UNIVERSITI PUTRA MALAYSIA

SPECIES DYNAMICS AND ESTABLISHMENT OF SILVICULTURE AGROFORESTRY REGIME AT SOUTHERN GUNUNG MERAPI NATIONAL PARK, JAVA, INDONESIA

PRIYONO SURYANTO

FH 2011 19

SPECIES DYNAMICS AND ESTABLISHMENT OF SILVICULTURE AGROFORESTRY REGIME AT SOUTHERN GUNUNG MERAPI NATIONAL PARK, JAVA, INDONESIA

PRIYONO SURYANTO

DOCTOR OF PHILOSOPHY
UNIVERSITI PUTRA MALAYSIA

2011

SPECIES DYNAMICS AND ESTABLISHMENT OF SILVICULTURE AGROFORESTRY REGIME AT SOUTHERN GUNUNG MERAPI NATIONAL PARK, JAVA, INDONESIA

By

PRIYONO SURYANTO

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

January 2011

Allah is the Light of the heavens and the earth. The parable of His Light is as if there were a Niche, in which there is a lamp, the lamp is enclosed in crystal, the crystal is of a starlike brilliance, it is lit with the olive oil from a blessed olive tree which is neither eastern nor western, its very oil would almost be luminous though no fire touched it - as though all the means of increasing Light upon Light are provided - Allah guides to His Light whom He pleases. Allah cites such parables to make His message clear to the people; and Allah has knowledge of everything (QS. An Nur:35)

On the authority of Abdullah bin Abbas, who said: One day I was behind the prophet and he said to me:"Young man, I shall teach you some words [of advice]: Be mindful of Allah, and Allah will protect you. Be mindful of Allah, and you will find Him in front of you. If you ask, ask of Allah; if you seek help, seek help of Allah. Know that if the nation were to gather together to benefit you with anything, it would benefit you only with something that Allah had already prescribed for you, and that if they gather together to harm you with anything, they would harm you only with something Allah had already prescribed for you. The pens have been lifted and the pages have dried "(Narrated by Tirmidzi, who said it is true and fine hadith)

Specially dedicated to my beloved parents, my dearest wife Utik and my daughters Balqis & Aisyah for their doa, love, endless support and great inspiration

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

SPECIES DYNAMICS AND ESTABLISHMENT OF SILVICULTURE AGROFORESTRY REGIME AT SOUTHERN GUNUNG MERAPI NATIONAL PARK, JAVA, INDONESIA

By

PRIYONO SURYANTO

January 2011

Chairman : Assoc. Prof. Mohd. Zaki bin Hamzah,PhD

Faculty : Forestry

Gunung Merapi National Park (GMNP) which was established in 2004, as a new management for Merapi forest, has a long historical relationship with the local community. Notably, the pattern of relationship between the GMNP management and the local community is still a paradoxical situation. The existing intervention by local community is through harvesting the grass in the national park areas and this activity is perceived as a *lose-win situation*. On the other hand, in the perspective of formal legal Indonesian national park principle which introduces the renewal of zonation system that prohibits the local community to harvest grass in GMNP is viewed as a *win-lose situation*. This study is aimed to develop silviculture agroforestry regime (SAR) model based on synergized agroforestry systems outside national park that are compatible with forest rehabilitation and renewal zonation in GMNP. SAR also supported the basic information on the succession of Mount Merapi following the eruption in 2006 to strengthen the Merapi lava tour.

The study was carried out in GMNP, Sleman district, Yogyakarta, Indonesia with the establishment of five (5) permanent sample plots to identify species diversity, species dynamic and potential standing stock of *Acacia decurrens* post Merapi eruption. Assessment of typology agroforestry was carried out in Kaliadem and Jambu Village with clustering approach. Local community intervention and scheme for forest rehabilitation were based on the index intervention and allometric model. SAR was developed by compatible management between typology agroforestry best practices and the scheme of the forest rehabilitation and renewal zonation system on GMNP as well as supported succession information. The exploring potential of SAR employed the SWOT analysis (i.e. strength, weakness, opportunity and threat), synergized with the Analytic Hierarchy Process (AHP) approach to quantify the potential of the regime.

The species that have the ability to grow on the early successional stage after Merapi eruption in 2006 are limited. Based on the importance of value index (IVI) analysis, all the plots were dominated by *A. decurrens*. Some species recorded IVI values of more than 10%, i.e. the species were *A. decurrens, A. villosa, Cinchona rebbeca, Erythrina hypaporus, Euphorbia ciacembus, Ficus kubeba, Psidium guajava, Palotus* sp, *Pinus merkusii, Schima wallichii* and *Trema* sp.

A. decurrens recorded the highest trend of species recruitment and mortality in P1 and P2, while in P3 and P4 were *A. decurrens* and *P. merkusii.* In P5, the trend of species mortality was dominated by *P. merkusii* and *A. villosa*, while the recruitment species was dominated by *S. wallichii* and *A. villosa*.

The performance of *A. decurrens* based on the highest average values of diameter and height were 14.22±1.85 cm and 5.97±0.66 m, respectively. Based on density, the average of the highest density was 23965.22±4553.39 individuals/ha, while the lowest was 330.44±69.31 individuals/ha. The standing stock of *A. decurrens* based on the basal area also showed that P1 had the highest basal area, i.e. 72.07±18.51 m^2/ha, while the lowest was found in P2, i.e. 0.45±0.08 m^2/ha. Based on volume, P4 was the highest, i.e. 184.44±24.59 m^3/ha, while the lowest was found in P2, i.e. 1.11±0.18 m^3/ha.

There are five SAR models, which are appropriate for agroforestry cluster (AF) i.e. AF1-SAR1, AF2-SAR2, AF3-SAR3, AF4-SAR4 and AF5-SAR5. SAR 1 to SAR 5 have the ability to balance agroforestry management with decreasing local community intervention and increasing biodiversity level on GMNP. The ratio of grass productivity outside GMNP with the implementation of SAR is close to optimum point of one (1). The ratio values of SAR 1 to SAR 5 are 0.982, 1.010, 1.44, 1.047 and 1.253, respectively.

SAR has a high potential to be implemented in GMNP as a compatible management approach. In accordance with the stakeholders' perception, the strengths and opportunities outweigh the model's weaknesses and threats. In addition, SAR is of immense potential for encouraging prospective buffer zone with intensive agroforestry management and also for accelerating forest rehabilitation and renewal zoning system of GMNP. SAR is also a prospect an innovation of collaborative management in the national park, whereby it does not only maintain the biodiversity, but also enhance the wealth of the poor. Nonetheless, the implementation of SAR

must be integrated with various strategies, for instance, the capacity building, documentation process and outcome, participative monitoring and evaluation, backup policy, experimental plot, compensation programme and skill improvement of silviculture agroforestry.

Hence, SAR is a compatible management model between the GMNP and the local community - serving as a "window opportunity" for learning model that includes the reference outside the national park as a promising buffer zone for developing this new Indonesia's national park, which avoids the image of "paper park".

Abstrak Tesis yang dikemukakan kepada senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

SPECIES DINAMIK DAN PEMBENTUKAN SISTEM PERHUTANAN TANI SILVIKULTUR DI BAHAGIAN SELATAN TAMAN NEGARA GUNUNG MERAPI, JAWA, INDONESIA

By

PRIYONO SURYANTO

Januari 2011

Pengerusi : Assoc. Prof. Mohd. Zaki bin Hamzah, PhD

Fakulti : Perhutanan

Gunung Merapi National Park (GMNP) ialah sebuah taman negara yang ditubuhkan pada tahun 2004, sebagai satu pengurusan baru untuk hutan Merapi, mempunyai satu hubungan sejarah lama dengan masyarakat tempatan, terutamanya pola perhubungan antara pengurusan GMNP dan masyarakat tempatan masih dalam satu situasi yang bertentangan. Masyarakat tempatan menceroboh masuk untuk menuai rumput dalam kawasan taman negara dan kegiatan ini dianggap situasi "kalah-menang" oleh masyarakat tempatan. Sebaliknya, daripada perspektif taman negara Indonesia yang memperkenalkan pembaharuan kepada sistem pengezonan yang melarang masyarakat tempatan untuk menuai rumput dalam GMNP dilihat sebagai satu situasi "menang-kalah". Kajian ini adalah bermatlamat untuk membangunkan sistem perhutanan tani silvikultur (SAR) berdasarkan sinergi sistem-sistem perhutanan tani di luar taman negara yang serasi dengan pengezonan pemulihan hutan dan pembaharuan dalam GMNP. Sebagai tambahan, SAR juga disokong maklumat asas kepada sesaran Gunung Merapi setelah ledakan pada tahun 2006 yang memperkuatkan Pelancongan Lahar Merapi.

Kajian ini telah dijalankan di GMNP, daerah Sleman, Yogyakarta, Indonesia melalui penubuhan 5 plot sampel kekal untuk mengenalpasti kepelbagaian spesies dan potensi dirian bagi stok *Acacia decurrens* selepas ledakan Merapi pada tahun 2006. Penilaian terhadap tipologi perhutanan tani dijalankan di Kaliadem dan Kampung Jambu melalui pendekatan berkelompok. Gangguan masyarakat tempatan dan skim untuk pemuliharaan hutan adalah berdasarkan indeks gangguan dan model alometri. SAR telah dibangunkan oleh pengurusan serasi antara amalan-amalan terbaik perhutanan tani tipologi dan skim pengezonan pemulihan hutan dan pembaharuan sistem pada GMNP serta menyokong maklumat sesaran. Tinjauan terhadap potensi SAR digunakan melalui analisis "SWOT" (kekuatan, kelemahan, peluang dan ancaman), sinergi dengan pendekatan "Analytic Hierarchy Process" (AHP) untuk mengira potensi SAR.

Spesies yang mempunyai kemampuan untuk tumbuh pada sesaran awal selepas ledakan Gunung Merapi pada tahun 2006 adalah tersangat terhad. Berdasarkan indeks nilai penting (IVI) semua plot didominasi oleh *A. decurrens*. Beberapa spesies yang merekodkan nilai IVI melebihi 10% adalah *A. decurrens, A. villosa, Cinchona rebbeca, Erythrina hypaporus, Euphorbia ciacembus, Ficus kubeba, Psidium guajava, Palotus* sp, *Pinus merkusii, Schima wallichii* dan *Trema* sp.

