governance under certain conditions (Ostrom 1990). Similarly, Williamson (1985) states that when splitting up transaction costs into exclusion, monitoring, negotiation, application and information costs, all of these, apart from negotiation costs, are low for local communities. Carbon offset projects typically entail a variety of transaction costs in their design and implementation. These arise from project search, feasibility studies, as well as negotiation, monitoring and verification, enforcement and regulatory approval, plus insurance costs. Results from a study by Michaelowa and Jotzo (2005) indicate transaction costs to range from US$ 1.48 per tCO_2 for large projects to US$ 14.78 per tCO_2 for small ones. According to experience from a variety of carbon sequestration projects the monitoring and enforcement activities in particular can be easily integrated into community processes and costs minimised (Cacho et al. 2003). In the International Small Group and Tree Planting Programme (TIST) in Tanzania the monitoring and supervision activities were performed by the local institutions and reduced overall transaction costs (Jindal et al. 2008).

We explained in Chapter 1 and 3 that we want to investigate in depth the institution of the KKMs as an example of a community natural resource management scheme. In particular, we aim to explore if this agreement can provide an institutional platform allowing for the involvement of the local households in its negotiation and establishment, as well as a regulatory framework. This would need to have an organisational structure which represents the village households, as well as a requirement for the community to be involved in the resource management process, since the legitimacy of regulatory interventions is increased when the resource users participate in its design and the implementation (Hanna 1995). Furthermore, this institution would need to be able to monitor and enforce the forest usage regulations and finally, also be able to administer funds from potential carbon payments and channel them towards the individual recipients. Consequently, before presenting the results of the empirical analysis, we give an outline of the structure of the KKMs, as well provide some background information on the institutional arrangements of the monitoring and enforcement activities and the participation of the villagers in the agreements.

8.1.1. Community Conservation Agreements: State of the Art in 2006

Using the definition given above, we are looking at institutions not in the sense of organisations, but as a system of rules and procedures guiding practices and relationships among people. For this particular case, we are analysing the institution of the KKMs established in several villages in the vicinity of the TNLL. They are a "*negotiated agreement between community representatives and the National Park Management, which constitute part of a co-management strategy. Their objective is to find a balance between the goals of nature conservation and the objectives of the local communities to secure self-determined sustainable livelihoods*" (Agreement of Customary Community of Toro, 2003 (Mappatoba 2004)). The negotiations for the agreements between BTNLL and the villages started in the late 1990s and were promoted by international and local NGOs. According to the survey conducted by Palmer (2007), 49 villages in the surroundings of the TNLL had negotiated or were in the process of negotiation for a KKM in 2006[26]. The National Park Authority had acknowledged and recognised 78 percent of the agreements by 2006. Out of these 24 percent had been recognised before 2004, 58 percent in 2004 and 18 percent in 2005. The majority of the arrangements were first initiated by the village or village leader (49 percent), and to a lesser extent by an NGO (22 percent) or CSIADCP (19 percent) and only one by the National Park director. The negotiations were usually conducted by the village elders and the customary council (LA) who typically signed the agreement. All of the agreements were supported and operated by one or more NGOs and can be characterised according to the motivations and philosophies of these organisations, which differ considerably (Mappatoba and Birner 2004). TNC is advocating a more environmental approach in connection with the development of a zoning and management strategy for the National Park. They have been actively involved in the area since 1992. The second approach is focusing on development. This is pursued by CARE, also an international NGO, which has been working in the region since 1995. Their objective is to promote sustainable agricultural practices and address the needs of poor farmers in the area, whilst protecting the ecological balance of the environment. YTM, an Indonesian NGO, was founded in 1992 and promotes empowerment for the indigenous groups in Central Sulawesi. Their approach advocates the indigenous rights and places a strong emphasis on the acknowledgement of customary land- and forest- use patterns. YTM facilitated the first KKMs in the region. There are some other local organisations also involved in the agreements, but to a lesser degree. JAMBATA and PEI both have an

[26] They repeated the survey in the same sample villages as Maertens in 2001 (80 villages), however, their sample was reduced to a total of 72 villages because of funding and time constraints.

environmental focus and have been working in a few villages, usually together with one of the bigger NGOs. The CSIADCP project, described in Chapter 4, combined development and environmental objectives and aimed to establish traditional KKMs (KKMA) in 60 villages surrounding the National Park. Different NGOs have been working either alongside or in turn in some villages, for example in the research village Salua. It appeared that the coordination between the NGOs concerning their activities was not very strong and they seemed to only promote their own agreement. This caused confusion sometimes as the community members were not certain as to which organisation initiated and carried out which activity.

8.1.2. Monitoring and Enforcement

In most villages TNC has established a separate village conservation council (*Lembaga Konservasi Desa* -LKD) for the supervision and co-ordination of the KKM. In order to implement co-management structures, the LKD is made up of one member from each village institutions and one official National Park ranger, as well as other personalities whose opinions are perceived as relevant (Burkard 2007). This structure varies slightly between villages. The LKD is normally in charge of the monitoring and enforcement activities. Paragraph 21 of the agreement in Wuasa summarises the functions of the LKD as follows:

- to provide an umbrella for communication between the community and the BTNLL,
- to socialise the KKM to the local community,
- to carry out participatory planning with the BTNLL,
- to supervise the implementation of the KKM,
- to evaluate the KKM,
- to report the evaluation results of the KKM to the village head (Desa Wuasa 2002).

In other villages similar institutions to the LKD have been set up, such as *Olungata* in Salua and in Kapiroe the *Langgamba Ngata* is planned. These institutions also constitute the monitoring team and organise the monitoring activities. The number of members varies (see Table 8.1.), and especially in Langko and Wuasa, they may be members of different village institutions at the same time, such as the LA.

The frequency of the monitoring activities also varies between the villages. According to paragraph 7 in the agreement in Wuasa and Langko, the LKD is required to carry out a minimum of one monitoring activity every six months (Desa Wuasa 2002) (Desa Puroo; Langko; Tomado dan Anca 2005) Usually, there is no established schedule in the village, but it is carried out according to the personal time schedules of the members or if there is a specific reason to do so. In some villages the National Park Authority has given some capacity training to the members of the monitoring team. Sometimes there is financial support from the NGOs towards the monitoring teams, however, in most cases the members are not paid and work on a honorary basis.

Table 8.1. Attributes of the Village Conservation Council

	Salua	Langko	Wuasa	Kapiroe
Agreement name	KKM/KKMA	KKM	KKM	KKM
Monitoring team	*Olungata*	LKD	LKD	*Langgamba Ngata*
No of members	10	4	7	minimum 3 (plan)
Start monitoring	Sept 2005	2004	March 2006	Not established yet
Frequency monitoring	Varies, usually every 6 months	Every 3 months	1-2 per month, can be adjusted	
KKM area	6,600 ha (forest area inside NP)	3,323 ha (forest area inside NP)	287 ha	80 ha

Source: own data

The villages have all agreed to specific commitments entailed in the agreements. Again, these differ according to the NGO negotiating the agreement and range from; the very vague responsibility of forest conservation, to preventing outsiders from other villages, as well as general outsiders using the village forest, to following the TNLL rules and not allowing resident villagers to utilise the forest (Palmer 2007).

The agreements entail rules and sanctions concerning the allowed amount of timber to be harvested, the use and the sale of the timber, forest conversion for agriculture, plantation development, the collection, sale and use of rattan and NTFP, as well as hunting. These are listed in a forest management plan. The village LA has the punishment or sanctioning capacity, but exercising these measures can only be carried out in the presence of the village administration and the village representative body (*Badan Perwakilan Desa* -BPD). The sanctions differ between villages but are usually based on the traditional customary rules. For example, in a trial in Wuasa, a suspect had to first make a cash payment (IDR 100,000), then make a payment of two buffalo and finally replant the trees he had cut plus extra ones. In Watutau the penalty is a payment of IDR 1,500,000 for illegal logging and the chainsaw is confiscated by the LA. If the offender wants the chainsaw back, he will need to pay IDR 2,500,000. This is another peculiarity that in some village regulations the sums of money are mentioned, whereas in other villages they are quoted in-kind, such as buffalo. The money from the punishment is received by the LA and used for the development of the village. In the sub-district Lore Utara the agreements have been violated seven times between 2004 and 2006. However, the LKD can get active only in the area which has been designated as the KKM zone, as the area of the National Park is under the jurisdiction of the TNLL administration (Ignatius, Village Secretary of Wuasa, pers. comm., 06.April06).

8.1.3. Participation of Villagers in the Community Conservation Agreements

Participation in social sciences is an umbrella term including different means by which the public can directly participate in political, economic, management or other social decisions. Ideally, each individual would have a say in decisions directly proportional to the degree that a particular decision affects him or her (Chambers 1997). When talking about participation in natural resource management processes it is obvious that not the entire community will be able to be involved in all the meetings and activities carried out for the implementation of such schemes. However, some villagers should take part in meetings in order for village interests to be presented as well. Educational activities can also be seen as a possibility to pass on knowledge of natural resource management matters. This also points towards the very simple participation selection indicator to be the knowledge of the issues at stake.

In two studies of the KKM in the Lore Lindu region certain aspects with respect to participation have been assessed. They point towards a biased participation of the village leadership in the negotiation of the agreements which only fulfils state requirements. Burkard (2007) focused not specifically on the involvement of the households, but on the activities associated with the implementation of the agreements. According to Burkard these are neither devolution nor community-based resource management in the real sense, as a transfer of action takes place but not of power or authority. Even though the village can define its own sanctioning system, the main objective of the KKM is to conform to state rules aiming at the protection of the forest. Burkard concludes that the most important aspect of the KKM is not its suitability as an organisational device to safeguard the stability of the forest margin, but rather to activate the processes of self-organisation and community discourse. Mappatoba and Birner (2004) specifically investigated the participation of villagers in the agreements in five villages. The knowledge with respect to the agreements varied among the villages, as different participation models had been employed by the three NGOs as based on their philosophies, as explained in Chapter 8.1.1. In those villages where CARE/CSIADCP and TNC worked, the knowledge of the agreements, as well as on the details of the agreements was very limited. Additionally, in these villages the attendance and participation of farmers in meetings related to the agreement was the lowest among the five villages and one of the main reasons for not participating was that they never received an invitation or did not know about the meeting. The authors concluded that the KKM can not be considered to be a strategic negotiation between two parties and that participation was mostly restricted to official village leaders, at least for the agreements negotiated by CARE/CSIADCP and TNC.

These findings show a limited participation of the village community in the negotiation and establishment of the agreements, which will be further investigated in the next section.

8.2. Empirical Results of the Community Conservation Agreements' Analysis

The KKM have been analysed two-fold and the results will be presented accordingly. In the first section the participants of the focus groups appraised the KKMs during the workshops. They evaluated whether they observed a change in a number of different aspects as a result of the implementation of the KKMs; i.e. how they rated the situation before and after the implementation. In Kapiroe, since the KKM had not been implemented in 2006, the evaluation was carried out with respect to before the negotiations started and afterwards. The second part presents the results of the analysis of the content material of the discussions. One has to bear in mind that the changes, which were perceived and discussed by the participants, have not only been influenced by the KKM implementation or negotiations in isolation, but also by a number of other factors and mixed variables, for example National Park regulations and migration fluxes. Thus, we will try to be as objective as possible in order to highlight only the impact of the agreements.

8.2.1 Self-assessment of Changes in Resource Management Processes

The focus group started with a brainstorming session. This gave the participants the time and space to mention all ideas which they associated with the KKM. We grouped the ideas into specific topics and the Figure 8.1. gives an overview of the frequency of ideas mentioned in the different categories.

The first four columns indicate the frequency of the topics mentioned by the decision makers and the last four columns by the villagers[27]. The bigger the circle is, the more often ideas associated with this topic were mentioned. The villagers in Salua, as well as the decision

[27] The term villagers and farmers are used interchangeably for this group of participants.

makers in Wuasa were very active and came up with most ideas, followed by the decision makers in Langko and the villagers in Wuasa. The topics which received most ideas were; environmental impact, monitoring, education and institution. This indicates that these were topics which the participants most associated with the agreements, whereas topics such as cacao plots inside of the National Park, rattan collection and economic impact did not receive great attention. Hence, the respondents considered them to be less connected with the agreements .

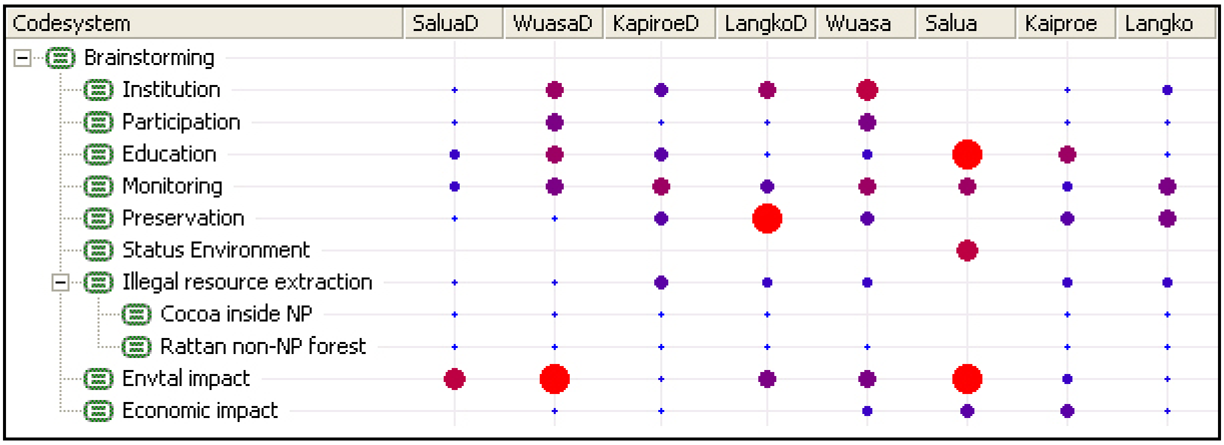

Figure 8.1. Frequency of Mentioned Topics

Source: own data (Column 1-4=decision makers, 5-8=villagers)

With the exception of Langko, the topic institution was evaluated by all villages to have improved because of the implementation of the KKM as we can see in the following Figure 8.2. (the scores range from +3 (very good) to -3 (very bad). In Wuasa and Kapiroe the situation was perceived to have improved from being negative to positive for both groups.

