WORKING PAPER

Opportunities for implementing REDD+ to enhance sustainable forest management and improve livelihoods in Lombok, NTB, Indonesia

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Forest of Mountain Rinjani, North Lombok, Indonesia

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Abbreviations

A/R CDM	Clean Development Mechanism for Afforestation and Reforestation
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Development Planning Board)
BAU	business as usual
CDM	Clean Development Mechanism
CIFOR	Center for International Forestry Research
DBH	diameter at breast height
DNPI	Dewan Nasional Perubahan Iklim (National Council on Climate Change)
ETM+	enhanced thematic mapper plus
FAO	Food and Agriculture Organization of the United Nations
FGD	focus group discussion
GDP	gross domestic product
GG	*gouvernement grond* (government lands)
GHG	greenhouse gases
HA	*hutan adat* (customary forest)
HD	*hutan desa* (village forest)
HDI	Human Development Index
HH	household
HKm	*hutan kemasyarakatan* (community forest)
HL	*hutan lindung* (protected forest)
HP	*hutan produksi* (production forest)
HPH	*hak pengusahaan hutan* (forest enterprises)
HPHH	*hak pemungutan hasil hutan* (forest harvest rights)
HR	*hutan rakyat* (public forest)
HTI	*hutan tanaman industri* (industrial forest plantation)
HTR	*hutan tanaman rakyat* (community plantation forest)
IPCC	Intergovernmental Panel on Climate Change
KPH	*kesatuan pengelolaan hutan* (forest management unit)
KPHL	*kesatuan pengelolaan hutan lindung* (protected forest management unit)
KPHL RB	*kesatuan pengelolaan hutan lindung Rinjani Barat* (West Rinjani protected forest management unit)
KOICA	Korea International Cooperation Agency
MRV	measurement, reporting and verification
MSS	Landsat multispectral scanner
NGO	nongovernmental organization
NTB	Nusa Tenggara Barat (West Nusa Tenggara)
PES	payments for ecosystem services
PRA	participatory rural appraisal
REDD	Reducing Emissions from Deforestation and Forest Degradation
REDD+	REDD and conservation and sustainable management of forests and enhancement of forest carbon stocks in developing countries

REL	reference emission level
TGHK	*tata guna hutan kesepakatan* (consensus forest-use plan)
TM	Landsat thematic mapper
UNFCCC	United Nations Framework Convention on Climate Change
VCS	Verified Carbon Standard
WRS	worldwide reference system
WWF	World Wildlife Fund

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Preface

REDD+ refers to a newly established mechanism that aims to reduce greenhouse gas emissions from deforestation and forest degradation, and includes conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries; it enables developed countries to financially support REDD+ activities in developing countries through sustainable forest management. The Intergovernmental Panel on Climate Change (IPCC) has determined that REDD+ can be a very cost-effective policy option for mitigating climate change, with potential economic, social and other environmental co-benefits, if implemented sustainably. Reducing forest loss could therefore contribute to climate change mitigation, biodiversity conservation, and improved livelihoods for local communities.

However, in order to effectively implement REDD+ in developing countries, a number of constraints must be addressed. First, forest managers must develop the skills and methods to identify land-use change and estimate carbon stock change over time. Local technical capacity remains limited, and significant challenges remain in working effectively with forest margin communities and other local stakeholders. Developing effective forest governance and institutions is a critical aspect of designing and implementing successful REDD+ projects, as is the commitment to provide adequate and sustained financial support. In Indonesia, the development of more localized forest management units (KPHs) represents a promising opportunity to address these challenges.

The Korea Forest Research Institute (KFRI), together with the Center for International Forestry Research (CIFOR), Northern Arizona University (NAU), the University of Arizona, and the University of Mataram in Indonesia, have completed a REDD feasibility study on the island of Lombok, Indonesia, where there are high poverty rates, rapid population growth and complex social dynamics. This study was completed using the five essential elements: (1) identification of land-use changes, (2) estimation of average carbon stocks in forests and shrubland, (3) socioeconomic surveys to identify drivers of deforestation and forest degradation, (4) estimation of future reference emission levels, and (5) developing alternatives to reduce the rates of deforestation and forest degradation.

We hope the results of this study provide important insights for REDD+ implementation for scientists, policy makers, practitioners, and local communities as they work together in planning and implementing REDD+ projects.

Lombok KPH REDD Research Team

1. Introduction

The world's forests decreased at a rate of 8.3 million ha per year during 1990–2000. Although the annual net forest loss decreased to 4.8 million ha during 2000–2005, it rose again to 5.6 million ha during 2005–2010 (FAO 2010). During 2005–2010, the area of tropical forest decreased rapidly in several developing countries, including Brazil (2,194,000 ha annual loss), Indonesia (685,000 ha), and Nigeria (410,000 ha); in Australia, severe drought and forest fires have exacerbated the loss of forest since 2000 (FAO 2010). Brazil and Indonesia together accounted for 52% of the world's net loss of forest during this same period. Especially, decrease of primary forests is particular concern, accounting for 38% of the 15.79 million ha of forest cover loss for Indonesia for the period 2000–2012 (Hansen et al. 2013). This forest loss has contributed significantly to greenhouse gas (GHG) emissions, with emissions from deforestation and decay of biomass accounting for approximately 17.4% (CO_2 equivalent) of the world's GHG emissions in 2004 (IPCC 2007a). The reversal of these trends of net tropical forest loss in developing countries would greatly contribute to mitigating climate change.

Reducing emissions from deforestation and forest degradation in developing countries (REDD) is a results-based mechanism currently under negotiation through the United Nations Framework Convention on Climate Change (UNFCCC). The REDD mechanism seeks to create financial value for reductions in emissions by offering incentives for developing countries to reduce emissions from forested lands and encourage investment in low-carbon paths to sustainable development (UN-REDD 2011). REDD+ extends beyond reducing deforestation and forest degradation to include the additional dimensions of conservation, sustainable forest management and enhancement of forest carbon stocks (UNFCCC 2010).

REDD+ activities were discussed under the UNFCCC as climate mitigation actions that would allow developing countries to be eligible to receive adequate and predictable financial and technical support from developed countries, as a reward for achieving real reductions in emissions (UNFCCC 2010). However, the eligibility of land use, land-use change and forestry activities under the Clean Development Mechanism (CDM) during the second commitment period (2013–2020) under the Kyoto Protocol does not include REDD+ activities (UNFCCC 2012). Since 2013, international negotiations under the UNFCCC have addressed REDD+ as a component of a new post-2020 climate change regime, instead of within the Kyoto Mechanism (UNFCCC 2012). The recent Warsaw REDD+ Framework clarified the structural design of REDD+ implementation, reducing uncertainties about the financial and technical support that developing countries can receive (UNFCCC 2012). A 2012 survey showed that many carbon market experts are optimistic that REDD+ credits will be permitted in California before 2020 and they will have equivalent status to the CDM under the UNFCCC umbrella by the same date (IETA 2012).

Indonesia features heavily in international discussions on REDD+ because its large expanse of tropical forest offers immense potential for reducing GHG emissions. In 2005, Indonesia was the third largest emitter of GHGs after the United States and China; approximately 85% of Indonesia's total GHG emissions are linked to land-use change and the forestry sector, including destruction of peatlands (Leitmann et al. 2009). The Indonesian Government has set an ambitious target for reducing the country's emissions: 26% below business-as-usual (BAU) levels by 2020, or 41% below BAU with international support (Norad 2011). According to this plan, more than 87% of Indonesia's total emission reduction target will be attributable to the forestry sector and peatlands (ROI 2011). Consequently, although REDD+ modalities and procedures have not yet been fully developed under the UNFCCC, Indonesia not only has the most REDD+ readiness and demonstration activities in the world (Cerbu et al. 2010), but it has also received the largest portion of REDD+ funding, through both multilateral and bilateral channels (Simula 2010). Indonesia has great potential to receive funding from the international community, and REDD+ funding would constitute a significant contribution. The estimated market value for avoided deforestation for Indonesia (US$108 million per year) exceeds the entire Ministry of Forestry budget (US$102 million) for 2005 (Niles et al. 2002; Phelps et al. 2010).

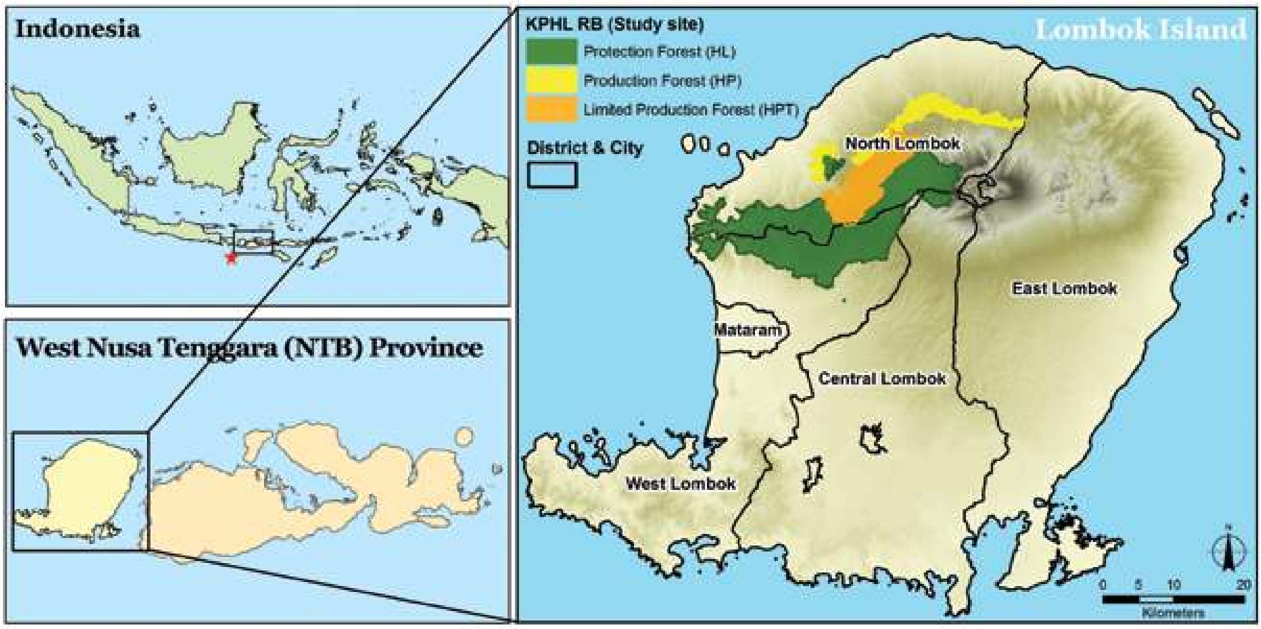

Figure 1.1 Location maps of the KPHL RB in NTB province, Indonesia

Due to the large forest reserves on Sumatra and Kalimantan, and their significant potential to reduce GHG emissions, more than two-thirds of the REDD+ projects conducted to date in Indonesia have occurred on these two islands. However, plans continue for expanded REDD+ programs through Indonesia's vast archipelago of more than 17,500 islands.

The work described in this paper focuses on the dynamics of deforestation and forest degradation on the island of Lombok, in West Nusa Tenggara (NTB) province (see Figure 1.1). We examine Lombok as a potential REDD site for several important reasons:

- NTB is an economically underdeveloped region that has the second-lowest Human Development Index (HDI)[1] nationally, ranked 32nd out of Indonesia's 33 provinces (CAS 2014). NTB is considered less favorable for developing REDD+ projects since it has relatively low forest cover, limited financial revenues from forestry activities, and insufficient human resources and management capacity. For this reason, we anticipate opportunities not only to conserve forests but also to strengthen the capacity of various stakeholders through REDD+ project development.
- The development of new and more localized forest management units (*kesatuan pengelolaan hutan* or KPH) in Indonesia provides a unique opportunity to work more closely with forest margin communities in understanding the dynamics of deforestation and forest degradation. The Indonesian government has underscored the KPH's role in achieving sustainable forest management at the local level, and particularly in mitigating climate change impacts. In principle, KPHs can have greater familiarity with local conditions (stakeholders, forest status, concession operations and regulatory standards) – an advantage that endows them with the potential to play a critical role in resolving land-use conflicts within and among forest margin communities, and ensures the legitimacy and effectiveness of forest carbon projects (BAPPENAS 2009). In 2012, the West Rinjani Protected forest Management Unit (KPHL RB) in Lombok was recognized as one of the most successful KPHs among the 481 KPHs in Indonesia.
- We also note the KPHL RB's high potential for reducing GHG emissions, given that the forests of Lombok have experienced historically high rates of deforestation (Bae et al. 2012). REDD+ projects have the potential for reducing a large proportion of GHG emissions on the island of Lombok.

1 The Human Development Index combines life expectancy, educational attainment and income into a composite indicator of development.

This paper explores opportunities for implementing REDD+ activities in the KPHL RB, with particular emphasis on the potential role of the KPH as an institutional partner in addressing the drivers of deforestation and forest degradation. In examining the feasibility for implementing REDD+ projects, we relied on five essential elements for our analysis (see Figure 1.2):

1. **Identification of land-use changes in both the reference region and project area.** As the term 'REDD' suggests, changes in deforestation and forest degradation must be clearly defined and quantified before initiatives to reduce these impacts are considered. Although a universal definition of 'forest' is still under debate (Sasaki and Putz 2009), we have chosen to follow general international guidelines, such as those established by IPCC and FAO, for assessing and monitoring human-induced carbon losses, in order to accurately and cost-effectively follow carbon stock changes over time (Guariguata et al. 2009). *Deforestation* is generally understood to include the long-term or permanent loss of forest cover (FAO 2002) or the direct human-induced conversion of forested land to non-forested land (UNFCCC 2001). *Forest degradation* is a reduction of the canopy cover or stocking within the forest (FAO 2000). However, precise distinctions between deforestation and forest degradation are difficult to measure through remote sensing analysis when it progresses temporarily, and it requires careful field assessment and direct monitoring. For example, a forest crown cover decrease from 60% to below 10% during a project period would be categorized as deforestation. But any forest loss of over 10% of crown cover would be categorized as forest degradation, because even with its reduction in net carbon stock, the forest still remains.

   The Verified Carbon Standard (VCS) requires identification of change in land use at least over 10 years. The IPCC (2006) suggests adopting six land use categories: forest land, cropland, grassland, settlements, wetlands and other land. Our research developed a land-use-change matrix of Lombok Island from 1990 to 2010 by analyzing Landsat imagery and classifying all land areas in accordance with these six landuse categories. We further classified forests into two major subcategories: primary forest and secondary forest, distinguishing these categories from shrubland, which often occurs after forest clear-cutting and in forest transition areas. Classifying shrubland as a distinct sub-class is unique to this study, based upon our analysis of the local context of landuse change. We categorized shrubland as a separate land use class, and noted the change from primary and secondary forest types into shrubland as the intermediate process of forest conversion to agricultural uses, identifying this change in both spatial and temporal dimensions.

2. **Estimation of average carbon stocks in forests and shrubland.** The IPCC (2006) recommends assessing forest carbon by evaluating carbon stocks in above- and belowground biomass, litter, deadwood and soil organic carbon. The assessment of biomass is generally a mandatory requirement for Afforestation/Reforestation Clean Development Mechanism (A/R CDM) and VCS. We determined a sample size for the survey of primary and secondary forests and shrubland, and developed a field survey manual, conducted training for KPH staff, and carried out forest inventory surveys in 45 sample plots to estimate forest carbon stock. Through this process, we obtained a quantitative assessment of carbon stocks for forests and shrublands within the KPHL RB.

3. **Socioeconomic surveys to identify drivers of deforestation and forest degradation**. Considerable discussions have focused on the direct and underlying drivers of deforestation (Angelsen 1995; Angelsen and Kaimowitz 1999; Geist and Lambin 2001). An understanding of local social and economic conditions, and livelihood strategies in forest margin communities is an essential element in assessing REDD+ project feasibility and readiness. Our socioeconomic research included an analysis of population census and other secondary data, as well as primary data collection in 14 administrative villages (*desa*) within the KPHL RB (Figure 6.1), using participatory rural appraisal (PRA) through focus group discussions and in-depth interviews with key informants, as well as household surveys. We used multiple methods to estimate the extent and degree of forest encroachment and to understand community forest-use dynamics that have contributed to deforestation and forest degradation.

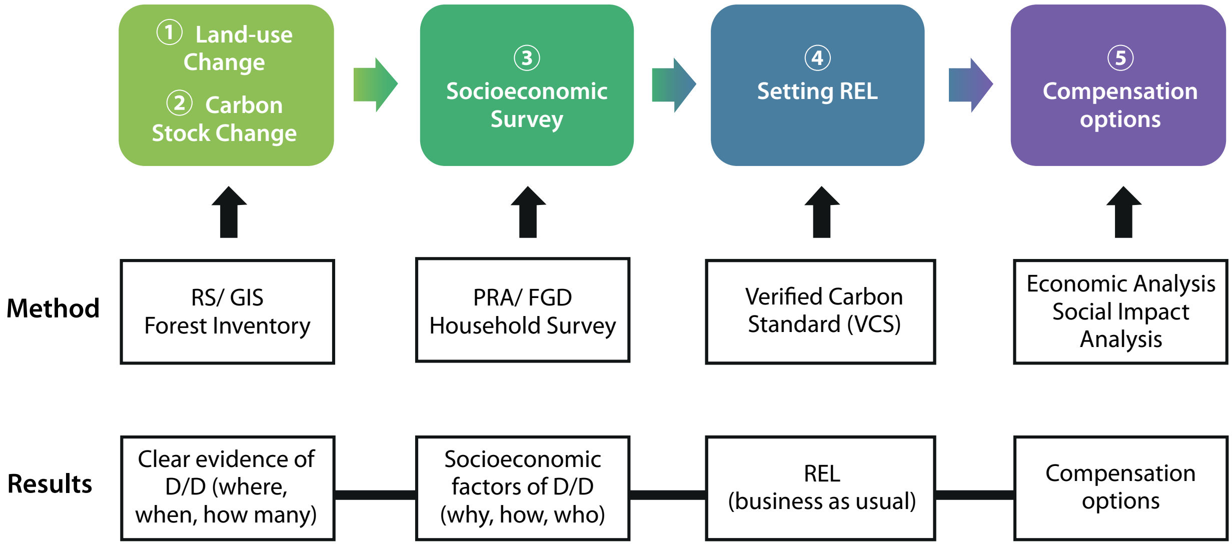

Figure 1.2 Five elements of REDD project analysis

Note: PRA (participatory rural appraisal), FGD (focus group discussion), REL (reference emission level)

Detection of land-use change, carbon stock change estimation, and socioeconomic surveys are complementary means for estimating and projecting carbon stock changes over time. Based on this deeper understanding of ecological and social changes in and around the KPHL RB, and in consultation with the KPHL RB and other local partners, we have proposed compensation options and policy alternatives for addressing deforestation and forest degradation.

4. **Establishment of future reference emission levels (REL).** For climate mitigation, simply reducing rates of deforestation and forest degradation is insufficient, since the amount of avoided emissions must be quantified and demonstrated. The reference emission level (REL) is the expected carbon emission rate from deforestation and forest degradation in the absence of interventions. Establishing a REL at the start of a project is necessary to determine what is being rewarded, how to measure success, and how to link project-level, subnational and national actions to international reporting (Ashton et al. 2009). We have generally followed VCS guidelines for estimating baseline carbon stock changes from unplanned frontier deforestation. We extrapolated future land-use changes based on population growth and projected new forest cultivation demand; we also projected carbon emissions from unsustainable fuelwood collection.

5. **Developing alternatives to reduce the rates of deforestation and forest degradation.** Based on lessons learned from other forest and biodiversity conservation projects, we have expanded the scope of analysis beyond the conventional definition of payments for ecosystem services (PES). We evaluated various options of rewards and co-investments for ecosystem services, which include developing more secure land-tenure schemes and encouraging alternative energy sources. The ongoing challenge for this final phase of the study is to determine how to promote effective and equitable forest governance practices, while ensuring efficient reduction of deforestation and forest degradation that is results-based.

The paper discusses each of these elements in turn. Chapter 2 offers a general description of forest conservation and development in Lombok, including demographics, geography, politics, economics and resources. Chapter 3 provides a general history of forest governance in Indonesia and in Lombok, with particular emphasis on the more recent introduction of the local KPHs. Chapter 4 presents our analysis of land-use changes in Lombok (Element #1), with a special focus on the KPHL RB, while Chapter 5 provides estimates of average carbon stocks in forests and shrublands (Element #2). In Chapter 6, we present the results of the socioeconomic surveys, examining the drivers of deforestation and forest degradation (Element #3). Chapter 7 assesses REL (Element #4), offers recommendations on alternative incentive and compensation schemes (Element #5) and discusses the challenges and opportunities in addressing deforestation and forest degradation in Lombok.

