Natural Resource Use Conflicts in Indonesia: A Challenge for Sustainable Development and Education for Sustainable Development

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Sebastian Koch
aus Volkmarsen

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Autor:

Sebastian Koch (Dipl.-Geogr.)

Kontakt:

skoch@gwdg.de

D 7

Mitglieder des Betreuungsausschusses:	Prof. Dr. Susanne Bögeholz
	Prof. Dr. Heiko Faust
	Dr. Jan Barkmann
Referentin:	Prof. Dr. Susanne Bögeholz
Koreferent:	Prof. Dr. Heiko Faust
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Why should I care about posterity? What's posterity ever done for me?

Groucho Marx

(American Comedian, Actor and Singer, 1890-1977)

Abstract

Many of Indonesia's natural resources are degraded due to over-utilization. Examples are over-exploitation of fish stocks or non-timber forest resources. In many cases 'commons dilemmas' regularly occurring in open access situations are responsible for the difficulties in natural resource management. Commons dilemmas are characterized by an incongruity between resource appropriators and those burdened with the negative impacts of resource use. Not surprisingly, the 2010 targets for halting biodiversity loss were missed. Sustainable solutions are unlikely to be forthcoming without changes in the institutional setting of the problem.

In order to govern open access natural resources more sustainably, measures to improve the effectiveness of traditional local institutions – formal and informal – are promoted. An empirical investigation on current natural resource management practice in Indonesia's Lore Lindu region in Central Sulawesi has confirmed the effectiveness of local institutions while state-induced rules and regulations have failed.

From a natural resource management education perspective, well educated graduates as future educators, agricultural advisers or decision makers in the field of natural resource management are essential. With a profound background concerning commons dilemmas and possible solution strategies the graduates contribute to the sustainable utilization of natural resources which serve as livelihood for many rural poor and the preservation of biological diversity, respectively.

However, agronomy and biology teacher students in Central Sulawesi have so far failed to recognize the commons dilemma characteristics of rattan over-exploitation. Results from a study on future Indonesian decision makers in the field of natural resources (n=882) also shows severe knowledge gaps. While there were certain improvements comparing 3rd and 7th semester students concerning ecological and socio-economic knowledge, improvements in institutional knowledge were lower or absent.

These knowledge gaps are reflected in international educational agendas. Key documents of the United Nations 'Decade on Education for Sustainable Development' sometimes denote shortcomings relating to crucial knowledge on the socio-economic and institutional dimensions of biodiversity conservation and related resource use issues.

Zusammenfassung

Viele natürliche Ressourcen Indonesiens, die als Lebensgrundlage für einen Großteil der Bewohner im ländlichen Raum Indonesiens dienen, sind durch Übernutzung geschädigt. Als Beispiele sind die übermäßige Nutzung von Fischbeständen oder Wald-Ressourcen zu nennen. Oft werden ökologisch-soziale Dilemmata als Erklärungsmuster für eine derartige Ressourcenübernutzung herangezogen. Diese zeichnen sich durch eine Inkongruenz zwischen den Nutzern der Ressource und jenen aus, die von den negativen Auswirkungen der Ressourcennutzung betroffen sind. So ist es nicht überraschend, dass die jüngsten Ziele zum Rückgang des Biodiversitätsverlusts bis 2010 nicht erreicht wurden. Lösungen, die auf ein nachhaltiges Management natürlicher Ressourcen abzielen, sind nicht ohne Veränderungen im institutionellen Rahmen der Umweltproblemsituation zu erwarten.

Traditionelle, sowohl formelle als auch informelle Institutionen, werden als ein vielversprechender Weg angesehen, um natürliche Ressourcen in *open-access* Situationen

nachhaltig zu bewirtschaften. Eine empirische Untersuchung zum Management der natürlichen Ressourcen in der Lore Lindu Region in Zentralsulawesi, Indonesien zeigt die Wirksamkeit von lokalen Institutionen, wohingegen sich staatliche Regularien und Gesetze als ineffektiv erweisen.