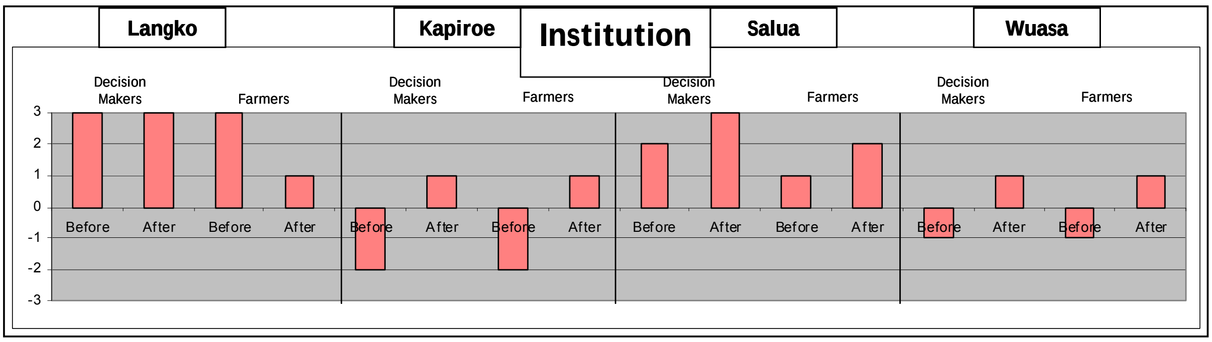

Figure 8.2. Evaluation of the Topic "Institution"

Source: own data

In Langko, the decision makers were already very content about the institutional situation, whereas the villagers observed a deterioration (decrease by 2). Some of the comments, which were made with respect to this topic, were: "*if the people from outside Lindu obey the Lindu* *customary rules, the forest damage will not happen*" (DM, Langko, 338)[28], as well as "*tighten, make more strict*" (DM, Kapiroe, 288). It is therefore apparent that traditional institutional rules are seen as an important protection against resource extraction in the forest. However the regulations are not rigorous enough for this protection.

Interestingly, participation was a topic that did not receive many comments during the brainstorming session. When it was evaluated we can see that, in all villages, the participants of the sessions noted an improvement in participation due to the implementation of the agreements (see Figure 8.3.). However, this improvement was not very pronounced with an increase of just +1 in most cases. The villagers (apart from those in Salua) evaluated the situation to have been negative before the KKM negotiations. Some of the collected comments with respect to this topic were: "*active together*" (V, Wuasa, 223) and "*cooperation between community and government*" (V, Wuasa, 223), indicating that participation is seen as a combination of different institutions and organisations being active together and involving the villagers in these activities.

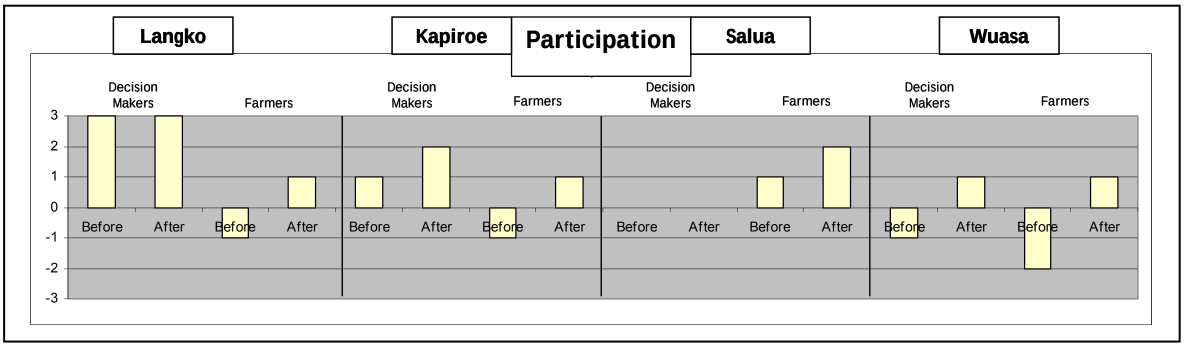

Figure 8.3. Evaluation of the Topic "Participation"

Source: own data

The monitoring situation was perceived by all groups across all villages to have improved due to the implementation of the agreements, as illustrated in Figure 8.4. The villagers in Langko, as well as the decision makers in Wuasa recognise the most intense increase in the monitoring situation (+3). It was however not observed in several villages that: "*we need to be more strict and improve monitoring*" (V, Langko, 203; V, Wuasa, 223; DM, Kapiroe, 288). The activation of a village monitoring entity is a positive movement, but should conform to the established rules.

[28] In brackets is the participant group (DM=decision makers, V= villagers), village, and line number in the original English transcript.

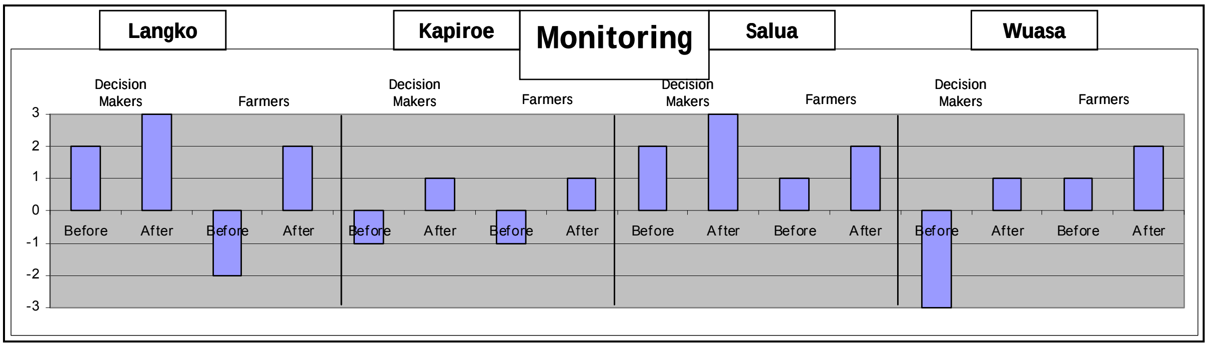

Figure 8.4. Evaluation of the Topic "Monitoring"

Source: own data

With respect to the topic of resource extraction, the situation has also improved according to the perception of the farmers and village authorities across all villages, with less illegal resource extraction. Apart from Salua, all villagers rated the situation to have been negative before the agreement negotiation and the decision makers in Wuasa rated the resource extraction to have been extremely bad (-3) before KKM (see Figure 8.5.). Some of the comments made were: "*for daily needs building material*" (V, Wuasa, 223) and "*the [forest] collection should be limited*" (DM, Kapiroe, 269). This highlights the conflict over the natural resources, which are an important input for the daily activities of the households, but at the same time the villagers realise that certain restriction with respect to its use are reasonable.

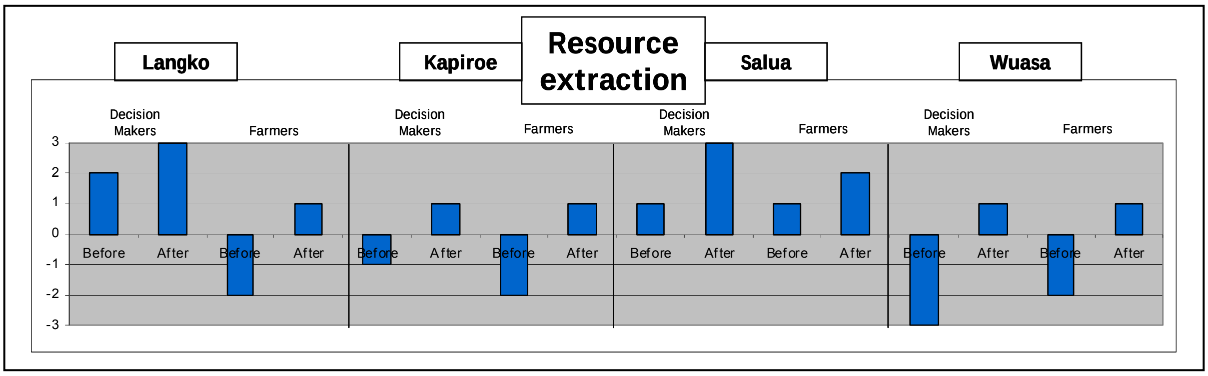

Figure 8.5. Evaluation of the Topic "Resource Extraction"

Source: own data

In the Appendix VIII an overview is given of the ratings of all the topics by the villagers and decision makers across all four villages.

In this subchapter we have given an overview of the appraisal of the villagers and the decision makers of the different topics related to the KKM implementation. In general we can see that, according to the rating of the evaluation game, an improvement is seen by both groups with respect to the situation and development over time of these issues. In broad terms the villagers have been evaluating the situations often more critical (negative), whereas the decision makers perceived the situation to be positive. The participants perceived the monitoring to have increased, whereas the resource extraction activities seemed to have decreased. Thus, there seems to be a positive impact caused by the establishment of the KKMs. However, these first conclusions are only preliminary and based mainly on the scores of the evaluation game. Already several of the comments show that there is also criticism with respect to the institutional regulations and their application. Sometimes it appeared that some of the concepts of the topics might not have been fully grasped by all the participants. In order to investigate the understanding of the concepts and topics, as well as their interpretation, the results of the in-depth analysis of the discussion material is presented in the following section.

8.2.2. Impact of the Agreements on Natural Resource Management

The content analysis of the focus group discussions with respect to the KKMs is based upon the framework in Chapter 3, Figure 3.5. We concentrate on the four central points of institution, participation, monitoring and enforcement and finally the status of the environment. The information from all group discussions was analysed with respect to the differences between both participant groups, as well as to the situation before and after the implementation of the KKMs. The information has been summarised and aggregated across all four villages. Only in specific cases will the differences will be highlighted, but in the final part of this Chapter the main divergences between the villages are discussed. Additionally, we shortly outline the perceptions of the concept of compensation payments, an extra benefit to consider and assess the possibility of using the KKMs as a platform for a carbon sequestration project.

Community Conservation Agreement Institution

With respect to the *traditional customary institution* in the village, which is the *Lembaga Adat* (LA), there is little knowledge and understanding of the institution among the villagers, as well as decreasing acceptance of the regulatory framework. The decision makers understand the LA and the customary regulations very well. The *purpose behind the agreements* is not known by the farmers in two of the villages, whereas the village leadership could quite clearly define it to have been set up for conservation needs and a conservation management system. Concerning the *structure* of the agreements, the farmers were familiar with the monitoring institution (LKD, *Olungata* or *Langgamba Ngata*) and they had observed monitoring activities taking place. Among the decision makers, there was a clear distinction between Kapiroe- where they did not have a monitoring body at that time but recognised the need for its establishment- and the remaining villages. The definition given in one village for the LKD was "*the village fence to prohibit someone from entering a preserved location*" (DM, Kapiroe, 49-52) which points towards its protective function for the forest. The village authorities remarked that the LA gives a good foundation for the agreements and its regulatory framework such as the sanctions. The monitoring activities are carried out every one to three months, but not on a constant basis. The villagers pointed out that the *participation* in the negotiation and formation of the agreement was restricted to specific people and various participants did not know the date of the start of the negotiations or the establishment. This is reflected by the comment of the decision makers in Kapiroe that "*it's a kind of participation from inside, it's a decision made by the customary institution… and all villagers will support this participation*" (DM; Kapiroe, 273-274).

When we evaluated the *change in the institutional setting* the farmers across all villages were quite critical towards the LA and its regulatory structure in the past and said that the rules were not enforced. However, presently the villagers could see an improvement in the institutional arrangement due to the new monitoring agency, the LKD; there was only one village in which they still observed rule-breaking. The village leadership remarked that due to the traditional rules of the customary agency, the regulatory framework and its enforcement structure were in place and could be used by the new village conservation council, but that they had observed an improvement in the institutional setting. However, in one village they noted that the monitoring institution had become an abettor of government forest guard.

In summary, there is a gradient of knowledge in the community with respect to the agreement formation. It is primarily the village leadership which participates in the negotiations and is informed about its purpose and its structure, whereas many villagers do not know the agreement nor its details or purpose. Thus, it appears as if the agreements have been imposed downwards from an upper hierarchy. The traditional customary institution has provided a good framework for the rules and regulations of the KKM.

Participation in the Negotiation and Establishment of the KKM

Both groups pointed out that there were previously hardly any *educational activities* and information campaigns offered by the TNLL administration with respect to the National Park, the forest and its functions. This has led to wide ignorance among the community members regarding preservation and conservation issues. Sometimes extension programmes were offered to the community but never put into practice. Following the implementation of the agreements there is still a lack of understanding of the purpose of the National Park and the need for it among the villagers. The village leadership appears well informed about the

National Park after the KKM negotiations. Also, the authorities have observed less confrontation between the government forest guard and the farmers.