Our main objective in conducting this research has been to contribute to the growing body of experience and literature for developing sustainable and replicable approaches for promoting co-investment in environmental conservation, particularly in areas with complex social dynamics. We hope that our analysis – particularly the use of mixed research methods combining remote sensing analysis, field surveys, and both participatory and more conventional socioeconomic research methods – will yield important methodological insights for REDD+ researchers and practitioners. Our findings highlight the importance of strengthening local capacity to manage, monitor and provide incentives that reflect the social values of ecosystem services, including enhancing intermediaries' capacity for effective collaboration.

However, as we note in our conclusions, the most important lesson from this analysis is the pivotal role of the KPH as a viable forest governance structure for implementing these projects.

The KPHL RB was a key consideration in selecting the project area for this initial stage of the REDD+ feasibility study, and KPHL RB staff have been essential partners in sharing data and information, in conducting field research, and in consultations with local communities. In the land-use change and carbon stock change analysis, and in the participatory socioeconomic surveys, the KPHL RB provided leadership support and validation for the analysis, conclusions, and recommendations, based on their on-site knowledge, experience and relationships. The information presented here serves as an essential resource for the KPHL RB in establishing short- and long-term forest management plans, and the accumulated information from this research also provides the foundation for a long-term forest information management system.

Despite the significant contributions of the KPHL RB in West Lombok, and the high expectations for the role of KPHs in REDD+ implementation in Indonesia, the national capacity for KPHs to fulfill this role remains limited (Bae et al. 2014), and it is unrealistic to assume that the Indonesian Government can instantly address this need. Indonesia has committed to prioritizing the KPH system because it serves as a basic tool for building local capacity, improving working relationships with forest margin communities and other local stakeholders, and represents a more flexible and localized approach to forest governance. Nevertheless, a commitment to capacity building and adequate financial support are critical aspects in the early development of the KPH system. In particular, the national government must provide sufficient training and funding to enable the KPHs to implement their most basic tasks: forest inventory and forest management planning.

The national government can also help connect more advanced KPHs and REDD+ project developers by working to create and promote close working partnerships between REDD+ activities and the KPH. Finding reliable partners is a common and critical challenge for REDD+ project developers in Indonesia because, although the forests belong to the Indonesian government, much of the forest estate is managed by local jurisdictions, and by indigenous peoples and local communities through their customary laws. No specific regulations yet exist to guide the distribution of monetary and non-monetary benefits from REDD+ activities, and accessing information on forest resources in Indonesia remains challenging. In this context, the KPHs that oversee clearly defined forest areas can function as reliable partners for REDD+ project developers and the many affected local stakeholders. Development and implementation of REDD+ activities can also support the KPHs in fulfilling their fundamental tasks in relation to forest inventory and forest management planning. A collaboration of this nature, complemented by technical and financial support from developed countries, can help local KPHs gather more precise forest information and develop more effective forest management plans, and these survey results and plans will be valuable assets for future REDD+ projects.

2. Lombok: A general profile

Lombok is one of two main islands in the province of West Nusa Tenggara (NTB), sandwiched between Bali and the Lombok Strait in the west, and Sumbawa and the Alas Strait in the east (see Figure 2.1). Lombok's topography is dominated by the Mount Rinjani volcanic complex, located in the north-central part of the island and rising to 3726 m, making it the second highest volcano in Indonesia, and the nation's third highest mountain. Central Lombok is hilly, sloping to the relatively flat relief in the southern part of the island. The island is about 70 km across, with a total area of 4738 km^2 (BPS 2012).

Annual precipitation varies greatly by geography, ranging from 400 mm in the eastern and southern parts of the island, to 4250 mm in the west and north. Humidity is relatively high, averaging 81% (Idris et al. 2010, 2011; Fachry et al. 2011).

The 2010 Census reported the population of NTB province at 4.5 million, with 1.25 million households and an average of 3.59 family members per household (see Table 2.1). Seventy percent of NTB's population resides on the island of Lombok, although the island is only about a quarter of the province's total land area. Northern and western Lombok show generally lower population densities and higher forested areas than other parts of the island. Lombok's annual population growth rate decreased from 2.31% during 1971–1980 to 1.12% during 2000–2010[2] (this generally attributed to successful family planning and improved health service programs); however, the population of Lombok has continued to increase significantly during the last three decades, doubling from 1.6 million in 1971 to 3.2 million in 2010. Population growth rates are comparatively higher in West Lombok and Mataram City (see Table 2.2). Urban areas, in particular, have expanded dramatically during this time, increasing five-fold in NTB province (Fachry 2011).

Based on age classification, the population profile in NTB during 2000–2010 is dominated by children under the age of 14; gender distribution is somewhat evenly balanced, with slightly higher numbers of women (see Table 2.3).

Based on census figures for Lombok in 2010, more than 1.6 million people (51.8%) lived in rural areas (BPS 2012). The World Wildlife Fund (2006) reported that 600,000 people live in the upland areas surrounding Mount Rinjani and are dependent on forest resources for their livelihoods. With population growth rates at 1.7%, it is estimated that the pressure on these limited forest resources will continue to increase.

There are three major ethnic groups in NTB province, the Sasak, Samawa and Mbojo people, with additional populations of Balinese, Javanese and other migrants. Sasak is the indigenous and majority ethnic group on the island of Lombok, comprising more than 90% of residents, while Samawa and Mbojo people originate from neighboring Sumbawa Island. The traditional language of Lombok is Sasak, which is derived from Javanese and Balinese. More than 96% of Lombok's residents are Muslim (BPS 2012).

Lombok society remains strongly traditional, with deeply held cultural values and the continued active role of local institutions. Customary and community-based regulations (or *awiq-awiq*) remain an important aspect of social life, and while largely an oral tradition, continue to bind local community structure and tradition. In many communities, the *awiq-awiq* related to forest management are still upheld in protected customary forests (*hutan adat*).

Local leaders also retain strong influence within Lombok communities. In North Lombok, traditional *adat* leaders (such as *mangku*), continue to play an important role in society, while in other parts of Lombok, the religious leaders (or *tuan guru*) exercise strong influence. However, changing social and cultural values over the past few decades have brought new influences, particularly in terms of economic development. Despite these changes and the impact of the formal political structure, local culture and institutions still play an important role in the development of local and district regulations and social structure (Sukardi 2009; Fachry 2011).

2 These growth figures are below the provincial and national rates (1.17% and 1.47%, respectively).

Table 2.1 Population change on Lombok Island

District	1971	1980	1990	2000	2010
West Lombok	510,068	654,878	583,907*	665,749	599,986*
Central Lombok	477,262	576,910	678,746	745,578	860,209
East Lombok	594,725	725,340	865,283	973,296	1,105,582
North Lombok	-	-	-	-	200,072*
Mataram City	-	-	275,089	315,738	402,843
Lombok Island	1,582,055	1,957,128	2,403,025	2,700,361	3,168,692

* Mataram City and North Lombok district were separated from West Lombok in 1986 and 2008, respectively.

Sources: BPS 2012; Population Censuses 1971, 1990, 2000 and 2010 (Fachry et al. 2011)

Table 2.2 Annual population growth rate (%) of Lombok Island

District	1971–1980	1980–1990	1990–2000	2000–2010
West Lombok	2.80	2.75	1.40	1.50
Central Lombok	2.11	1.64	0.98	0.94
East Lombok	2.19	1.78	1.18	0.78
North Lombok			1.09	0.94
Mataram City			1.44	1.97
Lombok Island	2.31	2.01	1.17	1.12
NTB	2.36	2.15	1.34	1.17

Source: BPS (NTB Statistics 2011)

Table 2.3 Size, gender ratio, household and average family size of Lombok population in 2010

District	Population			Gender ratio*	Household	Family size
	Male	Female	Total			
West Lombok	293,528	306,458	599,986	95.78	168,813	3.55
Central Lombok	407,079	453,130	860,209	89.84	259,968	3.35
East Lombok	515,148	590,434	1,105,582	87.25	324,424	3.41
North Lombok	98,667	101,405	200,072	97.30	55,546	3.60
Mataram City	199,332	203,511	402,843	97.95	110,184	3.66
Lombok Island	1513,754	1654,938	3,168,692	91.47	918,935	3.46
NTB	2183,646	2316,566	4,500,212	94.26	1,252,581	3.59

* Gender ratio = number of males per 100 females

Source: BPS 2012

NTB province is administratively divided into eight districts (*kabupaten*), two cities, 116 sub-districts (*kecamatan*), and 1117 villages (*desa*), while Lombok consists of four districts and one metropolitan area (Mataram City). Prior to 1986, Lombok was divided into three districts: West Lombok (Lombok Barat), Central Lombok (Lombok Tengah) and East Lombok (Lombok Timur). Mataram City was separated from West Lombok in 1986, and in 2008 West Lombok district was further divided to establish the district of North Lombok. The current number of sub-districts and villages in Lombok is 53 and 592, respectively (NTB Statistics 2012).

NTB province ranked the second lowest among 33 provinces in Indonesia in the Human Development Index (HDI). The lowest HDI in Lombok was in North Lombok district: 57.79 in 2008, rising slightly to 60.93 in 2011. This figure reflects a life expectancy of 60.94 years, a literacy rate of 76.97%, an average 5.60 years of schooling, and per capita annual expenditure of IDR 615,900 (or approximately US$55 at current exchange rate). The latest figures (BPS 2012, Table 2.4) indicate that Mataram City also ranked highest in HDI (life expectancy, 67.13 years; 91.85% literacy rate, 9.22 years schooling, per capita annual expenditure, IDR 648,010 or US$ 57.86). Although the average income per capita of Lombok is lower than that of NTB province as a whole, Mataram City had the highest per capita expenditure in NTB in 2010 (BPS NTB 2012).

Table 2.5 presents an overview of NTB's economy and the contribution of each sector to the gross domestic product (GDP) of NTB. The largest contribution is from the agricultural sector (24.3%), which employs about half of the population (44%, based on 2007 figures), followed by mining (20.7%), and trade/hotels/restaurants (16.2%) (BPS 2012).

Table 2.4 Area, number of districts, sub-districts and villages in Lombok

District (Kabupaten)	Area (km^2)	Sub district (*Kecamatan*)	Village (*Desa*)	2010 Adjusted per capita income (USD)*	Human Development Index (2011)
West Lombok	1054	10	124	656.6	62.50
Central Lombok	1208	12	139	539.4	61.66
East Lombok	1606	20	246	562.2	63.93
North Lombok	810	5	33	705	60.93
Mataram City	61	6	50	1199	72.83
Lombok Island	4739	53	592	669 (NTB)	66.23 (NTB)

Source: BPS NTB (2012)

Table 2.5 NTB's GDP at 2000 constant prices for the business sector in 2009–2011

Category	Sector	2009 (USD)	% GDP	2010 (USD)	% GDP	2011* (USD)	% GDP
1	Agriculture	448,577	23.8	454,538	22.6	472,667	24.3
1.1	Food crops	267,419	14.2	269,604	13.4	283,269	14.6
1.2	Estate crops	52,377	2.8	51,426	2.6	51,657	2.7
1.3	Livestock	66,308	3.5	68,508	3.4	70,606	3.6
1.4	Forestry	1,290	0.1	1,308	0.1	1,346	0.1
1.5	Fishery	61,183	3.2	63,692	3.2	65,789	3.4
2	Mining/Quarrying	490,587	26.0	549,111	27.4	403,204	20.7
3	Manufacturing	90,995	4.8	94,425	4.7	97,377	5.0
4	Electricity/Gas/Water	6,676	0.4	7,171	0.4	7,762	0.4
5	Construction	145,795	7.7	150,958	7.5	158,722	8.2
6	Trade/Hotels/Restaurants	275,020	14.6	293,950	14.6	315,192	16.2
7	Transportation/ Communication	140,985	7.5	150,818	7.5	162,288	8.4
8	Finance/Real estate/ Business Services	97,264	5.2	102,593	5.1	113,086	5.8
9	Services	191,542	10.1	203,425	10.1	212,930	11.0
	NTB Total GDP	**1,887,441**	**100.0**	**2,006,989**	**100.0**	**1,943,229**	**100.0**

Source: (BPS 2012) (Note that 2011 figures are reported as "preliminary")

Forest resources in Lombok

Indonesian Law Number 41/1999 defines 'forest' as an ecosystem unit or natural area dominated by trees and an integral element of the natural environment, while 'forest area' is defined as a particular area designated or classified by the government as permanent forest. Data on the extent of forest area in Indonesia therefore includes forest areas that have been designated and set aside administratively, as opposed to the biophysical definition of forest. This means that figures on forest area in Indonesia do not necessarily represent actual forest cover.

The Indonesian Government classifies forest area based upon the following functional considerations:

- production forest or forests whose primary function is providing forest products;
- protected forest or forests whose principal function is ecosystem protection, for example buffer, water management, flood protection, erosion control, preventing salt water intrusion and maintenance of soil fertility;
- conservation forest or forests with specific characteristics whose main function is biodiversity and ecosystem conservation.

Data on forest area in Nusa Tenggara Barat and Lombok varies considerably by source. Statistics reported by the national Ministry of Forestry, the provincial government and the provincial-level Forest Service are inconsistent, and the figures have also changed over time. For example, the Ministry of Forestry reported a total forest area of 1,063,273 ha in 1982, 1,021,566 ha in 1999, 1,046,959 ha in 2009, and 1,071,723 ha in 2011 (see Table 2.6).

Note that the discrepancies in forest area reported above and in subsequent tables are likely due to several factors: (1) differences in the use of base maps (e.g. from the National Topographic Map (*Rupa Bumi Indonesia*) to the Basic Forest Map (*Peta Dasar Tematik Kehutanan*)), (2) adjustments in forest boundaries, functions and uses, consistent with development and change within NTB, (3) definition and classification of forests based on the interpretation of satellite images, (4) the result of continued revisions of forest boundaries, and (5) technological advances in the use of remote sensing that allow for more detailed evaluation of forests and landscapes.

The most recent data from the NTB Provincial Forest Service reports that NTB province has 1,071,723 ha forest area (53% of the total area of the province). The forest classification (Table 2.7) includes 173,182 ha conservation forest, 449,141 ha protected forest, 289,313 ha limited production forest, and 160,085 ha production forest in total (Dinas Kehutanan Provinsi NTB 2011).

About 15% of the forest area in NTB is on the island of Lombok (see Table 2.8). Conservation and protected forests comprise more than 80% of the total forest area on Lombok, spreading across the four rural districts (Mataram City has no designated

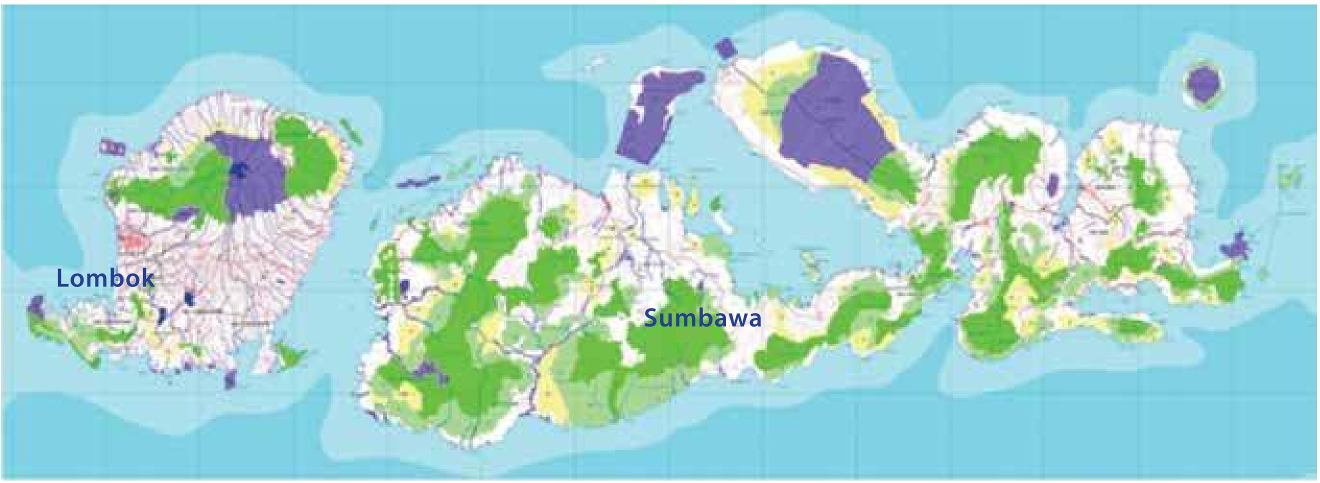

Figure 2.1 West Nusa Tenggara Province

Note: Protected forests are in bright green, production forests in light green, conservation forests in purple.

Source: Dinas Kehutanan Provinsi NTB (2012)

Table 2.6 Comparison of total forest area data from Ministry of Forestry, NTB Provincial Planning Board, and NTB Provincial Forest Service

	MoF	NTB Planning Board	NTB Forest Service
1982	1,063,273.3	-	-
1999	1,021,566.0	-	-
2009	1,046,959.0	1,069,997.78	1,069,997.78
2011	1,071,722.8	1,069,997.78	1,071,722.83

Sources: Ministry of Forestry (1982, 1999, 2009, 2011); Bapedda Provinsi NTB (2009, 2011)

Table 2.7 Forest area by functional classification

Forest class	Forest area (ha)				Non forested (ha)	Total (ha)
	Primary	Secondary	Planted	Total		
Conservation	35,626	124,655	-	160,281	12,901	173,182
Protection	320,730	96,849	-	417,579	31,562	449,141
Limited production	109,212	104,974	2.450	216,636	72,677	289,313
Production	49,897	28,596	17.545	96,038	64,048	160,085
Total	**515,465**	**355,074**	**19.995**	**890,534**	**181,188**	**1,071,723**

Source: Dinas Kehutanan Provinsi NTB (2011)

Table 2.8 Forest area in Lombok

District	Forest Function (ha)				Forest area	Percentage (%)
	Conservation	Protected	Limited production	Production		
West Lombok	6,557.27	25,078.94	10,041.00	304.69	41,981.90	25.70
Central Lombok	5,824.29	9,926.14	-	4,583.89	20,334.32	12.40
East Lombok	27,445.00	31,498.67	-	5,565.00	64,508.67	39.50
North Lombok	13,164.00	11,198.22	6,984.38	5,171.52	36,518.12	22.40
Mataram	-	-	-	-	-	-
Lombok Island	52,990.56	77,701.97	17,025.38	15,625.10	163,343.01	100.00

Source: NTB Forest Agency Statistics (2011)

forest area), with the greatest portion located in the eastern part of the island. The total area of 163,434 ha also includes some protected and production forests designated for research and education. As noted above, the total forest area does not represent all areas of forest cover as defined in Law Number 41/1999. For example, even though it is classified as a marine conservation area, Gili Matra (2954 ha) remains under the jurisdiction of the Ministry of Forestry (NTB Forest Statistics 2011; WWF 2008).

Of the 163,343 ha of total forest area in Lombok, approximately 25% (40,101 ha) is classified by the NTB Government as in 'critical' (or degraded) condition, with more than 70% of this area (30,909 ha) located in the districts of North and East Lombok. The most seriously affected forests are those in Sekaroh and Sambelia (East Lombok), and Mareje Bunga (Central Lombok), largely due to widespread forest clearing for agriculture, and in Sekotong (West Lombok, primarily due to expanded mining operations) (Dinas Kehutanan Provinsi NTB 2011).

Lombok is located on the eastern side of the Wallace Line, with flora and fauna considered part of a transitional zone between the mainland Southeast

Table 2.9 KPHs on Lombok

KPH	Area (ha)	Legal Foundation	Authority
Unit I KPHL Rinjani Barat (KPHL Model Rinjani Barat)	40,983	MoF Decree 785/Menhut-II/2009	NTB (North and West Lombok Districts)
Unit II KPHP Pelangan	19,636	-	West Lombok
Unit III KPHL Tastura	16,153	MoF Decree No. 971/Menhut-II/2013	Central Lombok
Unit IV KPHL Rinjani Timur	37,589	Mof Decree No. 225/Menhut-II/2012	East Lombok
KPHK Rinjani National Park	41,330	MoF Decree No. 781/Menhut-II/2009	Ministry of Forestry
KPHK Lombok	6,668	-	Ministry of Forestry

Source: BKSDA NTB (2012)

Table 2.10 KPHL Rinjani Barat

No.	Forest unit	Forest Class (ha)			Total (ha)
		Protection	Limited production	Production	
1.	Gunung Rinjani (RTK 1)	28,278	6,997	4,335	39,610
2.	Pandan Mas (RTK 2)	630	-	740	1,370
3.	Ranget (RTK 6)	2.7	-	-	2.7
Total		28,911	6,997	5,075	40,983

Source: KPH Rinjani Barat (2012)

Asia and Papua-Australia systems. Forest types on Lombok include lowland and upland rainforests, mangroves, savannahs and mixed grasslands. The main forest species in this transitional zone include the dipterocarps, principally *Dipterocarpaceae recutus* and *Casuarina junghuhniana* (BAPPENAS 2003; WWF 2004). Several important faunal species include mammals such as the Sunda fruit bat (*Acerodon macklotii*) and long-tailed macaques (*Macaca fasciocularis*); birds such as the Rinjani scops owl (*Otus jolandae*), Brahminy kites (*Haliastur indus*) and scaly-crowned honeyeater (*Lichmera lombokia*); reptiles such as the water monitor lizard (*Varanus salvator*) and gecko (*Gekko gecko*); amphibians such as the green frog (*Rana erythrea*); and a variety of insects, including beetles (e.g. *Prosopocolius* sp.) and butterflies (*Cethosia* sp., *Papilio* sp.). Forest-related flora includes rosewood (*Dalbergia latifolia*), kusum or soapberry (*Schleichera oleosa*), kalanggo (*Duabanga moluccana*), Malabar ebony or kelicung (*Dyospiros malabarica*), nyamplung (*Callophyllum inophyllum*), bajur (*Pterospermum javanicum*), gaharu (*Gyrinops verstegii*) and candlenut (*Aleurites moluccana*). Lombok forests are also rich in non-timber forest products, which are used in a variety of local industries; these include bamboo (*Bambusa* sp.), ferns (*Lygodium circinnatum*), palm sugar (*Arenga pinnata*) and mimba or neem (*Azadirachta indica*) (BKSDA 2012).