A. decurrens merekodkan kadar perekrutan spesies dan kematian yang tertinggi di P1 dan P2, sementara di P3 dan P4 adalah *A. decurrens* dan *P. merkusii*. Pada P5, kadar kematian spesies didominasi oleh *P. merkusii* dan *A. villosa*, sedangkan spesies perekrutan didominasi oleh *S. wallichii* dan *A. villosa.*

Prestasi *A. decurrens* berdasarkan nilai purata tertinggi diameter dan tinggi adalah 14.22 ± 1.85 cm dan 5.97 ± 0.66 m. Berdasarkan ketumpatan, purata kepadatan tertinggi adalah 23965.22 ± 4553.39 individu/ha, sementara yang terendah adalah 330.44 ± 69.31 individu/ha. Stok dirian *A. decurrens* berdasarkan ”basal area” juga menunjukkan P1 nilai yang tertinggi, iaitu 72.07 ± 18.51 m^2/ha, sedangkan yang terendah pada P2 iaitu 0.45 ± 0.08 m^2/ha. Berdasarkan isipadu, P4 adalah yang tertinggi dengan 184.44 ± 24.59 m^3/ha, sementara yang terendah adalah pada P2 dengan 1.11 ± 0.18 m^3/ha.

Terdapat lima model SAR yang bersesuaian dengan kelompok perhutanan tani (AF): AF1-SAR1, AF2-SAR2, AF3-SAR3, AF4-SAR4 dan AF5-SAR5. SAR 1 hingga SAR 5 mempunyai keupayaan mengimbang pengurusan perhutanan tani dengan menurunkan gangguan masyarakat tempatan dan meningkatkan kepelbagaian spesies di GMNP. Nisbah bagi produktiviti rumput di luar GMNP dengan adanya pelaksanaan SAR telah menghampiri kepada titik optimum iaitu satu (1). Nilai nisbah SAR 1 sampai SAR 5 adalah 0.982, 1.010, 1.44, 1.047 dan 1.253.

SAR berpotensi tinggi untuk digunakan di GMNP sebagai satu pendekatan pengurusan yang selari. Persepsi pemegang taruh menunjukkan bahawa kekuatan dan peluang adalah lebih tinggi daripada kelemahan dan ancaman. Selain daripada itu, SAR juga berpotensi untuk menggalakan pengzonan pengurusan perhutanan tani yang intensif dan mempercepatkan pemulihan hutan dan pembaharuan sistem pengzonan di GMNP. SAR juga mempunyai potensi inovasi dalam pengurusan bersama taman negara dimana ianya tidak hanya mengekalkan kepelbagaian hayat, juga meningkatkan taraf hidup masyarakat miskin. Walau bagaimanapun, SAR mesti

dizahirkan secara integrasi bersama strategi lain seperti pembangunan modal insan, proses dan hasil dokumentasi, pengawasan dan penilaian bersama, peraturan sokongan, plot kajian, program pemampasan dan peningkatan kemahiran tentang silvikultur perhutanan tani.

SAR merupakan satu model pengurusan selari antara GMNP dan masyarakat tempatan yang berfungsi sebagai “peluang tingkap” untuk model pembelajaran yang termasuk rujukan di luar taman negara sebagai satu zon penampan baik dalam membangunkan taman negara baru Indonesia bagi menghindari imej "taman kertas".

ACKNOWLEDGMENTS

Bismillahi Allahu Akbar and Alhamdulillahirabbil'alamin, All praise to Allah S.W.T. whose countless blessing enabled me to accomplish this study. My sholawat and salam are addressed to His righteous messenger, the prophet Muhammad S.A.W.

First and foremost, I wish to express my deep gratitude to my supervisor Assoc. Prof. Dr. Mohd. Zaki Hamzah for his unflagging interest, concerns and inspiration throughout the period of this study. His discreet assistance of many kinds has helped me to steer uphill, especially during the write-up. I gratefully acknowledge my indebtedness to my co-supervisors Assoc. Prof. Dr. Mohamad Azani Alias and Assoc. Prof. Dr. Azmy Mohamed who furnished invaluable comments and suggestions, which significantly improved the thesis.

I take this opportunity to express my thanks to Gunung Merapi National Park, Ministry of Forestry, Indonesia for permission given to conduct the study and also Sleman local government for permission given to conduct the study at Kaliadem and Jambu Village. The appreciation is also due to the Faculty of Forestry, Gadjah Mada University for its approval to pursue my PhD program at Faculty of Forestry, Universiti Putra Malaysia. I gratefully acknowledge the financial support from Ministry of Education and Rector of Gadjah Mada University, Yogyakarta, Indonesia.

I would like to express my profound appreciation to my dearest wife dr. Astuti Tjondronegoro and my daughters Putri Balqis Khanza Al Khanza and Putri Aisyah Kautsar Al Kautsar for their sacrifices, patience and moral support that enabled me to successfully carry out the study. Special thanks are due to my colleague Dr. Eka Tarwaca and Dr. Tata Rahayu family that support on special room at Serdang. Prof. Dr. SM. Widyastuti and Prof. Dr. Moh. Sambas Sabarnurdin that support of my standing on this study. Ust. Dr. Usman Ja'far, Ust. KH. Tulus Musthofa, LC.MA, Ust. Daarul Falah, MP and ikhwahfillah for their support and kindness.

I would like to thank Nawari Akhmad and Winda for field measurements and data management. Drs. Wiyono, M.Sc, Faculty of Forestry Gadjah Mada University for species identification. I'm also grateful to the farmers of Kaliadem and Jambu for their participation and patience with this study. A special thank you to Pak Sabar, Pak Yadi and Pak Midi, as well as to Pak Suyamto and Pak Ngadirejo for their guidance of this study.

Last but not least I would like to thank my parents (H. Hadi Sukarno - Hj. Hadi Ginem and Drs. H. Samudro Tjondronegoro - Hj. Sunarti). Their spirit remains strong inside me.

I certify that an Examination Committee has met on January 11, 20011 to conduct the final examination of Priyono Suryanto on his Doctor of Philosophy thesis entitled "Species Dynamics and Establishment of Silviculture Agroforestry Regime at Southern Gunung Merapi National Park, Java, Indonesia" in accordance with Universities and University colleges Act 1971 and the Constitution of the Universiti Putra Malaysia (P.U. (A) 106) 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Thesis Examination Committee were as follow:

Ahmad Ainuddin bin Nuruddin, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Faridah Hanum binti Ibrahim, PhD
Professor
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Pakhriazad bin Hassan Zaki, PhD
Senior Lecturer
Faculty of Forestry
Universiti Putra Malaysia
(Internal Examiner)

Wilfredo M. Carandang, PhD
Professor
University of the Philippines Los Banos
Philippine
(External Examiner)

NORITAH OMAR, PhD
Associate Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 19 April 2011

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Mohd. Zaki bin Hamzah, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Chairman)

Mohamad Azani bin Alias, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Member)

Azmy Mohamed, PhD
Associate Professor
Faculty of Forestry
Universiti Putra Malaysia
(Member)

_____
HASANAH MOHD GHAZALI, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or other institution.

PRIYONO SURYANTO

Date : 11 January 2011

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AHP	Analytic Hierarchy Process
ANOVA	Analysis of Variance
BA	Basal Area
DMRT	Duncan's Multiple Range Test
DBH	Diameter at Breast Height
DI	Diversity Index
FAO	Food and Agricultural Organization
GMNP	Gunung Merapi National Park
GH	Grass Harvesting
IVI	Important Value Index
IUCN	International Union Conservation Nation
IIASA	International Institute for Applied Systems Analysis
IPCC	Intergovernmental Panel on Climate Change
KSA	Kawasan Suaka Alam (nature preservation areas)
KPA	Kawasan Perlindungan Alam (nature conservation areas)
MEA	Millennium Ecosystem Assessment (MA)
MENHUT	Menteri Kehutanan (Ministry of Forestry)
MDS	Multi Dimensional Scaling
NWFP	Non Wood Forest Product
NGO	Non Government Organization
PP	Peraturan Pemerintah (Government Regulation)
PHKA	General Directorate of Forestry Protection and Nature Conservation
PP	Peraturan Pemerintah (Government Policy)

PSP	Permanent Sample Plot
RRC	Relative Rate Change
RD	Relative Density
RF	Relative Frequency
RGP	Ratio Grass Productivity
SAR	Silviculture Agroforestry Regime
SWOT	Strength Weakness Opportunity Treat
SPSS	Statistical Package for the Social Sciences
SK	Surat Keputusan (ministerial decree)
UNEP	United Nations Environment Programme
UU	Undang Undang (Law)
WCMC	World Conservation Monitoring Centre
WWF	World Wide Fund for Nature

CHAPTER 1

INTRODUCTION

1.1 Background of the study

The world of civilization has placed forest as important for human life, and it is not limited in time and space dimensions. In fact, forest's strategic position in the human life is increasingly important, and this is in line with human life order which is also becoming progressively complex. Human activities, over the past several hundred years, have left significant and growing footprints on the forests. Unfortunately, the world only has less than 4 billion hectares of forests, covering about 30 percent of the world's land area (FAO, 2007). Forests are randomly spread more or less into 229 countries in the world. More than 25 percent of the world's populations, i.e. an estimated 1.6 billion people, rely on the forest resources for their livelihood, and of these, almost 1.2 billion live in marvellous poverty (World Bank, 2001).

The increase in the population of human beings on earth has also given consequences on the forests around the world. The people have more demands and in fulfilling them and in this condition, the forests have become a centre to support human life. Nevertheless, people involved in forest management have applied unmatched sustainability principles which have resulted in degradation of this priceless natural source. In no period of human history has our species had a greater impact on the biophysical world. Generally, forests in the world have similarities in their existing status, i.e. forest on degradation. It is a serious environmental problem throughout

the tropics that has caused rural poverty, watershed degradation and loss of biodiversity. The Global Forest Resources Assessment 2000 (FAO, 2006a) estimated the net annual change in the forest area worldwide in the 1990s to be 9.4 million ha, representing the difference between the estimated annual rate of deforestation of 14.6 million ha and the estimated annual rate of forest area increase of 5.2 million ha (FAO, 2001).

In particular, the rapid forest degradation in the Southeast Asia has more than 2.8 million ha of forests destroyed per year; Indonesia is on the highest level with 1.9 ha per year, and this is followed by Myanmar, Cambodia, Filipina and Malaysia, respectively (FAO, 2007). The degraded land size in Indonesia, i.e. 96.3 million ha, with distributed 54.6 million ha as forest production, forest conservation and forest protection, while the remaining 41.7 million ha of the degraded land were on the outside forest (Nawir et al., 2007). In Southeast Asia, forest degradation leads to biodiversity crisis. It is particularly serious (Sodhi et al., 2004; Sodhi and Brook, 2006), where across the board extinctions are previously in the process of unfolding (Brook et al., 2003).

Forest degradation does not only occur in forest production, but also on protected area. Human disturbance and forest clearing affect all major tropical forest areas, including destruction to the protected area which is becoming increasingly isolated from each other (DeFries et al., 2005). Biodiversity crisis has even become more complicated with the existing poverty among the local community surrounding the protected area. In the tropics, this is especially true because the increase in the local

populations are normally followed by their instantaneous needs that often supersede long-term plans to sustainable use of natural resources (Balmford et al., 2003).

Forest resources management continue to change according to the public demand and the dynamics human need on the forest functions to support life. Based on the situation, the main goal of forestry management is still considered to be one of timber productions but more and more of the goal must now be channelled to be synergized with the multiple forest usage in order to meet the new paradigm for ecological sustainability and biodiversity (Lahde et al., 1999).