As mentioned above, the *participation* of the villagers in the past has been very limited in community decision-taking, as well as in the establishment and management of the National Park and the KKMs. The same was remarked by the decision makers who said that there was very little "socialisation"[29] by the BTNLL concerning the rules and regulations of the National Park, as well as their activities and programmes taking place. After the agreement negotiation the farmers still observed a lack of participation in meetings with respect to the KKM and conservation programmes and activities, whereas the village authorities noted an improvement of the community participation in conservation activities.

To summarise, very little information has been passed on in the past to the community members with respect to the conservation activities by the National Park administration and no community-level involvement took place in the formation of the KKM. Overall the decision makers have mixed opinions, some note a change and an improvement of socialisation and educational activities by the TNLL administration and other NGOs because of the establishment of the agreements, whereas others are more critical: "*so you have any suggestion for the [government] apparatus that they can have better approaches to the community, not only threatening the villagers. Because it only triggers conflict amongst villagers and forest guards*" (DM, Wuasa, 391-392) and "*before the KKM was formed, none of the villagers are willing to support the government to conserve the forest due to shortage of socialisation*" (DM, Wuasa, 343). These statements are motivated by the bad collaboration between the community and the National Park forest guards, which have been mentioned in all villages.

Monitoring and Enforcement Activities

For monitoring and law enforcement it is important to know how *illegal activities* are defined. In this case they are those activities which violate the customary and KKM laws, as well as the state law with respect to the TNLL. Examples are illegal logging, extraction of rattan, clearing land for agricultural activities in the TNLL and KKM area. Discussing illegal activities is a sensitive issue, since nobody wants to admit their own faults or put the village into a bad light. It is interesting therefore to contrast the opinions between both groups in the same village. In the past the farmers had observed many illegal activities such as rattan and

[29] This word comes from Bahasa Indonesia and means to make people aware of something through interaction, i.e. meetings. It will be used in due course as it expresses very well the concept of knowledge sharing.

timber extraction, as well as animal hunting, especially by outsiders. With the new regulations they noticed that less new land was opened up for plantations. The decision makers in Wuasa also declared illegal logging to have taken place inside the KKM area and that they were conscious that "socialisation" of the regulations is important to stop these activities. Neither of the groups in Kapiroe noticed many illegal extraction activities, and in Langko the decision makers did not observe any illegal deforestation activities, in contrast to the villagers who did. Some villages have *preservation strategies*, such as the assignation of specific usage and conservation zones through the traditional customary rules by the LA. In Langko, for example, there are the so-called Suaka. The restricted area is called Suaka Wiyata and should not be entered, otherwise bad things will happen, or the Suaka Ntodea is customary land, which the community can use for cultivation but can not own it. The traditional limits are often different with government borders of the National Park causing conflict. Usually, the elders in Langko are engaged in the forest protection and their vision of preservation is that it is not only important for their own sake, but for humanity in general: "*especially in the National Park no one should collect rattan inside of that area because that does not only belong to the people in Lindu but also belongs to the world*" (DM, Langko, 731).

Monitoring and enforcement activities, as explained in Chapter 8.2.1., are mainly looked after by the newly established LKD. The farmers are very critical and remark that in the past the penalties existed only in theory and little implementation and enforcement took place. The National Park could be entered and timber extracted without any control. The decision makers have a similar opinion, ascertaining that no direct forest control existed and embezzlement of responsibilities occurred frequently. There are different perceptions by the farmers with respect to the situation after the KKM implementation. In Wuasa and Salua there are apparently no more illegal resource extraction activities in the forest area which the villagers attribute to the introduction of sanctions. However, in Kapiroe and Langko the farmers say that the existing regulations do not hinder forest conversion activities, as there is no enforcement of the rules. The decision makers in Wuasa and Salua share the opinion of the farmers in their villages and all ascertain a decrease in deforestation activities. In Langko the decision makers are of the opinion that the situation has improved in comparison to the past and that the existing customary structures help to support the new KKM regulations. They do however clarify that that their activities are constrained because they do not receive any financial support for their activities. The village conservation council members take their monitoring responsibilities quite serious: "*I told my members when you patrol and someone gives you a cigarette in order to halt your patrol, you should decline it. We are appointed by* *the community to do our duty because they have confidence that we will execute our duties well*" (DM, Wuasa, 760-761).

The perceptions and also the situations across the villages are different with respect to monitoring and enforcement. To conclude; in the past many illegal activities with respect to forest resource extraction took place and the regulatory structures did not seem to constrain these. After the introduction of the conservation agreements and the establishment of the monitoring agencies, even if there was not a complete halt of the degradation activities, a significant decrease occurred. The existing customary regulatory framework with respect to illegal forest activities has provided a good foundation for the KKM.

Status of the Environment

In general, across all villages and both groups the impression was prevailing that the environmental condition was good in the past, that there were plenty of birds and animals and less natural disasters such as flooding and droughts. Both groups perceived the *environmental impacts* to have become worse after the implementation of the KKM in the recent past. For example in Palolo, strong flooding occurred and droughts were recorded due to El Niño. However, they observed less clearing of land taking place now. Obviously, the KKM in itself is not the determining factor for a change in environmental impacts. However the aim is to detect whether it has influenced certain practices which in turn had an impact on the environment. In all villages the farmers said that, in the past extensive *resource extraction* such as forest conversion and rattan collection took place, an opinion which was mirrored by the decision makers. In Langko, the extraction was only for private needs according to the village authorities. Nearly all farmers observed a decrease of natural resource exploration nowadays, whereas in Langko mixed comments were made, in that deforestation still takes place, but less land is opened up for further plantations. The village authorities all perceive a decrease in illegal activities, which corroborates the information by the farmers from all villages excluding Langko. Obviously, forest extraction activities can not just be seen as simply illegal, since people are often also driven by their needs, which have to be satisfied: „*in the past time, in the age of our ancestor, if the population increased, the land was also extended because they opened up new lands. This is in contrast with the current situation......nowadays, the number of people increased but the land space is constant.... in the past, people were able to open up new land. So, sometimes people break the rules because they have the necessity.*" (F, Wuasa, 630).

To summarise, the perceived status of the environment in the past was better than presently; yet, the awareness of protecting the given natural resources was not given. Thus, due to an increasing human impact the environment has suffered considerably. Nowadays, less resource extraction occurs or it is more controlled, but the consequences of previous human activities are felt with a higher intensity of floods, erosion and other environmental disasters.

Compensation Payments

In the 1980s compensation payments were addressed in the villages but the farmers' previous experience was bad as the incentive, which was promised to them by the Central Sulawesi government in order not to further explore the forest, was never paid out. The fear is that compensation payments would not be equally distributed, since in general "*Indonesia is well known to have corruption*" (F, Langko, 629), and very often kin relationships influence the distributional patterns. Payments are seen, however, also as a possibility to stimulate and exert control over forestry extraction activities. Furthermore, since people have to forego a potential income source when they cannot use the forest resources anymore, the compensation is regarded as equitable.

The decision makers are overall quite critical of compensation payments and fear corruption, especially if a variety of institutions are involved. Based on their experience, NGOs intermingle their personal interests with the management of funds, causing embezzlement. Often they do not fully understand the village realities and therefore use inappropriate targets and objectives in the realisation of projects. The village authorities argue that if payments would be channelled directly to the communities, the funds could be used efficiently to improve the monitoring system. However, they also recognise that the payment cannot compensate their need for work, as being idle does not make them happy: „R4: *But especially in Suaka Ntodea we disagree [about complete preservation] because we still need the rattan and woods from there.* R3: *Even though that we will be given money, if we do not work anymore so we will be unhealthy*." (Langko, DM, 859-862).

To summarise, the people in the villages fear corruption when compensation payments are made and advocate for fewer organisations to be involved in order to secure more transparency. However, payments can not solve their need for land and work, which are perceived as necessities in their life.

Differences between Villages

Some of the information has been generalised across all villages, however, in some cases there are also differences, which should be addressed. In Langko, the decision makers and the villagers are very often of different opinions, a result obtained already in their self-assessment of the KKM (Chapter 8.2.1.). This corroborates the finding from the last Chapter that the farmers are, in general, more critical then the village authorities. This can be attributed to the fact that the decision makers have been much more involved in the negotiation of the agreements and, therefore, do not want to shed bad light on their own actions. Furthermore, a gradient in compliance or acceptance of the KKM which is proportional to the time length the village has been involved in the negotiations is quite apparent. First there is Wuasa, followed by Langko, and Kapiroe and Salua have the weakest agreements. Wuasa is probably the most active village in terms of conservation activities and the awareness both among the decision makers, as well as the farmers is very high. They have been involved the longest in negotiations with the TNLL administration due to the limited access to the forest caused by the establishment of the National Park. In an interview with the village secretary Pak Ignatius, he explained that the dialogue at the village level started in 2000 in Lore Utara in five villages to collect arguments for the discussion with the government. TNC assisted in the facilitation of the discussions and the negotiation of the agreement. When we presented the generalised results in the workshop in Wuasa in 2008, a participant from the villagers group remarked immediately that they, as a group, did know what the KKM stands for and entails (see purpose behind the agreements in the section about the KKM Institution). In Langko, even though the views differ between both groups, a standpoint is provided by the very traditional customary institution. Even though some farmers criticise it as not being respected anymore, it gives groundwork to establish the new regulatory framework for the KKM. Among the participants in Kapiroe we detected awareness with respect to the conservation need for the forest and the consequences of deforestation are quite apparent in this area. However, the agreement negotiations are still in process, influencing the knowledge status of the community. In particular the villagers were not very well informed or integrated into the discussions between the village, the BTNLL and TNC. Finally, in Salua the agreements were implemented by different institutions which led to confusion with respect to the responsibilities of the activities. The first negotiations were in 1996 and therefore were not well remembered, and the second agreement was never signed in 2006 so the promoting organisation started to retreat from the project region. Additionally, very little communication towards the community has occurred with respect to the purpose of the agreement.

8.3. Discussion

The KKM is backed up by an organisational structure which is usually the village conservation council LKD. The community is familiar with this new organisation and aware of its activities. However, in all villages apart from Wuasa, the villagers were not involved in the agreement negotiation and sometimes did not even know of the existence of the agreement. In contrast, the village authorities are familiar with the agreement and a knowledge gap is therefore apparent between the different social strata in the village. This finding is corroborated by the results of Mappatoba and Birner (2004) who detected that often persons who have functions in the village were among those selected to participate in KKM meetings.

The traditional customary institution LA is present in all villages and its regulatory framework provides a good foundation for the rules of the conservation agreement. It can be build upon in order to improve the local population's acceptance of the new regulations. However, the LA has different strength in the four villages, as well as acceptance among the community members which is related to the socio-cultural situation in the village. Both in Wuasa and Langko, the population is still dominated by the original ethnic groups. Thus, the LA and the LKD, especially in Wuasa, have become a "voice" for the local community to fight for their access to the forest. Burkard (2002) points out that in an ethnically mixed resettlement, such as Kapiroe and Salua, the LA is comparatively weak and does not play a significant role in the management and utilisation of natural resources.

A monitoring entity has also been constituted in most villages and is, with the limitations it faces, relatively active. Several cases of law enforcement were recorded; however, restricted or lacks of funds constrain the entity's activities considerably and the monitoring is adjusted according to personal schedules arrangements. Similarly, Palmer points out that the monitoring entities carried out regular checks in just 50 percent of the villages with KKMs; in 25 percent checks were only carried out when there was a special reason to do so. Approximately two thirds of the monitoring teams did not receive any financial resources to pay for the enforcement activities (2007). Thus, the newly formed monitoring institutions provide a simple basis for the monitoring and enforcement structures, but the entity needs to be financially supported and strengthened to be more efficient.

The awareness with respect to nature conservation has become more widespread only in the recent past and they can not be attributed purely to the establishment of the KKMs. As considerable resource extraction has left its marks in the region with the participants believing that environmental problems such as flooding and erosion have increased, the villagers are more concerned about protecting the forest. 90 percent of the KKM villages perceived a positive impact on the forest due to the agreement (Palmer 2007).

Finally, compensation payments are regarded on the one hand as a good reimbursement for desisting from using the forest resources. On the other hand, the fear of corruption and embezzlement of funds has been expressed caused by bad experience. Indonesia is a country which has considerable problems with corruption, and Transparency International has listed it as Number 143 out of 179 countries on the Corruption Perception Index in 2007 - it scores 2.3 from 10 points, which is equal to very high perceived corruption (Transparency International 2007). Similarly, bribery is a topic ingrained in Indonesian culture and seen as “almost morally acceptable” (Palmer 2005). Compensation payments are additionally not seen as a solution for the inherent problem of land scarcity, associated with the need to work, obtain food and pass on land to the villagers’ children. This was also mentioned to be one of the main disadvantages of the National Park, that not enough land will be available for their children (Mappatoba and Birner 2004).

These findings allow us to make some judgements as to whether the institutional arrangement of the KKM could provide a basis for a carbon sequestration project or more generally for a forest PES project.