Für eine nachhaltige Ressourcennutzung sind gut ausgebildete Hochschulabsolventen als zukünftige Lehrer, landwirtschaftliche Berater oder aber Entscheidungsträger im Bereich der Nutzung von natürlichen Ressourcen unabdingbar. Verfügen Absolventen über ein fundiertes Hintergrundwissen in Bezug auf ökologisch-soziale Dilemmata und möglichen Lösungsstrategien, können sie damit wesentlich zu einer nachhaltigen Nutzung der natürlichen Ressourcen und dem Erhalt der biologischen Vielfalt beitragen.

Eine Analyse internationaler Dokumente bezüglich einer ‚Bildung für Nachhaltige Entwicklung' zeigt, dass im Bezug auf nachhaltiges Ressourcenmanagement nicht auf Wissen über die sozio-ökonomischen und institutionellen Dimensionen des Schutzes der Biodiversität eingegangen wird.

So zeigt eine empirische Studie das Studenten in Zentralsulawesi die Dilemmata-Situation am lokalen Beispiel der Rattan-Übernutzung nicht erkennen. Ebenfalls konnte in einer Untersuchung gezeigt werden, dass das Wissen von zukünftigen Entscheidungsträgern im Bereich der natürlichen Ressourcennutzung in Indonesien (n=882) defizitär ist. Es gibt zwar Wissenszuwächse zwischen dem 3. und 7. Semester im Bereich des ökologischen und sozio-ökonomischen Wissens, allerdings sind die Zuwächse im institutionellen Wissen niedriger oder nicht vorhanden.

Abstrak

Banyak sumberdaya alam Indonesia terdegradasi karena eksplotasi yang berlebihan. Contohnya eksplotasi yang berlebihan terhadap sumberdaya ikan di laut dan hasil hutan bukan kayu.

Dalam banyak kasus 'dilema umum' yang muncul dalam situasi dimana sumberdaya dapat diakses secara terbuka menjadi penyebab kesulitan dalam pemgelolaan sumberdaya alam. Dilema umum dikarakteristikkan dengan suatu ketidaksesuaian antara penyedia sumberdaya dan mereka yang dibebani dengan dampak negatif dari penggunaan sumberdaya. Tidak mengherankan, penghentian kehilangan keanekaragaman hayati yang ditargetkan pada tahun 2010 tidak tercapai. Solusi yang lestari tidak mungkin akan datang tanpa perubahan dalam seting kelembagaan dari permasalahan tersebut.

Dalam rangka menata sumberdaya yang bersifat dapat diakses publik agar lebih lestari, perlu mempromosikn langkah-langkah untuk meningkatkan efektivitas kelembagaan

lokal yang tradisional, baik kelembagaan formal maupun informal. Suatu penelitian empiris di wilayah Lore Lindu, Sulawesi Tengah, Indonesia telah menegaskan keefektifan lembaga lokal dalam pengelolaan sumberdaya alam saat ini, dimana peraturan dan perundangan negara justru gagal menanganinya.

Dari sudut pandang pendidikan pengelolaan sumberdaya alam, lulusan yang terdidik dengan baik sebagai pendidik masa depan, penasehat pertanian, atau pengambil keputusan dalam pengelolaan sumberdaya alam adalah sangat penting. Dengan latar belakang yang mendalam tentang dilema umum dan strategi pemecahan masalah yang memungkinkan lulusan dapat berkontribusi terhadap pemanfaatan sumberdaya alam yang lestari yang merupakan sumber kehidupan banyak masyarakat miskin di pedesaan dan pemeliharaan keanekaragaman hayati.

Namun mahasiswa pendidikan guru biologi dan mahasiswa agronomi di Sulawesi Tengah sejauh ini tidak berhasil mengenali karakteristik dilema umum dari eksploitasi rotan yang berlebihan. Hasil dari suatu studi terhadap calon pengambil keputusan masa depan dalam bidang pengelolaan sumberdaya alam (n=882) juga menunjukkan adanya perbedaan pengetahuan yang cukup besar. Walaupun terdapat peningkatan tertentu antara mahasiswa semester 3 dibandingkan semester 7 dalam pengetahuan ekologi dan sosial ekonomi, namun peningkatan pengetahuan kelembagaan rendah atau hampir tidak ada.