The shifting forest paradigm has also taken place in Indonesia through protection of area management that is gradually increasing by giving domination to establishment of national park, i.e. at 65% (Ministry of Forestry, 2006a). Unfortunately, the status of many protected areas is known to only exist as 'paper parks' that are not only extremely degraded, but also the targets of continuing exploitation (Curran et al., 2004). In Indonesia, particularly, almost all of the national parks have variant interactions with the local community and they are dominated by non-synergized interaction. The intervention of the local community is the major issue in the new management of national parks. The typology of the land use management in the surrounding national park is usually dominated by a combination trees and crops in the same area, or popularly known as agroforestry system.

Agroforestry, as a new approach for sustainable rural development, plays a vital role in improving food security, poverty reduction, and natural resource management (Leakey et al., 2006). In particular, one of the best alternatives for planting trees

outside forests is through agroforestry (FAO, 2006b). It is a part of the sustainable approaches for land use management which has been integrated into the present production system to get the maximum benefits from the multiple products by combining agriculture and forestry (Kidd and Pimentel, 1992; Nair, 1998). Agroforestry could play a role in helping to maintain a higher level of biodiversity, both within and outside the protected areas. In revegetation program that is combined with agroforestry practices can promote biodiversity conservation (Schroth et al., 2004).

The fundamental issue in Gunung Merapi National Park (GMNP) is redesigning the zonation system, and this is followed by the principle Indonesia national parks, especially forest rehabilitation to increase the functions of the ecosystem because of the local community's intervention. GMNP is still new as it was established in 2004, and in this management system, the collaboration approach is used for the local community (Ministry of Forestry-Indonesia, 2004a). Thus, GMNP is necessary for the development of silviculture conservation regime on the scheme pro-poor conservation approach. Silviculture deals with the methods that are used for the establishment and maintenance of healthy communities of trees and other vegetations which are valuable to people (Nyland, 2002).

Configuring agroforestry as a buffer zone inside and outside national park has a high potential in supporting and maintaining biodiversity that is compatible with sustainable national park. In fact, a silviculture regime that is synergistic with agroforestry, i.e. silviculture agroforestry regime (SAR), has a strategic positioning to construct innovation through compatible management between the national park

and agroforestry systems surrounding the GMNP. Therefore, compatible forest management in simple sense enables production of multiple valuable products without decreasing the value of other things the surrounding, and all is done in a socially acceptable manner (Haynes et al., 2003).

Another way to support SAR is related to the unique characteristics of Mount Merapi, i.e. one of active volcanoes in the world that is known as the 'fire mountain'. The recent eruption on 2006 disturbed recreation parks and Kaliadem village. The location is a new alternative promising tourism with the existence of Merapi lava tour at present. Therefore, the information related to the succession of post eruptions is of great value, particularly the information on its biodiversity to support tourism and the pioneer species has the potential in providing the local people with woodfuel. The Merapi's succession post eruption will provide information to synergize more tourist attraction to it. In short, preparing SAR which supports tourism is promising in the future.

In Indonesia, national park model as a reference for prospective compatible management is very important and the GMNP has the potential for this purpose. One of the alternative models can be designed by managing based on the compatibility between the GMNP and agroforestry systems in its surrounding areas through silviculture agroforestry regime.

Therefore, the focus of this study was started with the development of a permanent plot to study the succession post Merapi eruption in 2006 as a supporting resource for information on its biodiversity and the opportunity for the local interest,

particularly the woodfuel. The existing intervention of the local community on the GMNP and its impacts on the biodiversity status serve as a way to design scheme forest rehabilitation, assess the typology of agroforestry surrounding the southern GMNP as a potential intensive buffer zone management, and to finally develop a model of the silviculture agroforestry regime as a compatible management in the GMNP, followed by continuously assessing the potential of the regime model.

1.2 Objectives of the study

The objectives of the present study are as follows:

1. To determine and provide information related to the succession post Merapi eruption 2006 by integrating it with species diversity performance and to enrich the information on the Merapi lava tour and the pioneer potential standing stock for supporting local community woodlfuel. Detailed information pertaining to this objectives are listed below:
    a. Species diversity on the early stage of Mount Merapi succession.
    b. The species dynamic on early succession Merapi post eruption.
    c. The performance growth of *Acacia decurrens*, as a pioneer species, and its standing stock for woodfuel.
2. To conduct a preliminary analysis on the existing level of local community intervention and its impact on biodiversity and provide as scheme to minimize the intervention and accelerate silviculture for forest rehabilitation at GMNP.
3. To identify the typology of the agroforestry systems surrounding the national park and its implications on GMNP.

4. To develop a model of silviculture agroforestry regime as a contextualization of the local community interest to encourage more innovation and intensive buffer zone that has a compatible management with the GMNP prospective.
5. To assess the potential of the SAR as a compatible management in GMNP on among the stakeholders.

1.3 Outline of the thesis

This thesis is divided into eleven chapters. Chapter 1 provides the background of the study, especially the strategic positioning of the SAR as a compatible management for the GMNP.

Chapter 2 gives a review of the literature to explain the situational forest management in the world, forest degradation and problems in relation to poverty. This is followed a discussion on the shifting paradigm from forest timber management to forest resource management and later to ecosystem management, followed by an innovative silviculture regime that is related to agroforestry system. It is important to highlight that the silviculture agroforestry regime that is compatible with forest conservation management can serve as a window of opportunity, while innovative silviculture agroforestry acts as an art and science.

After a brief review of the literature, Chapter 3 elaborates details pertaining to the experimental methodology which include study site, data collection, data analysis and the flow chart of the study. In Chapter 4, a description of the species diversity at GMNP following the 2006 eruption, as well as the species diversity on the early

succession viz., species richness, heterogeneity, evenness, species distribution pattern and species performance (e.g. diameter, height and density) is given. Chapter 5 describe about the species dynamic of post-eruption at GMNP, was described following the examination of the pattern of the species recruitment, mortality and survival over a period of 18 months in five permanent plots.

The dynamic growth and standing stock of *A.decurrens*, following the 2006 eruption in GMNP, in relation to the Chapter 4 and Chapter 5, are discussed in Chapter 6. This includes the assessment of the dynamic growth of this particular species. During the period of 18 months, monitoring of the recruitment, mortality and survival of *A.decurrens* were carried out in the selected area. The findings of this study provide important information to support the Merapi lava tour, not only on the geology basis but also the vegetation and the standing stock of *A.decurrens*, which promises the local community with a schematic compatible management for the GMNP.

The impacts of community intervention on grass stock at GMNP, were investigated in Chapter 7. This was done to determine the intervention level of the local community. The chapter further identifies the biodiversity status of the GMNP that causes grass harvesting and creates a scheme to minimize the local community intervention, forest rehabilitation as well as renewal of zonation system for GMNP. The situation of the GMNP is discussed in Chapter 8. This includes the existing land use surrounding the GMNP. The information is summarized with in the sub-section entitled, "Agroforestry typology and its implications on the surrounding South Region of GMNP".

Chapter 9 describes the core of this study, and this is included in the sub-section with the subtitle, “Silviculture agroforestry regime: compatible management in Southern GMNP”. The chapter concludes with the results of the simulations of the silviculture agroforestry regime as an alternative model for a more prospective GMNP management scheme, which includes both the renewal ecosystem of the national park and poverty reduction local community, as summarized in Chapter 4 to Chapter 8.

Chapter 10 investigates the potential regime among the stakeholders (government, local community and researcher), and determine the strategic positioning to implementation of SAR. Exploring the potential of the SAR employed the SWOT analysis (i.e. strength, weakness, opportunity and threat), synergized with the Analytic Hierarchy Process (AHP) approach to quantitative the potential of the regime. Finally, Chapter 11 offers a summary of the findings, as well as conclusions and some recommendations for future research and development efforts.

REFERENCES

Abebe, T. (2005). *Diversity in homegarden agroforestry systems in Southern Ethiopia*, PhD Thesis, Wageningen University, Wageningen.

Adams, W.M., Aveling, R. and Brockington, D. (2004). Biodiversity conservation and the eradication of poverty. *Science* 306:1146-1149.

Adams, W. and Hulme, D. (2001). Changing narratives, policies and practices in Africa conservation. In *African Wildlife and Livelihoods: the Promise and Performance of Community Conservation*, ed. D.Hulme, and M.Murphree, pp 24-37.Oxford. James Currey.

Ananda, J. and Herath, G. (2003). The use of Analytic Hierarchy Process to incorporate stakeholder preferences into regional forest planning. *Forest Policy and Economics* 5:13-26.

Anderson, L.S. and Sinclair, F.L. (1993). Ecological interactions in agroforestry systems. *Agroforestry Abstracts* 6:57-91.

Aronson, J. and van Andel, J. (2006). Challenges for ecological theory. In *Restoration Ecology*, ed. J. van Andel, and J. Aronson, pp. 223-233.Oxford, U.K. Blackwell.

Aronson, J., Clewell, A.F., Blignaut, J.N. and Milton. S.J. (2006). Ecological restoration: a new frontier for nature conservation and economics. *Journal for Nature Conservation* 14:135-139.

Arrieta, S. and Suarez. F. (2005). Spatial patterns of seedling emergence and survival as a critical phase in holly (*Ilex aquifolium* L.) woodland recruitment in Central Spain. *Forest Ecology and Management* 205:267-282.

Arredondo, S., Aronson, J., Ovalle, C., del Pozo, A. and Avendano, J. (1998). Screening multipurpose legume trees in central Chile. *Forest Ecology and Management* 109:221-229.

Ashley, R., Russell, D. and Swallow, B. (2006). The policy terrain in protected area landscapes: challenges for agroforestry in integrated landscape conservation. *Biodiversity and Conservation* 15:663-689.

Ashton, M.S. and Montagnini, F. (2000). A philosophical approach to silviculture in agroforestry. In *The Silvicultural Basis for Agroforestry Systems*, ed. M.S. Ashton, and F. Montagnini, pp. 1-6. CRC Press LLC.

Alavalapati, J.R.R. andNair, P.K.R. (2001). Socioeconomic and institutional perspectives of Agroforestry. In *World Forests, Society and Environment-Markets and Policies*, ed. M. Palo and J. Uusivuori, pp. 52-62. Kluwer Academic Publishers.

Baland, J.M. and Platteau, J.P. (1996). *Halting degradation of natural resources: is there a role for rural communities*? New York, NY.Oxford University Press.

Balmford, A., Gaston, K.J., Blyth, S., James, A. and Kapos, V. (2003). *Global variation in terrestrial conservation costs, conservation benefits, and unmet conservation needs*. Proceedings of the national academy of sciences of the United States of America, pp.1046-1050, PNAS.

Baplan (Forest Planology). (2002). The policy of designing MP-RHL. Ministry of Forestry. Jakarta.