A carbon sequestration project could benefit from the framework of the rules and regulations of the KKM established on the basis of the traditional customary institution, providing an important groundwork for the implementation of a PES project. The given regulatory framework can be used and enriched. However, in the present circumstances the purpose of the agreement has not been communicated to all stakeholders, and the involvement, at least of some villagers or representatives of these villagers, is not given. As argued by Hanna (1995) and mentioned in Chapter 3, a resource management process must represent the range of user interests and have a clear purpose and transparent operation, which allows for a better identification of the community with the aims of such a project. Thus, for a PES or forest carbon sequestration project, the participation of all those affected by it can not be guaranteed by the present institutional arrangement of the KKM. For an internationally financed project, the LKD needs to be reinforced and monitoring activities have to be conducted more thoroughly and frequently. More financial support can help to foster these activities. A PES project typically involves payments to the providers of the environmental service at stake. This requires a transparent organisational structure and the objectives and responsibilities have to be clearly defined. The present structure of the community conservation agreements and the associated village conservation councils differs between villages, because on the one hand the NGOs used different approaches for the agreements and on the other hand the village structures, due to their ethnic compositions, diverge. We have the additional problem in

Indonesia, that due to high levels of corruption, which are even present in daily operations, a mistrust is engrained in the people; whether projects will be carried out according to their stated objectives and funds be handled efficiently and distributed fairly. Thus, with the present institutional arrangement of the KKMs the administration and management of such a PES project is very difficult.

We can conclude from this particular case study in Indonesia, that the structures of existing natural resource management agreements can provide initial institutional linkages and framework conditions to implement a forest PES project. It needs to be assessed on a case to case basis, whether the natural resource management structures are sufficient and, as we have seen from this case study, the socio-cultural aspects of the specific circumstances need to be taken account of. In addition, it is of major importance to integrate the community members into the processes of the management of the natural resource projects. Compliance with regulations increases when they are considered acceptable and legitimate by those whose interests are regulated. Obviously not all community members can participate in these processes, yet an option might be to let the villagers vote on the outcome. Finally, the governance structures in a country are an important factor for the success of development and conservation initiatives, as the experience of a world-wide study shows. Higher governance rates therefore, have a positive influence on conservation projects (Smith et al. 2003).

Specifically for PES projects this means for their establishment that advantage should be taken of “intermediary bodies” which can be provided through traditional community resource management institutions. Using known institutional arrangements can ensure familiarity for the participants and they have trust in it. Negotiations can be rendered much more efficiently, as a contact is given and contractual arrangements can be made with the entire group rather than with individuals. This can substantially decrease transaction costs. Additionally, if specific arrangements are already established, such as in this case monitoring and enforcement structures, costs can be reduced even further.

8.4. Summary

This Chapter presents the results of the analysis of the institutional arrangement of the community conservation agreements present in some of the villages in the Lore Lindu region. We are using four central points for the analysis, and they are the institutional structure of the agreements, the involvement of different social village groups in their establishment, the regulatory structures for monitoring illegal activities, and the impact on the environment due to the agreements as perceived by the villagers. The results obtained in this case study allow for making conclusions and recommendations as to whether community natural resource management projects can be used as a foundation for a payment for environmental services scheme.

9. CONCLUSIONS

9.1. Synthesis of Results

Climate change is posing increasing challenges to humanity and requires action at different levels and in distinct fields. One focus area for current mitigation strategies is to reduce greenhouse gas emissions caused through land-use changes and deforestation activities. The present study focuses on PES schemes, a class of economic instruments that are used as market-based incentives to enforce or support sustainable forest management and conservation activities.

We have used the Lore Lindu region in Central Sulawesi, Indonesia as a case study to address the following research objectives. The principal purpose of the study was to investigate the impact of a payments for carbon sequestration scheme on local households and their land-use systems, as well as the conditions for the institutional arrangement of such a scheme. At the household level, we explored not only the impact of such payments, but also their potential as an incentive for the adoption of more environmentally beneficial land-use systems, and their ability to offer a mechanism for the protection of the rainforest. At the institutional level, the objective was to investigate the structures of the existing community conservation agreements, and whether they can be used as a platform for a potential payments for carbon sequestration scheme.

In order to meet these objectives we selected a quantitative and a qualitative research design. The first part of the study focused on the household level. We conducted a survey with a standardised questionnaire and evaluated the data in a comparative static linear programming model. This way, we could assess the household behaviour and its adaptation with respect to resource allocation in light of new policy options, as the solution to the model indicates the optimum activities for the households. In the second part we discussed and evaluated the impact of the institutional arrangement of community conservation agreements in focus groups, using participatory rural appraisal tools.

The two complementary methodological approaches have allowed us to provide answers to the research objectives outlined in the introduction. The quantitative analysis revealed the following findings:

- The impact of carbon payments depends on the prices they obtain on the carbon markets. With low carbon certificate prices of €5 tCO_2e^{-1}, the additional remuneration for the agroforestry system in general is quite low, especially in comparison to the very high gross margin of €1,460 per hectare of the intensively managed cacao. However, with carbon certificate prices at the upper end, the households who obtain the lowest total gross margin from their crop activities can realise an 18 percent increase of their gross margin from cropping activities with the introduction of payments. These households also realise the highest increase in absolute terms of their gross margin. Additionally, they provide the second highest (and only marginally lower than the highest) environmental benefit in terms of the annual carbon sequestration rate from their cacao agroforestry systems.
- Therefore, in this specific context, the important question with respect to the carbon payments is which household type derives more benefit and what are implications of this? If the payments are targeted towards the high-shade cacao agroforestry systems, indirectly the poorer households from the local ethnic group benefit, as they primarily cultivate the low-input and shade intensive cacao systems. In turn, this additional income can reduce their need to open up further land at the forest margin and sell it to the migrants. A win-win situation is possible whereby the vicious cycle of poverty and deforestation can be broken.
- Additionally, compensation payments can be used as an incentive for deforestation reduction, which ultimately leads to avoided greenhouse gas emissions. The analysis shows that the credit prices currently observed on carbon markets could be sufficient for the majority of households in the Lore Lindu region to stop them from further forest conversion.

The qualitative analysis revealed the following information about the institutional context:

- If one would want to implement such a payment scheme for carbon sequestration in the region, the present institutional arrangement of the community conservation agreements could be used as a starting point. They provide an existing regulatory framework, which is based on the rules and regulations of the traditional customary council, the *Lembaga Adat*. The entity, that has been established on the basis of the agreements and is in charge of monitoring activities, usually is the village conservation council LKD. It addresses illegal activities, such as timber removal from the assigned conservation areas and is involved in rule enforcement. Extractive activities have declined since the establishment of the institution and environmental awareness has increased, however, not homogeneously across all villages.

- Thus, for a potential PES project, the institutional framework needs to be strengthened and community participation in the conservation activities fostered. This is because the newly formed institution of the LKD is not very strong, due to financial limitations, but also to sometimes unclear definitions of responsibilities between the different village institutions. Additionally, the participation of the villagers in the negotiation and formation of the agreement was restricted, which makes the acceptance and compliance with the regulations difficult, since their interests have not been represented in the process of the agreements' establishment.

To summarise, payments for carbon sequestration can provide positive impacts for the research region. If the carbon credits are specifically targeted towards more sustainable agroforestry systems, increased environmental benefits in terms of higher carbon sequestration rates, as well as increased income benefits for the poorer households can be obtained. Such a scheme could build upon existing community conservation agreements. However, the participation structures for the villagers, as well as monitoring and enforcement need to be improved to safeguard the stability of the rainforest margin in the Lore Lindu region.

9.2. Strengths and Limitations of the Study and Further Research

The present study exhibits some significant strengths and research findings. These are subsequently summarised:

- By combining a quantitative and qualitative research design we were able to concentrate on two different levels associated with PES schemes. The methods and the advantages of each approach complement each other, allowing for a stronger research design that results in valid and reliable results. The quantitative analysis permitted us to measure the impact of carbon payments using the tool of linear programming. The results enabled us to make recommendations with respect to the application and usefulness of this incentive measure. The qualitative approach makes it possible to include the individuals' or group behaviour, their perceptions and thoughts, which are not easy to document using numbers. "It captures what people say and do as a product of how they interpret the complexity of their world, and allows researchers to understand events from the viewpoint of the participants (Burns 2007, p11). Therefore, we obtained an in-depth insight into the participation processes and institutional framework of the agreements, as perceived by two different social groups in four villages.

- This study provides valuable input to the research on payments for carbon sequestration and its associated benefits. Our results indicate that targeting payments on a site-specific basis can have the most advantageous impact, both in terms of fostering environmental services, as well as households' income. Specifically, the carbon sequestration rates of more environmentally friendly land-use systems are increased and poorer households realise a rise in their revenues. Thus, for future research in the region in light of the proposal of a cacao certification project, we recommend to target payments to specific segments of the population.
- In comparison to most other studies using a linear programming approach and modelling households' behaviour when introducing new policy options, this investigation focuses on the economic instrument of PES schemes and specifically on carbon sequestration. In addition, there is hardly any research on the economics of carbon sequestration, which uses optimisation techniques at the household level. The particular advantage of this study is, therefore, to obtain results for the introduction of this market-based incentive for farmers and the impact on their land- and forest use systems and transformation processes.

The study does face some limitations and restrictions, which are important to mention, as these can guide further research towards remaining questions.

- When we considered the research methodology, we adopted a static comparative linear programming model under certain assumptions which were outlined in Chapter 7.1.5. An extension of the model that would yield additional results refers to integrating cacao production data of an entire life span of the trees and obtaining a dynamic or multiperiod model. Such a model would be more sensitive towards the production cycle of the cacao trees, as they do not produce a uniform stream of output over the years and the results could provide an optimal growth strategy on a farm level. Moreover, the linear programming model could be expanded by integrating further biophysical parameters, such as soil variables and nutrient availability. This can allow for a more holistic approach and account for the changes in these parameters and their impact on economic decisions with respect to the land-use. Future research may explore these methodological extensions in more detail.

- Furthermore, we have only calculated and integrated into the model the direct economic value of the cacao agroforestry systems in terms of their gross margin, to which we added the potential payments to be received for the carbon sequestration of the cacao and shade trees. Yet, there are further benefits to be obtained from these cacao agroforestry systems. On the one hand there are the values of the NTFPs obtainable in the agroforestry systems. These include, for example, the products of fruit and other trees, such as bananas, kemiri nuts and coconuts. Vanilla and cloves, as well as certain medicinal plants, which are used by traditional healers, are also sometimes found in these agroforestry systems. In addition, apart from carbon sequestration, other environmental services are provided by the agroforestry systems, such as nutrient cycling, erosion control, especially in steep areas, as well as ecosystem functioning and biodiversity values. Integrating these direct and indirect values into the analysis of the land-use systems of the households would most probably result in a shift in the valuation of the different agroforestry systems, providing higher economic values for the shade-intensive systems.
- We made the assumption that the compensation payments for avoiding any further deforestation are made to the farmers. In essence, the farmers would be paid to cease illegal extraction activities, as they are not allowed to convert forest inside the National Park. The current command-and-control approach by the National Park administration does not work and is not respected by the villagers. Therefore, we recommend investigating the appropriate structures for the payment modalities for avoided deforestation. The potential receivers could also be institutions at the community or regional level. Further approaches also need to be developed with the villagers to stop their conversion activities of the National Park forest and involving them more in conservation actions.
- With respect to the qualitative methodology we adopted for the second part of the study, it is important to keep in mind that these results, strictly speaking, represent the

situation in a localised environment in four villages. It is difficult to extrapolate the findings of a qualitative approach to a wider population, i.e. all villages in the research region. However, we conducted the focus group discussions in specifically identified villages in order to detect certain phenomena. We used a cross-section of four villages which were at different stages in the implementation process of KKMs in order to contrast them and identify emerging patterns. Thus, we have to keep in mind that these results therefore are not representative for the entire research region. Yet, they indicate certain trends and can complement the results of other studies in the region, which have collected data in a wide cross section of villages in a standardised survey, such as Palmer in 2006 and Reetz in 2007.

- Finally, a major shortcoming of the study is its application to the real world. The next section discusses policy implications and recommendations based on the emerging trends of the research are formulated, however, the results of the study remain hypothetical constructs. Specifically in the reality of the Indonesian villagers, the question that was always raised among the respondents referred to the benefits they can obtain from the investigation. As we outlined in Chapter 2, there are a considerable number of carbon projects carried out and more and more funds (e.g. World Bank Forest Carbon Partnership Facility) available, especially in the voluntary sector, as these projects have the great advantage of being "charismatic" with public appeal. However, it is a long way off for forestry offset projects to be implemented in the mainstream and the question remains whether they could eventually become reality in the Lore Lindu region.

Notwithstanding, we can draw some important insights from this study which can be of help for the advancement of the market-based inventive mechanism of the PES schemes.

9.3. Policy Implications and Recommendations

The potential advantage of PES programmes can be seen in the results of this study. They can provide a stable income source for the farmers involved in these schemes. Especially in light of fluctuating crop prices, a phenomenon which has been observed on the world market, but also on local markets for cacao prices, this additional income can contribute to a reduction of the vulnerability for the smallholders in the research region. The cash-flow, once the farmers are participants and beneficiaries of such a scheme, is constant and stable. Potentially, this support for the cash crop cacao could lead to a reduction in food supply, as the farmers would have an incentive to switch towards these perennial cropping systems. However, in previously formulated contracts with the farmers, the areas which are designated to these schemes will be decided on and cannot be enlarged afterwards. Obviously, the advantage of a stable income source is also applicable for cash-poor smallholders in other regions of the world. However it is important to help ensure that the support of specific land-use systems does not displace the crop production systems which are necessary for local food supply.