Perbedaan pengetahuan tersebut direkfleksikan dalam agenda pendidikan intenasional. Dokumen-dokumen kunci PBB tentang Dekade Pendidikan untuk Pembangunan Berkelanjutan terkadang menunjukkan kekurangan berkaitan dengan pengetahuan penting dalam dimensi sosial ekonomi dan kelembagaan dari konservasi keanekaragaman hayati dan isu-isu terkait pemanfaatan sumberdaya lainnya.

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Abbreviations

AABE	Asian Association for Biology Education
AGFI	Adjusted Goodness of Fit Index
ANOVA	Analysis of Variance
ASEAN	Association of Southeast Asian Nations
BCC	Biology Conservation Club
CBC	Competency Based Curriculum
CBD	Convention on Biological Diversity
CCA	Community Conservation Agreement
CFA	Confirmatory Factor Analysis
CIA	Central Intelligence Agency
COP	Conference of Parties
CSIADCP	Central Sulawesi Integrated Area Development and Conservation Project
DAAD	German Academic Exchange Service

DESD	Decade of Education for Sustainable Development
DFG	Deutsche Forschungsgemeinschaft
DPSIR	Drivers, Pressures, States, Impacts, and Responses
EEA	European Environmental Agency
AEEAP	Environmental Education Action Plan
EIU	Economist Intelligence Unit
ESD	Education for Sustainable Development
FAO	Food and Agriculture Organization of the United Nations
FWI	Forest Watch Indonesia
GFI	Goodness of Fit Index
GoBi	Governance of Biodiversity
GPA	Grade Point Average
IAD	Institutional Analysis and Development
IPB	Institut Pertanian Bogor
IUCN	International Union for the Conservation of Nature and Natural Resources
KLH	Kajian Lingkungan Hidup
LKD	Lembaga Konservasi Desa
LLNP	Lore Lindu National Park
MDGs	Millennium Development Goals
MNDP	Ministry of National Development and Planning
NBSAP	National Biodiversity Strategy Action Plan
NGO	Non-Governmental Organization
NTFP	Non-Timber-Forest-Products
OECD	Organisation for Economic Co-operation and Development
PA	Protected Area
PCA	Problem-Centred Interview
PES	Payments for Environmental Services
PGFI	Parsimony Goodness of Fit Index
PL	Pengetahuan Lingkungan
PNS	Pegawai Negeri Sipil
PRA	Participatory Rural Appraisals
REDD	Reducing Emissions from Deforestation and Degradation

RMSEA	Root Mean Square Error of Approximation
SFB	Sonderforschungsbereich
SPSS	Statistical Programme for the Social Sciences
STORMA	Stability of Rainforest Margins in Indonesia
TNC	The Nature Conservancy
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UI	University of Indonesia
UNTAD	Universitas Tadulako
WCED	World Commission on Environment and Development
WCS	World Conservation Strategy
YTM	Yayasan Tanah Merdeka (Independent Earth Foundation)

CHAPTER 1:
Introduction

1.1 Natural Resource Degradation and Biodiversity Loss in der Tropics

Humans profit from nature in many different ways. Today's prosperity – especially in developed countries – is to a large extent ascribable to the exploitation of the environment and its resources at the expense of biological diversity (Hayami & Godo, 2005, p. 116f.; Rands, et al.,2010). The term 'biological diversity' is widely accepted as defined in the Convention on Biological Diversity (CBD) "[…] *the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and ecosystems*"(UNCED, 1992b: Article 2). The term biodiversity is the commonly used short form for biological diversity (Secretariat of the CBD, 2010a).

The majority of the world's biodiversity is harboured by developing and emerging countries (Bradshaw, Sodhi, & Brook, 2009; Laurance, 2006). Two-thirds of the earth's biodiversity resides in the tropics (Dirzo & Raven, 2003). At the same time, population growth is especially high in these countries and thereby the demand for a life in modest affluence increases (Cincotta, Wisnewski, & Engelman, 2000). As a consequence, the pressure put on natural resources and thus, on biodiversity, rises constantly (Bradshaw, et al., 2009; Clough, et al., 2011; Dirzo & Raven, 2003; Sodhi, Posa, et al., 2010). In spite of the commitment of governments in 2002, through the CBD, to significantly reduce the rate of biodiversity loss by 2010 – also established as Millennium Development Goal 7b – biodiversity still declines at alarming rates in virtually all regions of the world (Butchart, et al., 2010; Secretariat of the CBD, 2010b). In addition, it as argued that biodiversity loss often comes along with poverty, and therefore, conservation efforts and poverty reduction should be tackled together (Adams, et al., 2004). Habitat loss not only has a negative impact on biodiversity but also on people (Sodhi, 2008) since ecosystem destruction may depress human well-being, food protection, pollination, and other ecosystem services (Balmford & Bond, 2005; MEA, 2005).