Baplan (Forest Planology). (2001). Statistic of Indonesia Forestry. Ministry of Forestry, Jakarta.

Barber, C.V. (2004a). Designing protected area systems for a changing world. In *Securing Protected Areas in the Face of Global Change: Issues and Strategies*, ed. C.V. Barber, K.R. Miller, and M. Boness, pp. 41-96. IUCN, Gland, Switzerland and Cambridge, UK.

Barber, C.V. (2004b). Parks and people in a world of changes: governance, participation and equity. In *Securing Protected Areas in the Face of Global Change: Issues and Strategie*, ed. C.V. Barber, K.R. Miller, and M. Boness, pp. 97-134. IUCN, Gland, Switzerland and Cambridge, UK.

Barber,C.V., Bergst,B., Janetos, A.C., Scherr, S., and Wolcott, R.M. (2004). Understanding global change. In *Securing Protected Areas in the Face of Global Change: Issues and Strategies*, ed. C.V. Barber, K.R. Miller, and M. Boness, pp. 1-30. IUCN, Gland, Switzerland and Cambridge, UK.

Barrow, E. and Fabricius, C. (2002). Do rural people really benefit from protected areas thetoric or reality? *Parks* 12 (2): 67-77.

Bazzaz, F. A. (1990). Plant-plant interactions in successional environments. In *Prespectives on Plant Competition*, ed. J. B. Grace and D. Tilman, pp. 240-263. Academic Press, San Diego, USA.

Bergeron, Y. and Harley, B. (1997). Basing silviculture on natural ecosystem dynamics: an approach applied to the southern boreal mixed wood forest of Quebec. *Forest Ecology Management* 92:235-242.

Bensel, T. (2008). Fuelwood, deforestation, and land degradation: 10 years of evidence from Cebu Province, The Philippines. *Land Degrad. Develop* 19:587-605.

Beyers, J. L. (2004). Postfire seedling for erosion control: effectiveness and impacts on native plant communities. *Conservation Biology* 18:947-956.

Bickford, D., Supriatna, J., Andayani, N., Iskandar, D., Evans, B.J.,. Brown, R.M., Townsend, T., Umilaela., Azhari, D. and Mcguire, J.A. (2008). Indonesia's protected areas need more protection: suggestions from island examples. In *Biodiversity and Human Livelihoods in Protected Areas: Case Studies from the Malay Archipelago*, ed. N.S. Sodhi, G. Acciaioli, M. Erb, and A.Khee-Jin Tan, pp 37-53. Cambridge University Press, New York.

Borg, I. and Groenen, P. (2005). *Modern multidimensional scaling: theory and applications* (2nd ed.), Springer-Verlag New York.

Breugel, M. v., Bongers, F. and Martínez-Ramos, M. (2007). Species dynamics during early secondary forest succession: recruitment, mortality and species turnover. *Biotropica* 39:610-619.

Breugel, M. v., Martínez-Ramos, M. and Bongers, F. (2006). Community dynamics during early secondary succession in Mexican tropical rain forests. *Journal of Tropical Ecology* 22:663-674.

Brookfield, H., Potter, L. and Byron, Y. (1995). *In place of the forest: environmental and socio-economic transformation in Borneo and the Eastern Malay Peninsula*. United Nations University Press, Tokyo.

Bruchánik, R. (2006). *Close to nature silviculture. Support to the design and development of innovative forest management schemes*. Food and Agriculture Organization of The United Nations Technical Co-Operation Programme.

Brook, B.W., Sodhi, N.S. and Ng, P.K.L. (2003). Catastrophic extinctions follow deforestation in Singapore. *Nature* 424:420-423.

Brown, J. and Mitchell, B. (2000). The stewardship approach and its relevance for protected landscapes. *The George Wright Forum* 17(1):70-79.

Brody, S. D. (2003). Implementing the principles of ecosystem management through local land use planning. *Population Environ* 24:511-540.

Buttoud, G. (2002). Multipurpose management of mountain forests:which approaches? *Forest Policy and Economics* 4:83-87.

Buckley, R. (2000). Neat trends: current issues in nature, eco- and adventure tourism. *International Journal of Tourism Research* 2:437-444.

Casson, A., Setyarso, A., Boccucci, M. and Brown, D. (2005). *Illegal logging and law enforcement in Indonesia*: draft summary, results from the WWF/World Bank Alliance assessment of illegal logging and law enforcement (2002–2004).

Chape, S., Harrison, J., Spalding, M. and Lysenko, I. (2005). Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. *Philosophical Transactions of the Royal Society of London Biological Sciences* 360:443-455.

Chape, S., Blythe, S., Fish, L., Fox, P. and Spalding, M. (2003). *2003 United Nations List of Protected Areas.* IUCN, Gland, Switzerland and Cambridge, UK and UNEP-WCMC, Cambridge, UK.

Charnley, S., Fischer, A. P. and Jones. E. T. (2007). Integrating traditional and local ecological knowledge into forest biodiversity conservation in the Pacific Northwest. *Forest Ecology and Management* 246:14-28.

Charbonnier, S.J. and R.Gertisser. (2008). Field observations and surface characteristics of pristine block-and-ash flow deposits from the 2006 eruption of Merapi Volcano, Java, Indonesia. *Journal of Volcanology and Geothermal Research* 177: 971-982.

Chazdon, R.L. (2003). Tropical forest recovery: legacies of human impact and natural disturbances. *Perspectives in Plant Ecology, Evolution and Systematics* 6: 51-71.

Chinea, J.D. (2002). Tropical forest succession on abandoned farms in the Humacao Municipality of Eastern Puerto Rico. *Forest Ecology and Management* 167:195-207.

Clark, J.S., Beckage, B., Camill, P., Cleveland, B., HilleRisLambers, J., Lichter, J., McLachlan, J., Mohan, J. and Wyckoff, P. (1999). Interpreting recruitment limitation in forests. *American Journal of Biology* 86:1-16.

Clason, T.R. and Sharrow, S.H. (2000). Silvopasture practices. In *American agroforestry: an integrated science and practice*, ed. H.E. Garrett, pp. 119-147.ASA, Madison.

Coates, K.D. (2002). Tree recruitment in gaps of various size, clearcuts and undisturbed mixed forest of interior British Columbia, Canada. *Forest Ecology and Management* 155:387-398.

Coggins, C.R. (2000). Wildlife conservation and bamboo management in China's southeast upland. *The Geographical Review* 90 (1):83-111.

Colfer, C.J.P., Dahal, G. R. and Moeliono, M. (2008). Setting the stage: money and justice in Asia and Pacific Forests. In *Lessons from Forest Decentralization: Money, Justice and the Quest for Good Governance in Asia-Pacific*, ed. C.J.P Colfer, G.R. Dahal, and D. Capistrano, pp. 1-16. Earthscan.

Colon, S.M. and Lugo, A.E. (2006). Recovery of a subtropical dry forest after abandonment of different land uses. *Biotropica* 38:354-364.

Colchester, M. (2004). Conservation policy and indigenous peoples. *Environmental Science & Policy* 7:145-153.

Condit, R., Hubbell, S. and Foster, R.B. (1994). Density dependence in two understory tree species in a neotropical forest. *Ecology* 75: 671-680.

Cortina, J., Maestre, F.T., Vallejo, R., Baeza, M.J., Valdecantos, A. and Pe´rez-Devesa, M. (2006). Ecosystem structure, function, and restoration success: Are they related? *Journal for Nature Conservation* 14:152-160.

Curran, L.M., Trigg, S.N. and McDonald, A.K. (2004). Lowland forest loss in protected areas of Indonesian Borneo. *Science* 303:1000-1003.

Cubina, A. and Aide, T.M. (2001). The effect of distance from forest edge on seed rain and soil seed bank in a tropical pasture. *Biotropica* 33: 260-267.

Cullen, L.J., Lima, J.F. and Beltrame, T.P. (2004). Agroforestry buffer zones and stepping stones: tools for the conservation of fragmented landscapes in the Brazilian Atlantic Forest. In *Agroforestry and Biodiversity Conservation in Tropical Landscapes*, ed. G. Schroth, G.A.B. da Fonseca, C.A. Harvey, C.Gascon, H.L. Vasconcelos, and A.M.N. Izac, pp. 415-430. Island Press.

Dale, V.H., Campbell, D.R., Adams, W.M., Crisafulli, C.M., Dains, V.I., Frenzen, P.M. and Holland, R.F. (2005). Plant succession on the Mount St. Helens Debris-Avalanche deposit. In *Ecological Responses to the 1980 Eruption of Mount St. Helens*, ed. V.H. Dale, J. Frederick, M. Swanson, Charles, and Crisafulli, pp. 59-72. Springer.

Davies, S. J. (2001). Tree mortality and growth in 11 sympatric macaranga species in Borneo. *Ecology* 82: 920-932.

DeFries, R., Hansen, A., Turner, B.L., Reid, R. And Liu, J., (2007). Land use change around protected areas: management to balance human needs and ecological function. *Ecological Applications* 17(4):1031-1038.

DeFries, R., Hansen, A., Newton, A.C. and Hansen, M.C. (2005). Increasing isolation of protected areas in tropical forests over the past 20 years. *Ecological Applications* 15:19-26.

del Moral, R., Lawrence, R.W. and Bakker, J.P. 2007. Insights Gained from Succession for the Restoration of Landscape Structure and Function. In *Linking Restoration and Ecological Succession*, ed. L.R. Walker, J. Walker, and R.J. Hobbs, pp. 19-44.Springer.

Denslow, J.S. (1995). Disturbance and diversity in tropical rain forest: the density effect. *Ecol. Appl* 5:962-968.

Donfack, P., Floret. C. and Pontanier. R. (1995). Secondary succession in abandoned fields of Dry Tropical Northern Cameroon. *Journal of Vegetation Science* 6:499-508.

Donoghue, E. (2003). Social values and compatible forest management. In *Compatible Forest Management*, ed. R.A. Monserud. R.W. Haynes, and A.C.Johnson, pp 429-452. Dordrecht, The Nederlands. Kluwer Academic Publishers.

Dorren, L.K.A., Berger, F., Imeson, A.C., Maier. B. and Rey. F. (2004). Integrity, stability and management of protection forests in the European Alps. *Forest Ecology and Management* 195:165-176.

Dove, M.R. (2008). Perception of volcanic eruption as agent of change on Merapi volcano, Central Java. *Journal of Volcanology and Geothermal Research* 172:329-337.

Dudley, N., Gujja, B., Jackson, W., Jeanrenaud, J-P., Oviedo, G., Phillips, A., Rosabel, P., Stolton, S. and Wells, S. (1999). Challenges for protected areas in the 21st century. In: *Partnerships for Protection: New Challenges for Planning and Management for Protected Areas.* WWF and IUCN. Earthscan.

Ellis, E.A. and Bolland, L.P. (2008). Is community-based forest management more effective than protected areas? A comparison of land use/land cover change in two neighboring study areas of the Central Yucatan Peninsula, Mexico. *Forest Ecology and Management* 256:1971-1983.