In light of searching for options for climate change mitigation, it is important to settle on cost-efficient solutions, which provide a high potential for the abatement of greenhouse gases. The present study demonstrates that comparing different options in the agricultural sector, the protection of the Lore Lindu National Park offers the possibility of a low-cost alternative for the reduction of carbon dioxide in comparison to biofuel options in Germany. We can recommend therefore, to conduct further studies in forest or protected areas in different parts of the world with respect to their potential for carbon sequestration. This can potentially allow for the provision of further investment funds for the conservation of forests. This is specifically important in the light of the expansion of land dedicated to the production of bioenergy crops. In some regions this takes place at the expense of primary forest, as in Indonesia for the oil palm production, as well as sometimes displacing the traditional food crops, which has been happening in the USA with maize production.

If the aim of a PES project is to integrate farmers, the findings of the present study indicate that for their implementation, any scheme should take into account existing structures of institutional arrangements. These institutions should either already focus on the management of natural resource processes, and/or they should be institutions with existing participation structures for the local communities which are affected by the project. Therefore, regulatory structures can be built upon and compliance can be much more easily ensured. Using existing structures offers the additional advantage of familiarity with the institution for the participants. As the socio-cultural conditions differ between continents and countries, and even sometimes in the same project region as we have observed in this study, it is advantageous to work with local institutional frameworks. These usually have integrated local customs already, and are reflected in the structure of the institution, making it easier for new projects to build upon.

Finally, based on the results of the qualitative research findings we propose that PES schemes need to be assessed on a case-by-case basis for their applicability to a specific region and circumstances. They can offer win-win situations, whereby environmental benefits can be boosted, as carbon sequestration is augmented or biodiversity services safeguarded, in addition, the incomes of the local rural population can be increased and finally, incentives are given to break the vicious cycles of poverty and deforestation. Therefore, climate change policies should integrate this market-based incentive mechanism, as it offers mitigation solutions for carbon dioxide emissions and at the same time offering a potential to complement poverty reduction policies.

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APPENDIX

Appendix I: Survey Questionnaire

STORMA – Stability of Rainforest Margins
University of Goettingen and Kassel, IPB/Bogor – UNTAD/Palu

Household Survey Questionnaire 2006

We are researchers from a research collaboration between Indonesia and Germany, working together with 4 universities: Universitas Tadulako and Institut Pertanian Bogor (Indonesia) and University of Goettingen and Kassel (Germany). The project is called STORMA. We have already visited your households a few times during the last five years. This time we are conducting a strudy about the contribution of the forest system to your agricultural production. We also want to talk about the relationship you have with the forest and the Lore Lindu region. Your response is very helpful to derive a good and useful result for this research, and your answers are kept anonymous.

STORMA is an interdisciplinary research project collecting and exchanging data. The data collected by the researchers can later be used by decision makers for a better assessment of the situation of the Lore Lindu region.

STORMA is NOT a NGO or a regional development programme. That means, STORMA is not providing (material) help or development funding at present or in the future. STORMA and its members are NOT part of the government or from non-governmental institutions! After STORMA there may also no other donor coming in and paying for projects in your village.

If you agree to participate in this study you will be asked to answer the survey questions asked by the interviewer. The interview will take about 2 hours.

We respect the answers you give and want to remind you, that there are no right or wrong answers. We hope you will give answers that comply with your knowledge and opinion.

If you have any question regarding this research, please address them to the interviewer.

Interviewer Name: ______________________________

Date of interviews (dd/mm/yy): _____/_____/_______

Supervisor Name: _____________________________

Date questionnaire checked by supervisor (dd/mm/yy): _____/_____/_______

Signature supervisor: _____________________________

000. Household Identification

Use the Household ID from previous surveys and put the ID nr. on top of every page. First ask about general household characteristics

001 Household ID:

___________	002. Desa:		003. Dusun / RT: ______/______		
004. Kecamatan (circle):	1. Sigi Biromaru	2. Palolo	3. Kulawi	4. Kulawi Selatan	5. Lore Utara

005. Name of Respondent: ____

006. Status of respondent:	1. HH head	2. Spouse	3. other (specify)
007. Respondents sex:	1. Male	2. Female	

008. If respondent is not HH head: Name of HH Head? ______________________________

010. Environmental and social issues

011. With which one of these statements about the natural environment and the economic well-being do you most agree? (read and circle answer)

a) Protecting the natural environment should be given priority, even at the risk of slowing down economic growth.

b) Economic growth should be given priority, even if the natural environment suffers to some extent.

012. How serious do you rate the following social problems in your village at the moment? (read problems)

Social problem	**Not at all serious**	**Slightly serious**	**Somewhat serious**	**Serious**	**Very serious**	**Don't know**
a) Not enough food						
b) Crime (e.g. stealing crops from neighbour)						
c) Bad health facilities						
d) Religious conflict						
e) Bad education						
f) Bad housing conditions						
g) Ethnic problems						

013. Which environmental problem have you noticed that has become stronger during the last 5 years in your village and its surroundings? ***(do not read, circle, multiple answers possible)***

0= None
1=excessive drought
2= soil degradation
3=water pollution
4= deforestation
5=flooding
6= More pest/diseases
7= land sliding
8= erosion
9= other (specify)

014. How serious do you rate the following environmental problems in your village at the moment? (read problems)

Environmental problem	**Not at all serious**	**Slightly serious**	**Somewhat serious**	**Serious**	**Very serious**	**Don't know**
a) Loss of forest						
b) Excessive drought						
c) Less rattan						
d) Soil degradation /poor soils						
e) Flooding						
f) Loss of endemic animals						
g) Water degradation						

015. Have these problems had an impact on you and your family? *(circle)*	1= Yes	0= No	(If no, skip to 017)	
016. If yes, which impact have you noticed? *(Do not read, circle, multiple answers possible)*	*1= harvest failure* *2= reduced agricultural output* *3=reduced water supply for irrigation*	*4= reduced water supply for household use* *5= less forest animals* *6= increase in time for wood collection*	*7= less fire wood* *8= flooded rice fields* *9= other (specify)* ______________	
017. Which products do you get from the Forest for personal use /consumption? *(do not read, circle, multiple answers possible)*	*0= None* *1= rattan* *2= dammar (resin)* *3= fire wood* *4= wood* *5= wild pig*	*6= anoa* *7= bird* *8= other animal* *9= fruit* *10= vegetables* *11= roots*	*12= bamboo* *13= leafs* *14= palm sugar* *15= other plants* *16= other (specify)* ______________	
018. Which other functions has the forest for you? *(do not read, circle, multiple answers possible)*	*0= None* *1= water supply* *2= biodiversity* *3= soil control*	*4= climate control* *5=landscape scenery* *6= traditional function (specify)____________*	*7=religious /cultural values* *8= medicine* *9=other (specify)___*	
019. Which type of forest is located closest to your house, this does not necessarily have to be located in your village? *(circle)*	*1= Don't know*	*2=TNLL*	*3= Hutan Lindung*	*4= Productive Forest* / *5 = Other (Specify)*
020. In your opinion, what is the condition of the forest in the TNLL? *(circle)*	*1= Very good*	*2= Good* *3= Ok*	*4= Less well* *5= Not good*	*0= Don't know*
021. In your opinion how has the forest area in the TNLL, changed in the last 10 years? *(If 1, 2, or 0, skip to 023)*	*1= increased*	*2= remained the same*	*3= decreased*	*0= don't know*
022. In your opinion, if the forest area has decreased, what is/are the reasons for this? *(do not read, circle, multiple answers possible)*	*1= more cacao plantations* *2= more people in the village*	*3= political pressure* *4= land scarcity*	*5=land claim* *6= economic pressure*	*7= other (specify)* ____________
023. Which community organisations are dealing with natural resource management in your village?	*1=*	*3=*	*5=*	*7=*
	2=	*4=*	*6=*	*8=*
024. What are their duties?	*1=*	*3=*	*5=*	*7=*
	2=	*4=*	*6=*	*8=*

025. In your opinion, how does the institution comply with their duties?		*1= Extremely well*	*2= Very well*	*3= Well*	*4= Moderately well*	*5= Not at all*	*0= Don't know*
	1						
	2						
	3						
	4						
	5						
	6						
026. Does the KKM exist in your village?	*1= yes*		*0=no*		*3= Don't know*	*(if no, skip to 028)*	
027. In your opinion, has the Community Conservation agreement in your village had an impact on the forest area in the TNLL? *(circle)*	*1=increase in loss of forest area*		*2= forest area remained the same*		*3=more forest*	*0= don't know*	

028. If there would be a development project in your village; in your opinion, which focus should this have? *(do not read, circle, multiple answers possible)*	*0= don't know* *1= Infrastructure* *2= Agricultural development*	*3= Education* *4= Roads* *5= Water management*	*6= Health service* *7= Forest management* *8= Other (please specify)*__________
029. If there would be an environmental project; in your opinion, which focus should this have? *(do not read, circle, multiple answers possible)*	*0= don't know* *1= Water management*	*2= Forest management* *3= Land management*	*4= other (specify)* ______________

030. In your opinion, if there would be an environmental project for your village which aims at stopping the loss of forest, which enforcement measure for penalties or incentive to protect trees will work make the villagers comply and help to save the forest in the TNLL?

____

031. How well do you think the following enforcement and incentive measures work to stop villagers cutting trees in the TNLL? (read each point and tick category)

	1= Extremely well	**2= Very well**	**3= Well**	**4= Moderately well**	**5= Not at all**	**0= Don't know**
a) Individual cash payment of penalty						
b) Individual payment of penalty with a good (buffalo, rice, etc.)						
c) village cash payment of penalty						
d) Village penalty payment with goods (buffalo, rice, etc.)						
e) physical punishment						
f) compensating villagers with a payment to stop cutting trees						
g) compensating villagers with seeds and trees (Cacao, Jati and Kemiri's tree) to stop cutting trees						

Household ID Nr. ________

040. Household labour composition

041. How many people live in your household? ____________ Persons
Note: Members of the household are all people who eat from the same pot and sleep under the same roof. Include also members, who are absent for less than two months.

042. How many household members (including you) work on the farm regularly? _____ Persons

043. Who works on the farm regularly? (Start with HH head, carry on with spouse, then children, then other HH members)

Member ID No.	Relation with Head (Code 1)	Name	Sex 1=Male 2=Female	Age in years	How often this person works on the farm (on average)			How often this person works as a wage labourer on the farm or any other labour (on average)		How often this person works any other labour (on average)		How often this person works at the forest in collecting rattan or wood	
					Hours per day?	*Days per week?*	*Months per year?*	*Days per week?*	*Months per year?*	*Days per week?*	*Months per year*	*Days per week*	*Month per year*
1	*HH head*												
2													
3													
4													
5													
6													
7													
8													
9													
10													

Code 1
1= Spouse
2= Son or daughter
3= Step son/daughter
4= Father or mother
5= Grandchild
6= Grandparents
7= Mother-, father-, son- or daughter-in-law
8= Other relative
9= Other non-relative

Household ID Nr. ________

050. Land owned/rented

051. Please draw the map of your house and plots (Prepare a sheet of paper)	**Number** of plots	
052. How many **plots** do your family **own**?		
053. How many of these **plots** are **rented out**?		
054. How many **plots** has your family **rented in**?		
055. How many **plots** has your family **borrowed**?		
056. How many **plots** has your family **lent** from someone else?		
057. How many **plots** does your family have with the **shared harvest** (bagil hasil) system?		Do you own this plot? 1= yes, 0= no
058. How many **plots** does your family have with the **tangala** system?		Do you own this plot? 1= yes, 0= no
059. How many **plots** are you using for **agriculture** now (excluding lahan pekarangan)?		

060. Changes in possession of land use

Before the survey, fill out the plot ID number and plot size from last survey. Please ask for the information for the already registered plots. If the plots have been merged or split and the size has changed, give the plot a new number.

Plot ID number	Plot type	Plot size are	Do you still own the plot? 1= yes, 0= no	Who cultivates the plot? 1=himself 2= another person	Is the area still the same 1= yes, 0= no	If plot size has changed, state new size (Are)	Distance to plot from homestead on foot Minutes	meter	How far is that plot from the forest? Code 1	Is the plot still used for the same crop as in last survey? 1= yes, 0= no	For what do you use the plot? Code 2
1	Homegarden										

Code 1
1= Inside TNLL
2=In the forest
3=Directly bordering the forest
4=Less than 50m
5=Less than 100m
6=Less than 500m
7=Less than 1km
8=More than 1km

Code 2
1=Lahan pekarangan
2=Sawah with simple irrigation
3=Sawah with semi-technical irrigation
4=Sawah with technical irrigation
5=Plot in the plains
6=Ladang (upland plot)
7=Garden in the forest (pagalan)
8= Uncultivated land
9=Primary forest
10= Secondary forest
11= Pasture
12= Fallow land
13= Abandoned/unused land
14= Other (please specify):
____
____

Household ID Nr. ________

061. Have you any other plot that did not mention on table 060 (circle) 1= yes 0= no If no, skip to 070

062. If you own any **newly acquired plots**, please give further information:
Continue with numbering of plots from Table 060.