Southeast Asia is one of the most bio-diverse regions in the world (Sodhi, Posa, et al., 2010). However, continuing habitat loss and overexploitation endanger forests, mangroves, savannas, and coral reefs in the region (Bradshaw, et al., 2009; Sodhi, Koh,

et al., 2010). Within Southeast Asia, Indonesia has the largest expanse of tropical rain-forests, and after Brazil and the Democratic Republic of Congo, the third largest worldwide. Indonesia has the second highest level of biodiversity in the world. While Indonesia also displayed the second highest annual net forest loss (~1.7% p.a.) in the 1990s, current published data show a significant reduction in the average annual area lost between 2000 and 2010 with an annual rate of ~0.5% (FAO, 2011, p. 113). However, the rate has increased again in recent years (FAO, 2010, p. 19; Hansen, et al., 2009). Indonesia is home to two of today's 34 Biodiversity Hotspots, 'Wallacea' and 'Sundland', and contains one of the three 'Major Tropical Areas' (Mittermeier, et al., 2004). Biodiversity Hotspots are bio-geographical regions of global conservation priority due to their richness in biodiversity, but are, at the same time, under anthropogenic threat. To be characterised as a Biodiversity Hotspot, at least 0.5% or 1.500 species of vascular plants in a region must be endemics and at least 70% of its primary vegetation must have been lost (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000).

The loss of biodiversity continues unabatedly and can be traced back to the expansion and intensification of industrial agriculture, such as palm-oil (Koh & Wilcove, 2008), commercial lumbering or oil and gas operations that have recently been the most obvious drivers (Butler & Laurance, 2008). However, smallholders play a decisive role in forest conversion and land use change, particularly in remote forest frontier areas (FWI/GFW, 2002, p. 24; Meyfroidt & Lambin, 2011). The presence of smallholders in agriculturally marginal but highly bio-diverse environments is often a result of unequal tenure regimes and international policies strongly biased against the rural poor (de Sherbinin, et al., 2008). Deregulation, for example, often supports large-scale industrial farmers to expand their agricultural land and displaces the poor, who are not able to participate due to low financial capital and their dependency on subsistence agriculture. In consequence, rural farmers often migrate to forest frontier areas (Sunderlin, et al., 2005).

In addition to Indonesia's unique terrestrial biodiversity, the Indonesian archipelago shows the highest level of marine tropical biodiversity as well (Gray, 2002). The 'Coral Triangle', spanning parts of the Philippines, Malaysia, Indonesia, Timor-Leste, Papua New Guinea, and the Salomon Islands, is the global centre of marine biodiversity (Allen, 2008). However, it is also severely threatened by species extinction due to climatic

change and sea temperature rise, poor coastal management, pollution, overfishing and destructive fishing (Roberts, et al., 2002). About 80% of the reefs have already been damaged by dynamite fishing (Lundin & Lindén, 1993). Dynamite or 'blast' fishing is one of the most immediate and destructive threats to coral reefs worldwide (Fox & Caldwell, 2006). It is widespread in Indonesia (Pet-Soede & Erdmann, 1998), leading to the massive destruction of marine ecosystems (Edinger, Jompa, Limmon, Widjatmoko, & Risk, 1998). As a consequence, in 1999, the new elected president Abdurrahman Wahid established the Ministry of Marine Affairs and Fisheries and the Indonesian Maritime Council, specifically designed to take care of the sustainable management of Indonesia's coastal and ocean resources (Dahuri, Kusumastanto, Hartono, Anas, & Hartono, 2009).