Farris, E., Filigheddu, R., Deiana, P., Farris, G.A. and Garau, G. (2010). Short term effect son sheep pasture land due to grazing abandonment in a Western Mediterranean is land ecosystem. A multidisciplinary approach. *Journal for Nature Conservation* doi:10.1016/j.jnc.2009.11.00

Ferrari, M.F. (2006). Rediscovering community conserved areas in South-east Asia: peoples' initiative to reverse biodiversity loss. *Parks* 16(1) Community Conserved Areas.

Ffolliott, P.F. (2003). *Agroforestry-A Primer*. Tucson, AZ: School of Renewable Natural Resources, University of Arizona.

Fisher, B. (2003). Within boundaries: the implications of pro-poor conservation for protected areas. *Presentation at the Vth IUCN World Parks Congress, Durban.* IUCN 2003. *Pro poor conservation: elements of IUCN's conceptual framework.*

Finegan, B. (1996). Pattern and process in Neotropical Secondary Rain Forests: the first 100 years of succession. *Trends in Ecology & Evolution* 11:119-124.

Font, X, and Tribe, J. (2000). Recreation, conservation and timber production: a sustainable relationship? In *Forest tourism and recreation: case studies in environmental management*, ed X.Font, and J. Tribe, pp. 1-22. CABI Publishing.

Food and Agricultural Organization (FAO). (2008). *Agroforestry systems*. FAO Rome, Italy.

Food and Agricultural Organization (FAO). (2007). State *of the World's Forests*. FAO Rome, Italy.

Food and Agricultural Organization (FAO). (2006a). Global Forest Resources Assessment 2005 - Progress Toward Sustainable Forest Management. FAO Rome, Italy.

Food and Agricultural Organization (FAO) (2006b) Better Forestry, Less Poverty: A Practitioner's Guide. FAO Forestry Paper No. 149. FAO Rome, Italy.

Food and Agricultural Organization (FAO). (2005). State of the World's Forests 2005. FAO Rome, Italy.

Food and Agricultural Organization (FAO). (2003). State of the World's Forests. FAO Rome, Italy.

Food and Agricultural Organization (FAO). (2001). Global Forest Resources Assessment 2000: main report. FAO Forestry Paper No. 140. FAO Rome, Italy.

Franklin, J.F., Spies, T.A., Robert, V.P, Carey, A.B., Thornburgh, D.A., Rae, B.D., Lindenmayer, D.B., Harmon, M.E., Keeton, W.S., Shaw, D.C., Bible, K. and Jiquan, C. (2002). Disturbances and structural development of natural forest ecosystems with silvicultural implications, using Douglas-fir forests as an example. *Forest Ecology and Management* 155:399-423.

Frey, B.R., Ashton, M.S., McKenna, J.J., Ellum, D. and Finkral. A. (2007). Topographic and temporal patterns in tree seedling establishment, growth, and survival among masting species of southern New England mixed-deciduous forests. *Forest Ecology and Management* 245: 54-63.

Frivold, L.H. (1992). *Ecologically oriented silviculture in the boreal coniferous forest zone*. IUFRO, Proc. Centennial, Berlin-Eberswalde, Germany, 31 August to 4 September.

Fuehrer, E. (2000). Forest functions, ecosystem stability and management. *Forest Ecology and Management* 132:29-38.

Gajaseni, J., Matta-Machado, R. and Jordan. C.F. (1996). Diversified agroforestry systems: buffers for biodiversity reserves, and landbridges for fragmented habitats in the tropics. In *Biodiversity in managed landscapes: theory and practice*, ed. R.C. Szaro, and D.W. Johnston, pp. 506-513. Oxford, UK: Oxford University Press.

Gamborg, C. and Larsen, J.B. (2003). Back to nature: a sustainable future for forestry? *Forest Ecology and Management* 179:559-571.

Garrity, D. (2006). Science-based agroforestry and the achievement of the Millennium Development Goals. In *World Agroforestry into the Future*, ed. D. Garrity, A. Okono, M. Grayson, and S. Parrott, pp. 3-10. Nairobi, Kenya: World Agroforestry Centre.

Garrity, D.P. (2004). Agroforestry and the achievement of the millennium development goals. *Agroforestry Systems* 61:5-17.

Garret, H.E., Kerley, M.S., Ladyman, K.P., Walter, W.D., Godsey, L.D., Van Sambeek, J.W. and Brauer, D.K. (2004). Hardwood silvopasture management in Noth America. *Agroforestry Systems* 61:21-33.

Gaston, K.J. and Spicer, J.I. (2004). *Biodiversity: An Introduction*. Second ed. Blackwell Publishing.

Geisler, C. (2003). Your park, my poverty: using impact assessment to counter the displacement effects of environmental greening. In *Contested Nature: Promoting International Biodiversity with Social Justice*, ed. Brechin, S.R., Wilshusen, P.R., Fortwangler, C.L, and West, P. SUNY Press, NY.

Gold, M.A., Rietveld, W.J., Garrett, H.E. and Fisher, R.F. (2000). Agroforestry nomenclature, concepts, and practices for the USA. In *North American Agroforestry: an Integrated Science and Practice*, ed. H.E. Garrett, W.J. Rietveld, and R.F. Fisher, pp. 63-76. ASA, Madison,WI.

Goltenboth, F. and Hutter. C.P. (2004). New options for land rehabilitation and landscape ecology in Southeast Asia by ‘‘rainforestation farming’’. *Journal for Nature Conservation* 12:181-189.

Graham, R.T. and Jain, T.B. (2004). *Past, present and future role of silviculture in forest management*. Proceedings of the National Silviculture Workshop: silviculture in special places: Granby, CO, ed. W.D. Shepperd, and L.G. Eskew, pp. 1-14. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Guldin, J.M. and Graham, R.T. (2007). *Silviculture for 21st century-objective and subjective standards to guide successful practice*. USDA Forest Service Gen.Tech.Rep.PSW-GTR-203.

Guldin, J.M. (2006). Uneven-aged silviculture of longleaf Pine. In *The Longleaf Pine Ecosystem Ecology, Silviculture, and Restoration*, ed. S.Jose, E.J. Jokela, and D.L. Miller. Springer.

Guariguata, M.R., Cronkleton, P., Shanley, P. and Taylor, P.L. (2008). The compatibility of timber and non-timber forest product extraction and management. *Forest Ecology and Management* 256:1477-1481.

Guariguata, M. R. and Ostertag. R. (2001). Neotropical secondary forest succession: changes in structural and functional characteristics. *Forest ecology and management* 148:185-206.

Guo, Q. (2000). Climate change and biodiversity conservation in Great Plains agroecosystems. *Global Environmental Change* 10:289-298.

Gustave, R. and Borchers, H. (2008). Conservation and conflict in Komodo National Park. In *Biodiversity and Human Livelihoods in Protected Areas: Case Studies from the Malay Archipelago*, ed. N.S. Sodhi, G, Acciaioli, M. Erb, and K.J.T. Alan, pp. 166-187. Cambridge University Press.

Hadikusumah, H.K., Balla, M.K., Chaudhary, S., Karkee, T.B., Cruz, F.A., Ortega-Espaldon, M.V., Juma, J.C., Polthanee, A., Suphanchaimat, N. and Na-Lampang, P. (1991). *Wood fuel flows: rapid rural appraisal in four Asian countries*. FAO, Bangkok, Thailand.

Hanna, K.S., Clark, D.A. and Slocombe, D.S. (2008). Introduction: Protected areas in a changing world. In *Transforming parks and protected areas:policy and governance a changing world*, Ed. Hanna K,S. Clark, D.A. and D.S. Slocombe. Routledge 270 Madison Avenue, New York,NY 10016.

Hansen, A.J. and DeFries, R. (2007). Ecological mechanisms linking protected areas to surrounding lands. *Ecological Applications* 27(4):974-988.

Harvey, B.D., Leduc, A., Gauthier, S. and Bergeron, Y. (2002). Stand-landscape integration in natural disturbance-based management of the southern boreal forest. *Forest Ecology and Management* 155:369-385.

Haveraaen, O. (1995). *Silvicultural systems in the Nordic countries*. Proceeding Innovative silvicultural systems in Boreal Forests, ed. C.R. Bamsey, pp. 1-4. IUFRO Symposium in Edmonton, Alberta, Natural Resources Canada, Canadian Forest Service.

Hayness, R.W., Monserud, R.A. and Johnson, A.C. (2003). Compatible forest management: background and context. In *Compatible Forest Management*, ed. R.A. Monserud, R.W. Haynes, and A.C. Johnson, pp. 3-34. Dordrecht, The Nederlands. Kluwer Academic Publishers.

Haynes, R.W. and Monserud, R.A. (2002). *A basis for understanding compatibility among wood production and other forest values*. General technical report PNW-GTR-529.

Heltse, J.F. and Forrester, N.E. (1983). Estimating species richness using the jacknife procedure. *Biometrics* 39:1-11.

Hines, W.G.S. and Hines, R.J.O. (1979). The Ebehardt Index and The Detection of Non Randomness of Spatial Points Distributions. *Biometrika* 66: 73-80.

Holl, K. D., Crone, E. E. and Schultz, C. B. (2003). Landscape restoration: Moving from generalities to methodologies. *BioScience* 53:491-502.

Hooper, D. U., Chapin, F. S., Ewel, J.J., Hector, A., Inchausti, P., Lavorel, S., Lawton, J.H., Lodge, D., Loreau, M., Naeem, S., Schmid, B., Setala, H., Symstad, A.J., Vandermeer, J. and Wardle, D.A. (2005). Effects of biodiversity on ecosystem functioning: A consensus of current knowledge. *Ecological Monographs* 75:3-35.

Huang, W., Pohjonen, V., Johansson, S., Nashanda, M., Katigula, M.I.L. and Luukkanen, O. (2003). Species diversity, forest structure and species composition in Tanzanian tropical forests. *Forest Ecology and Management* 173:11-24.

Huttl, R.F., Schneider, B.U. and Farrell, E.P. (2000). Forest of the temperate region: gaps in knowledge and research needs. *Forest Ecology and Management* 132:83-96.

Hurtt, G.C. and Pacala, S.W. (1995). The consequences of recruitment limitation: reconciling chance, history and competitive differences between plants. *Journal of Theoretical Biology* 176:1-12.

Huxley, P.A. (1999). *Tropical Agroforestry*. Oxford, UK: Blackwell Science.

IUCN. (2005). *Benefits beyond boundaries*. Proceedings of the Vth IUCN World Parks Congress. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN. (2003). Ecosystem management: lessons from around the world- a guide for development and conservation practitioners. ed. J.Y. Pirot, P.J. Meynell, and D. Elder, IUCN, Gland, Switzerland.

IUCN. (1994). *Guidelines for Protected Area Management Categories*. IUCN, Gland, Switzerland and Cambridge, UK.