The forest plays an extremely important role in the lives of local communities in Lombok. With more than 80% of the forest area classified as protected or conservation forest, Lombok's forests provide a critical array of ecosystem products and services, including water, food, timber, many important non-timber forest products (including medicinal plants), as well as regulatory services such as erosion control and flood mitigation, air quality, pollination of major economic crops, pest and disease control, maintenance of important habitat for biological and genetic diversity, cultural benefits such as ecotourism and recreation, and many other educational and spiritual values.

The forests surrounding Mount Rinjani constitute the primary watershed for 90% of all rivers on the island. These forests, and their waterfalls, vistas and wildlife, and the unique Segara Anak Lake within the volcanic cone have more recently become important as major international tourist destinations. As noted above, many non-timber forest products provide the primary material for many local household needs and livelihoods: bamboo, honey, rattan, palm sugar, furniture and construction materials. Customary forests (*hutan adat*) are a fundamental aspect of local culture and religious history that continue to enrich the lives of local communities.

Forest governance and the KPHL RB

Ministry of Forestry Decree 337/Menhut-II/2009 established 29 Forest Management Units (KPHs) in NTB province, including 12 Protection KPHs, 11 Production KPHs and 6 Conservation KPHs. The management authority for the protected and production forests lies with the local government, while conservation forests (KPHK) remain under the jurisdiction of the national government. Six of the 29 KPHs in NTB province are located in Lombok (see Table 2.9).

The KPHL RB is considered a model KPHs for Indonesia. Covering an area of 40,983 ha, it spans the districts of North and West Lombok, encompassing 9 sub-districts, 38 villages and 104 hamlets. The KPH has jurisdiction over three forest units: Mount Rinjani (RTK 1), Pandan Mas (RTK 2) and Ranget (RTK 6), which include protected forest (28,911 ha), limited production forest (6,997 ha) and production forest (5,075 ha) (see Table 2.10).

In the NTB provincial land-use planning documents, the KPHL RB is described as a strategic area for tourism development, due to its position along the coastal zone of North Lombok, its natural beauty, and the fact that it is the point of departure for trekking expeditions into Mount Rinjani, with its five waterfalls, unique scenery and wildlife habitat. Given its proximity to the major population center (Mataram City), the KPHL RB is also the source of many economically important forest industries, including timber and fuelwood, as well as non-timber forest products such as coffee, cacao, coconut, jackfruit, durian, and a range of products that support local handicraft industries (BAPEDDA 2011; KPHL Rinjani Barat 2012).

3. The evolution of forest governance in Lombok

The pre-colonial era: Indigenous management

Very little is known about access, use and community management of forests prior to the arrival of the Dutch. Much of the forests in Lombok were certainly under local management and subject to traditional or customary (*adat*) control. According to Kraan (2009), the forests surrounding Mount Rinjani and Segara Anak Lake were regarded as sacred by both Sasak and Balinese cultures. These forests were used primarily for religious rites and ceremonies, and a variety of cultural practices, including hunting, by the kings and local leaders who ruled the area during that time. Yudilastiantoro and Sulistyo (2008) report that 30 customary forests (*hutan adat*) are still recognized in Lombok (29 in North Lombok and one in East Lombok) and, in these forests, community-based management has continued, having been passed down through the generations. The traditional forests in North Lombok are all within or on the boundaries of the KPHL RB. Through this local knowledge and these traditions, communities have protected and used forest resources, accommodating the various needs for forest conservation, household needs, economic benefits, and cultural and religious practices. In principle, much of the exploitation of forest resources was at a subsistence level during this time.

Traditionally, communities recognized two types of forest management systems: (1) *pawang*, or sacred forests, often associated with important springs or water sources, frequently surrounded by large, old growth trees, and protected from any active use and (2) *gawah*, or forests where more active use was allowed (e.g. collection of timber and non-timber products, hunting), but managed under the jurisdiction of a *pemangku* (priest or steward). The term *gawah toak* was used to describe a fully intact forest, while *gawah tutupan* was used for protected, but managed forests (Yudilastiantoro and Sulistyo 2008; Sukardi 2009).

Traditional communities in Lombok often recognized local regulatory agreements (*awiq-awiq*) that codified rules of access and management, and outlined these rules in terms of the community's relation to the natural and spiritual world and individuals' responsibilities to each other within the community. Some examples of *awiq-awiq* associated with forest management include: (1) sanctions against hunting certain animals or felling certain tree species without the permission of the *pemangku* (e.g. in the villages of Semokan and Sukadana). Offenses are paid for with fines, either monetary or by replacement of the wood or animals (Wadi 2011), and these fines are determined by the *pemangku*; (2) rules regarding the personal use of fire, hunting, grazing, immoral activity, pollution of the water source or any other activity that has a negative impact on the forest (e.g. in Bayan); and (3) rules that involve serious sanctions (including sacrifice of livestock) for breaking forest restrictions (e.g. in Bentek and Baru Murmas). In these communities, customary forests are still used only for ritual and religious practices (Sukardi 2009; Wadi 2011).

In communities with extant customary forests, focus group discussions validated the continued role of the *pemangku* (sometimes referred to as *mangku*), or forest steward, as the recognized local authority with responsibility for maintaining these traditions and the rules and sanctions outlined in the *awiq-awiq*. In North Lombok, the term *Wet Tu Tlu* is used to describe the traditional division of authority and control in Sasak society, and this term encompasses all social interactions, including religious affairs (with leadership by the local *kyai*), community-level governance (led by the *pembekel*) and customary law or *adat* (under the authority of the *pemangku*). With respect to forest management, the *pemangku* is known by several different names in different locations in North Lombok: *Pemangku Lawangan* for the traditional (*Pawang*) forest in Lawangan, *Pemangku Perumbak Lauk* for the forest in Montong Gedeng and *Pemangku Perumbak Daya* for the forest in Bangket Bayan. In several traditional forests, communities have appointed forest guards (or *lang-lang*) to assist the *pawang* in forest protection activities (Yudilastiantoro and Sulistyo 2008; Sukardi 2009; Wadi 2011).

Dutch colonial period

At the end of the eighteenth century, economic and social development in Lombok was still largely focused on the central part of the island along the west–east corridor, and the upland forests surrounding Mount Rinjani were largely neglected. During this early period of Dutch colonialism, forests outside of Java were largely under the control of local chiefs or *rajas* and their traditional communities. In addition, many of the *rajas* in Lombok were preoccupied with local wars and conflicts, and gave little attention to exploiting natural resources. By the mid-nineteenth century, the Dutch government adopted more aggressive control measures, including the establishment of a national forest service (*Jawatan Kehutanan*, in 1865) to begin assuming greater authority over forest management in Indonesia. The Basic Agrarian Law of 1870 recognized the authority of local *rajas* and traditional communities over forest resources, but declared these forest areas under the jurisdiction of the Dutch Government. The Basic Agrarian Law established forest areas as state lands, with local rights (*swapraja*) granted under the supervision of Dutch colonial officials or *pamong praja*. Forest boundaries were delineated through negotiated agreements with local communities (Djajapertjunda 2002; Kraan 2009).

In the 1920s, the Dutch Government began mapping and measuring forest lands, particularly those deemed of high potential productivity, with the goal of increasing revenues from land taxes and from the harvesting of forest products (Kraan 2009). Formal gazetting of forest lands was completed during 1930–1950 (Djajapertjunda 2002). The result of this process was termed registered forest land (*Register Tanah Kehutanan* or RTK). The forests of Lombok were divided into 20 RTKs, with a total area of 162,437 ha. For the current KPHL RB, several documents show that forest boundaries were delineated on 9 September 1929 and included: (1) RTK 1 Rinjani, with a total area of 125,000 ha (boundaries formally approved 1941),[3] within which 41,330 ha was designated as a wildlife preserve (*suaka margasatwa*). RTK 1 was subsequently divided into the Mount Rinjani National Park and the KPHL Rinjani Barat (in 2009); (2) RTK 2 Pandan Mas (boundaries delineated in 1936), and (3) RTK 6 Ranget, established in 1941 (KPHL Rinjani Barat 2013).

Unlike in Java, where the Dutch Government gained full control of forest areas and applied intensive management practices, forest management in the outer islands was still generally limited to functional designation and inventory. As noted above, these forests were largely under the control of local *rajas* and traditional communities, so much so that national regulations, such as the *Bosreglement* (1913), *Bosordonatie* (1927) and other laws and policies were adapted to suit local conditions. While the Dutch Government recognized customary *adat* rights, the establishment of forest management institutions and the emerging legal framework resulted in diminished authority of the *swapraja*. However, limited control over forest management in Lombok, as one of many islands outside of Java, was the result of a number of factors, primarily the challenges of transportation, access and communication, the lack of dedicated professional staff, and the continued strong role of local *rajas* and traditional communities (Djajapertjunda 2002; Kraan 2009).

During the period 1941–1945, when the Dutch were forced from Indonesia during the Japanese invasion, most forest management activities (planning, exploitation, conservation management), especially in the outer islands, were effectively discontinued.

Early independence: 1945–1965

Following Indonesia's independence in 1945, forest management activities outside Java were quite limited, given the priorities for establishing a national government and formulating domestic policies. The new government approved the national constitution, which, among other things, provided the legal foundation for natural resource management, including forest management; Article 33 Section 3 stated that "land, water and all natural resources are under the control of the state, and used for the broadest public welfare." This Article provided the basis for the development of a strategic plan for forest management during this period (Departemen Kehutanan RI 1986).

At this time, the government of NTB consisted of distinct regional councils in Lombok and Sumbawa. The government largely adopted the existing system

3 SK GB. 15, STBL Number 77, 12 March 1941.

of colonial administration, initially referring to subregional areas as districts (e.g. Bayan or Tanjung) and subsequently as *kecamatan*, which were later split into what are currently referred to as *desa* (villages) and *dusun* (hamlets) (Kraan 2002).

Consistent with this emerging government administration, forest management in Lombok through 1949 was administered under the western Forest Inspection, part of the National Forest Agency established by the Dutch in Jakarta (Departemen Kehutanan RI 1986).

Beginning in 1954, forest gazettement continued, with the surrender of certain government lands, or 'GG' (*Gouvernement grond*) within the forest estate under the Forest Agency (*Jawatan Kehutanan*), e.g. in Bayan district. In the 1960s, forest management in Lombok remained under the administration of the Forest Service for Eastern Indonesia, and the emphasis remained on the delineation of forest zones, based on reference maps from registered forest land identified during Dutch rule.

Central control: 1965–1998

This period marks the pivotal development of forest management in Indonesia. Basic forestry policies were established through Law Number 5, 1967, and these significantly shaped forest management practices, including policies related to traditional community access and use rights. During this period, forest management by the state largely emphasized central control over all aspects of forest management and administration.

Forest terminology was described in Article 2 Section 1, which defined forest as non-private land under State control, with use rights and management under the national government, and no longer recognizing tribal, traditional or regional forest areas. Subsequently, regional authority over forest management rested with provincial governments (based on Article 12), delegitimizing the *swapraja* system established under colonial rule, and establishing the national government as the principal planning and management authority. This law also provided the foundation for forest enterprise development by outside entities, as defined in Article 14 Section 3: "permits for forest management may be granted to national, regional, and private enterprises." In addition, Law Number 1, 1967, regarding foreign investment (Indrarto et al. 2012), and Government Regulation Number 21, 1970 regarding Forest Enterprises (*Hak Pengusahaan Hutan* or HPH) and Forest Harvest Rights (*Hak Pemungutan Hasil Hutan*, HPHH), led to rapid private investment and a shift in forest management to private, third party entities, with permits issued by the national government. During this period, government policies and regulations were dominated by these HPHs and emphasized extensive timber harvesting.

As noted above, in Lombok, community involvement in forest management before the issuance of private permits, was limited to fulfilling basic livelihood needs and local cultural practices. The HPH and HTI permits approved in the early 1990s in NTB and in Lombok were essentially the first direct experience with the large-scale economic development model that was a signature of the Suharto era (Indrarto et al. 2012). During this period, the central government issued two concession permits in Lombok: (1) PT Tambora Buana Lestari (HTI – 5000 ha) and (2) PT Angkawijaya Raya Timber (HPH – 22,000 ha) (Dinas Kehutanan Provinsi NTB 1990a and 2000b).

As will be seen in the analysis below, these concessions represent a pivotal event in recent deforestation in the KPHL Rinjani Barat. Forest areas in Senaru and Bayan were clear-cut by PT TBL and PT ART, and although their permits were valid through 2010, operations were discontinued in 2000 after the companies were driven out by local communities.[4]

Government agencies responsible for forest management have changed with subsequent government reforms. Until 2000, forest management was under the jurisdiction of the Regional Office of the Ministry of Forestry, representing the central government in the NTB region, and the Provincial Forest Service (Level 1), representing local government (Statistik Kehutanan 2000). This structure reflects the emphasis on central government control in providing a range of permits related to the HPHs – for timber harvest, sale and distribution of forest products, and forestry industries, including those for non-timber forest products.

4 One of the areas that exemplifies this reaction was Mejet Forest, located within the PT ART concession. The clearing of this forest encouraged extensive encroachment into the area, including the illegal division and occupation of the forest by the community, which to this day is still unresolved (Huzaini 2002; Pramaria 2013; Mukarom 2013b; dan Sutikno 2013 personal communication).

Delineation of forest boundaries continued to be based on registered forest land designations through 1981, but during this period of growing centralized control the national government approved Law Number 756/KPTS/UM/10/1982, which established the Consensus Forest Use Plan (*Tata Guna Hutan Kesepakatan* or TGHK). TGHK was designed as a formal agreement-seeking process between the national government and the provinces, with the intention of re-establishing boundaries determined during the Dutch era. In Lombok, 98% of the forest boundaries were affirmed through the TGHK process.

During the new order era, active law enforcement restricted local access and use within designated forest areas. However, following the fall of Suharto in 1998, a combination of factors – weak law enforcement capacity, increasing population pressure, and the advent of migrants into the forest seeking access to agricultural land, and the legacy of animosity toward the concessions – emboldened communities to occupy the forest to open new farming areas.

As a response to this extensive illegal encroachment, and as a reflection of the move to regional autonomy, the government shifted its focus to encouraging greater local participation in forest management. This emerging policy orientation actually predated the fall of the new order, formulated in Ministerial Decree 622/KPTS-II/1995, Guidance for Community Forestry (later revised as 677/Kpts-II/1998). In Lombok, the first experiments with community-based forestry projects (*Hutan Kemasyarakatan* or HKm), offering formal recognition of the community's role in forest management, were implemented in the villages of Santong and Sesaot.

These changes in government policies and programs coincided with the rapid emergence of civil society organizations, or nongovernmental organizations (NGOs), which promoted community-based and pro-poor development approaches. In Lombok, since the early 1990s the first NGOs (LP3ES and Balai Karya) played a significant role in empowerment and advocacy in rural communities. Initially, NGOs were largely constrained by project-based funding, with no particular sectoral focus, but in the early 1990s they began to emphasize particular issues, such as migrant workers (Koslata), urban development, legal aid (LBH APIK), and community-based forest management (LP3ES) (Sarbani, 2013, personal communication).

Transition period: 1998–2002

The passage of Law Number 41, 1999 marked the end of the regulatory framework established under the Basic Forestry Law of 1967, providing the foundations for the determination of status and function of Indonesia's forests, and the system of forest stewardship and management. During this transition period, illegal logging, encroachment, and occupation reached its peak, due to the political instability, the government's inability to enforce basic laws, lack of clarity on sanctions for offenders and growing dependence on forest lands for agricultural expansion. These conditions catalyzed a range of new policies and programs designed to achieve sustainable and equitable forest management, increase community participation and foster a more balanced approach that considered ecology, economic development, and social and cultural benefits.

Nationally, 1999 marked the beginning of Indonesia's transition to regional autonomy; the passage of Law Number 22, 1999 (regarding regional governments) and Law Number 25, 1999 (related to regional financing) provided the legislative foundation for the move toward decentralized governance. These changes outlined the transition in decision-making over natural resource management to local governments. For the forestry sector, this meant that local governments gained jurisdiction over production and protected forests, while conservation forests remained under the authority of the national government. However, due to limited local government capacity and the general uncertainty during this transition period, these new policies were inconsistently implemented. This period also saw extensive transfer of forest lands previously under local control to outsiders with access to technology, knowledge and capital, given the growing awareness of the productive capacity of these lands and the ease of obtaining permits for timber harvesting on private lands (*Ijin Pengusahaan Kayu di Tanah Milik* or IPKTM).

Regional autonomy: 2002 to present

The current national political system, in which authority has been devolved to provincial and district-level control, has meant significant change for the forestry sector. Local government units have begun to focus on resolving forest management disputes by emphasizing social, cultural and economic development. However, the excitement of reform has in many ways enabled increased access to the forest due to management neglect. BAPPENAS (2010) has reported that among all the causes of deforestation and forest degradation, the most important is the lack of effective management at the local level. For this reason, recent government policies in the forestry sector have shifted toward accelerating and strengthening local forest management institutions as an important means of decentralizing forest management authority (Widiaryanto 2014). The KPHs are responsible for improving forest management for multiple benefits – timber, forest products and a range of ecosystem services. In general, forestry development under this new management paradigm devolves responsibility for *forest stewardship* to the Provincial and District Forest Service and *forest management* to the KPHs.

In addition to the formation of the KPHs, there have been some recent key changes in laws and policies that continue to redefine national forest management authority and affect the delineation of forest boundaries. As one example, a recent decision of the Constitutional Court reinforced the rights of traditional *adat* communities, even if located within national forest boundaries (www.mahkamahkonstitusi.go.id 2013). While the implications of this ruling remain uncertain, it is worth noting that within the KPHL RB there are at least 30 customary forests that would in principle be removed from the KPH management area and become the management responsibility of local communities (Yudilastiantoro 2008).

With the establishment of the KPH system, a continuing challenge will be to develop the KPHs into professionally functioning institutions. The KPH has authority to manage forest areas that are not yet under concession or permit agreements (HKm, HTR, HTI, HPH, HD, etc. – see below), and they have crucial responsibilities in the area of forest inventory, planning, project implementation, education, and law enforcement.

NTB is among the provinces that have been quick to adapt to these rapid changes in forest management and administration. The province was among the first to respond to the 1999 initiative to designate the KPHs, and by 2008 had proposed the establishment of 29 units.[5] The recent 5-year strategic planning process (2009–2013) reflects concerns for a more balanced approach to forest management, one that considers both forest conservation and the well-being of local communities. Specific initiatives identified in the strategic plans include: a logging moratorium, the "one man, one tree" reforestation program, promotion of native forest species (including non-timber forest products and support for native seed nurseries), support for a range of community-based forestry models (HKm), community forest plantations (*hutan tanaman rakyat*, HTR), industrial forest plantations (*hutan tanaman industri*, HTI), and community forests (*hutan rakyat*, HR), and village forests (*hutan desa*, HD), development of payment for ecosystem services (PES) programs, and strong support for the KPH system, including human resource development (Dinas Kehutanan Provinsi NTB 2012).

However, although reports have generally been optimistic, in reality the underlying forest management challenges have not changed dramatically. Data from the KPHL Rinjani Barat shows that 24,000 families continue to occupy more than 18,000 ha of forest, with escalating conflicts in many forest margin communities (Mukarom 2013). Illegal logging continues, even though the scale has been reduced. Encroachment, occupation and the illegal transfer of forest lands all continue apace and have not been adequately addressed. From the economic standpoint, 20 years of forest utilization has done little to improve conditions in KPHL RB communities, which continue to reflect high poverty rates for the region, even though in a few locations (e.g. in the HKm project in Santong), forest productivity has significantly increased economic benefits to the community.