Profit-based and consumption-oriented interests of the northern countries are not the only reason behind these problems. Although large-scale ecosystem conversion, for example, palm-oil production in Southeast Asia is primarily triggered by the rising demand for biofuels in Europe (Koh & Wilcove, 2008), in many cases, however, such as over-exploitation of fish stocks or dynamite fishing as well as over-exploitation of Non-Timber-Forest-Products (NTFP), structural 'commons dilemmas' are responsible for the difficulties to maintain biodiversity (Ostrom, et al., 2002). Commons dilemmas describe situations in which individual and collective rationalities collide. While individual rationality tends to favour unrestrained resource exploitation, collective rationality suggests restrictions in favour of the long-term utilization of the resource (Dietz, Dolsak, Ostrom, & Stern, 2002; Edney & Harper, 1978; Gordon, 1954; Hardin, 1968; Scott, 1955).

Psychologists have explained commons dilemma situations with the occurrence of so-called traps. Among these traps are a social trap, a temporal trap, and a spatial trap (Edney & Harper, 1978; Ernst, 1997, 2008; Messick & McClelland, 1983; Platt, 1973; Vlek & Keren, 1992). The social trap (Platt, 1973) focuses on the unequally distributed costs and benefits of resource utilization. Using the example of Hardin's influential article 'The Tragedy of the Commons' (1968), the profits from overuse were gained by the respective individuals while costs were incurred by the whole community. The temporal trap (Messick & McClelland, 1983) refers to the fact that negative consequences of today's action may only become visible in the long run or impacting

future generations. Finally, the spatial trap (Vlek & Keren, 1992) describes situations in which the consequences of resource utilization at a certain place affect other people or groups elsewhere, for example, river pollution or climate change. Economists usually refer to consequences of human action that negatively impact someone else other than the actor as 'negative externalities' (Mishan, 1969; Tullock, 2005). The divergence between individual rationality and group rationality was customarily explained after Hardin with the specific attributes of many natural resources as common pool goods (Berkes & Folke, 1998, p. 6). Common pool resources are characterised as open-access resources – difficult to protect and easy to deplete – due to rivalry in consumption and non-excludability (Janssen, Goldstone, Menczer, & Ostrom, 2008; McKean, 2000, p. 29). Overfishing or the extraction of NTFP such as rattan, are exemplary cases for the occurrence of commons dilemmas.

With respect to solutions of commons dilemma situations a paradigm shift has taken place in natural resource management in the last two decades since government-centred approaches failed and, indeed, contributed to environmental degradation (Schlager, 2004). Efforts were made in order to solve common pool resource dilemmas (commons dilemmas) through the analysis of institutions governing commons resources. The analysis of successful resource management showed that local rather informal institutions can be successful in governing common pool or open-access resources (Dietz, et al., 2002; Dietz, Ostrom, & Stern, 2003; Ostrom, 1990; Ostrom, Burger, Field, Norgaard, & Policansky, 1999); whereas institutions are not organisations, they are "[…] *the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction*" (North, 1990, p. 3).

To resolve commons dilemmas, the 2009 Nobel Prize laureate in economics, Ellinor Ostrom, argues that resource appropriators must work through three closely related issues – supply, commitment, and monitoring (Ostrom, 1990, p. 42). Users of a commons resource have to devise and adopt a set of rules, i.e., institutions to coordinate their use of the resource within the limits set by the natural supply of the resource. Since institutional arrangements themselves represent public goods and thus collective action problems may occur, effective monitoring and sanctions are needed to ensure that most appropriators are following the rules, which, at the same time, support credible commitment to such rules (Ostrom, 1990). Although the process of devising,

implementing, and sustaining institutional arrangements in order to resolve commons dilemmas is not that simple, the Ostrom school provides promising approaches (Schlager, 2004).