IIASA and FAO. (2002). *Global agro-ecological assessment for agriculture in the 21st century*, by G. Fischer, M. Shah, H. van Velthuizen & F.O. Nachtergaele. Laxenburg, Austria and Rome.

IPCC (Intergovernmental Panel on Climate Change). (2007). *Climate Change 2007; Mitigation, Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC (Intergovernmental Panel on Climate Change). (2000). *Land-use, Land-use Change and Forestry*, ed. R.T. Watson, I.R. Noble, B.Bolin, N.H. Ravindranath, D.J. Verardo, and D.J. Dokken. Special report. Cambridge University Press, Cambridge.

Izquierdo, G.G., Pastur, G.M., Cellini, J.M. and Lencinas, M.V. (2004). Forty years of silvicultural management in southern *Nothofagus pumilio* primary forests. *Forest Ecology and Management* 201:335-347.

Izac, A.M.N. and Sanchez. P.A. (2001). Towards a natural resource management paradigm for international agriculture: the example of agroforestry research. *Agricultural Systems* 69:5-25.

Jama, B., Eyasu, E. and Mogotsi, K. (2006). Role of agroforestry in improving food security and natural resource management in the drylands: a regional overview. *Journal of the Drylands* 1:206-211.

James, C.D., Landsberg, J. and Morton, S.R. (1999). Provision of watering points in the Australian arid zone: a review of effects on biota. *Journal of Arid Environments* 41:87-121.

JongHo, K., KyuHun, K. and ChinKyu, L. (1997). A study on the establishment of classification index for choosing the objective areas of mountain village region development project. *Journal of Forest Science* 55:105-124.

Jose, S. and Gordon, A.M. (2008). *Ecological knowledge and agroforestry design: an introduction in toward agroforestry design an ecological approach*, ed S. Jose, and A.M. Gordon. Springer.

Kangas, J. (1994). An approach to public participation in strategic forest management planning. *Forest Ecology and Management* 70:75-88.

Kiessling, W. (2005). Long-term relationships between ecological stability and biodiversity in Phanerozoic reefs. *Nature* 433: 410-413.

Kidd, C.V. and Pimentel D. (1992). *Integrated Resource Management: Agroforestry for Development*. San Diego, CA: Academic Press, Inc.

Kimmin, J.P. (1997). *Forest ecology a foundation for sustainable management*. Prentice Hall, Upper Saddle River, New Jersey.

Kindt, R., Damme, P.V. and Simons, A.J. (2006). Tree diversity in Western Kenya: using profiles to characterise richness and evenness. *Biodiversity and Conservation* 15:1253-1270.

Kothari, A. and Lockwood, G.L. (2006). Social context. In *Protected Areas Management: A Global Guide*, ed. M. Lockwood, G.L. Worboys, and A. Kothari, pp. 41-72. Earthscan in the UK and USA.

Krauchi, N., Peter, B. and Walter, S. (2000). Forests of mountainous regions: gaps in knowledge and research needs. *Forest Ecology and Management* 132:73-82.

Krebs, C.J. (1989). *Ecological methodology*. University of British Columbia-Harper Collins Publisher. Inc. New York.

Kumar, B.M. and Nair P.K.R. (2004). The enigma of tropical homegardens. *Agroforestry Systems* 61: 135-152.

Kumm, K.I. (2003). Sustainable management of Swedish seminatural pastures with high species diversity. *Journal for Nature Conservation* 11:117-125.

Kurttila, M., Pesonen, M., Kangas, J. and Kajanus, M. (2000). Utilizing the analytic hierarchy process AHP in SWOT analysis-a hybrid method and its application to a forest-certification case. *Forest Policy and Economics* 1:41-52.

Kurtz, W.B., Garrett, H.E. and Slusher, J.P. (1996). *Economics of agroforestry*. Agriculture MU Guide. University Extension, University of Missouri, Columbia.

Lahde, E., Laiho, O. and Norokorpi. Y.(1999). Diversity-oriented silviculture in the boreal zone of Europe. *Forest Ecology and Management* 118:223-243.

Lahde, E. (1993). *Diversity of forests as a global goal*. Proceedings of the workshop valuing biodiversity on the social costs of and benefits from preserving endangered species and biodiversity of the Boreal Forests, ed. M. Linddal, and A. Naskali, Espoo, Finland.

Laiolo, P. (2003) Diversity and structure of the bird community overwintering in the Himalayan subalpine zone: is conservation compatible with tourism? *Biological Conservation* 115:251-262.

Lambert, D.M., Sullivan, P., Claassen, R. and Foreman, L. (2007). Profiles of US farm households adopting conservation-compatible practices. *Land Use Policy* 24:72-88.

Larson, A.M. and Ribot, J.C. (2007). The poverty of forestry policy: double standards on an uneven playing field. *Sustainability Science* 2:189-204.

Lavigne, F., Thouret, J.C., Voight, B., Suwa, H. and Sumaryono, A. (2000). Lahars at Merapi volcano, Central Java: an overview. *Journal of Volcanology and Geothermal Research* 100: 423-456.

Leakey, R., Tchoundjeu, Z., Schreckenberg, K., Simons, T., Shackleton, S., Mander, M., Wynberg, R., Shackleton, C. and Sullivan, C. (2006). Trees and markets for agroforestry tree products: targeting poverty reduction and enhanced livelihoods. In *World Agroforestry into the Future*, ed. D. Garrity, A. Okono, M. Grayson, and S. Parrott, pp. 11–22. Nairobi, Kenya: World Agroforestry Centre.

Lynagh, F.M. and Urich, P.B. (2002). A critical review of buffer zone theory and practice: a Philippine case study. *Society and Natural Resources* 15:129-145.

MacKay, D. (2003). *An example inference task: clustering. information theory, inference and learning algorithms*. Cambridge University Press.

Magurran, A.E. (2004). *Measuring biological diversity*. Blackwell Publishing, Malden, MA, USA.

Margules, C. and Sarkar, S. (2007). *Systematic conservation planning*. Cambridge University Press.

Mawapanga, M.N. and Debertin, D.L. (1996). Choosing between alternative farming systems: an application of the analytic hierarchy process. *Review of Agricultural Economics* 18:385-401.

Mayers, J. and Vermeulen, S. (2002). *Power from the Trees: How Good Forest Governance Can Help Reduce Poverty.*World Summit on Sustainable Development Opinion. IIED, London.

McDonald, T., Wale, K. and Bear, V. (2002). Restoring blue gum high forest: lessons from Sheldon Forest. *Ecological Management and Restoration* Vol 3 No 1.

McElwee, P. (2001). *Parks or people: Exploring alternative explanations for protected areas development in Vietnam*. Yale Center for Comparative Research workshop: Conservation and sustainable development-comparative perspectives, Yale.

McNeely, J. and Schroth, G. (2006). Agroforestry and biodiversity conservation—traditional practices, present dynamics, and lessons for the future. *Biodiversity and Conservation* 15:549-554.

McShane, T.O. and Wells, M.P. (2004). *Getting Biodiversity Projects to Work*: *Towards More Effective Conservation and Development*. Columbia University Press, NY.

Mertens, B., Sunderlin, W., Ndoye, O. and Lambin, E. (2000). Impact of macroeconomic change on deforestation. World Development 28 (6):983-999.

Mesquita, R., Ickes, K., Ganade, G. and Williamson. G.B. (2001). Alternative successional pathways in the Amazon basin. *Journal of Ecology* 89:528-537.

Meybeck, M., Green, P. and Vorosmarty, C. (2001). A New Typology for Mountains and Other Relief Classes: An Application to Global Continental Water Resources and Population Distribution. *Mountain Research and Development* 21(1):34-45.

Mlinsek. (1996). *From clear-cutting to close-to-nature silviculture system*. International Union Research Organizations, IUFRO News 25 (4):6-8.

Michon, G. and de Foresta. H. (1995). The Indonesian agro-forest model: forest resource management and biodiversity conservation. In *Conserving Biodiversity outside protected areas. The role of traditional agroecosystems*, ed. P. Halladay, and D.A. Gilmour, pp. 90-106.IUCN.

Mielikainena, K. and Hynynen. J. (2003). Silvicultural management in maintaining biodiversity and resistance of forests in Europe–boreal zone: case Finland. *Journal of Environmental Management* 67:47-54.

Millennium Ecosystem Assessment (MEA). (2005). *Ecosystems and human well-being*: *scenario*. Island Press.Washington, D.C

Ministry of Forestry, Indonesia. (2007). *Review core productivity at three national park in Indonesia*. Project Report, Jakarta, Indonesia.

Ministry of Forestry. (2006a). Recognizing 21 national park model in Indonesia. General Directorate of Forestry Protection and Nature Conservation. Ministry of Forestry, Indonesia. *http://www.dephut.go.id*

Ministry of Forestry-Indonesia. (2006b). *Ministry of Forestry Regulation about the guiden of national park zonation* (No.P.56/Menhut-II/2006). Ministry of Forestry, Jakarta. *http://www.dephut.go.id*

Ministry of Forestry, Indonesia. (2004a). Ministry of Forestry Decision (SK.134/MENHUT-II/2004). Changing function forest conservation, sanctuary and natural park recreation merapi located at Magelang, Boyolali and Klaten District, Central Java Province and Sleman District, Yogyakarta Province to Gunung Merapi National Park. [online] Available :http://www.dephut.go.id (February 3, 2010)

Ministry of Forestry. (2004b). *Ministerial decree on collaboration for the management of protected areas* (No.19/Menhut-II/2004). Ministry of Forestry, Jakarta. www.dephut.go.id/informasi/skep/2004/p19_04.htm.

Ministry of Forestry, UNESCO and CIFOR. (2003). Guidebook of the 41 National Parks in Indonesia. Jakarta, Indonesia: Ministry of Forestry, UNESCO and CIFOR.

Ministry of Forestry, Indonesia. (2002). Merapi Mountain, The candidate of new national park (in Indonesian). Press Release No. 1000/II/PIK-1/2002. http://www.dephut.go.id.

Ministry of Forestry, Indonesia. (2001). Draft: National Forest Statement; Through Multi-Stakeholder Participation. Jakarta, Indonesia.

Ministry of Energy and Mineral Resources. (2009). Press release, Establishing Gunung Merapi Museum. Directorate Geology, Ministry of Energy and Mineral Resources, Indonesia. http://www.esdm.go.id/

Miyazawa, Y., Tatsuya, S., Kikuzawa, K. and Otsuki, K. (2006). The light environment, morphology and growth of the early successional tree species *Litsea citiodora*. *Forest Ecology and Management* 236:251-258.

Mizunaga, H., Nagaike, T., Yoshida, T. And Valkonen, S. (2010). Feasibility of silviculture for complex stand structures: designing stand structures for sustainability and multiple objectives. *Journal of Forest Research* 5:1-2.