Reducing Emissions from Deforestation and Forest Degradation (REDD+)

As a commitment to REDD+ programs, and in the context of a cooperative agreement between Indonesia and Norway, the development of REDD+ institutions is a high priority for Indonesia, particularly in preparing for REDD+ implementation. In 2010, Indonesia formed a national REDD+ Working Group, which in 2013 became the REDD+ Management Agency, under

5 To date, the Governor and District Heads (*bupatis*) have only approved a total of 23 KPH units.

the direct supervision of the President. The development of the National REDD+ Action Plan was also begun in 2010. Despite almost four years of activity, the National REDD+ Management Agency has yet to identify a similar entity at the provincial level. Coordination of REDD+-related activities is currently the responsibility of the Provincial Forest Service (personal communication from Andi Pramaria, 2013).

REDD-related activities in NTB date from 1996–1997, in the form of the A/R CDM program sponsored by the Japan International Forestry Promotion and Cooperation Center (JIFPRO) in Sekaroh and Sambelia, Central Lombok. In 2009, the Korea International Cooperation Agency (KOICA) followed up in the Sekaroh area with a similar program (A/R CDM); in 2011, approval for a 306 ha HKm program was granted in this area (Siregar and Ridwan 2014).

At the same time, KOICA initiated a REDD Demonstration Area (DA) in the community of Aik Berik (Central Lombok) (Resusudarmo 2013). During the first 2 years (2009–2011) KOICA conducted a feasibility study, and began implementing program activities at the end of 2012.

The NTB provincial government instituted programs related to climate change and greenhouse gas emissions in 2010–2011 with the formation of a Working Group on Greenhouse Gases (*Satuan Tugas Gas Rumah Kaca* or Satgas GRK). The Working Group formulated an action plan that identified major sources of emissions, including those attributed to forest encroachment, illegal logging, and forest fires. In 2012 the NTB Provincial Forest Service, in cooperation with the Ministry of Forestry's Center for Climate Change Policy (PUSPIJAK) conducted several REDD-related outreach and research projects, with a specific focus on monitoring, reporting, and verification (MRV), and identified 33 sites for continuous carbon stock monitoring. MoF's Center for Standardization and Environment (PUSTANLING) focused on capacity building (training and workshop events) and the development of a professional network (personal communication from Andi Pramaria, 2013).

Other actors' role in forest management

While the focus of this analysis has been on the evolution of government policies and institutions, the pace of development in the forestry sector owes much to the role of other important actors, particularly local communities, NGOs and universities. Analysis of satellite imagery and focus group discussions from communities within the KPHL RB affirm the fact that community planting and reforestation efforts are largely responsible for the significant forest cover change noted in these areas, primarily due to the planting of a variety of agroforestry species. Concurrently, the emergence of local farmer working groups has been a critical aspect of successful community forestry projects. The new opportunities afforded to local communities to legally participate in forest management have encouraged communities to request additional approval for HKm projects, which now cover a total area of 14,836 ha in Lombok and Sumbawa, with four projects in the KPHL RB (Dishut NTB 2012). Recognition of the importance of local communities as a cornerstone of effective forest management has been reinforced by a number of recent regulations that seek to protect access and usufruct rights. Nevertheless, this emerging regulatory framework, particularly the process for approving HKm requests (which has been in place since 2007), continues to be slowed by an inefficient bureaucracy, a continuing source of frustration to local communities and community forestry advocates. Once again, the KPH is seen as a key opportunity for overcoming this bureaucratic inertia, since the KPHs can develop direct partnership agreements with local communities, circumventing the complex national approval process.

During this time, NGOs have also played an important role in the progress noted above, particularly in their work in building local leadership, education and capacity building, and in strengthening farmer working groups. The number of NGOs, particularly local NGOs, involved in the forestry sector, has increased significantly in recent years. Many of the key program innovations – such as PES, carbon accounting and conflict resolution efforts – have been initiated and led by NGOs. The NGOs have also been important partners in HKM programs in identifying project areas and facilitating the approval process, and they will continue to play an important intermediary role in building partnerships between communities and the KPHs. Among the NGOs that have provided consistent support for community-based forestry programs are: Konsepsi, YKSSI NTB, Transform, Samanta, Koslata, FFI (Flora & Fauna International) and the WWF (World Wildlife Fund).

Table 3.1 Summary of the evolution of forest governance in NTB

Period	Laws and policies	Boundaries	Institutions	Role of local communities	Role of civil society (NGOs)
Indigenous control	Customary laws (*awiq-awiq*)	No information	Customary institutions	• Limited forest protection and stewardship (ritual and religious practices)	N/A
Dutch colonial era	• Bosreglement (1913) • Bosordonatie (1927)	Registered Forest Land (RTK)	Forest Board for Lombok dan Sumbawa	• Limited forest protection and stewardship (ritual and religious practices)	N/A
Early independence (1945–1965)		Registered Forest Land(RTK)	Western Forest Inspection Agency Forest Inspection and Planology Brigade	• Inter-community warfare; forest used for protection, defense, and for household and community needs	N/A
Central control: 1965–1998	• Basic Forestry Law No. 5/1967 • Law on Investment No. 1/1968 • Government regulation No. 21/1970 regarding Forest Use Permits and Forest Harvest Permits	• RTK to 1982 • Consensus Forest Use Plan (TGHK), 1999	Regional Office – Forest Service Level 1 Branch Office – Forest Service (District Level)	• Laborers for forest concessions (HPH/HTI) • HKm project participants • Laborers for government-sponsored projects	• NGOs emerge – support community-based and government-sponsored programs
Transition period 1998–2002	• Forestry Law No. 41/1999 • Establishment of KPHP No. 34/2002 re Forestry and Forest Management Planning, Forest Use, and Use of Forest Area • KPHP concept approved	• Delineation of forest boundaries by the national government: Ministerial Decree No. 418/Kpts-II/1999	Forest Service – provincial and district level	• Illegal encroachment and occupation	• NGOs develop with support from a variety of donor agencies, provide support for community empowerment, capacity building, institutional development • Key local NGOs: Konsepsi, Mitra Samiya, Koslata

continued on next page

Table 3.1 Continued

Period	Laws and policies	Boundaries	Institutions	Role of local communities	Role of civil society (NGOs)
Regional autonomy: 2002-present	• Forestry Law No. 41/1999 (revised based on judicial review by the Constitutional Court, 2013) • Law No 34, 2004 re local government • Government regulation 44/2004 re forest planning • Government Regulation No. 6/2007 and No.3/2008 re forest planning and management • Government Regulation No. 38/2007 re division of provincial and district government authority • Ministry of Forestry Regulation 6/Menhut/2009 re formation of forest management units (KPHs) • Ministry of Forestry Regulation No. P.47/ Menhut-II/2013 re criteria and standards for forest management within the KPHL dan KPHP	• Delineation of NTB provincial forest boundaries (2009): Ministry of Forestry Decree No. 598/Kpts-II/2009 • Establishment of KPHL and KPHP boundaries, based on Ministerial Decree No. 337/Menhut-VII/2009	Forest Service – provincial and district level KPHs emerge as local level institution (beginning in 2009)	• Forest management through HKm, based on Ministerial Regulation No. 37/Menhut-II/2007 • Co-management through agreement with KPH, based on Ministerial Regulation No. 39/Menhut-II/2013	• NGOs increase focus on community-based forest management, many assisting with HKm permit applications • Role and number of NGOs increases – support for communities and for local government capacity building • NGOs involved in the forestry sector: Konsepsi, Mitra Samiya, Koslata, YKSSI, Samanta, Transform, FFI, WWF, etc.

Note: Names for government forest management agencies have changed over the years, and have periodically been merged with agencies responsible for agriculture, estate crops and fisheries.

4. Land-use change

REDD+ financing is designed to provide incentives to protect forests for the value of their standing carbon. Thus, estimating verifiable carbon credits in a transparent way is essential for starting a conversation on any REDD+ proposal. For climate mitigation, simply reducing rates of deforestation and forest degradation is not enough; project proponents must demonstrate the amount of avoided emissions, based on the reference emission level (REL), which is the expected carbon emission rate from deforestation and forest degradation in the absence of interventions. The baseline for establishing RELs for REDD+ projects should include two components: land use and land-cover change and the associated carbon stock change. In this chapter, we describe the process for estimating the first component; Chapter 5 discusses methods for estimating carbon stock change.

Land use and land-use changes are the result of human uses of land and the interactions of global climate changes on the earth's surface. Land use and land cover play a major role in the carbon cycle by acting as a source or sink of carbon. Deforestation, afforestation and forest regrowth drive the release and sequestration of carbon, thereby affecting atmospheric CO_2 concentration and the overall greenhouse effect (Asner et al. 2005; Gullison et al. 2007). Regular monitoring and assessment of land use and land-cover change are therefore critical for understanding how anthropogenic and natural changes (such as deforestation and forest degradation) at local, regional or global scales affect greenhouse gas concentrations in the atmosphere (Potapov et al. 2008).

Remotely sensed data has been widely used to classify land-cover and to provide estimates of land-uses. Remote sensing combined with ground measurements played a key role in determining the extent of forest cover loss with confidence from the 1990s (DeFries et al. 2006; GOFC-GOLD 2009). The strength of remote sensing is in its ability to provide spatially explicit information and repeated coverage of large areas, especially remote areas that are difficult to access otherwise (Lillesand et al. 1999). A variety of satellite data sources are used in classifying land use and establishing historical trends of forest changes, especially for deforestation and forest degradation. The selection of data sources depends upon the type of forest, coverage of the project area, existence of ground monitoring data, deforestation, the size of forest clearing and budget (Rosenqvist et al. 2003; DeFries et al. 2005; Gibbs et al. 2007).

Remote sensing image classification is a complex process that involves many steps, including the definition of a land cover classification system, collection of data sources, selection of a classification algorithm, extraction of thematic information, and accuracy assessment (Jensen 2005; Lu and Weng 2007). Technical progress in image classification has been achieved since the 1990s and a great deal of research has been conducted to classify land cover and monitor forest loss, especially for tropical forest vegetation (Tucker et al. 1985; Woodcock et al. 1994; Foody et al. 1996; Kartawinata et al. 2001; Tottrup 2004; Curran et al. 2004; Lu 2005; Li et al. 2011).

For REDD baseline setting, the most appropriate dataset is medium resolution satellite data, such as Landsat thematic mapper (TM) imagery. With global coverage, the regularly acquired largest historical archive and freely available space-based earth observations, Landsat imagery is preferred for monitoring tropical forests (Vieira et al. 2003; Salovaara et al. 2005; Kumar et al. 2010; Potapov et al. 2012; Das and Singh 2013; Zhuravleva et al. 2013). Several studies have reported deforestation and forest area changes in Indonesia using Landsat satellite data (Curran et al. 2004; Hansen et al. 2009, Miettinen and Liew 2010; Margono et al. 2012). These datasets play a key role in establishing historical deforestation rates in a particular region.

For this analysis in Lombok, we used available satellite Landsat TM images to analyze land use and land-cover changes, especially those related to deforestation and forest degradation during the past 20 years. This summary outlines our findings and their implications for developing a potential REDD+ program.

Materials and methods

Satellite images

We used medium-scale Landsat multispectral scanner (MSS), thematic mapper (TM), and enhanced thematic mapper plus (ETM+) satellite images for the analysis. The study area, Lombok Island, is located at the position of Path 116/ Row 66 of the Landsat Worldwide Reference System (WRS). Landsat time-series data from 1990 to 2010 with 5-year intervals were selected for extracting information on land use and land-cover changes. The images were downloaded from the US Geological Survey National Center for Earth Resources Observation and Science through the GLOVIS data portal (http://glovis.usgs.gov). Landsat datasets used for the study are listed in Table 4.1 and Figure 4.1.

In humid tropical forest environments such as Indonesia, cloud cover is a major problem in working with optical remotely sensed data (Asner 2001; Hansen et al. 2008; Margono et al. 2012). For regions with persistent cloud cover, obtaining timely data suitable for research objectives is frequently restricted. In this study, supplementary datasets were used to create improved time sequential image composites nominally centered for 1990, 2000, 2005 and 2010.

Land-use classification system

All land classes of interest in the survey area must be selected and defined carefully to successfully classify remotely sensed data into land-use and land-cover information. This requires the use of a classification scheme containing clear taxonomic definitions. Classes in the system should normally be mutually exclusive, exhaustive and hierarchical (Jensen 2005).

The IPCC Good Practice Guidance suggests six broad categories for representing land areas within a country: forest, cropland, grassland, wetland, settlements and other land (IPCC, 2003). Based on these land-use classifications, countries can estimate changes in carbon and other greenhouse gas stocks and emissions associated with different land uses.

We used the IPCC categories above and also further classified ten categories of land uses: forest (primary forest, secondary forest), shrubland, cropland (paddy field, dryland cultivation, estate croplands, such as coconut plantations), upland grassland, wetland, settlements and others, through direct field work and by referencing earlier reports (Jaya et al. 2011; Korindo 2012). Each class sufficiently represents different land uses on Lombok, reducing possible overlap and omissions as much as possible. The characteristics of each land-use category are described below:

Table 4.1 Satellite datasets used in the study

No	Satellite image	Spatial resolution	Acquisition date		Remarks
			Primary data	Supplementary	
1	Landsat-4 MSS	80 m	8 August 1987	12 March 1991	
2	Landsat-5 TM	30 m	26 May 1995		
3	Landsat-7 ETM+	30 m	19 August 2000	18 May 2001	
4	Landsat-7 ETM+	30 m	13 May 2005	16 May 2006	SLC-off, gap-filled
5	Landsat-7 ETM+	30 m	24 March 2010	15 October 2009	SLC-off, gap-filled

A) 1990 B) 1995 C) 2000 D) 2005 E) 2010

Figure 4.1 Landsat satellite images of Lombok from 1990 to 2010 at 5-year intervals

Forest
Forest includes all land with woody vegetation, consistent with thresholds used to define forest land in a country (i.e. land area more than 0.5 ha with trees higher than 5 m and tree canopy of more than 10%) (FAO 2010). Forest land in Lombok is further subdivided into primary forest and secondary forest. Primary forest in this study is defined as mature or intact forest, where standing stocks have almost reached stability. The forest is generally of native tree species; there are no clear indications of human activities and the ecological processes are not significantly disturbed. Secondary forest is regenerated forest that has been disturbed by human activities or natural disasters; it may include a natural forest with timber extraction, retaining artificial gaps in the tree canopy to 50–60%.

Shrubland
Shrubland refers to land with woody vegetation where the dominant woody elements are shrubs, bushes and young generation trees, and generally less than 5 m in height (FAO 2001a). The latter appears usually after forest clear-cutting activities without crop cultivation.

Cropland
Cropland is arable and tillable land, including rice fields and dryland cultivation areas. Cropland includes land covered with temporary (or annual) crops, followed by harvest and a period of bare soil or fallow. Coconut plantations are considered a sub-category of cropland in Lombok since they have been established for estate crop production.

Upland grassland
Upland grasslands are areas with herbaceous cover, but without crop cultivation. Trees and shrubs can be present, but cover is less than 10%. Upland grassland usually appears around the upper elevations of Mount Rinjani.

Wetland
Wetlands includes areas and lands that are covered or saturated by water for all or part of the year. These include reservoirs, rivers, lakes and streams, and these are classified as either natural or constructed.

Settlement
Settlement comprises all developed land, including areas of human habitation and transportation infrastructure.

Other
This class includes exposed soil, rock and all other unmanaged land areas that do not fall into any of the previous classes.

Image classification and change detection
For image classification, a supervised classification method was principally used. Supervised classification usually requires a *priori* knowledge about the region, where ground truth data has been collected for the training sites that are representative and homogeneous for each land-use class. A multi-date land-use change detection was conducted using a 'binary change mask applied to date 2' algorithm which uses two-image datasets, i.e., Date 1 and Date 2 data (Jensen et al. 1993; Jensen 2005). We selected this method because it provides detailed 'from–to' change information in spite of the complexity of the analysis.

We used the 1995 image as a base image and classified beforehand using a supervised classification method. Change detection using a binary change mask was then applied to the 2000 image, identifying 'changed' areas and producing a classification map of 2000 with the changed information between 1995 and 2000. This process was subsequently applied to 2005, 2010 and again to 1990 (see Figure 4.2).

Results and discussion

Land-use classification
Land-use and land cover data from 1990 to 2010 are summarized in Table 4.2. As of 2010, cropland dominates the land cover of Lombok, comprising 61.4% of the total area. Forest is the second dominant land cover class, covering approximately 118,369 ha, or about 25.8% of the land. Shrubland, occupying 7.5% of the land area, appears around the transition zone between forested and non-forested lands, or along the edges of the Mount Rinjani crater. Because of their similar spectral reflectance signatures, it was difficult to differentiate shrubland from dryland agriculture on Landsat images. Land-use classification maps from 1990 to 2010 are shown in Figure 4.3.

Primary and secondary forests are relatively well distinguished in Landsat imagery. On the Landsat TM false color composite image, the tones of primary forests appear dark reddish brown compared to secondary forests, which usually show a redder and smoother texture than mature forests. Primary forests

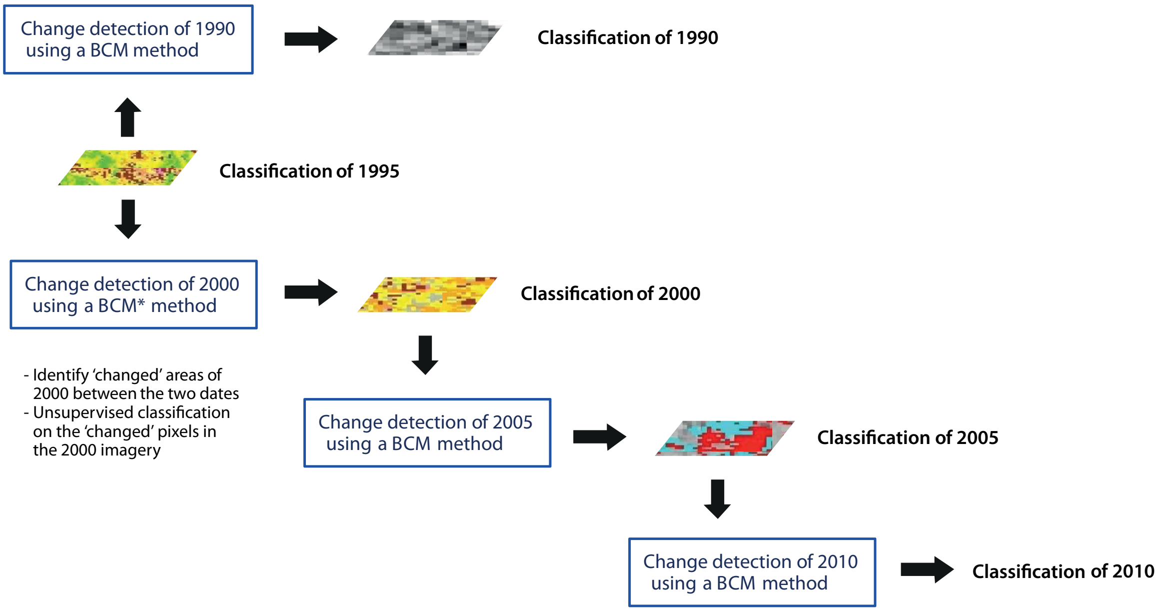

Figure 4.2 Diagram of multi-date image classification and change detection

* BCM: Binary Change Mark

Table 4.2 Land-use classification of Lombok, from 1990 to 2010 (ha)

Class name	1990	1995	2000	2005	2010
Primary forest	66,433.4	54,880.7	53,139.5	51,114.4	51,110.6
Secondary forest	99,299.1	105,064.2	77,452.3	69,752.1	67,258.0
Shrubland	14,119.2	12,767.3	33,626.5	42,051.6	34,418.6
Dryland agriculture	154,337.2	145,704.5	171,472.2	165,500.1	175,844.4
Paddy field	54,010.5	62,834.2	63,822.5	66,286.6	66,213.5
Estate crop	52,957.7	53,067.6	36,975.5	39,263.1	39,119.3
Upland grassland	4,382.9	7,682.8	6,314.9	7,161.4	7,158.0
Wetland	3,439.7	3,329.9	3,328.9	3,346.2	3,346.6
Settlement	3,073.2	7,940.8	7,384.9	8,666.5	8,663.4
Others	6,154.0	4,935.1	4,689.8	5,064.6	5,074.1
Total	**458,207.0**	**458,207.0**	**458,207.0**	**458,206.5**	**458,206.5**

in Lombok are mainly distributed in the remote and hilly areas around Mount Rinjani, while secondary forests are found at low altitudes, near roads and settlements.