1.2 Sustainable Development & Education for Sustainable Development

In consideration of the continuing loss of biological diversity, sustainability has become central in the conservation of the earth's biodiversity (UNEP, 2007). Nowadays, the term 'sustainability' has advanced to the position of a widely used buzzword (Scoones, 2007). In a broader sense, sustainability stands for the optimization of human well-being with minimal ecological damage or resource depletion (Paehlke, 2004). The term 'sustainability' has its origin in the German forestry of the early 18th century. H. C. von Carlowitz introduced the term in his 1713 published manuscript 'Sylvicultura Oeconomica' on long-term forest management (Scoones, 2007). In England too, thoughts about sustainability arose in the 18th century. The English economist T.R. Malthus concluded in his 'Essay on the Principle of Population', published in 1798, that human population inevitably exceeds the ability to produce sufficient food (Paehlke, 2004). In the last century, environmental concerns got a hold on broader society due to the oil crisis of the 1970s, the 'Limits of Growth' published by the Club of Rome (Meadows, Meadows, Randers, & Behrens III, 1972), the United Nations Conference on the Human Environment, held in Stockholm in 1972, and the emergence of an environmental movement in the late 1970s and 1980s.

The 1972 United Nations Conference on the Human Environment was the beginning of international conferences explicitly focusing on environmental degradation and a milestone to put environmental concerns on the international agenda (Du Pisani, 2006). In addition, it laid the foundation for the establishment of the United Nations Environment Programme (UNEP). The UNEP and the World Wildlife Fund financially supported the publication of the World Conservation Strategy (WCS) prepared by the International Union for the Conservation of Nature and Natural Resources (IUCN) in 1980. Although the WCS highlighted new ideas with respect to environment and

development and carried forward the concept of sustainable development beyond simple renewable resource systems, economic and political forces had not been given much attention (Sum & Hills, 1998). Not much later, the General Assembly of the United Nations established the World Commission on Environment and Development (WCED) in 1983, comprised of representatives from both developed and developing countries. The commission was chaired by the former Norwegian prime minister Gro Harlem Brundtland. In 1987 the commission published its report 'Our Common Future' (WCED, 1987) which is also known as the Brundtland Report. The report focused on human needs and interests. It propagated global equity for future generations through the redistribution of resources so that all human beings are able to meet their human needs. For developing nations, economic growth is of importance; however, it must be environmentally sound (Du Pisani, 2006). One of the main outcomes of the report is the fact that economic development and environmental protection can be reached, but only through sustainable development (Dresner, 2008).

The Brundtland report is one of the most cited works with respect to a definition of sustainable development. Sustainable development was defined as "[…] *development that meets the needs of the present without compromising the ability of future generations to meet their needs*" (WCED, 1987, p. 43). The report laid the groundwork for the United Nations Conference on Environment and Development (UNCED) held in 1992 in Rio de Janeiro. As a result, international legally binding agreements such as the Convention on Biological Diversity (CBD) or documents such as the Agenda 21 – the programme of action for sustainable development – emerged from the conference (UNCED, 1992a, 1992b). Both opened new directions in international long-term politics and moral commitments respectively. The CBD aims at (1) the conservation of biological diversity, (2) the sustainable use of its components, and (3) a fair and equitable sharing of benefits from genetic resources (UNCED, 1992b: Article 1). All signatory governments had to develop national biodiversity strategies and action plans. 168 countries signed the CBD, including Indonesia. However, the CBD and the Agenda 21 have been criticized due to a lack of specific policy commitments or financial mechanisms for poorer countries (Sum & Hills, 1998).

Chapter 36 of the Agenda 21 and Article 13 of the CBD both highlight the pivotal role of education in achieving the aims of preserving biodiversity and using natural resources

sustainably. Ten years later, the United Nations General Assembly proclaimed the years 2004-2014 as the United Nations Decade of Education for Sustainable Development' (DESD) (UNESCO, 2006b) with Education for Sustainable Development (ESD) as the educational manifestation of the concept of sustainable development (Selby, 2006). Considering ESD, economic growth, social development, and environmental conservation need to be linked together in order to improve the quality of life of future generations (UNESCO, 2006a). Through ESD, one of the main objectives of the DESD is to make progress towards attaining the Millennium Development Goals (MDGs) adopted at the World Summit on Sustainable Development in 2002 in Johannesburg.

ESD should be integrated in all educational institutions including higher education (Jones, Selby, & Sterling, 2010). It should promote interdisciplinary education and a holistic perspective on human environment interactions across curricula. It should foster critical thinking and problem solving with respect to the dilemmas and challenges of sustainable development (Jones, et al., 2010). In terms of ESD, the DESD highlighted the important role of higher education during the decade. Higher education should provide leadership through teaching and implementing sustainable development. Interdisciplinary system approaches, problem solving, and critical thinking should be encouraged through local relevant contents, case studies approaches and examples of best practices (UNESCO, 2006b, p. 23).