Plot ID number	Description of plot	Type of plot Code 1	Plot size are	Distance to plot from homestead on foot minutes	meter	How far is the plot from the forest? Code 2	How was it acquired? Code 3

Code 1
1=Lahan pekarangan
2=Sawah with simple irrigation
3=Sawah with semi-technical irrigation
4=Sawah with technical irrigation
5=Tegalan (dry fields in the valley)
6=Ladang (upland dry fields)
7=Garden in the forest (pagalan)
8=Non-agricultural land
9=Primary forest
10= Secondary forest
11= Pasture
12= Fallow land
13= Abandoned/unused land
14= Other (please specify):

Code 2
1= Inside TNLL
2=In the forest
3=Directly bordering the forest
4=Less than 50m
5=Less than 100m
6=Less than 500m
7=Less than 1km
8=More than 1km

Code 3
1= Bought
2=Gift
3=Through marriage
4=Heritage
5=Received from government
6=Cleared primary forest
7=Share harvest (bagi hasil)
8= Leased against fixed payment
9= Borrowed for cultivation
10= Share land (bagi tanah)
11=Taken as loan from defaulting borrowers
12= Other (please specify)

070 Plot specific production activities – annual crops – last 12 months!

Do not include crops planted in the lahan pekarangan. The information needed concerns all plots cultivated with annual crops and refers to the last crop harvested in the last 12 months. The input use refers to the same time period as the output. The output for each crop has to be transferred into the unit in brackets (code 1). Please write your calulations at the bottom of the sheet.

071 What was the last annual crop you harvested on the plot? (Planting and seed use)

Plot ID Use from 060/062	Crop grown Code 1	1= Last Harvest 2= Previous Harvest	Area planted ares	Intercropped with perennials? 1= yes, 0= no	When did you plant? month/week	How do you prepare your land? Code 2	Expenditures for land preparation (herbicide or equipment used) Rp.	Expenditures for land preparation (hired labour) Rp.	*Rice/Maize* Types of seed used Code 3	*Rice*: Did you transplant your rice? 1= yes, 0= no	Amount of seeds used Liter.	Expenses for seeds Rp.
					____/_____							
					____/_____							
					____/_____							
					____/_____							
					____/_____							
					____/_____							
					____/_____							
					____/_____							
					____/_____							

Code 1
1=Padi Sawah (kg)
2= Maize on the cob, tongkol (kg)
3= Kernel Maize, pipilan (kg)
4= Fodder Maize, hijauran(kg)
5= Peanuts(kg)
6= Cassava (kg)
7= Beans (kg)
8= Other veggies(kg/pieces) (write)____________
9= Other annual crop (kg/pieces) Write ___________________

Code 2
1= with tractor
2= with buffaloes
3= with cattle
4= manually with hoe
5= no land preparation done

Code 3
1= local variety (newly bought seeds)
2= improved variety (newly bought seeds)
3= hybrid variety (newly bought seeds)
4= recycled local seeds
5= recycled improved seeds
6= recycled hybrid seeds
7= Ratoon crop local
8= Ratoon crop improved

072 Input continued - Fertiliser and irrigation

Do you use any fertiliser? 1= yes, 0= no (if no skip to the question of sawah plots)

			Mineral/ Chemical fertiliser use											In case of sawah plots	
Plot ID Use from 060/062	Crop grown Code 1/071	1= last harvest 2= previous harvest	**Type** Code 1	Total amount applied Kg.	Price per bag Rp.	**Type** Code 1	Total amount applied Kg.	Price per bag Rp.	**Type** Code 1	Total amount applied Kg.	Price per bag Rp.	Expenses for transport ation Rp. total	Expenses for application (hired labour) Rp.	Expenses for semi technical irrigation system Rp. per year	Expenses for technical irrigation system Rp. per year

Code 1
1=Urea
2=Triple super phosphate (TSP)
3=ZA
4=KCL
5=NPK
6=Pupuk daun
7=Other (specify):

073 Input continued - Weed control and pesticides

					In case herbicides were applied						In case pesticides were applied			
Plot ID Use from 060/062	Crop grown Code 1/071	1= Last harvest 2= Previous harvest	Was growth of weeds controlled? 1=yes, 0= no	Method of weed control Code 1	Total amount applied? litres	Price paid per litres Rp.	Total expenses for hiring equipment Rp.	Total expenses for hiring labour for weed control Rp.	Were pesticides used? 1=yes, 0=no	Used against what? Code 2	Amount applied litres	Price paid per litre Rp.	Expenses for hiring labour for application Rp.	Expenses for hiring application equipment Rp.

Code 1
1=Herbicides
2=Manual weeding
3= Water management

Code 2
1=Insect caterpillar
2=Insect wereng
3=Insect penggerek(cut)
4=Walang sangit
5=Lychen /cendawan
6=Other (specify):

074 Output for annual crops *(please write down your calulations next to the table, monthly outputs, and the summations)*

Plot ID Use from 060/062	1= Last harvest 2= Previous harvest	When did you harvest? month/week	Quantity harvested	Unit Code 1	How often do you harvest? times/year	Equipment costs involved in harvesting/ threshing Rp.	Hired labour costs involved in harvesting/ threshing Rp.
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		
		______/_____			______/_____		

Code 1:
1=kg *4=Blek (can)*
2=litres *5= Ikat*
3=Bags *5=Other (specify):*

Household ID Nr. ________

080 Plot specific production activities - perennial crops

Do not include crops planted in the lahan pekarangan. The next questions only concern perennial crops, and refer to the last 12 months, unless otherwise stated. The input refers to the same time period as the output.The output for each crop needs to be transferred into the units in brackets (Code 1). Please write your calulations on an extra sheet (monthly outputs). Ask about major perennial crops only; do not include single fruit trees or crops planted along the borders.

081 Plantation characteristics

				Questions only for cacao:						
Plot ID Use from 060/062	Crops grown Code 1	Plot size are	Variety of cacao /coffee trees? Code 2	Did you grow another crop on the same plot before cacao? 1= yes, 0=no	Why did you switch to cacao? Code 3	How many years have the present trees been productive?	Have you replaced your trees with new ones already? 1= yes, 0= no	*If yes*, When?	is there any other crops grown in your plot excluding cacao? 1=Cacao only, 2= Other crops	Type of shading trees of cacao plot Code 4 Show with pictures

Code 1
10= Cacao
11= Coffee
12= Coconuts
13= Cloves
14= Bananas
15= Fruit trees
16= Jati putih
17= Gamal
18= Vanille
19= Kemiri
20 =Other tree crop (specify):

Code 2
1= Criollo (young fruit are green)
2= Forastero (young fruit are violet)
3=’Hibrida’ (Forastero × Trinitario, fruit are large, young fruit are violet)
4=’Local’
5= kopi robusta
6= kopi arabica
7= kopi kate
8= Other (specify):

Code 3
1= Cacao is more profitable
2= The previous crop is less productive
3= It is easier to take care of cacao
4= There is less work involved for cacao plantations
5= other

Code 4
1=Cacao under forest trees originating from the forest
2= Cacao under planted shading trees AND trees originating from forest
3= Cacao under planted shading trees(mainly one shading tree species)
4= Cacao without shading trees

082 Land preparation and pesticide use

							In case pesticides were used:				
Plot ID Use from 060/062	Crops grown Code 1/081	Age of tree (in year)	Expenses for land preparation (equipment + herbicide) Rp.	Expenses for land preparation (hired labour)) Rp.	Expenses for seeds and young plants Rp.	Was any pesticide used? 1=yes, 0= no	.. used against what? Code 1	Amount applied Litres	Price paid per litre Rp.	Expenses for application (hired labour) Rp.	Expenses for application (equipment) Rp.

Code 1

1=Insect caterpillar
2=Insect wereng
3=Insect penggerek(cut)
4=Walang sangit
5=Lychen /cendawan
6=Other (specify):

083 Use of mineral fertiliser

			If yes: 1. fertiliser				2. fertiliser					
Plot ID Use from 060/062	Crops grown Code 1/081	Was any mineral fertiliser used? 1=yes, 0=no (if no, skip to 084)	**Type** Code 1	No. of applications	Total amount applied Kg.	Price per bag Rp.	**Type** Code 1	No. of applications	Total amount applied Kg.	Price per bag Rp.	Expenses for transportation of fertiliser Rp. total	Expenses for application (hired labour) Rp.

Code 1
1=Urea
2=Triple super phosphate (TSP)
3=ZA
4=KCL
5=NPK
6=Pupuk daun
7=Other (specify):

084 Maintenance of the plantation :

				If herbicides were applied:			
Plot ID Use from 060/062	Crops grown Code 1/081	Was growth of weeds controlled? 1=yes, 0= no (if no, skip to 085)	*If yes*, Method of weed control Code 1	Total amount applied litres	Price paid per litre Rp.	Total expenses for hiring equipment Rp.	Total expenses for hiring labour for maintenance of plantation Rp.

Code 1
1=Herbicides
2=Manual weeding
3=Herbicide and manual

Household ID Nr. ________

085 Output from perennial crops *(please write down your calulations at the bottom of the table, monthly outputs, and the summations)*

										Ask for cacao only:		
Plot ID Use from 060/062	Crops grown Code 1/081	1= Panen Raya 2= Panen Antara	When did you harvest? Time/year	How many months for every single harvest Months	How often do you harvest? Code 1	Total amount harvested (quantity)	Unit Code 2	Costs involved in harvesting Rp.	Total labour costs Paid in cash Rp.	Which year was your first panen raya harvest?	How does the first (PR) harvest compare to the last (PR) harvest? Code 3	How does the price received per unit of first PR harvest with last harvest Code 3
			_____/____									
			_____/____									
			_____/____									
			_____/____									
			_____/____									
			_____/____									
			_____/____									

Code 1
1= every day
2= three times a week
3= twice a week
4= every week
5= every two weeks
6= every three week
7=every month
8=every two months
9=twice a year
10=every year
11= other (specify):______

Code 2
1=kg dried seed
2=kg fresh seed
3= pieces
4=Other (specify):

Code 3
1= More
2= Same
3= Less

090 Sales of annual and perennial crops

The output for each crop needs to be transferred into the units in brackets (Code 2)

				If yes:					If no:
Crop Code 1	How much did you produce during the last 12 months?	Unit Code 2	Did you sell any of this production? 1= yes, 0= no	How much did you sell during the last 12 months?	Price received Rp.	Price received per unit Rp/unit	Transportation costs from homestead to market Rp.	Costs involved in selling the whole harvest Rp.	How much would you have to pay at the market for the same quality of the product per unit? Rp./unit

Code 1
1=Padi Sawah (kg)
2= Padi Ladang beras
3= padi tadah hujan
4= Maize on the cob, tongkol (kg)
5= peanuts
6= Cassava
7= Beans
8= other veggies(write)..............
9= other annual crop

10=Cacao
11= Coffee
12= Coconuts
13= Cloves
14=Bananas
15=Fruit trees
16= Jati Putih
17= Gamal
18= Vanille
19= Kemiri
20= Other tree 1(specify)………
21= Other tree 2 (specify)………
22= Other tree 3 (specify)……..

23= Kernel Maize, pipilan
24= Fodder Maize, hijauran(kg)

Code 2
1=kg
2=litres
3=Bags
4=Blek
5= Ikat
6= pieces
7=Tundun
8=Other (specify):

095 Labour usage for crop production

096 Padi Sawah: Keperluan modal dan tenaga kerja untuk musim tertentu

Activity	Type of labour*	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sep	Okt	Nov	Des	Hire labour? (circle)	Take credit? (circle)
Penyiapan lahan	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pesemaian	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pencabutan (bundle)	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Penanaman (plant)	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pemupukan	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Penyiangan	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pen-yemprotan	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
Panen	**P**													Ya Tdk	Ya Tdk
	W														
	O-hari														
	P													Ya Tdk	Ya Tdk
	W														
	O-hari														

*** P = Pria; W = Wanita, O-hari = Orang- hari**

097 Maize: Keperluan modal dan tenaga kerja untuk musim tertentu (only for maize harvested in kg)

Activity	Type of labour*	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sep	Okt	Nov	Des	Hire labour? (circle)	Take credit? (circle)
Penyiapan lahan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Penanaman	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pemupukan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Penyiangan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pen-yemprotan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Panen	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
	P													Ya Tdk	Ya Tdk
	W														
	O-hari														

*** P = Pria; W = Wanita, O-hari = Orang-hari**

098 Cacao: Keperluan modal dan tenaga kerja untuk musim tertentu

Activity	Type of labour*	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agu	Sep	Okt	Nov	Des	Hire labour? (circle)	Take credit? (circle)
Pe-mupukan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Pen-yemprotan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Perawatan	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
Panen	P													Ya Tdk	Ya Tdk
	W														
	O-hari														
	P													Ya Tdk	Ya Tdk
	W														
	O-hari														

*** P = Pria; W = Wanita, O-hari = Orang-hari**

100 Daily Activities

101 On an average day, what are the different activities you do apart from sleeping? (do not read, circle)

A= spend time with family
B= spend time with friends
C= religious activities
D=agricultural production for home consumption
E= agricultural production for sales
F= collection of forest products
G= work as wage labourer
H= other paid work
I= watch TV
J= sport
K =Take a rest
L1 Other (specify)…………….
L2 Other (specify)…………….
L3 Other (specify)…………….

102 Which are your personal preferences usually for the mentioned activities above? Rank them according to importance (1= most important, highest number= least importance).