When attempting to identify agricultural cropland, the results may vary considerably depending on the date of image acquisition, because crop vegetation grows and is harvested according to seasonal and annual phenological cycles. Lombok is a tropical island with two seasons, a rainy season that begins in November and ceases in March, and a dry season that lasts from March to October. In areas with sufficient rainfall or irrigation, such as in western Lombok, rice is cultivated in paddy fields from December until the following July, and often intercropped with cassava, beans and vegetables. However, in other areas, plants that do not require much water (e.g. corn, peanuts and tobacco) are cultivated during the dry season. A location that could be classified as paddy fields or dryland agriculture in a satellite image will therefore depend

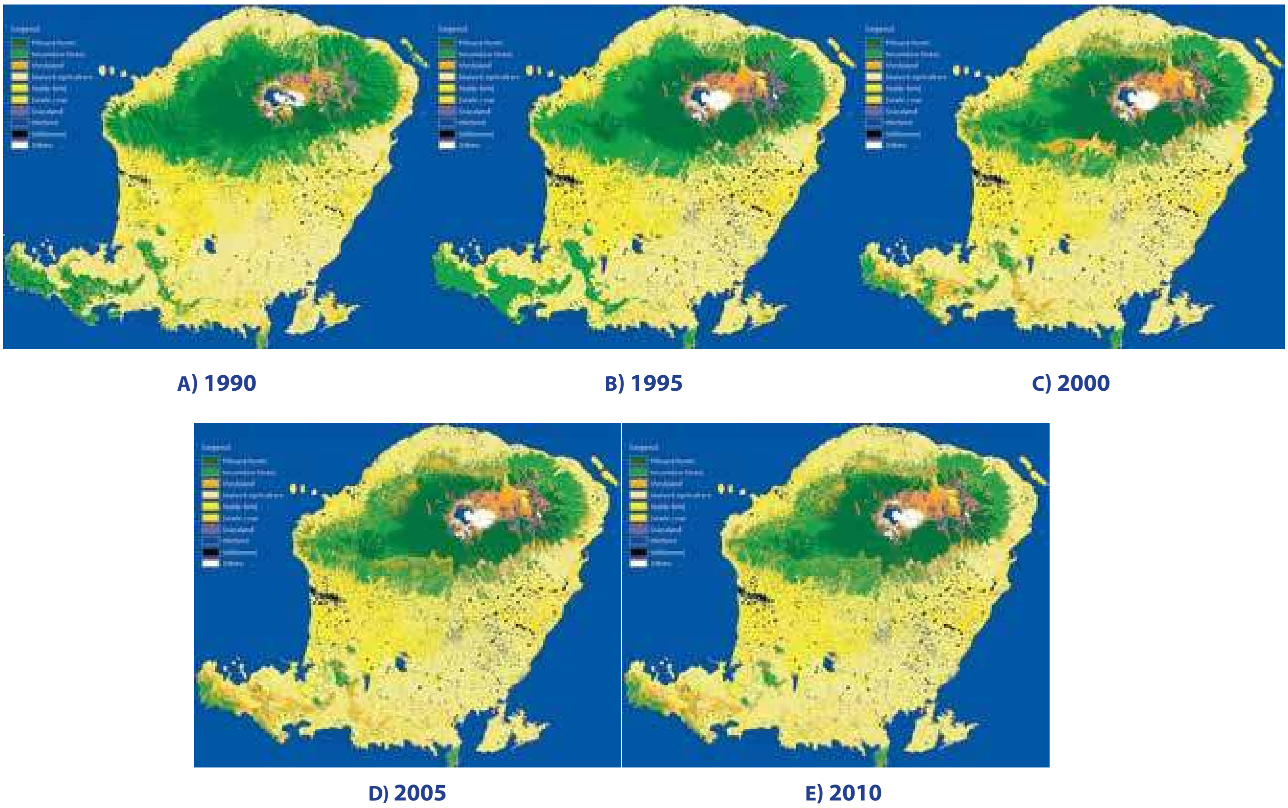

Figure 4.3 Land-use classification of Lombok from 1990 to 2010

on the date or season of observation. During the growing season, paddy fields exhibit a pink color in Landsat false color images, while dryland cultivation areas show light brown colors, often leading to confusion with shrubland. Therefore, comparing the area of paddy fields to dryland agriculture in Lombok is insignificant, although the total is somewhat indicative.

Coconut palm plantations constituted 39,119 ha or 8.5% of the total land area of Lombok. In tropical and subtropical regions, coconut is quite common, as it provides for many household necessities, including food, fiber, timber and fuel. Coconut is usually found from sea level to 150 m, but grows up to 600 m in elevation near the equator (Chan and Elevitch 2006). In Indonesia, it is illegal to plant coconut within designated forest areas, so they are generally established on private lands, either as a monoculture or mixed with other tree crops. Coconut is an estate crop like oil palm and both are woody perennials with a more or less defined crown, consistent with the threshold for definition of forest. For this reason, they are sometimes included within the forest category (FAO 2001b; FAO 2007). In this study, however, we decided to place estate croplands, such as coconut plantations, as part of cropland, as they represent human-induced encroachment. From Landsat imagery, this class exhibits a light orange color, but may appear similar to secondary forest. In Lombok, most coconut trees are distributed along the coastal areas and often on the slopes of lowland hills.

Shrubland is a type of wooded land area covered with shrubs, and intermixed with sprouts, saplings, or brush vegetation. It often occurs after forest clear-cutting, and appears around the edges of the volcanic crater. Shrublands are also found in arid and semiarid regions of eastern Lombok, occasionally in forest transition areas. These areas are often mixed with croplands, forests or other land uses. Vegetation height is relatively short and cover is sparse, so shrubland shows as light red on the Landsat TM false color composite image.

Classifying shrubland as a distinct subclass is unique to this study and is based upon the local context of land-use changes. FAO guidelines generalize land cover to forest, wooded lands and other land uses in

Table 4.3 Land-use and land-cover transition in Lombok, 1990 to 2010

		2010							
		Forest	Shrubland	Cropland	Grassland	Wetland	Settlement	Others	Total
1990	Forest	113,291.6	22,420.6	25,749.0	3,154.9	21.7	112.2	982.5	165,732.5
	Shrubland	1,054.0	5,608.9	5,992.5	894.6	6.0	114.5	448.8	14,119.2
	Cropland	3,370.9	4,810.5	245,739.9	770.6	477.1	5,173.2	963.2	261,305.5
	Grassland	228.7	1,351.7	413.6	2,302.7	0.3	0.6	85.3	4,382.9
	Wetland	13.6	4.4	405.9	0.2	2,437.4	220.7	357.5	3,439.7
	Settlement	1.0	1.2	414.3	0.2	7.9	2,627.0	21.7	3,073.2
	Others	408.8	221.4	2,462.1	34.7	396.2	415.2	2,215.6	6,154.0
Total		**118,368.6**	**34,418.6**	**281,177.2**	**7,158.0**	**3,346.6**	**8,663.4**	**5,074.6**	**458,207.0**

Table 4.4 Land-uses of KPHL Rinjani Barat from 1990 to 2010 (ha)

Class name	1990	1995	2000	2005	2010
Primary forest	22,839.3	16,509.5	16,439.8	15,804.0	15,772.5
Secondary forest	15,969.3	21,656.5	17,803.1	15,955.3	15,905.6
Shrubland	224.2	454.7	3,742.0	6,266.9	5,389.8
Dryland agriculture	121.0	169.5	888.4	852.7	1,661.0
Paddy field	94.4	113.9	105.3	104.4	102.0
Estate crop	212.6	76.7	43.3	41.2	40.0
Grassland	80.4	529.9	488.1	485.7	481.7
Wetland	5.8	0.0	0.0	0.0	0.0
Settlement	0.1	2.3	2.0	1.8	1.7
Others	52.7	86.7	87.8	87.7	85.8
Total	**39,599.6**	**39,599.6**	**39,599.6**	**39,599.6**	**39,440.3**

monitoring the world's forests through the Forest Resources Assessment Programme (FAO 2010). Here, shrubland is categorized as a subclass of other wooded land, which refers to "land not classified as forest", with a crown cover of 5–10% of trees able to reach a height of 5 m at maturity, or with a combined cover of shrubs, bushes and trees greater than 10% (FAO 2001a). The definition of forest by the UNFCCC and FAO includes areas that are temporarily unstocked as a result of human interventions, such as harvesting or natural causes, and which are expected to regenerate or return to forest within several years. In this context, shrubland classified through image interpretation in this study may include certain areas that are 'temporarily unstocked' due to clear-cutting or overexploitation, i.e. they are assumed to be non-forests, but are expected to regenerate, and therefore may be included as forest in the future. In this study we inferred such unstocked land area and shrubland as forest degradation for the present time, since they suffer structural and functional changes that reduce biomass and the capacity of the forest to provide goods and services. However, there remained some difficulties in differentiating such future forests from genuine arid or alpine shrubland with Landsat satellite images.

For the accuracy assessment, an error matrix was created (Congalton 1991; Foody 2002) for the 384 reference points to compare the land-use classification results obtained by satellite data analysis with the reference or ground truth data. The overall assessment of accuracy was 75.3%, and the kappa coefficient was 70.1% for the study. Major errors were due to the confusion between secondary forest and coconut plantations, and low separation between shrubland and dryland agriculture.

Land-use change

Forest land in 1990 was estimated at 165,732 ha, or 36% of the total land area on Lombok (Table 4.3). Since then, forest land has decreased by 47,363 ha over the past 20 years. This means that 28.6% of forests (based on 1990 figures) have been converted to non-forest land use, and mostly to cropland and shrubland. Forest land decreased most significantly during the 5-year period from 1995 to 2000. The forested areas in the southwestern parts of the island revealed much greater deforestation, while the central and northern regions around Mount Rinjani showed deforestation mostly along the forest edges, characterized by a pattern of frontier deforestation and forest degradation due to agricultural land expansion.

KPHL Rinjani Barat

Land use and land-use changes in the KPHL Rinjani Barat, are presented in Table 4.4. In 2010, primary forests and secondary forests comprised 80.3% of the total land area of this region, shrubland accounted for 13.7%, and agricultural land 4.5%, respectively. Forest cover in the area was more than 95% until 1995, with persistent decreases since then, and with an increasing tendency for conversion to shrubland. From 1995 to 2010, forest area decreased by 432 ha annually, and from 1990, a total forest cover of 7,130 ha (18.0%) has been deforested or degraded in some way. The pattern of forest cover decrease is both of a mosaic character and shows particular impacts along the forest boundary. Significant deforestation and conversion to agricultural land is particularly noted near the resort area of Senggigi.

Each province in Indonesia has its own history, and the drivers of forest cover change are very much influenced by a confluence of national and local factors. For example, forest fires played a major role in forest clearing in South Sumatra (Tacconi, 2003), while expansion of rubber plantations was the primary source of forest degradation in Jambi (Ketterings et al. 1999). In general, high rates of forest loss and fragmentation have been due to concession-based timber extraction, establishment of oil palm and pulp plantations, and weak governance institutions (Holmes 2002; Curran et al. 2004). In Lombok, patterns of deforestation and forest degradation are affected by unique local drivers, including demographic changes, development, and other socioeconomic conditions. The analysis of these factors in the KPHL Rinjani Barat, and their impacts on forest health are reviewed and analyzed in Chapter 6.

5. Estimation of carbon stock and carbon stock change

Forest carbon estimation and monitoring for REDD+ projects must comply with international agreements and standards, in order to maintain consistency and precision in these measurements. UNFCCC requires that countries follow IPCC guidelines regarding land use and forest carbon stock changes in GHG emissions (IPCC, 2003, 2006), and recommends the use of remote sensing and ground-based forest carbon inventory approaches in combination to estimate forest carbon stock for REDD+ (UNFCCC 2009). The IPCC (2003, 2006) suggests that carbon stock changes should be calculated and reported for the main carbon pools in the forest ecosystem, i.e. living biomass of trees, dead mass of litter, woody debris, and soil organic matter.

However, it is important to adopt an appropriate research design and methodology to fit each country's unique circumstances and needs, rather than applying a single uniform standard. In this study, we conducted surveys of the carbon stock for primary forest, secondary forest and shrubland. We estimated forest carbon stock for five carbon pools: aboveground biomass (big trees, smaller trees, saplings, understory vegetation), belowground biomass (roots), dead wood (standing and fallen deadwood, stumps), litter and soils. We applied these figures in establishing a reference emission level (REL) and quantifying the amount of avoided emissions in the KPHL RB.

Methodology and data collection

Sample size and arrangement

We used stratified sampling methods to estimate carbon stock in the KPHL RB, relying on land-use classifications (outlined in Chapter 4) for forest area estimation and stratification, and carried out ground surveys to determine forest carbon stock by stratum. The number of sample plots (*n*) for estimating carbon stock was determined with the following equation (1): (Pearson et al. 2007; Hirata et al. 2012)

$$n \geq (tc/e)^2 \quad (1)$$

where *e* is the allowable error rate, *c* is the expected coefficient of variation, and *t* is the value for a 95% confidence interval at the specified degree of freedom. The value of *t* is constant and usually substituted by 2. We applied an error rate of 12%, since previous experience suggests that the permissible error rate in a tropical forest is approximately 10% (Hirata et al. 2012), and no more than 20% (MoF 2011). The coefficient of variation (40%) was obtained by referencing other survey results from nearby forests in Lombok (KORINDO 2011). Based on the above equation, we identified a total of 45 sample plots. Using the Neyman optimum allocation method (Bartlett et al. 2001), we divided the sample plots by forest stratum, i.e. 26 sample plots for primary forest, 15 plots for secondary forest, and 4 plots for shrubland, respectively, and distributed the sample plots randomly within the stratum (Figure 5.1).

To estimate forest carbon stock by carbon pool in the KPHL Rinjani Barat, the shape of the sample plot was designed to be rectangular (0.1 ha.), with nested compartments of different sizes (Figure 5.2). Trees (DBH ≥ 20 cm) were inventoried within the base plot (Plot A), and deadwood, trees of small diameter (10 cm < DBH ≤ 20 cm), and saplings (2 cm < DBH ≤ 10 cm, height ≥ 1.5 m) were surveyed within subplots B, C and D, respectively. Understory vegetation, litter and soil were surveyed in subplot E. This survey system supports two replication measurements for small diameter trees, undergrowth vegetation and litter, and three replications for soil carbon.

Field measurement and analysis

We estimated forest carbon stock in the KPHL RB based on field measurements for five carbon pools: aboveground biomass, belowground biomass, deadwood, litter and soil. Direct measurement of carbon stock was conducted for all of the carbon pools except belowground biomass, for which we indirectly measured the amount of carbon stock using an estimation model. Staff of the Korea Forest Research Institute and survey crews of the KPHL RB conducted field surveys from June to August 2013.

Aboveground biomass is comprised of standing trees and undergrowth vegetation. All tree species

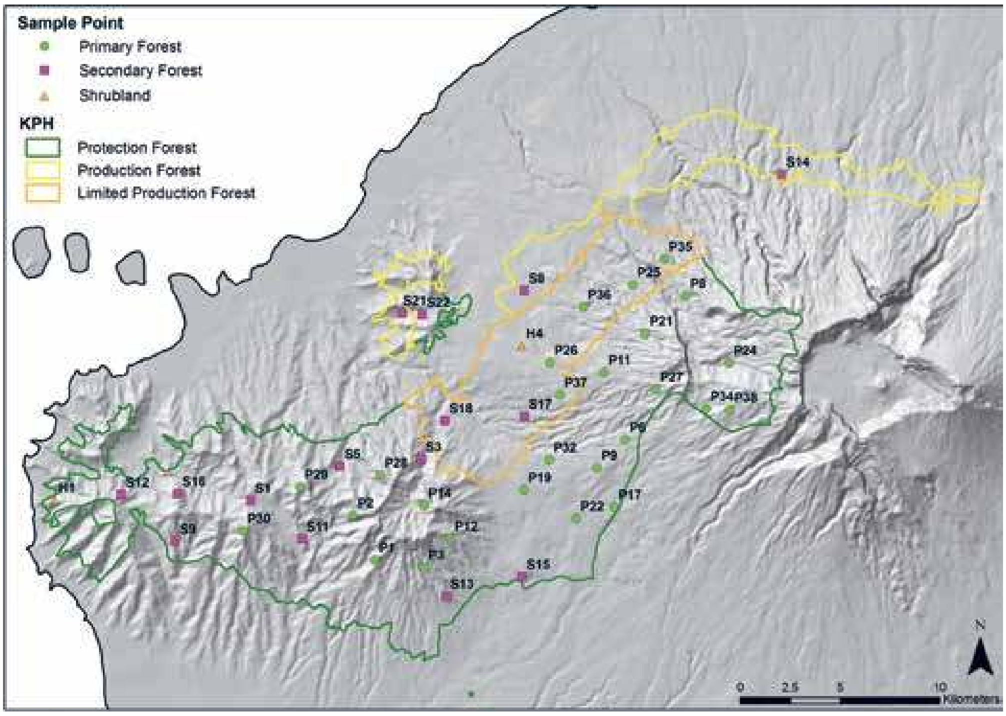

Figure 5.1 Location of the sample plots

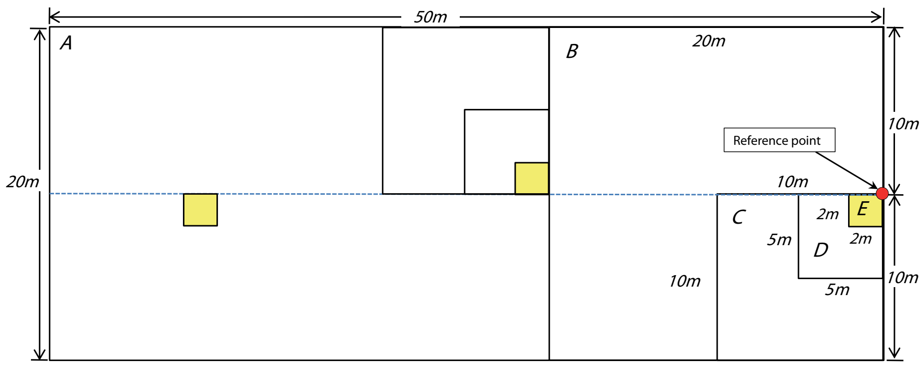

Figure 5.2 Sample plot design

were measured in plot A and within subplots C and D, including identified saplings and their diameter at breast height, or DBH (1.3 m). Tree volume and biomass were then calculated using the relevant allometric equation (Basuki et al. 2009; Ministry of Forestry 2012).

$$V = 0.000051464D^{2.5874} \quad (2)$$

$$LnAGB = -1.201 + 2.196lnD \quad (3)$$

Understory vegetation was obtained by the destructive harvesting method, which involves cutting and harvesting all aboveground herbaceous material within the relevant subplot. After measuring total fresh weight, samples of approximately 300 g were taken, weighed, and ovendried in a laboratory. Total undergrowth biomass was calculated based on the dry weight/fresh weight ratio. Litter was gathered within subplot E, and litter biomass calculated using the method described for understory vegetation.

Deadwood, both standing and on the ground, includes all nonliving stems and branches longer than 1 m, and 10 cm or larger in diameter. Deadwood was subdivided into standing deadwood, deadwood lying on the ground and stump, by type. For any deadwood within subplot B, wood volume was measured and decay class examined to the level of intactness for biomass estimation. Total organic matter of the deadwood was derived by multiplying wood volume by wood density.

For standing deadwood, the biomass was estimated with the same allometric equations used for trees. In this case, the estimated biomass is further adjusted with a correction factor of 0.9 (A), 0.8 (B) and 0.7 (C), respectively, according to the decay class, defined as: A: dead trees without leaves, B: dead trees without leaves and twigs, and C: dead trees without leaves, branches and twigs (MoF 2011). Belowground biomass (roots) was estimated based on the root/shoot ratio developed and generally used in tropical countries, as indicated by a basic default of 0.27 (IPCC 2006).

Calculation of carbon

Carbon content in trees, undergrowth vegetation and dead organic matter (litter and deadwood) was calculated from the biomass, using equation (4), its basic concept is consistent with relative IPCC equations (IPCC 2003, 2006):

$$C_b = Biomass \times CF \quad (4)$$

where C_b is the carbon content from biomass, *Biomass* is the total biomass of each pool, and *CF* (carbon fraction) is the percentage value of content, amounting to 0.47 in Indonesia. Soil carbon was analyzed in the laboratory using the Wakley and Black method (SSSA 1994), with soil samples collected during field surveys. Carbon stock for each the five carbon pools is then obtained for each sample plot and converted to an amount per hectare. The total carbon stock in one stratum was calculated by multiplying the mean value of carbon content per hectare by the area of the stratum, obtained through analysis of satellite images.