Moeliono, M. (2008). Hands off, hands on: communities and the management of national parks in Indonesia. In *Biodiversity and Human Livelihoods in Protected Areas: Case Studies from the Malay Archipelago*, ed. S. Navjot, Sodhi, G. Acciaioli, M. Erb, and A.K.J. Tan, pp. 165-186. Cambridge University Press.

Montagu, K.D., Kearney, D.E. and Smith, R.G.B. (2003). The biology and silviculture of pruning planted eucalypts for clear wood production-a review. *Forest Ecology and Management* 179:1-13.

Moran, E.F. and Ostrom, E. (2005). *Seeing the Forest and the Trees:Human-Environment Interactions in Forest Ecosystems*. MIT Press, Cambridge, MA.

Moran, E.F., Brondizio, E.S., Tucker, J.M., da Silva Forsberg, M.C., McCracken, S and Falesi, I. (2000). Effects of soil fertility and land-use on forest succession in Amazonia. *Forest Ecology and Management* 139: 93-108.

Motta, R. and Haudemand, J.C. (2000). Protective forests and silvicultural stability. An example of planning in the Aosta valley. *Mountain Res. Dev*. 20:74-81.

Mulyana, A. (2002). *History and national park real action: considerate global demand, declare local wisdom*. Handout for refection member of community development consortium in Nusa Tenggara. Nusa Tenggara, Indonesia.

Murniati., Garrity, D.P. and Gintings, A.N. (2001). The contribution of agroforestry systems to reducing farmers' dependence on the resources of adjacent national parks: a case study from Sumatra, Indonesia. *Agroforestry Systems* 52:171-184.

Naeem, S. and Baker, A.C. (2005). Paradise sustained. *Nature* 433:370-371.

Nair, P.K.R. (1998). Directions in tropical agroforestry research: past, present, and future. *Agroforestry Systems* 38: 223-245.

Nair, P.K.R. (1993). *An Introduction to Agroforestry*. Dordrecht, the Netherlands: Kluwer Academic Publishers.

Nair, P.K.R. (1991) State-of-the-art of agroforestry systems. In *Agroforestry: Principles and Practice*, ed. P.G. Jarvis, pp 5-29. Elsevier, Amsterdam, The Netherlands.

Nawir, A.A., Murniati and Rumboko, L. (2007). Reorientation of the rehabilitation programme in Indonesia. In *Forest rehabilitation in Indonesia: where to after three decades*?, ed. A.A. Nawir, Murniati, and L. Rumboko, pp. 177-222. Center for International Forestry Research (CIFOR). Bogor, Indonesia.

Nawir, A.A. and Rumboko, L. (2007). History and state of deforestation and land degradation. In *Forest rehabilitation in Indonesia: where to after three decades*?, ed. A.A. Nawir, Murniati, and L. Rumboko, pp. 11-32. Center for International Forestry Research (CIFOR). Bogor, Indonesia.

Neave, H.M. and Norton, T.W. (1998). Bilogical inventory for conservation evaluation IV.Composition, distribution and spatial prediction of vegetation assemblages in southern Australia. *Forest Ecology and Management* 106: 259-281.

Nelson, J. and Hossack, L. (2003). *From Principles to Practice: Indigenous Peoples and Protected Areas in Africa.* Moreton-in Marsh, UK: Forest Peoples Programme.

Niklas, K. J., Midgley, J. J. and Enquist, B. J. (2003). A general model for mass-growth-density relations across tree-dominated communities. *Evolutionary Ecology Research*, 5:459-468.

Noble, I.R. and Dirzo. R. (1997). Forests as human-dominated ecosystems. *Science* 277(5325):522-525.

Nuberg, I., Reid, R. and George, B. (2009). Agroforestry as integrated natural resource management. In *Agroforestry for natural resource management*, ed. I. Nuberg, B. George, and R. Reid, CSIRO Publishing.

Nussbaum, R., Anderson, J. and Spencer, T. (1995). Factors limiting the growth of indigenous tree seedlings planted on degraded rainforest soil in Sabah, Malaysia. *Forest Ecology and Management* 74:149-159.

Nyland, R. D. (2004). *Silviculture, Concepts and Applications*. The McGraw-Hill Companies, Inc. New York.

Nyland, R. D. (2002). *Silviculture: Concepts and Applications*, 2nd Edition. The McGraw-Hill Companies, Inc. New York.

Nyland, R. D. (1996). *Silviculture, Concepts and Applications*. The McGraw-Hill Companies, Inc. New York.

O'Hara, K.L. (2001). The silviculture of transformation-a commentary. *Forest Ecology and Management* 172:291-300.

Olson, R.K., Schoeneberger, M.M. and Aschmann, S.G. (2000). An ecological foundation for temperate agroforestry. In *North American Agroforestry: An Integrated Science and Practice*, ed. H.E. Garrett, W.J. Rietveld, and R.F. Fisher, pp. 31-61. Madison, WI: American Society of Agronomy.

Pandey, D.N. (2007). Multifunctional agroforestry systems in India. *Current Science* 92:455-463.

Park, Y.S., Verdonschot, P.F.M., Chon, T.S. and Lek, S. (2003). Patterning and predicting aquatic macroinvertebrate diversities using artificial network. *Water Res* 37:1749-1758.

Parviainen, J. and Frank, G. (2003). Protected forests in Europe approaches-harmonising the definitions for international comparison and forest policy making. *Journal of Environmental Management* 67:27-36.

Pena-Claros, M. (2003). Changes in forest structure and species composition during secondary forest succession in the Bolivian Amazon. *Biotropica* 35:450-461.

Perez, D. and Kanninen, M. (2003). Provisional equations for estimating total and merchantable volume of *Tectona grandis* trees in Costa Rica. *Forests, Trees & Livelihoods* 13:345-359.

Peyre, A., Guidal, A., Wiersum, K.F. and Bongers, F. (2006). Dynamics of homegarden structure and function in Kerala, India. *Agroforestry Systems* 66:101-115.

Peterson, C.E. and Monserud, R.A. (2002). *Compatibility between wood production and other values and uses on forested lands*. A problem analysis. General Technical Report PNW-GTR-564. Porland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Perz, S.G. (2004). Are Agricultural Production and Forest Conservation Compatible? Agricultural Diversity, Agricultural Incomes and Primary Forest Cover Among Small Farm Colonists in the Amazon. *World Development* 32(6):957-977.

Pesonen, M. (2001). Apllying A'WOT to forest industry investment strategies: case study of a finnish company in North America. In *The Analytic Hierarchy Process in Natural Resource and Environmental Decision Making*, ed. D.L. Schmoldt, pp. 187-198. Kluwer Academic Publisher.

Phillips, A. (2003). Turning Ideas on their Head-the New Paradigm for Protected Areas.*The George Wright Forum* 20 (2):8-32.

Phillips, A. (1998). Task Force on Economic Benefits of Protected Areas of the World Commission on Protected Areas (WCPA) of IUCN, in collaboration with the Economics Service Unit of IUCN. *Economic Values of Protected Areas: Guidelines for Protected Area Managers*. IUCN, Gland, Switzerland and Cambridge.

PHKA (General Directorate of Forestry Protection and Nature Conservation). (2009). *Gunung Merapi National Park*. Ministry of Forestry, Jakarta. http://www.ditjenphka.go.id/index.

Pickett, S.T.A. and Cadenasso. M.L. (2005). Vegetation dynamics. In *Vegetation Ecology*, ed. E.v.d. Maarel, pp. 172-198. Blackwell Science Ltd, Oxford.

Pickett, S.T.A. and White, P.S. (1985). Natural disturbance and patch dynamics: An introduction. In *The Ecology of Natural Disturbance and Patch Dynamics*, ed. S.T.A. Pickett, and P.S. White, pp. 3-13. Orlando: Academic Press.

Plieninger, T. (2007). Compatibility of livestock grazing with stand regeneration in Mediterranean holm oak parklands. *Journal for Nature Conservation* 15:1-9.

Price, M. F. and Butt, N. (2000). *Forests in sustainable mountain development: a state of knowledge report for 2000*. CAB International, Wallingford.

Purbawinata, M.A., Ratdomopurbo, A., Sinulingga, I.K., Sumarti, S., Suharno. (1997). *Merapi Volcano-A Guide Book*. Volcanological Survey of Indonesia, Bandung.

Purvis, A. and Hector, A. (2000). Getting the measure of biodiversity. *Nature* 405: 212-219.

Purata, S.E. (1986). Floristic and structural changes during old-field succession in the Mexican Tropics in relation to site history and species availability. *Journal of Tropical Ecology* 2:257-276.

Purnomo, A. (2005). *Winds of Change: Recent Progress towards Conserving Indonesian.Biodiversity*. Jakarta, Indonesia: Internal Paper for the World Bank.

Puri, S. and Nair, P. (2004). Agroforestry research for development in India: 25 years of experiences of a national program. In *New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry, 2004*, ed. P. Nair, M. Rao, and L. Buck. Advances in Agroforestry series, vol 1, Springer, New York, US.

Putz, F. and Fredericksen, T.S. (2004). Silvicultural intensification for tropical forest conservation: a response to Sist and Brown. *Biodiversity and Conservation* 13:2387-2390.

Rao, M.R., Singh, M.P. and Day, R. (2000). Insect pest problems in tropical agroforestry systems: contributory factors and strategies for management. *Agroforestry Systems* 50:243-277.

Regmi, B.N. (2003). *Contribution of agroforestry for rural livelihoods: A case of Dhading district, Nepal*. Paper presented at The International Conference on Rural Livelihoods, Forests and Biodiversity, Bonn, Germany.

Rey, P.J. and Alcantara, J.M. (2000). Recruitment dynamics of a fleshy fruited plant (*Olea europaea*): connecting patterns of seed dispersal to seedling establishment. *Journal of Ecology* 88:622-633.

Roberts, M.R. (2007). A conceptual model to characterize disturbance severity in forest harvests. *Forest Ecology and Management* 242:58-64.

Rodrigues, A.S.L., Andelman, S.J. and Bakarr, M.I. (2004). Effectiveness of the global protected area network in representing species diversity. *Nature* 428:640-643.

Roe, D. and Elliott, J. (2003). *Pro-poor conservation: the elusive win-win for conservation and poverty reduction*? Paper presented at the Vth IUCN World Parks Congress, Durban, South Africa.

Rogers, E.M., Burdge, R.J., Korsching, P.F. and Donnermeyer, J.F. (1988). *Social Change in Rural Societies: An Introduction to Rural Sociology*. Third edition. Prentice-Hall, Englewood Cliffs, NJ.

Saaty, T.L. (1993). The analytic hierarchy process: a 1993 overview. *Central European Journal of Operation Research and Economics* 2 (2):119-137.

Saaty, T.L. (1980). *The analytic hierarchy process*. McGraw-Hill, New York.

Saaty, T.L. (1977). A scaling method for priorities in hierarchical structure. *Journal of Mathematical Psychology* 15:234-281.