A	B	C	D	E	F	G	H	I	J	K	L1	L2	L3

Household ID Nr. ________

110. Forest products collected

011. Do you collect any forest any products from the forest? 1= yes 0= no (if no, skip to 120)

					If yes,		
Forest product	How often do you collect it? Code 1	Quantity collected	Unit Code 2	Do you also sell these products? 1= yes, 0= no	Percentage sold? (%)	Price per unit Rp.	Value received in last 12 months Rp.
Rattan							
Fire Wood							
Wood							
Bamboo							
Sugar palm							
Other (specify):							

Code 1 *1= Twice a week* *2= Weekly* *3= Fortnightly* *4= Monthly* *5= Every 6 months* *6= Every year* *7= Less frequently than yearly* *8= Never*

Code 2 *1= kg* *2= Log* *3= ikat* *4= cubic meter* *5= Other (specify)*

120. Capital owned

121. Have you had any savings in money or in kind in the last 12 months?	1= Yes 0= No (If no, skip to 124)
102. How much money did you save during the last 12 months?	……………………….Rp
123. How much did you spend on purchases of valuables in kind (gold or land) in the last 12 months?	___________________ Rp.
124. Did you sell any of your animals during the last 12 months?	1= Yes 0= No (If no, skip to 130)
125. How much did you earn from the sales of animals?	Rp…………..
126. In comparison to the last 12 months, how much did you earn from sales of animals in 2004? (circle)	1= More 2= The same 3= Less

130. Credit obtained

131. Have you borrowed or received a credit in the last 2 years? 1= yes 0= no (if no, skip to 135, don't ask 136)

Credit source	132 How much have you borrowed from the following sources? Rp.	133 When did you receive the credit? Month/year	134 How much do you owe at present? Rp.	135 What do you think is the maximum amount of money you and your family can borrow at present if you really need money in case of an emergency from these sources? Rp.
a) Bank		______/______		
b) Government Credit programme		______/______		
c) Credit group		______/______		
d) Shopkeeper/trader in the village		______/______		
e) Shopkeeper/trader outside the village		______/______		
f) Relatives in the village		______/______		
g) Friends in the village		______/______		
h) Other person in the village		______/______		
i) Other person outside the village		______/______		

136 What did you use the loan for? (don't read, can be more than one answer, circle)	*1= food*	*4= herbicides*	*7= pesticides*	*10= positive event*	*13= harvesting*
	2= health	*5= rent land*	*8= fertiliser*	*11= transportation*	*14= seeds /young plants*
	3= education	*6= land preparation*	*9= labour payment*	*12= agricultural equipment*	*15= other (specify)* ________________

140. Possession of assets

141. Do you own any of the following assets?

Type of asset	How many do you own? Last survey	current survey	Which year did you buy/own it/ them?	Estimate current sales value using method 1. Ask for current sales value 2. If sale is impossible ask about the costs to replace it	
				Method	Value in Rp.
a) Buffaloes					
b) Bulls and cows					
c) Pigs and goats					
d) Chicken					
e) Any building outside lahan pekarangan					
f) Mobil					
g) Sepeda motor					
h) Bicycle					
i) Other vehicle (boat)					
j) Carts/trailors					
k) Radio					
l) TV					
m) Satellite dish					
n) VCD/tape player					
o) Gas cookers					
p) Kerosene cooker					
q) Fans					
r) Knapsack sprayer					
s) Water pump					
t) Motor plough					
u) Husking machine					
v) House with content					

142. Do you own any other assets not mentioned in 141? 1= Yes 0= No

143. If yes, specify:

Type of asset	How many do you own?	Which year did you buy it/ them?	Estimate current sales value using method 1. Ask current sales value 2. If sale is impossible ask about the costs to replace it	
			Method	Value in Rp.
w)				
x)				

Thank you very much for your assistance and for your time helping to answer the questionnaire.

Interviewer comments:

Signature of interviewer: ____________________________________

Appendix II: Pictures taken during Interviews

Figure II.1. Pipin conducting an interview in Lempelero

Figure II.2. Rifai conducting an interview in Kapiroe

Figure II.3. Sumarno conducting an interview in Sintuwu

Appendix III: Graphical Presentation of the Four Agroforestry Systems

These illustrations were used in the interviews for the farmers to identify their cacao plot.

Source: Harry Wibowo

Figure III.1. Agroforestry System D

Figure III.2. Agroforestry System E

Figure III.3. Agroforestry System F

Figure III.4. Agroforestry System G

Appendix IV: Outline of Structure for Focus Group Meetings

1. Drawing a map of village and surroundings, of the forest, NP, hutan produksi etc., different zones, which area KKM applies to etc.
   Everybody should be drawing, and explain where specific zones are etc.

IRA

2. KKM – what? If you think about KKM, what are economic, environmental and social issues of the KKM?

They should write only the main idea/word on the card. S & I put them on the wall randomly. The order them according to groups /topics:

SUMARNO

3. Divide ideas/activities into topics: institution, participation, education, monitoring, preservation, status of the nature, illegal resource extraction, environmental impact and economic impact — Add ideas from list if necessary

a) Environmental impact	b) Social impact	c) Economic impact
Amount of rattan collection	Land rights acceptance	Penalty for rattan collection
Amount of illegal logging	Distribution of land	Penalty for illegal logging
Knowledge in village with respect to NP	Capacity building for villagers	Amount of cacao plantations
Forest (NP) monitoring by polisi hutan	Participation of all villagers	Income possibilities
Amount of flooding, erosion	Existing organisations abilities/ powers	Economic activity shifting
Rattan collection/illegal logging in non-NP forest	New organisations evolved?	
Amount of animals	Enforcement of rules	
Water pollution	Who has lost out?	

Before KKM /after KKM – give +++ or ----

IRA

4. Carbon sequestration – explain logic of payments
   - **Avoided deforestation**: need for complete protection, village institution enforcing rules & sanctions
   Participation of entire village
   - **Agroforestry**: contract for not cutting trees, but harvest allowed
   Cacao trees with old original forest trees receive higher payment
   SUMARNO

Appendix V: Pictures taken during Focus Groups

Figure V.1. Focus Group in Wuasa

Figure V.2. Focus Group in Langko

Figure V.3. Focus Group in Salua

Appendix VI: Monthly Labour Requirements per Household Class and Activity

	D				E			
	Sawah	**Ladang**	**Maize**	**Cacao**	**Sawah**	**Ladang**	**Maize**	**Cacao**
January	17.6	21.3		3.5		21.3	16.0	4.8
February	2.0	24.9		11.0		24.9	16.0	4.8
March	0.0	92.5		9.1	42.7	92.5	40.4	4.8
April				4.5	1.3			5.3
May				5.4	9.3			14.2
June				1.8	14.0			14.2
July				10.5	42.8		9.6	11.8
August		56.4		13.4	19.0	56.4	23.2	4.8
September	38.7	44.9		3.7	11.3	44.9	16.0	4.8
October	11.2	45.3		4.5	0.9	45.3	16.0	4.8
November	19.8	56.0		4.0	23.6	56.0	16.0	14.2
December	0.0	10.7		4.7		10.7	16.0	9.8
TOTAL	**89.2**	**352.1**		**76.1**	**164.9**	**352.1**	**169.2**	**97.7**

	F				G			
	Sawah	**Ladang**	**Maize**	**Cacao**	**Sawah**	**Ladang**	**Maize**	**Cacao**
January		60.0	12.0	9.5				10.5
February	7.0	40.5	48.0	7.5	7.0			9.4
March		81.0		14.2				9.4
April	16.0			14.2	16.0			10.5
May	19.0			7.5	19.0			18.0
June	37.0			9.5	37.0			9.4
July	12.0			10.4	12.0			9.4
August	1.0	101.0		7.5	1.0		13.3	10.2
September	32.0	61.0		14.2	32.0		4.0	9.9
October			24.0	14.2			40.0	9.4
November		28.0	12.0	7.5			16.0	16.9
December	41.0		12.0	9.9	41.0			11.3
TOTAL	**165.0**	**371.5**	**108.0**	**126.1**	**165.0**		**73.3**	**133.9**

Appendix VII: Linear Programming Models

All matrices are for scenario 2, with a discount rate of 10% and a CER of €12 per tCO_2e

Table V.1 Linear Programming Model Household Type D

Activities	*Sawah*	*Padi ladang*	*Maize*	*Cacao D*	*Cacao E*	*Cacao F*	*Cacao G*	*Cacao Dnew*	*Cacao Enew*	*Cacao Fnew*	*Cacao Gnew*	*Forest to Coc D*	*Forest to Coc E*	*Forest to Coc F*	*Forest to Coc G*	*Hired Labour*			*RHS*
Objective values (GM 000 IDR/ha)	2.114	832	2.264	1.187	2.469	2.170	7.009	1.187	2.459	2.140	6.989	66	87	153	197	-437			
Constraints																			
Land (ha)																			
January	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,52	<=	2,52
February	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,52	<=	2,52
March		1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,45	<=	2,52
April				1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,33	<=	2,52
May				1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,33	<=	2,52
June				1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,33	<=	2,52
July				1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,33	<=	2,52
August		1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,45	<=	2,52
September	1	1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,52	<=	2,52
October	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,52	<=	2,52
November	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,52	<=	2,52
December		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,45	<=	2,52
Forest Conversion Cacao D				1				1				-1					1,36	≥	0,00
Forest Conversion Cacao E					1				1				-1				0,94	≥	0,00
Forest Conversion Cacao F						1				1				-1			0,00	≥	0,00
Forest Conversion Cacao G							1				1				-1		0,04	≥	0,00
Land restrictions																			
Minimum sawah prodn (ha)	1																0,07	≥	0,07
Minimum padi prodn (ha)		1															0,11	≥	0,11
miminum maize prodn (ha)			1														0,00	≥	0,00
D-restriction				1				1									1,56	≥	0,59
E-restriction					1				1								0,94	≥	0,00
F-restriction						1				1							0,00	≥	0,25
G-restriction							1				1						0,04	≥	0,00
Deforestation												1	1	1	1		0,20	<=	0,20
MaxRes D				1													0,00	<=	1,56

MaxRes E					1												0,94	<=	0,94
MaxRes F						1											0,00	<=	0,00
MaxRes G							1										0,04	<=	0,04
Labour (mandays per month)																			
January	17,6	21,3	12,0	3,5	4,8	9,5	10,5	3,5	5,2	10,8	11,3	1,3	1,7	2,9	3,8	-1	14,25	<=	32,40
February	2,0	24,9	48,0	11,0	4,8	7,5	9,4	11,0	5,2	8,8	10,2	1,3	1,7	2,9	3,8	-1	25,17	<=	32,40
March		92,5		9,1	4,8	14,2	9,4	9,1	5,2	15,5	10,2	1,3	1,7	2,9	3,8	-1	29,84	<=	32,40
April				4,5	5,3	14,2	10,5	4,5	5,7	15,5	11,3	1,3	1,7	2,9	3,8	-1	12,58	<=	32,40
May				5,4	14,2	7,5	18,0	5,4	14,6	8,8	18,8	1,3	1,7	2,9	3,8	-1	22,61	<=	32,40
June				1,8	14,2	9,5	9,4	1,8	14,6	10,7	10,2	1,3	1,7	2,9	3,8	-1	16,73	<=	32,40
July				10,5	11,8	10,4	9,4	10,5	12,2	11,7	10,2	1,3	1,7	2,9	3,8	-1	27,96	<=	32,40
August		56,4		13,4	4,8	7,5	10,2	13,4	5,2	8,8	11,0	1,3	1,7	2,9	3,8	-1	32,40	<=	32,40
September	38,7	44,9		3,7	4,8	14,2	9,9	3,7	5,2	15,5	10,7	1,3	1,7	2,9	3,8	-1	18,68	<=	32,40
October	11,2	45,3	24,0	4,5	4,8	14,2	9,4	4,5	5,2	15,5	10,2	1,3	1,7	2,9	3,8	-1	18,05	<=	32,40
November	19,8	56,0	12,0	4,0	14,2	7,5	16,9	4,0	14,6	8,8	17,7	1,3	1,7	2,9	3,8	-1	28,20	<=	32,40
December		10,7	12,0	4,7	9,8	9,9	11,3	4,7	10,2	11,2	12,1	1,3	1,7	2,9	3,8	-1	18,31	<=	32,40
Capital (misc costs VC/ha 000IDR)	3.907	59	660	0	82	74	311	0	92	104	331	30	40	70	90	437	380	<=	380
Solution	**0,07**	**0,11**	**0,00**	**0,00**	**0,94**	**0,00**	**0,04**	**1,56**	**0,00**	**0,00**	**0,00**	**0,20**	**0,00**	**0,00**	**0,00**	**0,00**	**1,16**		**4.691**

Table V.2 Linear Programming Model Household Type E

Activities	*Sawah*	*Padi ladang*	*Maize*	*Cacao D*	*Cacao E*	*Cacao F*	*Cacao G*	*Cacao Dnew*	*Cacao Enew*	*Cacao Fnew*	*Cacao Gnew*	*Forest to Coc D*	*Forest to Coc E*	*Forest to Coc F*	*Forest to Coc G*	*Hired Labour*			*RHS*
Objective values (GM 000 IDR/ha)	4.310	1.446	1.188	1.453	4.488	8.696	7.009	1.453	4.478	8.666	6.989	66	87	153	197	-437			
Constraints																			
Land (ha)																			
January		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,74	<=	2,81
February		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,74	<=	2,81
March	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,81	<=	2,81
April	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,58	<=	2,81
May	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,58	<=	2,81
June	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,58	<=	2,81
July	1		1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,69	<=	2,81
August	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,81	<=	2,81
September	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,81	<=	2,81
October	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,81	<=	2,81
November	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,81	<=	2,81
December		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,74	<=	2,81
Forest Conversion Cacao D				1				1				-1					0,00	≥	0,00
Forest Conversion Cacao E					1				1				-1				0,00	≥	0,00
Forest Conversion Cacao F						1				1				-1			0,77	≥	0,00
Forest Conversion Cacao G							1				1				-1		1,74	≥	0,00
Land restrictions																			
Minimum sawah prodn (ha)	1																0,07	≥	0,07
Minimum padi prodn (ha)		1															0,11	≥	0,11
miminum maize prodn (ha)			1														0,12	≥	0,12
D-restriction				1				1									0,00	≥	0,24
E-restriction					1				1								0,06	≥	0,23
F-restriction						1				1							0,77	≥	0,29
G-restriction							1				1						1,74	=	0,00
Deforestation												1	1	1	1		0,06	<=	0,20
MaxRes D				1													0,00	<=	0,00