Results and implications

1. Forest survey

Overstory and understory vegetation

This area is a naturally regenerated deciduous forest (primary and secondary forest) that is dominated by *Eugenia polyantha* and *Callophylum inophyllum*; the shrubland is dominated by *Mangifera foerida* and *Duabanga mollucana*. The average DBH and tree height (H) were 33.4 cm and 16.0 m (Table 5.1). The number of trees per hectare for primary forest was 1094, secondary forest 1059 and shrubland 205, respectively. The volume stock was 137.1 m^3/ha of primary forest, 130.3 m^3 of secondary forest and 23.8 m^3/ha of shrub land. There was no significant difference between the volume calculated for primary forest and that obtained for secondary forest, although our figures are somewhat higher than the average 79 m^3 in Indonesia (IPCC 2003). In the previous survey, the protected forest showed volume stock at 92.0 m^3/ha (Ministry of Forestry 2010).

On the other hand, the most common understory woody vegetation (sapling) is *Eugenia polyantha* in primary forest, *Schoutenia ovate* in secondary forest and *Artocarpus elasticus* in shrubland. The abundance and frequency of understory species differs depending on land-use type; more understory species are found in the forest area than in shrubland, and the frequency of saplings in primary forests is almost twice that in secondary forest. In general, light and soil conditions are significant influences. The proportion of understory biomass (woody plus herbaceous) to aboveground biomass (overstory plus understory) ranges from 1.2% to 6.3%, which

Table 5.1. DBH and height of trees by forest type

Land-use type	Area (ha)	DBH (cm)	Height (m)	Stand density (trees/ha)	Volume (m^3/ha)	Dominant species
Primary forest	15,772.5	33.9 (±6.24)	17.1 (±3.66)	1,094	137.1	*Eugenia polyantha* (18.7%)
Secondary forest	15,905.6	37.1 (±15.91)	16.4 (±3.79)	1,059	130.3	*Callophylum inophyllum* (11.0%)
Shrubland	5,389.8	30.2 (±5.94)	15.6 (±4.60)	205	23.8	*Mangifera foetida* (36.4%)

Table 5.2 Soil characteristics by forest type and soil depth

Forest type	Soil depth cm	Bulk density g/cm³	Coarse fragment %	Carbon concentration %
Primary forest	Total	0.57bc	0.52a	5.29a
	0–10	0.58	0.53	5.52
	10–20	0.55	0.53	5.07
	20–30	0.57	0.51	5.28
Secondary forest	Total	0.68ab	0.48a	3.33b
	0–10	0.69	0.46	3.58
	10–20	0.67	0.49	3.47
	20–30	0.67	0.48	2.95
Shrubland	Total	0.66ab	0.54a	3.09b
	0–10	0.66	0.45	2.70
	10–20	0.62	0.64	3.50
	20–30	0.69	0.53	3.50

Note: Mean with different letters within columns are statistically different at $p<0.05$.

is negatively correlated with total aboveground biomass. Son et al. (2004) explained that light interception by overstory vegetation seems to influence production of understory vegetation.

Soil

Soil characteristics are shown in Table 5.2. Average bulk density and carbon concentration vary significantly among forest types based on differences in forest history and/or management. Although there were no significant differences among soil depths, carbon concentration tended to be higher in the upper layer (0–10 cm) than in deeper depths (10–20 cm, 20–30 cm) for primary and secondary forest. In the case of shrubland, however, carbon concentration was lowest in the upper soil layer and increased with soil depth, influenced by reduced litter content and increased soil hardness due to human disturbances on the surface.

2. Forest carbon stock

Calculation of forest carbon stock for each carbon pool and forest type is presented in Table 5.3. The total carbon stock (tC/ha) is 206.68 tC/ha for primary forest, 181.1 tC/ha for secondary forest and 75.3 tC/ha for shrubland. The average carbon stock for aboveground primary and secondary forest is 103.8 tC/ha. The average carbon stock in the aboveground measurements for the three land-use types is seen as the highest, with 78.0 tC/ha (47.5 %). Carbon stock for soils followed, with a mean of 34.7 tC/ha (24.0%). The carbon stock for soil and aboveground comprises 71.5 % of the total.

The results of previous studies estimating aboveground carbon stock for West and Central Lombok are summarized in Table 5.4. Carbon stock (tC/ha) ranges from 98.0 tC/ha for tropical dry forest in West Lombok to 334.5 tC/ha for Central Lombok (<1500 m). Except for the high elevation area in Central Lombok (334.5 tC/ha), the values are similar to the results for primary and secondary forests in this study. These values are similar to those reported in other studies, which ranged from 78 to 169 tC/ha in tropical regions (IPCC 2003; Gibbs and Brown 2007).

3. Forest carbon stock change

Based on land-use changes classified using Landsat images during the past 20 years (Table 4.4), figures for total forest carbon stock of KPHL Rinjani Barat are presented in Table 5.5.

Carbon stock decreased dramatically from 1990 to 1995 (from 4,729,236 tC to 3,410,636 tC). Due to the decrease in the total area of primary forest, carbon stock in these forests showed a decrease of 1.56% from 1990 to 1995, using 2010 as a standard. In contrast, the total area of secondary forest increased during this time, resulting in an increase in forest carbon stock from 2,891,347 tC to 3,921,216 tC. Note that the annual change in shrubland increased dramatically during this time

(115.2%). The soil carbon stock declined following conversion from native forest to plantation (-13%), native forest to agricultural land (-42%), and pasture to cropland (-59%) (Guo et al. 2002). The total carbon stock decreased at a rate of -0.72% annually, compared to the carbon stock of 2010.

Table 5.3 Carbon stock by land use type (tC/ha)

Forest Type \ Carbon pool	Total	Living vegetation				Dead wood	Litter	Soils
		Above-ground			Below ground			
		Sub-total	Tree	Undergrowth				
Primary forest	206.6 (±76.66)	109.9	108.6 (±59.89)	1.3 (±1.15)	29.7 (±16.12)	18.3 (±26.05)	1.7 (±1.25)	47.0 (±17.52)
Secondary forest	181.1 (±120.88)	97.8	96.2 (±85.74)	1.6 (±0.99)	26.4 (±23.03)	21.4 (±31.73)	1.8 (±0.84)	33.7 (±13.08)
Shrub land	75.3 (±6.74)	26.5	24.8 (±2.30)	1.7 (±0.98)	7.2 (±0.89)	16.7 (±6.76)	1.6 (±0.43)	23.4 (±3.72)

Table 5.4 Carbon stock (tC/ha) in other studies

Location	Elevation	Forest type	Pool	Carbon stock (tC/ha)	Reference
West Lombok, Indonesia	-		Above ground biomass	98.0 (84.3–169.6)	Takwim 2011
				125.7	FORDA 2012
Central Lombok, Indonesia	<1500 m	Natural forest		166.8	KORINDO 2011
	>1500 m			334.5	

Table 5.5 Carbon stock (tC/ha) changes by forest types (1990–2010)

Forest type	1990	1995	2000	2005	2010
Primary forest	4,729,236	3,410,636	3,396,175	3,264,790	3,258,386
Secondary forest	2,891,347	3,921,216	3,223,411	2,888,812	2,879,940
Shrubland	16,865	34,257	281,735	471,842	405,738
Total	**7,637,448**	**7,366,109**	**6,901,322**	**6,625,445**	**6,544,065**

6. Understanding drivers of deforestation and forest degradation

As outlined in Chapters 4 and 5, we analyzed land-use and forest carbon stock changes to identify where and when forest areas in the KPHL RB became deforested. Significant deforestation (and decreasing forest carbon stocks) occurred between 1995 and 2000, but the rate of deforestation has generally decreased since 2000. The deforestation has been spatially identified as primarily along the frontier, or forest margins (see Figure 4.4). In this chapter, we describe the social and economic factors behind this observed deforestation in forest margin communities. Understanding the dynamics between socioeconomic factors and forest cover change is essential for projecting future trends and developing potential intervention strategies to reduce deforestation and forest degradation (Lambin et al. 2001).

Methods

Lack of proper documentation, limited reliability of demographic data and low literacy rates are common challenges of socioeconomic research in developing countries, and these were certainly important considerations for designing our research methodology. We relied on multiple methods for data collection and analysis, including review of available secondary data, as well as direct, community-based survey methods, such as participatory rural appraisal (Chambers 1994; Pretty 1995). The use of these multiple methods helped validate the varied and sometimes inconsistent secondary data obtained from the KPHL RB, and from village, subdistrict, district, and provincial government sources.

Within the KPHL RB, we conducted village-level research in the districts of West Lombok (including the four subdistricts Narmada, Lingsar, Gunungsari and Batu Layar) and North Lombok (including the five subdistricts: Tanjung, Pemenang, Gangga, Kayangan and Bayan) (KPHL RB 2012). We worked closely with the KPHL RB to identify appropriate administrative villages and hamlets within the forest management unit.

We selected 13 villages (and 14 study sites) among the 38 administrative villages around the KPHL RB (see Figure 6.1). The locations for focus group discussions (FGDs) and household surveys were selected for representation and diversity, based on their proximity to forests with different designated functions (HL and HP) and forest governance status (e.g. HKm, HTI, HA and KPH).

Each of the FGDs was attended by at least 25 participants, and we sought balanced representation in terms of age, livelihood activities and income levels, and local/indigenous people and migrants. However, we acknowledge that most of the FGD participants were men, and we did not conduct separate FGDs for women. For household-level surveys, we selected 420 households from among the 14 study sites (30 households per site), and these households consisted of two groups – families working within, and those working outside the forest area. The proportion of those whose livelihoods depend on resources within the forest area is about 70%, or 292 households, and the remainder – those whose livelihoods do not directly depend on forest resources – is 128 households. Households were selected using simple random sampling for the two groups.

In this chapter, we briefly summarize the social and economic factors driving deforestation and forest degradation in the KPHL RB. In-depth analysis of both qualitative and quantitative information is ongoing, and will be developed as separate publications.

Table 6.1 presents the general profiles of the 13 villages and 14 study sites, and the summary statistics of demographic information collected through household surveys. Considering average per capita income (USD$669/yr) and household size (3.59) (see Chapter 2), the sampled population for this study represents a range of diverse social and economic conditions (per capita income ranging USD$260–1033/yr and average household size 2.8–4.37), as well as different geographic locations, nearby forest functions and governance status.

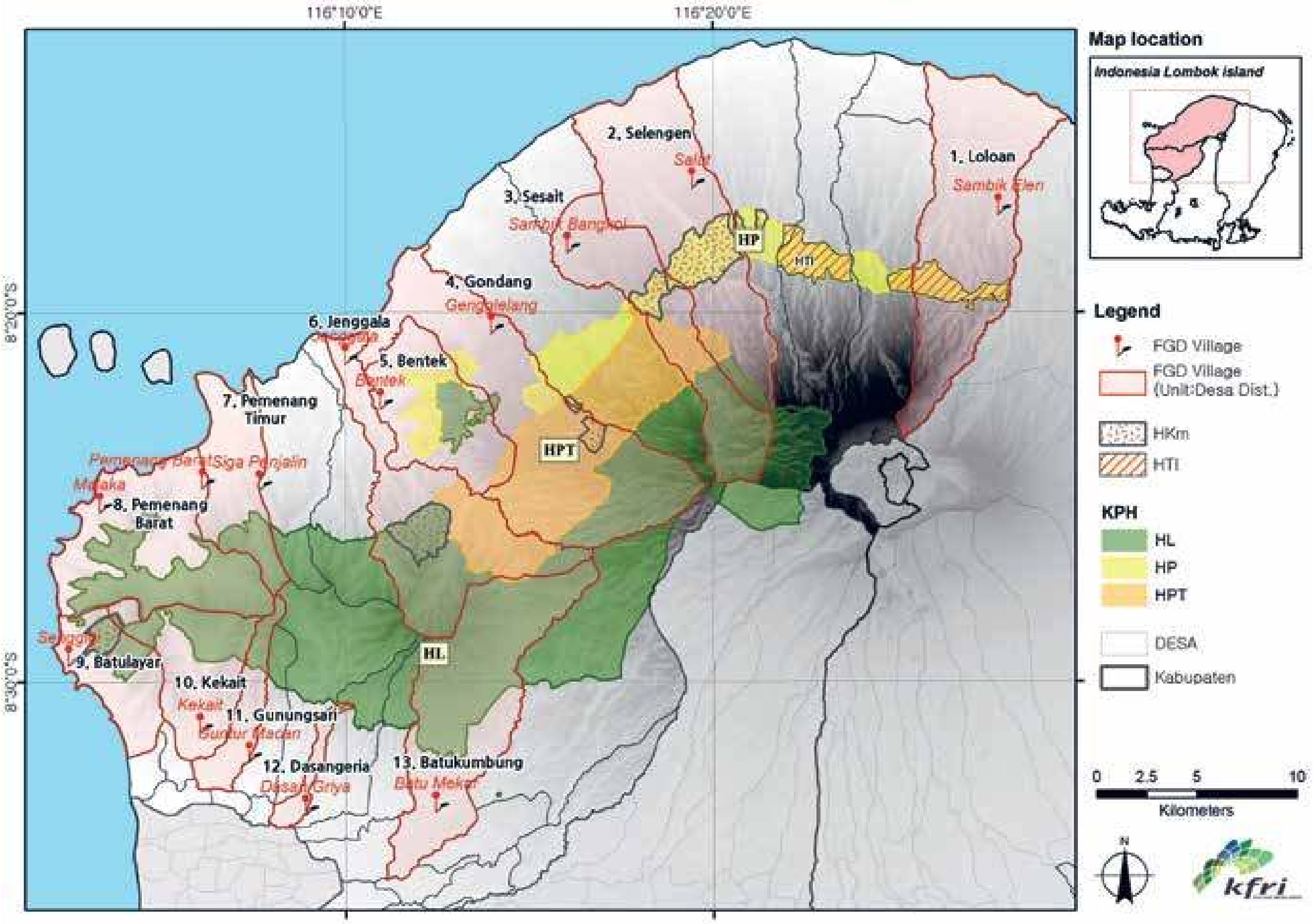

Figure 6.1 Map of study village locations

Table 6.1 Forest governance and forest functions of nearby forests for 14 FGDs and household survey locations

No.	Village (*Desa*)	FGD locations	Governance	Nearby forest function	Household sizes[1]	Per capita income per year (USD)*
1	Loloan	Sambik Elen	HTI	HP	4.03	482
2	Selengen	Salut	HKm	HP	3.83	404
3	Sesait	Sambik Bangkol	KPH	HL/HP/HPT	3.03	747
4	Gondang	Genggelang	KPH	HL/HP/HPT	3.07	802
5	Bentek	Bentek	KPH	HL/HP/HPT	2.90	494
6	Jenggala	Jenggala	HKm	HL/HPT	4.00	260
7	PemenangTimur	Sigar Penjalin	KPH	HL	4.27	321
8	Pemenang Barat	Pemenang Barat	KPH	HL	4.37	477
9	Pemenang Barat	Malaka	KPH	HL	3.60	640
10	Batulayar	Senggigi	HKm	HL	3.48	739
11	Kekait	Kekait	KPH	HL	4.90	567
12	Gunungsari	Guntur Macan	KPH	HL	2.83	635
13	DasanGeria	Dasan Griya	KPH	HL	2.90	1,033
14	BatuKumbung	Batu Mekar	KPH	HL	2.80	482

* Household survey at 14 locations.

Factors driving deforestation and forest degradation

Population

Population figures in the subdistricts surrounding the KPHL RB increased steadily during 1990–2010, although the growth rate per year has been decreasing (see Chapter 2). With limited arable land and development opportunity, the increase in population intensifies pressure on forests to meet the growing demand for food and fuel.

Overall, population growth shows a strongly positive correlation with deforestation and forest degradation. The village of Batu Layar, the center of the Senggigi Beach resort area, shows relatively high population increase (average 4.4% per year), and a similar high rate of forest cover loss (2.59% per year). Similarly, Batu Mekar, with a lower population increase (0.9% per year), shows a lower rate of forest cover loss (0.49% per year). Population increase is clearly an important driver of forest cover loss within the study area (see Table 6.2 and Figure 6.2).[6]

As discussed in previous chapters, the deforestation in the KPHL RB (0.75% per year) reflects conversion to shrubland (5139 ha) and to cropland (1664 ha). Conversion to shrubland implicates large-scale wood extraction, both legal and illegal, but conversion to cropland is largely due to agricultural expansion. In most of the study villages, FGDs revealed that local community residents and outsiders (immigrants) entered into forest areas, occupying particular lands with the intention of expanding agricultural production, which, as noted in Chapter 3, has been a common phenomenon in the history of deforestation and forest degradation in the KPHL RB.

Fuelwood to meet energy demand

Local residents use fuelwood for domestic needs and industrial uses, including both home industries and larger industrial needs. Most households still use fuelwood as their primary energy source, due to its relatively easy accessibility and low (or zero) cost. Almost all families (95.8%) gather fuelwood from their own or neighbors' farms or from nearby forest areas. Fuelwood consumption by household varies between 0.025 m^3 and 0.092 m^3 per day, with an average of 0.074 m^3 per day. However, only four (out of 349 responses) reported fuelwood consumption of more than 0.28 m^3 per day, and median fuelwood consumption is 0.040 m^3 per day.[7] Our surveys show that 30% of households collect fuelwood from forest areas. A summary of fuelwood demand in the study area is presented in Table 6.3.

Several households reported fuelwood consumption at more than 0.1 m^3 per day; this use includes local home industries producing palm sugar, tofu, tempeh, candies and other delicacies. These localized home industries appear to have a major impact on overall fuelwood consumption in forest margin communities.

However, the largest consumer of fuelwood in Lombok is the tobacco industry, as tobacco drying requires significant quantities of fuelwood (Agusdin 2012). In one of the study sites (Sambik Elen), a relatively isolated community in northern Lombok, the daily collection and transport of fuelwood was reported at between two and eight truckloads (approximately 80 to 240 m^3) during the tobacco harvest season (July to October).

Illegal logging and expansion of infrastructure

Illegal logging still occurs widely throughout the KPHL RB (2012) and it has increased with access to advanced wood harvesting technology (particularly the use of chainsaws) and with improved roads and transportation. Infrastructure is considered a critical factor in supporting economic development, but it has had the unintended consequence of accelerating deforestation and forest degradation, as improved accessibility to better roads and markets facilitate the production, transport and trade of a variety of forest products.

While improved roads and transportation are frequently cited as direct drivers of deforestation and forest degradation (Geist and Lambin 2001) they are part of the overall marketing system that influences the exploitation of forest resources. In the KPHL RB, markets and sawmills are yet another important factor, with significant registered wood

6 Nevertheless, several of the vilages with high population growth are also those that have benefited from improved infracture and access. Population growth and infrastrucure improvements therefore appear to be strongly correlated in our analysis.

7 By excluding the four responses with consumption greater than 0.28 m^3, the daily average consumption of fuelwood is only 0.047 m^3 per household.

Table 6.2 Population growth and deforestation rate by village (*desa*)

Village	Study sites	Forest cover[1]						Population[2]		
		1995	2000	2005	2010	ha	%/yr	2000	2010	%/yr
Loloan	Sambik Elen	2,699	2,224	1,988	1,817	-882	-2.2	5,527	6,812	2.3
Selengen	Salut	3,650	2,913	2,711	2,605	-1,045.2	-1.91	7,394	8,406	1.4
Sesait	Sambik Bangkol	2,943	2,762	2,642	2,609	-333.8	-0.76	5,900	5,969	0.1
Gondang	Genggelang	6,683	6,294	5,730	5710	-972.7	-0.97	9,145	10,566	1.6
Bentek	Bentek	2,503	2,263	2,109	1,950	-553.3	-1.47	7,282	8,099	1.1
Jenggala	Jenggala	4,823	4,688	4,489	4,463	-360.9	-0.50	6,255	7,453	1.9
Pemenang Timur	Sigar Penjalin	821	650	599	553	-267.4	-2.17	6,526	7,882	2.1
Pemenang Barat	Pemenang Barat/ Malaka	3,193	2,417	2,156	1,761	-1,431.2	-2.99	11,651	13,086	1.2
Batu layar	Senggigi	1,055	798	750	645	-410	-2.59	11,077	15,971	4.4
Kekait	Kekait	2,472	2,314	2,204	2,197	-275.1	-0.74	5,568	6,431	1.5
Gunungsari	Guntur Macan	776	708	670	680	-95.2	-0.82	N/A	2170	-
Dasan Geria	Dasan Geria	158	154	149	147	-11.1	-0.47	3,823	4,449	1.6
Batu Kumbung	Batu Mekar	5,422	4,881	4,775	5,023	-398.8	-0.49	8,095	8,807	0.9
Average							**-1,50**			**1.7**

Notes:

1 Forest-cover change is the average rate of land-use class conversation (1995–2010) from primary or secondary forests to other land uses within the administrative boundary of each village (*desa*).

2 Population data was unavailable for many of the villages before 2000 with reshaping of administrative boundaries. Population information of Gunungsari is also unavailable in 2000.