Salafsky, N., Parks, J., Margoluis, C., Bhatt, S., Encarnacion, C., Russell, D., Margoluis, R., Cauley, H., Balachander, G. and Cordes, B. (2001). A systematic test of an enterprise strategy for community-based biodiversity conservation. *Conservation Biology* 15:1585-1595.

Sanchez, P.A. (1999). Delivering on the promise of agroforestry. *Environment, Development and Sustainability* 1:275-284.

Sayer, J.A. (2001). Learning and Adaptation for Forest Conservation. In *Biological Diversity: Balanding interest through adaptive collaborative management*, ed. L.E. Buck, C.C. Geisler, J. Schelhas, and E. Wollenberg, pp. 69-80.CRC Press.

Sayer, J.A. and Maginnis, S. (2005). New challenges for forest management. In *Forest in Lanscapes: Ecosystem approaches to sustainability*, ed. J.A. Sayer, and S. Maginnis, pp. 1-16. Earthscan.

Schroth,G., da Fonseca, G.A.B., Harvey, C.A., Vasconcelos, H.L., Gascon, C. and Izac, A.M.N. (2004). Introduction: The Role of Agroforestry in Biodiversity Conservation in Tropical Landscapes. In *Agroforestry and Biodiversity Conservation in Tropical Landscapes*, ed. G. Schroth, G.A.B. da Fonseca, C.A. Harvey, C.Gascon, H.L. Vasconcelos, and A.M.N. Izac, pp. 1-12. Island Press.

Scherl, L.M., Wilson, A., Wild, R., Blockhus, J., Franks, P., McNeely, J.A. and McShane, T.O. (2004). *Can Protected Areas Contribute to Poverty Reduction*? *Opportunities and Limitations*. IUCN, Gland, Switzerland and Cambridge, UK.

Schutz, J.P. (2001). Opportunities and strategies of transforming regular forests to irregular forests. *Forest Ecology and Management* 151:87-94.

Seymour, R.S., White, A.S. and deMaynadier, P.G. (2002). Natural disturbance regimes in northeastern Nort America-evaluating silvicultureal systems using natural scales and frequencies. *Forest Ecology and Management* 155:357-367.

Shelton, D.P., Wilke, R.A. and Franti, T.G. (2009). Farmlink: promoting conservation buffers farmer-to-farmer. *Agroforest Systems* 75:83-89.

Shepherd, G. (2004). Poverty and Forests: Sustaining Livelihoods in Integrated Conservation and Development. In *Getting Biodiversity Projects to Work: Towards More Effective Conservation and Development*, ed. T.O. McShane, and M.P. Wells, pp. 340-371. Columbia University Press, NY.

Snelder, D.J. and Lasco, R.D. (2008). Smallholder tree growing in South and Southeast Asia. In *Smallholder tree growing for rural development and environmental services lessons from Asia*, ed. D.J. Snelder, and R.D. Lasco, pp. 3-36. Springer.

Singh, J.S. (2002). The biodiversity crisis: a multifaceted review. *Current Science* 82:638-647.

Silvertown, J. and Charlesworth, D. (2001). *Introduction to Plant Population Biology*. Blacjwell Science.

Smith, D.M., Larson, B.C., Kelty, M.J. and Ashton, P.M.S. (1997). *The Practice of Silviculture*. 9th ed. New York:John Wiley.

Sodhi, N.S. and Brook, B.W. (2006). *Southeast Asian Biodiversity in Crisis*. Cambridge, UK: Cambridge University Press.

Sodhi, N.S., Koh, L.P., Brook, B.W. and Ng, P.K.L. (2004). Southeast Asian biodiversity: the impending disaster. *Trends in Ecology & Evolution* 19: 654-660.

Soemarwoto, O. (1987). Homegardens: a traditional agroforestry system with a promising future. In *Agroforestry, a Decade of Development*, ed. Steppler H.A. and Nair P.K.R, pp. 157-172. ICRAF, Nairobi, Kenya.

Spehn, E.M., MesserliI, B. and Korner, C. (2002). A global assessment of mountain biodiversity: synthesis. In *Mountain Biodiversity*. A Global Assessment, Parthenon, Boca Ratone.

Spilsbury, M.J. and Nasi, R. (2006). The interface of policy research and the policy development process: challenges posed to the forestry community. *Forest Policy and Economics* 8:193-205.

Stræde, S. and Treue, T. (2006). Beyond buffer zone protection: A comparative study of park and buffer zone products' importance to villagers living inside Royal Chitwan National Park and to villagers living in its buffer zone. *Journal of Environmental Management* 78:251-267.

Stankey, G.H., Clark, R.N. and Bliss, J. (2003). Fostering compatible forest resource management: the conditional nature of social acceptability. In *Compatible Forest Management*, ed. RA.Monserud, R.W. Haynes, and A.C. Johnson, pp. 453-480. Kluwer Academic Publishers.

Strykstra, J.R., Bekker, R.M. and Van Andel, J. (2002). Dispersal and life span spectra in plant communities: a key to safe site dynamics, species coexistence and conservation. *Ecography* 25:145-160.

Straub, C.S., Finke, D.L. and Snyder, W.E. (2008). Are the conservation of natural enemy biodiversity and biological control compatible goals? *Biological Control* 45:225-237.

Sunderlin, W. D., Angelsen, A., Belcher, B., Burgers, P., Nasi, R., Santoso, L. and Wunder, S. (2005). Livelihoods, forests, and conservation in developing countries: an overview. *World Development* 33(9):1383-1402.

Sunderlin,W.D., Angelsen, A. and Wunder, S. (2004). *Forests and poverty alleviation*. CIFOR, Bogor, www.cifor.cgiar.org.

Supriyanto. (2007). *Working Group on Forest Land Tenure* (in Indonesian).Warta Tenure Nomor 4-Februari. www.wg-tenure.org.

Sutikno. (2002). *Potential Natural Resources of Merapi Mountain and Management for Supporting Life of Community*. Research Report. Research Center of Gadjah Mada University. Yogyakarta. Indonesia.

Thomas, L. and Julie, M. (2003). Guidelines *for Management Planning of Protected Areas*. IUCN Gland, Switzerland and Cambridge,UK.

Thorell, M. and Gotmark, F. (2005). Reinforcement capacity of potential buffer zones: Forest structure and conservation values around forest reserves in southern Sweden. *Forest Ecology and Management* 212:333-345.

Torquebiau, E.F. (2000). A renewed perspective on agroforestry concepts and classification. *Life Sciences* 323:1009-1017.

Tumbull, L.A., Crawley, M.J. and Rees, M. (2000). Are plant population seed-limited? A review of seed sowing experiments. *Oikos* 88:225-238.

Uriarte, M., Canham, C.D., Thompson, J. And Zimmerman, J.K. (2004). A neighborhood analysis of tree growth and survival in a Hurricane-Driven Tropical Forest. *Ecological Monographs* 74:591-614.

Vandermeer, J.H. (2002). *Tropical Agroecosystems*. Boca Raton, FL: CRC Press.

van Diggelen, R. (2006). Landscape: Spatial interactions. In *Restoration Ecology*, ed.J. van Andel, and J. Aronson, pp. 31-44. Oxford, U.K.Blackwell.

Viviroli, D. and Weingartner, R. (2004). Hydrological significance of mountains: from regional to global scale. *Hydrological Earth Systems Science* 8 (6):1016-1029.

Volcanological Survey of Indonesia (VSI). (1990). Volcanological Survey of Indonesia Gunung Merapi Merapi (in Indonesian). Directorate Vulcanology, Bandung.

Wang, Y.S., Shiyomi, M., Tsuiki, M., Tsutsumi, M., Yu, X.R. and Yi, R.H. (2002). Spatial heterogeneity of vegetation under different grazing intensities in the Northwest Heilongjiang Steppe of China. *Agriculture Ecosystems and Environment* 90:217-229.

Waite, S. (2000). *Statistical Ecology in Practice: A guide to analyzing environmental and ecological field data*. Pearson Education Limited.

Walker, L.R., Walker, J. and del Moral, R. (2007). Forging a New Alliance Between Succession and Restoration. In *Linking Restoration and Ecological Succession*, ed. Walker, L.R., Walker, J and Richard J. Hobbs, R.J, pp. 1-18. Springer.

Walker, L.R. and del Moral, R. (2003). *Primary Succession and Ecosystem Rehabilitation*. Cambridge: Cambridge University Press.

Wardojo, W. and Masripatin, N. (2002). *Trends in Indonesian Forest Policy*. Policy Trend Report. www.iges.or.jp/en/fc/pdf/reports/PTR0206.pd

West, P.W. (2009). *Tree and Forest Measurement*. Second Edition. Springer.

Whitmore, T.C. (1998). *An Introduction to tropical rain forests*. 2nd Edition. Oxford University Press. New York.

Whitmore, T.C. (1983). Secondary succession from seed in tropical rain forests. *For Abst* 44:767-779.

Wiens, J.A. (1997). Metapopulation dynamics and landscape ecology. In *Metapopulation Biology: Ecology, Genetics and Evolution*, ed. I. Hanski, and M.E. Gilpin, pp. 43-62. Academic Press, London.

Wijdeven, S.M.J. and Kuzee, M.E. (2000). Seed availability as a limiting factor in forest recovery processes in Costa Rica. *Restoration Ecology* 8:414-424.

Wiratno., Indriyo, D., Syarifudin, A. and Kartikasari, A. (2001). Looking Into A Cracked Mirror: Reflection of Conservation and Implication for Park Management. FoRest Press Bogor, Gibbon Foundation and PILI-NGO Movement, Jakarta, Indonesia.

Wishitemi, B.E.L. and Okello, M.M. (2003). Application of the Protected Landscape Model in southern Kenya. *Parks* Vol 13 No 2 Category V.

World Bank. (2005). 'Agriculture investment note on agroforestry systems', in *Sustainable Natural Resource Management for Agriculture*, Agriculture Investment Sourcebook: Module 5, World Bank, Washington, DC.

World Bank. (2004). *Sustaining Forest: A Development Strategy*. World Bank, Washington, DC.

World Bank. (2001). *A Revised Forest Strategy for the World Bank Group*. World Bank, Washington, DC.

Xu, J., Liding, C., Yihe, L. and Bojie, F. (2006). Local people's perception as decision support for protected area management in Wolong Biosphere Reserve, China. *Journal of Environmental Management* 78:362-372.

Yang, Y., Stephen, J.T. and Shongming. H. (2003). Modeling individual tree mortality for white spruce in Alberta. *Ecological Modelling* 163:209-222.

Zarin, D.J., Ducey, M.J. Tucker, J.M. and Salas, W.A. (2001). Potential biomass accumulation in Amazonian regrowth forests. *Ecosystems* 4:658-668.

Zhao, W., Qualls, R.J. and Berliner, P.R. (2003). Modeling of the short wave radiation distribution in an agroforestry system. *Agricultural and Forest Meteorology* 118:185-206.

Zuur, A.K., Ieno, E.N. and Smith, G.M. (2007). *Analyzing ecological data*. Springer.