MaxRes E					1												0,06	<=	0,06
MaxRes F						1											0,77	<=	0,77
MaxRes G							1										1,74	<=	1,74
Labour (mandays per month)																			
January		21,33	16,00	3,50	4,75	9,50	10,45	3,50	5,17	10,75	11,28	1,25	1,67	2,92	3,75	-1	13,74	<=	29,50
February		24,93	16,00	11,00	4,75	7,50	9,35	11,00	5,17	8,75	10,18	1,25	1,67	2,92	3,75	-1	10,70	<=	29,50
March	42,68	92,53	40,40	9,12	4,75	14,20	9,35	9,12	5,17	15,45	10,18	1,25	1,67	2,92	3,75	-1	29,50	<=	29,50
April	1,33			4,50	5,25	14,20	10,45	4,50	5,67	15,45	11,28	1,25	1,67	2,92	3,75	-1	13,18	<=	29,50
May	9,34			5,40	14,15	7,50	17,95	5,40	14,57	8,75	18,78	1,25	1,67	2,92	3,75	-1	22,12	<=	29,50
June	14,00			1,84	14,15	9,45	9,35	1,84	14,57	10,70	10,18	1,25	1,67	2,92	3,75	-1	9,03	<=	29,50
July	42,78		9,60	10,50	11,75	10,40	9,35	10,50	12,17	11,65	10,18	1,25	1,67	2,92	3,75	-1	12,79	<=	29,50
August	19,01	56,40	23,20	13,40	4,75	7,50	10,20	13,40	5,17	8,75	11,03	1,25	1,67	2,92	3,75	-1	17,97	<=	29,50
September	11,34	44,87	16,00	3,67	4,75	14,20	9,90	3,67	5,17	15,45	10,73	1,25	1,67	2,92	3,75	-1	19,91	<=	29,50
October	0,89	45,33	16,00	4,50	4,75	14,20	9,35	4,50	5,17	15,45	10,18	1,25	1,67	2,92	3,75	-1	18,27	<=	29,50
November	23,56	56,00	16,00	4,00	14,15	7,50	16,85	4,00	14,57	8,75	17,68	1,25	1,67	2,92	3,75	-1	29,50	<=	29,50
December		10,67	16,00	4,67	9,75	9,93	11,30	4,67	10,17	11,18	12,13	1,25	1,67	2,92	3,75	-1	14,62	<=	29,50
Capital (misc costs VC/ha 000IDR)	4.527	345	140	0	1.226	171	311	0	1.236	201	331	30	40	70	90	437	8.296	<=	8.296
Solution	**0,07**	**0,11**	**0,12**	**0,00**	**0,06**	**0,77**	**1,74**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,06**	**0,00**	**0,00**	**16,41**	**2,87**		**12.578**

Table V.3 Linear Programming Model Household Type F

Activities	*Sawah*	*Padi ladang*	*Maize*	*Cacao D*	*Cacao E*	*Cacao F*	*Cacao G*	*Cacao Dnew*	*Cacao Enew*	*Cacao Fnew*	*Cacao Gnew*	*Forest to Coc D*	*Forest to Coc E*	*Forest to Coc F*	*Forest to Coc G*	*Hired Labour*			*RHS*
Objective values (GM 000 IDR/ha)	5.670	2.538	3.371	1.906	4.173	4.412	7.009	1.906	4.163	4.382	6.989	66	87	153	197	-437			
Constraints																			
Land (ha)																			
January		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,71	<=	2,84
February	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,84	<=	2,84
March		1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,46	<=	2,84
April	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,56	<=	2,84
May	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,56	<=	2,84
June	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,56	<=	2,84
July	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,56	<=	2,84
August	1	1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,59	<=	2,84
September	1	1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,59	<=	2,84
October			1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,67	<=	2,84
November		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,71	<=	2,84
December	1		1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,80	<=	2,84
Forest Conversion Cacao D				1				1				-1					0,00	≥	0,00
Forest Conversion Cacao E					1				1				-1				0,00	≥	0,00
Forest Conversion Cacao F						1				1				-1			1,05	≥	0,00
Forest Conversion Cacao G							1				1				-1		1,38	≥	0,00
Land restrictions																			
Minimum sawah prodn (ha)	1																0,13	≥	0,05
Minimum padi prodn (ha)		1															0,04	≥	0,04
miminum maize prodn (ha)			1														0,25	≥	0,12
D-restriction				1				1									0,00	≥	0,00
E-restriction					1				1								0,00	≥	0,45
F-restriction						1				1							1,05	≥	0,58
G-restriction							1										1,38	≥	0,00
Deforestation												1	1	1	1		0,00	<=	0,20
MaxRes D				1													0,00	<=	0,00

MaxRes E					1												0,00	<=	0,00
MaxRes F						1											1,05	<=	1,05
MaxRes G							1										1,38	<=	1,38
Labour (mandays per month)																			
January		60,00	12,00	3,50	4,75	9,50	10,45	3,50	5,17	10,75	11,28	1,25	1,67	2,92	3,75	-1	28,91	<=	34,40
February	7,00	40,50	48,00	11,00	4,75	7,50	9,35	11,00	5,17	8,75	10,18	1,25	1,67	2,92	3,75	-1	34,40	<=	34,40
March		81,00		9,12	4,75	14,20	9,35	9,12	5,17	15,45	10,18	1,25	1,67	2,92	3,75	-1	30,15	<=	34,40
April	16,00			4,50	5,25	14,20	10,45	4,50	5,67	15,45	11,28	1,25	1,67	2,92	3,75	-1	30,68	<=	34,40
May	19,00			5,40	14,15	7,50	17,95	5,40	14,57	8,75	18,78	1,25	1,67	2,92	3,75	-1	34,40	<=	34,40
June	37,00			1,84	14,15	9,45	9,35	1,84	14,57	10,70	10,18	1,25	1,67	2,92	3,75	-1	27,00	<=	34,40
July	12,00			10,50	11,75	10,40	9,35	10,50	12,17	11,65	10,18	1,25	1,67	2,92	3,75	-1	24,66	<=	34,40
August	1,00	101,00		13,40	4,75	7,50	10,20	13,40	5,17	8,75	11,03	1,25	1,67	2,92	3,75	-1	25,21	<=	34,40
September	32,00	61,00		3,67	4,75	14,20	9,90	3,67	5,17	15,45	10,73	1,25	1,67	2,92	3,75	-1	34,40	<=	34,40
October			24,00	4,50	4,75	14,20	9,35	4,50	5,17	15,45	10,18	1,25	1,67	2,92	3,75	-1	32,97	<=	34,40
November		28,00	12,00	4,00	14,15	7,50	16,85	4,00	14,57	8,75	17,68	1,25	1,67	2,92	3,75	-1	34,40	<=	34,40
December	41,00		12,00	4,67	9,75	9,93	11,30	4,67	10,17	11,18	12,13	1,25	1,67	2,92	3,75	-1	33,69	<=	34,40
Capital (misc costs VC/ha 000IDR)	3.760	1.172	1.172	15	228	111	311	25	238	141	331	30	40	70	90	437	1.681	<=	11.682
Solution	0,13	0,04	0,25	0,00	0,00	1,05	1,38	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,69	2,84		15.650

Table V.4 Linear Programming Model Household Type G

Activities	*Sawah*	*Padi ladang*	*Maize*	*Cacao D*	*Cacao E*	*Cacao F*	*Cacao G*	*Cacao Dnew*	*Cacao Enew*	*Cacao Fnew*	*Cacao Gnew*	*Forest to Coc D*	*Forest to Coc E*	*Forest to Coc F*	*Forest to Coc G*	*Hired Labour*			*RHS*
Objective values (GM 000 IDR/ha)	2.735	1.605	2.232	1.906	6.628	3.848	16.948	1.906	6.618	3.818	16.928	66	126	220	283	-437			
Constraints																			
Land (ha)																			
January		1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		1,89	<=	2,39
February	1	1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,02	<=	2,39
March		1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		1,89	<=	2,39
April	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,02	<=	2,39
May	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,02	<=	2,39
June	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,02	<=	2,39
July	1			1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,02	<=	2,39
August	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,39	<=	2,39
September	1	1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,39	<=	2,39
October		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,26	<=	2,39
November		1	1	1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,26	<=	2,39
December	1	1		1	1	1	1	1	1	1	1	-1	-1	-1	-1		2,02	<=	2,39
Forest Conversion Cacao D				1				1				-1					0,00	≥	0,00
Forest Conversion Cacao E					1				1				-1				0,00	≥	0,00
Forest Conversion Cacao F						1				1				-1			0,00	≥	0,00
Forest Conversion Cacao G							1				1				-1		1,89	≥	0,00
Land restrictions																			
Minimum sawah prodn (ha)	1																0,13	≥	0,13
Minimum padi prodn (ha)		1															0,00	≥	0,00
miminum maize prodn (ha)			1														0,38	≥	0,38
D-restriction				1				1									0,00	≥	0,00
E-restriction					1				1								0,00	≥	0,33
F-restriction						1				1							0,00	≥	0,00
G-restriction							1				1						2,00	≥	0,79
Deforestation												1	1	1	1		0,11	<=	0,20
MaxRes D				1													0,00	<=	0,00

MaxRes E					1												0,00	<=	0,00
MaxRes F						1											0,00	<=	0,00
MaxRes G							1										2,00	<=	2,00
Labour (mandays per month)																			
January		21,33		3,50	4,75	9,50	10,45	3,50	5,17	10,75	11,28	1,25	1,67	2,92	3,75	-1	12,80	<=	31,60
February	7,00	24,93		11,00	4,75	7,50	9,35	11,00	5,17	8,75	10,18	1,25	1,67	2,92	3,75	-1	11,51	<=	31,60
March		92,53		9,12	4,75	14,20	9,35	9,12	5,17	15,45	10,18	1,25	1,67	2,92	3,75	-1	10,60	<=	31,60
April	16,00			4,50	5,25	14,20	10,45	4,50	5,67	15,45	11,28	1,25	1,67	2,92	3,75	-1	14,89	<=	31,60
May	19,00			5,40	14,15	7,50	17,95	5,40	14,57	8,75	18,78	1,25	1,67	2,92	3,75	-1	30,27	<=	31,60
June	37,00			1,84	14,15	9,45	9,35	1,84	14,57	10,70	10,18	1,25	1,67	2,92	3,75	-1	15,43	<=	31,60
July	12,00			10,50	11,75	10,40	9,35	10,50	12,17	11,65	10,18	1,25	1,67	2,92	3,75	-1	12,17	<=	31,60
August	1,00	56,40	13,33	13,40	4,75	7,50	10,20	13,40	5,17	8,75	11,03	1,25	1,67	2,92	3,75	-1	17,43	<=	31,60
September	32,00	44,87	3,99	3,67	4,75	14,20	9,90	3,67	5,17	15,45	10,73	1,25	1,67	2,92	3,75	-1	17,37	<=	31,60
October		45,33	39,99	4,50	4,75	14,20	9,35	4,50	5,17	15,45	10,18	1,25	1,67	2,92	3,75	-1	25,60	<=	31,60
November		56,00	16,02	4,00	14,15	7,50	16,85	4,00	14,57	8,75	17,68	1,25	1,67	2,92	3,75	-1	31,60	<=	31,60
December	41,00	10,67		4,67	9,75	9,93	11,30	4,67	10,17	11,18	12,13	1,25	1,67	2,92	3,75	-1	19,85	<=	31,60
Capital (misc costs VC/ha 000IDR)	4.907	525	668	15	1.100	246	972	25	1.110	276	992	30	40	70	90	437	6.569	<=	6.569
Solution	**0,13**	**0,00**	**0,38**	**0,00**	**0,00**	**0,00**	**2,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,11**	**8,52**	**2,50**		**31.386**

Appendix VIII: Overview of Ratings of all Topics in Focus Groups

	Langko				Kapiroe				Salua				Wuasa			
	DM		V		DM		V		DM		V		DM		V	
	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A
Institution	3	3	3	1	-2	1	-2	1	2	3	1	2	-1	1	-1	1
Participation	3	3	-1	1	1	2	-1	1	.	.	1	2	-1	1	-2	1
Education	2	3	1	2	1	2	-1	1	1	3	-2	-1	.	.	-2	2
Monitoring	2	3	-2	2	-1	1	-1	1	2	3	1	2	-3	1	1	2
Preservation	2	3	2	1	2	2	-1	-1	1	-1	3	1	-2	-1	3	2
Resource Extraction	2	3	-2	1	-1	1	-2	1	1	3	1	2	-3	1	-2	1
Rattan	3	3	2	1	-2	-1	-2	1	-1	2	.	.	-1	2	.	.
Cacao	2	2	3	3	.	.	.	.	1	-1	2	-1	1	-2	.	.
Environmental Impact	1	2	3	-2	-1	-1	2	1	-1	3	2	3	3	-3	3	2
Economic	.	.	-2	2	.	.	2	1	.	.	.	.	2	2	1	1

DM= Decision Makers, V= Villagers; B= Before, A= After