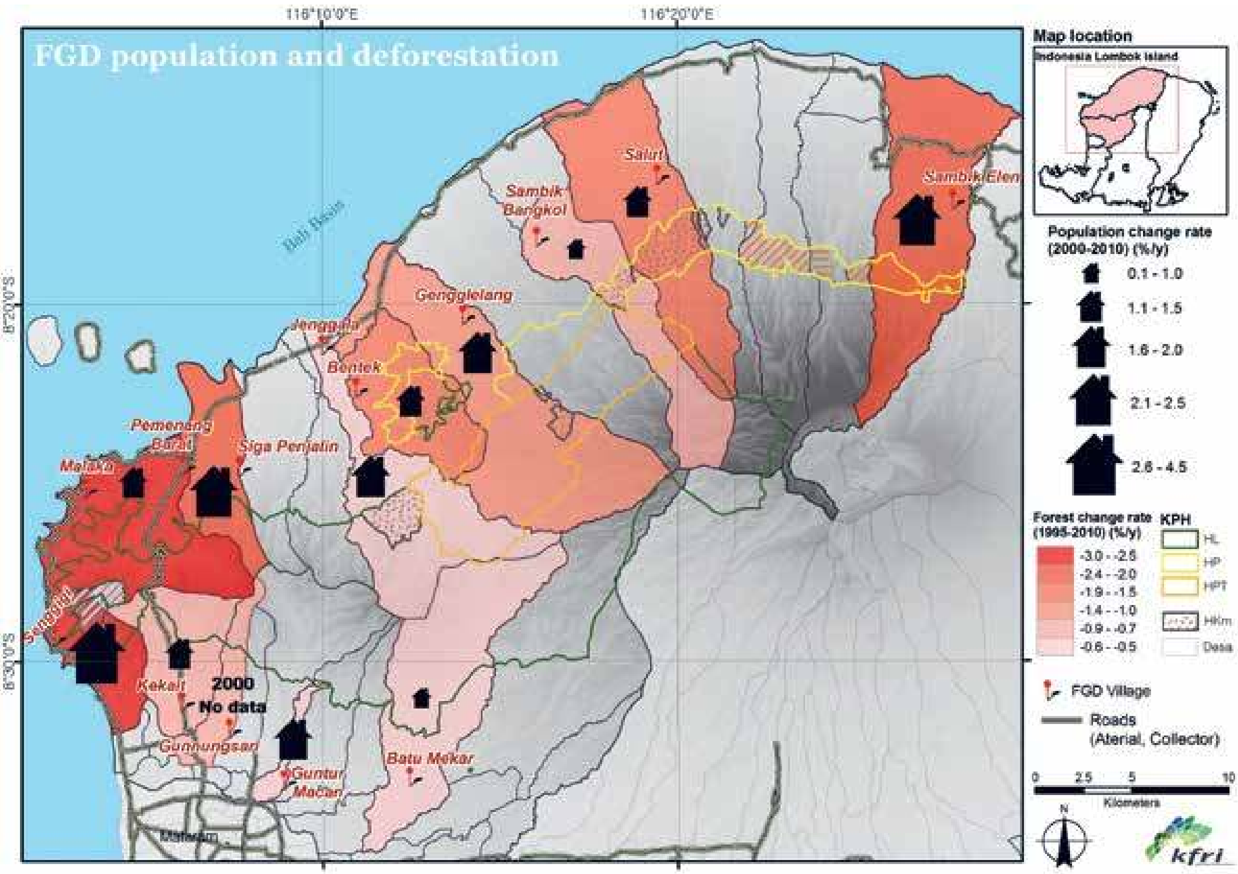

Figure 6.2 Population growth rates and forest change

Table 6.3 Fuelwood demand within the study area

Village	Population and household		Fuelwood demand			
	Population[1]	HH[2]	m^3/day, HH[3]	m^3/yr District[4]	% usage[5]	m^3/yr% District[6]
Sambik Elen	6,812	1,892	0.044	30,389	100	30,389
Salut	8,406	2,335	0.042	35,885	66	23,684
Sambik Bangkol	5,969	1,658	0.043	26,256	87	22,843
Genggelang	10,566	2,935	0.080	85,702	97	83,131
Bentek	8,099	2,250	0.040	32,846	76	24,963
Jenggala	7,453	2,070	0.036	26,868	93	24,987
Sigar Penjalin	7,882	2,189	0.025	20,218	100	20,218
Pemenang Barat[7)]	13,086	3,635	0.064	84,914	99	83,640
Senggigi	15,971	4,436	0.080	129,543	48	62,181
Kekait	6,431	1,786	0.056	36,514	33	12,050
Guntur Macan	2,170	603	0.028	6,147	60	3,688
Dasan Griya	4,449	1,236	0.092	41,342	77	31,833
Batu Mekar	8,807	2,446	0.044	39,024	90	35,122
KPHL RB	**Total**					**458,729**

Notes:

1 From NTB province statistics.

2 According to HH survey, average number of family in each household was 3.56.

3 From HH surveys.

4 Daily consumption of fuelwood × 365 days × number of household in 2010.

5 Percent households using fuelwood for cooking, based on household surveys.

6 Adjusted demand of fuelwood by % use.

7 Pemenang Barat includes two study sites: Pemenang Barat and Malaka.

industries, primarily for furniture making and home construction materials found in Mataram City and in North Lombok (Dinas Kehutanan 2011). These local enterprises utilize and sell both local and imported wood products.

Sawmills in forest margin communities – both legal and illegal – can accelerate deforestation and forest degradation, given the growing demand for forest products for both local use and wider consumption. Access to new, lower cost and more efficient equipment has enabled the emergence of mobile sawmills that expand the range of timber harvesting and processing. FGDs in Pemenang Barat and Senggigi communities with access to major roads and tourism development, revealed that several of these local sawmills were issued official permits by local government agencies, but these enterprises are more temporary in character; no permanent and permitted enterprises were found within the study area.

As has been reported in other parts of Indonesia (Smith et al. 2003), illegal logging became particularly prevalent following the fall of Suharto, given the political uncertainty, weak local governance and widespread corruption. Addressing the challenges of illegal logging requires strong forest governance institutions, including enhanced law enforcement and regulation of the illegal timber trade, and these are important current priorities for the KPHL RB (KPH 2011).

Land tenure

Legally, jurisdiction over forest area and land is regarded as clear and definitive: land within the forest area is under the authority of the Indonesian Government, and no individual can claim ownership or change the status of forest ownership by the State.

Nevertheless, every village within the study area has experienced significant encroachment, occupation and settlement of forest areas. Perceived uncertainty and/or conflict over forest status, boundaries, and use rights have resulted in varied interpretation of boundaries, jurisdictions, and ownership and access rights within forest margin communities. It was also apparent from our FGDs and interviews that local knowledge about government laws and policies related to forest management is often quite limited.

The perception of land tenure security clearly affects encroachment into forest areas. Many people were reported to have occupied forest areas based on their understanding that the forest area is government land (GG), and they believe that the status of the land can be changed through continued settlement and cultivation, to the point of securing a legal claim and certificate or deed.[8]

Land tenure conflicts of varying degrees of intensity have occurred in several locations within the KPHL RB during the period of analysis (KPH 2011). For example, when the forest concession withdrew in Ganggelang Village in 2000, many local residents felt justified in occupying the abandoned forest area, and expected the government to eventually issue tax certifications (*Surat Pemberitahuan Pajak Tanah* or SPPT), the first step toward land transfer and ownership, as full legal ownership is predicated on the issuance of this tax certification. In other villages, community occupation of forest areas occurred with the simple intention of fulfilling basic livelihood needs. Even in communities such as Baru Murmas, a relatively isolated Buddhist community where local people have traditionally managed portions of the forest as sacred or customary forests, massive encroachment occurred in 1998 with the political turmoil following the fall of the new order regime and the absence of central government control. As one participant noted during a FGD: "We felt that if we didn't cut the trees, someone else would..."

In these latter cases, individuals recognized that the land they occupied was within designated forest areas, and they generally accepted a range of government management directives and activities (primarily reforestation projects). People who participated in these forest management projects formed farmer working groups (*kelompok tani*), both for the benefits of cooperation and to improve their bargaining position with the government or other outside entities. Many of these participated in projects implemented by the government Forest Service or by NGOs. The total area for these activities is estimated at 14,627 ha (KPHL RB 2011).

Conflicts also occurred in a number of areas with lower levels of encroachment and occupation, for example in Sambik Bangkol and Sambik Elen, Villages with greater numbers of migrants from other parts of Lombok and from Bali. In many communities where this encroachment occurred, individuals still viewed the forest as GG (and thus open to settlement), while others understood that the forest was under Indonesian Government control. Some followed project guidelines as outlined above (i.e. reforestation as government initiative, with some latitude in selection of cultivated species), while others built semipermanent structures and were clearly seeking formal ownership in addition to their short-term economic interests.

More open and acute conflicts occurred in several locations, where occupation has included features of more permanent settlements, including homes, mosques and even hotels. In these locations, almost 90% of those occupying the forest originated from other parts of Lombok, and they are reported to have regarded the forest area as GG land, available for occupation and settlement. Their intention was to obtain certification and ownership, and they organized themselves into advocacy groups, often with NGO assistance. The Forest Service generally avoided these areas and did not undertake project activities there.

While our analysis underscores the conclusion that forest occupation and land-use conflicts were precipitated by a number of factors, the most commonly noted reference point in many discussions and interviews was the experience in Rempek (not part of the village study sample), where individuals were granted ownership certificates for 86 ha in 1984 through the National Agrarian Program (PRONA) (KPHL RB 2011). Many who occupied forest areas claimed to be motivated by the Rempek example, seeking similar legal rights to their forest gardens. Although many of those who encroached into forest areas withdrew their claims when ownership certification in Rempek was withdrawn, the Forest Service was slow to respond to the situation, leaving the impression that individuals could successfully occupy forest areas and eventually secure ownership rights. A related factor that precipitated occupation

8 Historically, the perception of GG land was that it was available to individuals as long as they cultivated the land productively but ownership status could only be changed by government decree.

was the general sense that the government maintained a very limited presence in these areas, with minimal supervision and enforcement capability, therefore tacitly encouraging settlement. This was particularly true during the transition period, 1998–2002.

Absent improvements in both legal clarity and local understanding of land tenure, and without a consistent official presence and enforcement of laws and policies, the problems with encroachment and occupation will certainly continue. Many local residents maintain hope that their claims will ultimately be validated; many others continue to access the forest illegally, both for temporary needs and for more sustained occupation.

Other factors

In addition to the drivers described above, a number of other factors are worth noting that have influenced deforestation and forest degradation in the KPHL RB. Permitted forest clearing by HPH and HTI concessions, without required reforestation efforts, ineffective forest management institutions, pressure for agricultural expansion, inconsistent (and sometimes contradictory) government programs, and weak law, enforcement have all contributed to the extensive forest loss and conversion that has taken place within the KPHL RB.

Communities have reclaimed the forest area that was cleared and then abandoned by the HPH and HTI. The lack of forest cover made it easier for local residents to move into these areas and convert these former forests into farms, agroforests and settlements. The occupation of these areas occurred during the period of political reform, when the concession holders withdrew.

Individuals moved into these forest areas, further cleared the forest vegetation and cultivated the land, despite the lack of authorization. Communities often took it upon themselves to divide the forest area among their residents, recognizing both their immediate livelihood needs as well as their long-term interest in securing tenure. They initially planted annuals and short-term tree crops for food and cash income, but with the approval of HKm projects, the government began encouraging the planting of designated forest tree species and a range of beneficial multipurpose tree crops. Over time, much of these converted forest lands, in both HKm sites and elsewhere, were transferred and/or sold to farmers from outside these communities.

The lack of strong forest management institutions is another reason for the extensive forest cover change that has taken place in the KPHL RB. This can be seen in the limited institutional management capacity, both organizationally and in terms of human resources in the forestry sector. Weak forest management capacity can be seen in the lack of clarity on forest boundaries, inconsistency in the permitting process, a lack of transparency and accountability, and contradictory authority between local and national government units.

Weak regulatory and law enforcement capacity further exacerbate the institutional problems described above. Forestry-related offenses committed by various parties within the forest, such as illegal logging, unauthorized clearing of forest areas for agriculture, setting of forest fires, illegal exploitation and transport of forest products, and illegal use of chain saws and other equipment, have all continued over the past 20 years (1990–2010), despite the fact that forest boundaries, classes and management actions have been formally established by the Ministry of Forestry. The legal framework for forest management is undermined by the weak institutional and enforcement capacity, and the inability to enforce sanctions and take legal action against law breakers. One indication of the weakness of the system can be seen in Table 6.4, which shows the limited number of convictions for forestry-related offenses. Many of our discussions and interviews reinforced a lack of public confidence and a general sense of neglect of forest management by government agencies, and many

Table 6.4 Adjudication of forestry-related offenses in NTB (2002–2011)

Year	Number of cases	Number of accused	Number sentenced
2002	120	158	16
2003	103	339	13
2004	125	118	38
2005	223	201	97
2006	127	114	33
2007	105	108	10
2008	66	79	9
2009	71	68	23
2010	41	24	21
2011	13	15	3

Source: Dinas Kehutanan Provinsi NTB (2011) people clearly believe the government is incapable of effectively prosecuting wrongdoers, which sends a message of tacit acceptance of these illegal activities. These conditions have certainly contributed to the deforestation and forest degradation that we have described for the KPHL RB.

Conclusion

The success of future approaches to reduced deforestation and forest degradation, including REDD+ initiatives, depends on a thorough understanding of the factors that have led to the current state of forest management. Addressing population growth, improving the general welfare of forest margin communities, reducing poverty, and seeking new sources of energy to substitute for the dependency on fuelwood use, are all important considerations in developing strategies to reduce pressure on dwindling forest resources. Enhanced efforts at building capacity –both institutional and individual– the application of new information technologies, and improved law enforcement, are additional elements of an effective future approach. The complexity of both problems and potential solutions requires renewed efforts to improve coordination among agencies, and increased participation of all affected stakeholders.

7. Reference emission level and compensation options

Estimating reference emission level

There are several well-established international carbon standards used in voluntary carbon markets. These standards provide the basic methods and best practices to design robust REDD+ methodologies to establish a REL to ensure additionality, prevent leakage, and assess permanence and risk of the proposed activities (Estrada 2010). In the absence of a unifying international agreement on carbon accounting, following VCS guidelines may be the best available option for project-level REDD+ activities (Ashton et al. 2009). We have generally followed the latest VCS guidelines for estimating baseline carbon stock changes from unplanned frontier deforestation and forest degradation from unsustainable fuelwood collection.[9]

We have calculated REL-based projected land-use and land-cover (LU/LC) change, and the associated carbon stock change. In addition to the project area, the KPHL RB (41,000 ha), the analysis area includes a potential leakage belt, a contiguous area containing the population census units (subdistrict or *kecamatan*) around the KPHL RB. The total analysis area is about 265,000 ha, and forest area accounted for 110,000 ha in 2010. Based on population data from 2000 and 2010,[10] we have projected future population and resulting changes in forest cover[11] and accumulated fuelwood consumption from 2015 to 2045, using a potential project period of 30 years.

Based on household surveys, most of the respondents have lived in their communities since birth (74%) or more than 10 years (18%), indicating that natural population growth is the main source of population pressure on forests, rather than in-migration or relocation for the last 10 years. However, in-migration could explain much of the deforestation before 2000, as described in Chapter 3. The proportion of the population that encroached and cultivated forests was about 70% and among those, new cultivation during the last 10 years accounts for 34%, with an average 0.83 ha of forest land. Thus new cultivation in the forest necessary to accommodate a new household would be 0.20 ha,[12] with average household size of 3.57. According to official census data, 51.5% of the population in the area reported agriculture as their main occupation. To be conservative, we took this proportion to calculate new forest clearing demands due to population increase.

With this method, the total new forest land cultivated in the first 10 years of the project period (2015–2025) would be close to 3600 ha (8.7% of forest) in the project area and 7200 ha (6.5% of total forest) in the larger area (Table 7.1). By the end of the 30-year project period, about 14,000 ha of the project area and almost 27,000 ha of the analysis area would be newly cultivated. In other words, more than one-third of the project area would be cultivated by 2045, without intervention. If REDD+ activities focus solely on the KPHL RB, without addressing the livelihood needs of the increasing population, we may simply shift new cultivation of forests outside of the KPHL RB, and the overall rate of new forest cultivation may not change from the projected 25% of forest being cleared from 2015 to 2045 in the analysis area.

As discussed in Chapter 4, the observed pattern of deforestation around the KPHL RB is gradual conversion of forests to agricultural uses, with shrubland being an intermediate land-use. We allocated the projected forest loss into two land-use classes (shrubland and all other land uses). Table 7.2 presents the area-weighted average of carbon stock. The total carbon loss from deforestation is estimated to be 2 million metric tCO_2 in the project area for the first 10 years, and 9 million metric tCO_2 for the project period, which is the

9 The sources include VCS Sectoral Scope 14: Agriculture, Forestry, Land Use, specifically VM0007 REDD+ Methodology Modules (REDD+-MF), v1.4, including estimation of baseline carbon stock changes and greenhouse gas emissions from unplanned deforestation (BL-UP), v3.2; and estimation of baseline emissions from forest degradation caused by extraction of wood for fuel (BL-DFW), v1.0 .

10 BPS, Population Censuses 2000, 2010 and Inter census survey 2005.

11 Population Driver Approach by VCS projecting new forest cultivation need per new household.

12 0.83 ha × 70% × 4%

Table 7.1 Annual areas of unplanned deforestation: Population driver approach (ha)

Subdistrict (*Kecamatan*)	Population						New forest cultivation	
	2000	2010	%/yr	2015	2025	2045	2015–2025	2015–2045
Aikmel	81,993	92,853	1.32	99,167	113,113	147,164	392	1,349
Batukliang	63,596	71,512	1.24	76,075	86,093	110,259	282	961
Batukliang Utara	40,260	47,268	1.74	51,528	61,233	86,473	273	982
Batulayar	31,841	45,388	4.25	55,900	84,792	195,091	813	3,913
Bayan	37,825	44,671	1.81	48,863	58,462	83,691	270	979
Gangga	36,614	40,836	1.15	43,245	48,499	60,998	148	499
Gunungsari	60,585	78,663	2.98	91,121	122,269	220,148	876	3,627
Kayangan	32,414	37,413	1.54	40,388	47,068	63,923	188	662
Kopang	67,408	75,719	1.23	80,503	90,998	116,271	295	1,005
Lingsar	54,085	63,409	1.72	69,066	81,941	115,336	362	1,301
Masbagik	82,541	93,993	1.39	100,697	115,573	152,244	419	1,449
Montong Gading	33,280	40,603	2.20	45,271	56,279	86,977	310	1,172
Narmada	76,841	87,897	1.44	94,405	108,902	144,917	408	1,420
Pemenang	26,798	32,546	2.14	36,189	44,746	68,405	241	906
Pringgabaya	81,920	90,548	1.05	95,418	105,957	130,658	297	991
Pringgarata	52,408	62,841	1.99	69,350	84,460	125,276	425	1,572
Pringgasela	44,168	50,059	1.33	53,488	61,065	79,594	213	734
Sambelia	24,779	29,422	1.87	32,284	38,869	56,345	185	676
Sembalun	16,663	18,786	1.27	20,014	22,715	29,260	76	260
Sikur	62,278	67,550	0.85	70,458	76,655	90,732	174	570
Suela	33,548	37,441	1.16	39,664	44,515	56,069	136	461
Tanjung	38,032	44,606	1.73	48,597	57,681	81,263	256	918
Wanasaba	54,864	59,317	0.81	61,764	66,964	78,714	146	477
KPHL RB only	395,035	475,429	2.09	527,775	654,360	1,033,772	3,561	14,225
All analysis areas total	**1,134,741**	**1,313,341**	**1.66**	**1,423,455**	**1,678,851**	**2,379,806**	**7,185**	**26,885**

Note: Subdistricts adjacent to the KPHL RB are indicated in bold

Table 7.2 Land-use change and carbon stock changes

		2015–2025		2015–2045	
		Project area	Analysis area	Project area	Analysis area
Projected land-use change (ha)	Forest	-3,561	-7,185	-14,225	-26,885
	Shrubland	1,967	3,969	7,858	14,852
	All others	1,594	3,216	6,367	12,033
Projected carbon change (tCO_2)	Forest	-3,979,222	-8,028,842	-15,895,655	-30,042,509
	Shrubland	1,083,654	2,186,479	4,328,832	8,181,417
	All others	668,342	1,348,509	2,669,804	5,045,882
	Total Change	-2,227,226	-4,493,855	-8,897,019	-16,815,210

Table 7.3 Projected emissions from fuelwood consumption in the project area

Year	2000	2005	2010	2015	2025	2045
Number of households	110,654	122,795	133,173	147,836	183,294	289,572
Fuelwood consumption (m^3)	304,741	338,178	366,758	407,140	504,792	797,481
Emission per year (metric tCO_2)	299,347	332,192	360,267	399,934	495,857	783,366
Accumulated emissions from 2015					**4,478,954**	**16,791,567**

equivalent of consuming 21 million barrels of oil or annual greenhouse gas emissions from 1.9 million passenger cars.