In Southeast Asia, the 'Association of Southeast Asian Nations' (ASEAN) Environmental Education Action Plan 2008-2012 (AEEAP) constitutes the regional plan for the implementation of ESD (Choi & Kipp, 2009). Indonesia, as member of the ASEAN, launched the DESD in 2005. The Indonesian Ministry of Education and the Ministry of the Environment signed an agreement for joint collaboration concerning ESD implementation at the national level. The Indonesian national DESD implementation strategy aimed, inter alia, at the improvement of professionalism and educational institutions based on knowledge, skills, and attitudes (UNESCO, 2011, p. 39). At school level, national curriculum institutions have already developed courses, plans, and textbooks related to ESD. However, except for the improvement of ESD-related content, it is argued that the implementation process is very difficult due to "[…] *a lack of qualified educational personnel, curriculum developers, teacher trainers, and in-service*

teachers", (UNESCO, 2011, p. 40). Notwithstanding the key role of higher education during the DESD, there are no binding rules or regulations concerning the implementation of ESD carried out so far. Universities are only advised to integrate ESD in its curricula (Direktorat Jenderal Pendidikan Tinggi [General Directorate of Higher Education], 2010). However, some efforts have been made in order to address ESD in higher education and research through collaborations of universities across the Asian-Pacific region (UNESCO, 2011).

With DESD and the recently declared United Nations Decade on Biodiversity (2011-2020), the international community established a tool that fosters the international exchange in educational activities concerning the requirements of sustainable development with respect to the conservation of biological diversity. Interdisciplinary approaches are necessary to reach sustainable development. However, these goals can only be reached through the integration of ecological, social and economic aspects (Eilam & Trop, 2010; Herremans & Reid, 2002; Marcinkowski, 2009).

1.3 Objective of the Study

Indonesia shows the second highest level of biodiversity in the world. At the same time, biodiversity loss continues unabatedly both in the terrestrial and aquatic sectors. Indonesia is a signatory of the CBD and the National Biodiversity Strategy Action Plan (NBSAP) aiming, for example, at a reduction of forest loss, coral reef depletion and other terrestrial and marine habitat destruction as well as the support of a more sustainable natural resource utilization (MNDP, 1993). The establishment of protected areas, such as biosphere reserves, is a common measure to preserve biodiversity (Gardner, et al., 2009). However, in situations of common pool or open-access resources, commons dilemmas often occur.

As shown above, in achieving the aims of preserving biodiversity and using natural resources sustainably, education plays a pivotal role according to the CBD and the Agenda 21. Sustainable resource management is one of the goals pursued by ESD under the umbrella of the DESD. In the past, much research has been done to further the discussion in regard to concepts and definitions of ESD or environmental education in

general. However, little attention has been paid to the analysis of case studies and evaluations of ESD that go along with international agendas. In-depth research on existing knowledge on the local level with relevance to ESD is still required (Choi & Kipp, 2009).

Therefore, the main objectives of this thesis are the following:

1. To evaluate the practice of sustainable forest management with respect to the role of formal and informal institutions governing protected areas in Indonesia. (Chapter 2).
2. To investigate subjective theories of university students (here biology teacher and agronomy students at UNTAD) on intensive rattan extraction as a commons dilemma situation qualitatively and explore perceptions on these commons dilemmas (Chapter 3 & 4).
3. To critically evaluate United Nations DESD and ESD guidelines with respect to the essential knowledge to solve commons dilemmas. (Chapter 5).
4. To assess university students' knowledge, differentiating types and domains of knowledge with respect to sustainable resource management quantitatively. (Chapter 6).
5. To compare Indonesian higher education programmes concerning ESD quantitatively. Do the university students increase their knowledge not only in their area of study but also in other domains which are relevant for sustainable development? (Chapter 7).
6. To examine courses of action for the sustainable utilization of forest resources in Indonesia. What are the current international efforts of ecologically and economically balanced biodiversity conservation? (Chapter 8).