Annual rate of fuelwood demand and carbon loss

Over 80% of households surveyed reported that they use fuelwood for cooking, and they report an average consumption of 15.3 m^3/yr, which is likely to include relatively large energy consumers for home industries such as candy, tofu, tempeh, palm sugar production and tobacco drying. Among all fuelwood consumers, we assumed the portion of unsustainable collection to be 18%.[13] Based on our observations and the opinion of local experts, we can reasonably expect that much of the fuelwood purchased from markets and collected for sale may be from unsustainable sources. The REL will need to be reexamined with better understanding of fuelwood demand and supply sources, including illegal logging activities. Here we calculated net carbon emissions based on total fuelwood consumption self-collected in the forest.[14] According to this calculation, carbon emissions from degradation caused by unsustainable fuelwood collection would reach half a million metric tCO_2 in 2025. The accumulated emissions during the first 10 years, and over the entire project period in the project area alone would be 4.5 million metric tCO_2, and 16.8 million metric tCO_2 (Table 7.3).

The potential carbon emission reduction in the analysis area through reducing fuelwood consumption could therefore be very significant – more than twice the amount from reducing deforestation.

13 76% reported self-collection, and 24% collection from forests.

14 VCS default value of 0.47 tC/tdm for carbon fraction of dry matter; regional average of 0.57 dm^{-3} for tropical Asia for the mean wood density (Brown 1997).

REDD+ compensation for climate mitigation: For what?

Together, the reference emission level was conservatively estimated at 25.7 million metric tCO_2. The global average price for forest carbon offset was US$7.8/metric tCO_2e in 2012. The price fell from US$9.2/metric tCO_2e in 2011, but it is still higher than the US$5.9/metric tCO_2e, average price for carbon from other types of projects (Peters-Stanley et al. 2013). Although the level of possible carbon emission reduction will depend on the type and extent of potential compensation options, the range of expected values of carbon can be projected based on expected market values (Table 7.4). Even at the lower end of carbon price and emission reduction, we can expect at least US$12 million of expected value generated by a REDD+ project.

If an initial investment of US$1 million can reduce 10% of REL, we can expect at least seven-fold return in 30 years at 3% discount rate (Table 7.5). The 3% discount rate is a reflection of time preference for monetary investment, and does not account for performance risk factors.[15]

REDD+ compensation for climate mitigation: How and how much?

As summarized in previous chapters, the patterns of deforestation and forest degradation around

15 Conventional discount rate applied or private investment in volatile markets in developing countries could be as high as 15–17%. Even with a 20% discount rate, NPV of US$1 million initial investment is still positive at US$1.3 million (10% reduction at US$5 per metric tCO_2e). VCS guidelines recommend addressing performance risk via buffering. Overall risk is a weighted sum of the ratings on the different risk categories. Increased overall risk rating would raise the buffer withholding percentage, meaning "based on the project's overall risk classification, the percentage of carbon credits generated by the approved project activity that must be deposited into an account to cover non-permanence related project risks" (VCS 2010).

Table 7.4 Potential market values of carbon emission reduction (US$ millions)

Carbon price	Rate of emission reduction (avoided emission per year)			
	10% (86 Kt CO_2/yr)	20% (171 Kt CO_2/yr)	30 % (257 Kt CO_2/yr)	50% (428 Kt CO_2/yr)
$5	$12.84	$25.69	$38.53	$64.22
$7.5	$19.27	$38.53	$57.80	$96.33
$10	$25.69	$51.38	$77.07	$ 128.44

Table 7.5 Net present value of US$1 million investment at 3% discount rate over 30-year project period

Carbon price (US$)	Rate of emission reduction (avoided emission per year)*			
	10% (86 Kt CO_2/yr)	20% (171 Kt CO_2/yr)	30 % (257 Kt CO_2/yr)	50% (428 Kt CO_2/yr)
$5	$7.42	$15.81	$24.20	$40.99
$7.5	$11.62	$24.20	$36.79	$61.97
$10	$15.81	$32.60	$49.38	$82.95

* Emission reduction evenly distributed over the 30-year project period

the KPHL RB show continuous unplanned encroachment by local communities around the boundaries of forests. Direct interventions limiting illegal cultivation, firewood collection and logging with increased enforcement is an important component of the overall REDD+ activities. However, reversing this trend of deforestation and forest degradation would have to address at least some of underlying drivers, such as population growth, persistent and widespread poverty and insecure land tenure (Chapter 6).

Our goals are to develop a successful bottom–up approach in REDD+ project design that can balance the needs of local communities (livelihood), with those of external funders (demonstrable results in carbon emission reduction) where the local KPH is bridging these interests. Thus, project activities should be designed to address the critical institutional and technical capacities of the KPH and improve forest governance, the key starting point of any external intervention.

Build institutional and technical capacity of the KPHL RB

Although the KPH system is a key element of forest governance reform in Indonesia, its lack of financial and human resources as well as technical capacity for management pose many challenges (Bae et al. 2014). The KPH is charged with reducing the deforestation rate, promoting reforestation and recovery of degraded lands, supporting forest conservation, building safeguards into forest management, improving local communities' use of forests through the stable provision of forest products and gathering data on natural resources (MoF 2009). Even as a model KPH with some support from the central government, *Madani Makarom*, the head of the KPHL RB (and current coordinator of the national association of KPHs) estimated that the number of his staff would need to increase ten-fold (to 332 from the current number of 32 as of 2013) before his KPH can accomplish the most basic operational tasks: clarifying boundaries, developing forest management plans and conducting forest inventory (personal communication from M. Makarom 7 September 2013). Technical assistance to the KPH, for example developing geographical information system (GIS) of forest boundaries and stand-level information with necessary training, could greatly assist the local KPH in carrying out its mandate.

In addition to enhanced capacity for forest mapping, inventory and planning, technical capacity is also needed for the KPH staff to understand and adapt national and international initiatives to the local context. If KPHs can provide consistent interpretation of these initiatives within the local context, and explain what REDD+ projects can and cannot be, it would reduce unrealistic expectations, as well as confusion and fear toward new government initiatives.

Assure *de facto* usufruct rights of the communities

As discussed in Chapter 6, local communities around the KPHL RB, and perhaps throughout Indonesia, share a common history of an open access situation created by the political void that occurred after 1998. As described in Chapter 3, communities adjacent to the production forest in northern Lombok experienced the impact of forest concessions even prior to that time, as forest concessions used clear-cutting in the 1990s, which resulted in extensive forest cover change and seriously limited access to forest resources by communities. Clearing of these areas, including sites considered sacred by local communities, resulted in violent demonstrations, which attracted external attention, and led several international and local NGOs to work with local government agencies in facilitating the establishment of the first government-recognized community forestry project (HKm). This formal recognition of usufruct rights helped create strong, capable institutions within the communities that can manage and protect their forest areas.

However, to date, there remain few HKm within the KPHL RB, and the legal process of establishing HKm projects is extremely bureaucratic, often requiring several years for approval. In addition, many local communities lack social and cultural congruency or the technical capacity for HKm management. The KPHL RB's survey noted that 18,000 ha of the forest area (44% of total KPH management area) is under encroachment, and is being managed illegally by local communities. The KPH system is required by national regulation to consider environmental conditions and local communities' aspirations and cultural values, including those of indigenous peoples, and their social, cultural and economic conditions (ROI 2007, 2009). Thus working within the KPH system to develop formal and informal arrangements with local communities may be the most feasible and cost-effective strategy to navigate complex land-tenure issues. One ready example of assuring de facto usufruct rights is already being implemented. In a '*mandor*' (forest guard/extensionist) program implemented by the KPHL RB, each community was encouraged to recommend a *mandor* for their area based on criteria outlined by the KPH. The *mandors* are responsible for monitoring illegal activities, educating their communities and assisting with enforcement. The selection and appointment of these local *mandors* is one of several indications that the KPHL RB is working to assign responsibility and accountability for forest conditions to local communities, while assuring their usufruct rights. This is also a way of increasing local representation within the system created by the central government, which helps generate local support for the KPH's management activities and increases downward accountability.

Look for opportunities for bundling ecosystem services for project sustainability

Ecosystem services, such as carbon sequestration and biodiversity, have global implications, but can be abstract notions to local communities. In contrast, other ecosystem services, such as water and watershed services, can attract immediate buy-in from local participants. There is a precedent of payments for watershed services in Lombok. The establishment of the PES scheme in Lombok took almost 10 years of perseverance and involved the establishment of a multi-stakeholder group (IMP, *Institusi Multi-Pihak*) governing PES, including WWF, the forest agency, a mineral water company, the district government and the national park (Pirard 2012). The accumulated social capital and enhanced awareness among local residents about the possibility of monetary payments for environmental services from upper watersheds and forests can provide favorable conditions for a successful co-management program. Thus looking for opportunities to 'bundle' carbon credits with other ecosystem services is a promising approach to ensure a sustained reduction of emissions with other complementary sources of funding.

Cultivate local intermediaries who can champion the project

Considering the complex and diverse social contexts and living history of local communities around the KPHL RB, compensation options cannot take a one-size-fits-all approach. What encourages collective action in forest conservation may vary depending on the local community context. The KPHL RB will need assistance developing "voluntary, realistic, conditional" agreements with each community to set individual economic development agendas. Previous project developers of RUPES (Rewarding Upland Poor for Ecosystem Services) noted that given opportunities, most communities developed their own rules for collective action and strategies for dealing with defectors, as individual actions can affect the rewards that the community as a whole can receive (RUPES 2013).

Although the KPHL RB has been exceptional in engaging local communities, they face many challenges coordinating their activities across ambiguous and overlapping boundaries and jurisdictions with other local forestry agencies (*Dinas Kehutanan*) as well as with local communities. The KPH will also need help training mandors recruited from local communities to understand both the technical and administrative aspects of their jobs. By working with diverse stakeholders including NGOs and local universities, the KPHL RP can implement cost-effective monitoring strategies with communities while engaging international and local researchers for continued innovation through action-oriented research, which can in turn lower transaction and other implementation costs.

For better coordination and engagement of multiple stakeholders in REDD+ project activities, a collaborative forum can be cultivated to explicitly recognize the role of intermediaries (e.g. NGOs, government agencies, universities and local organizations), a strategy which was noted as an important aspect of pro-poor PES development (Thuy et al. 2010). Established local NGOs and organizations can play important roles in accommodating the needs and perspectives of the most marginalized populations within communities, while international NGOs and universities can assist with technical training and information dissemination. Regular meetings and joint activities through a collaborative effort would facilitate improved coordination of program activities.

Develop alternative energy sources and improve efficiency

IPCC has estimated that 67% of traditional biomass (such as unsustainably collected fuelwood) is still being used for heating and cooking in developing countries (IPCC 2010). In Asia, even though consumption of fuelwood has been declining, there may still be 1.7 billion users in 2030 (IEA 2006). Emissions from deforestation and decay of biomass accounts for about 17% of the world's GHG emissions (IPCC 2007). However, if we consider emissions from the burning of biomass for energy, the GHG emissions from the forestry sector could be as much as 30% of the total. As described above, the emission reduction potential from reducing fuelwood use in the project area is much greater than that from reducing deforestation. Thus, addressing high fuelwood demand and developing alternative energy sources and burning methods may be one of the REDD+ project activities that can be implemented in a relatively short time, and with clear, demonstrable results in terms of carbon emission reduction. To address this issue, we must examine both supply and demand sides of fuelwood consumption and related policies.

Although promoting alternative energy sources would be a clear way to reduce the demand for fuelwood, converting to different burning methods is not a simple matter. More than 80% of households around the KPHL RB are still using fuelwood as their primary energy source, despite a government-sponsored gas conversion program distributing free propane stoves. Fuelwood is still the preferred, most accessible and inexpensive energy source around the KPHL RB for household cooking and for many small-scale home industries. Many urbanizing areas reported greater use of gas as their primary cooking fuel (e.g. 43.3% in the Senggigi areas). Certainly cost, access and reliable availability are key issues in adopting alternative energy sources.

Another way of reducing fuelwood demand is by improving the process of drying and burning biomass. Dry wood contains about 50% carbon of mass as cellulose, hemicellulose and lignin and this carbon content represents significant energy value. Inefficient fuelwood combustion can be caused by burning methods that result in significant energy loss, while incomplete combustion releases carbon monoxide and black tars, which are not only air pollutants and a health hazard for users, but also a source of GHGs. Therefore, developing more efficient ways of drying and burning fuelwood may have important multiple benefits.

On the supply side, whether or not fuelwood collected from local forests is sustainable depends on what types of biomass are collected and the difference between harvest and growth rates for the biomass species. Two policy options can be considered for the supply side: developing measures to limit harvest rates to sustainable levels, and promoting plantations to lessen the pressure on 'natural' forests (Ole Hofstad et al. 2009). Especially in Lombok, we found that shrublands created after clearing primary or secondary forests were often abandoned or converted to agricultural lands, representing significant carbon loss. Encouraging agroforestry in shrublands with consideration for fast-growing biomass species could alleviate the pressure on fuelwood supply from forests.

Policies to improve fuel efficiency and promote alternative energy sources will produce results in a relatively shorter term than the ones to address the supply side, especially if local governments can implement the policies consistently while ensuring that alternative energy sources are available and accessible to local communities. However, policies will have to consider income effects on marginalized groups in the population, as well as the incentives and regulations to encourage cooperation of large consumers of energy, such as the tobacco industry. To address the supply side, long-term policies for sustainable forest management are needed, making sure harvest rates are balanced with plantation and growth rates in terms of carbon.

Addressing underlying drivers: Economic development, capacity building and social investment

One of the major lessons learned from past external interventions for conservation is that many projects encouraged development of alternative livelihoods for local communities without ensuring markets for the products from these activities (Blom et al. 2010). Limited attention has been given to local priorities and needs in pre-REDD+ project design (Mustalahti et al. 2012). Local intermediaries (e.g. NGOs) can help explore new market opportunities that are viable and consistent with local communities' aspirations and needs. Small business development can also be encouraged through micro-financing programs (from banks and other smaller lending institutions), and through support for agricultural cooperatives.

Programs and activities that strengthen social safety nets and improve access and quality of health care and education for women and minorities would help reduce population growth and forest dependency and poverty. Increasing access to formal and informal education and job training would be a way to help communities take advantage of these opportunities.

Forestry is a small contributor to the larger economy in terms of official statistics (less than 1% of GDP). The province's main economic sectors are in the mining (27.4%) and agricultural (22.7%) sectors. These sectors and others (ecotourism, marine resources) are certainly supported by the ecosystem services provided by forests (e.g. water). Better recognition of these supporting services from forests among all government agencies would lead to improved coordination and more integrated program development, and help strengthen the institutional capacity in which the KPH must operate.

How much: Opportunity costs

If we assume that a 10% reduction of deforestation and forest degradation would directly affect non-timber forest products and fuelwood collection, the opportunity costs to the villagers would be 10% of its combined annual values at US$ 1.2 million (Tables 7.6 and 7.7). This is based on current retail market prices (BPS 2013), which are much higher than the producer prices paid to villagers. Thus, it is within the upper range of necessary compensation. Villagers may also be able to shift their activities within the boundaries of already cultivated land or find alternative livelihood options. However, more aggressive carbon emission reduction without clear livelihood alternatives for local communities would result in greater leakage, simple shifting of activities outside the project area and drive up the market prices of these products which would encourage more encroachment of other forests in Lombok and beyond.

Conclusions

There are many contextual challenges in applying international carbon standards to a relatively small, densely populated and socially complex area such as Lombok. We have applied multiple analytical methods, using all available data to triangulate and cross-validate the results, and have taken the most reasonably conservative approach to calculate the REL.

Each method presents its own limitations, and the results reported above should not be considered as absolute values. Our intent is to provide a general picture of the probable condition of future forests around the KPHL RB. Without intervention, carbon emission from deforestation and forest degradation in the project area is conservatively estimated at 25.7 million metric tCO2 during the next 30 years (2015–2045). It is of course unrealistic to completely eliminate deforestation and forest degradation within the project period, but many options exist for investing in effective programs to reduce these projected impacts.

The next step is to evaluate feasible carbon emission reduction targets, which should be established with consideration of potential compensation options. REL and the level of avoided emissions, including leakage, as well as the uncertainty and risk of permanence of emission reductions, should be re-evaluated after determining the type and extent of REDD+ project activities.

Table 7.6 Most commonly collected forest products and their market values

	kg/yr (median/ HH)	Price before October 2013 (IDR/kg)	Price as of November 2013 (IDR/kg)	% of HH collecting products[1]	# of HH collecting the products[2]	Total values/yr (million IDR)[3]	Total values/ yr (US$)
Coffee	30	30,000	35,000	36.10%	24,776	24,156	2,415,620
Cacao	25	8,000	17,500	23.20%	15,915	5,073	507,305
Banana	16	8,000	12,000	34.00%	23,299	3,727	372,782
Palm Sugar (liter)	25	2,000	5,000	5.00%	3,446	301	30,149
Durian	160	10,000	35,000	11.20%	7,712	27,762	2,776,179
Rambutan	55	10,000	15,000	2.40%	1,641	1,128	112,803
Melinjo	9	13,000	15,000	3.80%	2,625	331	33,078
Total						**62,479**	**6,247,917**

Notes:

1 % of household reporting collection of each product from forest

2 Total number of households in the analysis area × 51.5% (agriculture as primary occupation) × % reported in 1

3 Total value = quantity collected per HH × average price × number of HH collecting that product

Table 7.7 Fuelwood consumption and market value

	Mean / HH (m^3/yr)	Price, before October 2013 (IDR/m^3)	Price, as of November 2013 (IDR/m^3)	No. of HH fuelwood as primary energy source	Total Values/ yr (million IDR)[1]	Total Values/ yr (USD)[2]
Fuelwood	15.3	60,000	80,000	54,867	58,763	5,876,285

Notes:

1 Total value = consumption × price × no. of HH

2 Exchange rate: US$1 = IDR 10,000

REDD+ as a PES scheme has attracted immediate and widespread support from various international actors frustrated with the slow progress of conservation-by-development initiatives. Nevertheless, previous failures have taught us that increasing local capacity, consistent with the larger goals of social and political progress, is not only morally just, but the only feasible way for external interventions to succeed in the long term. In fact, in a recent survey of 32 REDD+ experts and project developers, "monetary benefits" was the lowest ranked criterion for REDD+ success, while "actions to improve governance and regulations" was the highest (Jaung and Bae 2012).

The residents of Lombok have seen many external interventions come and go over the years. Past failures can contribute to the collective lessons learned for future success. A fundamental lesson from this experience is that direct interventions are not enough, and investment in overall capacity building is necessary to address the underlying issues of deforestation and forest degradation. At the same time, external funders of REDD+ projects, as climate mitigation efforts, cannot be motivated without clear results shown by a reduction in carbon emissions. The continuing challenge will be in balancing these needs and establishing clear mileposts toward results-based compensation. Helping local communities understand the contours of REDD+ and engaging them in the design of REDD+ project activities is essential in developing "co-investments" for environmental stewardship, rather than simple "payments" for ecosystem services.

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This paper explores opportunities for implementing activities for reducing emissions from deforestation and forest degradation (REDD) in areas with high poverty rates, rapid population growth and complex social dynamics. We focus on the potential role of localized Forest Management Units (or KPH) as an institutional partner, using the West Rinjani Protected Forest Management Unit (KPHL RB) on the island of Lombok, Nusa Tenggara Barat province, Indonesia as a case study. We relied on five essential elements for our analysis: (1) identification of land use changes, (2) estimation of average carbon stocks in forests and shrubland, (3) socioeconomic surveys to identify drivers of deforestation and forest degradation, (4) estimation of future reference emission levels, and (5) developing alternatives to reduce the rates of deforestation and forest degradation.

From 1990 to 2010, the forested area of Lombok decreased by 28.6% in the project area, representing a loss of 7130 ha (18.0%), or 1 million tC ha^{-1}. Without intervention, carbon emission in the project area is conservatively estimated at 25.7 million metric tCO_2 during the next 30 years. With the global average price for forest carbon offset at $7.8/metric tCO_2, we can expect a seven-fold return on investment. Our recommendations for this investment include: strengthening the KPH's institutional and technical capacity, assuring de facto usufruct rights for local communities, bundling ecosystem services, cultivating local intermediaries, developing alternative energy sources and improving efficiency, and addressing the underlying drivers of deforestation through economic development, capacity building, and social investment.

RESEARCH PROGRAM ON Forests, Trees and Agroforestry

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