1.4 Description of the Study Area and Samples

Due to the research foci on both human and political ecology on the one hand and educational sciences on the other hand, the research took place at different places in Indonesia. The evaluation of the practice of sustainable forest management with respect to the role of formal and informal institutions governing protected areas in Indonesia at different levels (Objective 1) and the examination of courses of actions for sustainable utilization of forest resources (Objective 6), took place in the Lore Lindu region in Central Sulawesi. The Lore Lindu region with the Lore Lindu National Park (LLNP) provides a conservation core area of the 'Wallacea' Biodiversity Hotspot (Mittermeier, et al., 2004; Myers, et al., 2000).

From 2000 until 2009, the Lore Lindu region was the area of studies of the collaborative research centre SFB 552 – STORMA (Stability of Rainforest Margins in Indonesia) founded by the German Research Foundation (DFG). STORMA was a joint collaboration of the Universities of Palu (Universitas Tadulako (UNTAD)), Bogor Agricultural University (Institut Pertanian Bogor (IPB)), Indonesia, and the Universities of Kassel and Göttingen, Germany.

The Lore Lindu region is characterised by an increase in the area planted with cocoa from almost zero to >20,000 hectares since the early 1980s (Reetz, 2008). Particularly triggered by the increasing world market prices in the mid 1990s, cacao represents the most important cash crop in the region (Abdulkadir-Sunito & Sitorus, 2007, p. 171f.). Since the emergence of a 'cacao boom' in Central Sulawesi (Ruf & Yoddang, 1998), the newly converted cacao areas display a trend towards more intensified production characterised by increasing pesticide and fertiliser use, and a trend from mixed plots to cacao monocultures with few or no shading trees resulting in an loss of biodiversity (Clough, et al., 2011; Steffan-Dewenter, et al., 2007). In spite of the cacao boom since the 1980s, Central Sulawesi is regarded as one of the poorest provinces in Indonesia (van Edig, Schwarze, & Zeller, 2010).

In Central Sulawesi, the climbing palm rattan is the most important NTFP. About 90% of the global rattan demand for the furniture industry is supplied by Indonesia. Because little rattan is cultivated in Indonesia, most of the harvested rattan comes from wild stocks found in primary forests (Dansfield & Manokaran, 1994). Intensive rattan

harvesting – mostly of the valuable species *Calamus zollingeri* – began in Central Sulawesi in the 1980s. Current rattan extraction rates exceed growth rates in the Lore Lindu region, and will ultimately lead to commercial depletion of rattan stocks (Siebert, 2004). Thus, rattan collection is a highly relevant resource use issue in Central Sulawesi (Bynum, 1999).

Both qualitative educational science studies that investigate the subjective theories of university students on intensive rattan extraction as a commons dilemma situation and the perceptions of these commons dilemma (Objective 2) took place at Universitas Tadulako, Palu. Palu is the capital city of Central Sulawesi and the LLNP is located close by.

The three quantitative studies on the critical evaluation of DESD and ESD guidelines with respect to essential knowledge to solve commons dilemmas (Objective 3), the assessment of university student knowledge with respect to sustainable resource management (Objective 4), and the comparison of higher education programmes concerning ESD (Objective 5) took place at Institut Pertanian Bogor. IPB is the leading national institution of higher education in the field of agronomy, forestry and marine sciences. IPB is the 134th ranked university in Asia and the 6th ranked university in Indonesia (http://www.topuniversities.com/university-rankings/asian-university-rankings/2011). "Managing utilization of biodiversity" is one of its four "thematic pillars". IPB is internationally well known through long standing cooperation with other universities worldwide. In line with IPB's motto "searching and serving the best", only the best performing students from all over Indonesia and elsewhere are accepted for a course of study.

1.5 Outline of the Thesis Manuscripts

Local Institutions: Regulation and Valuation of Forest Use – Evidence from Central Sulawesi, Indonesia

Mehring, M., Seeberg-Elverfeldt, C., **Koch, S.**, Barkmann, J., Schwarze, S. & S. Stoll-Kleemann (2011): Local Institutions: Regulation and Valuation of Forest Use – Evidence from Central Sulawesi, Indonesia. *Land Use Policy 28*(4): 736-747.

This publication contributes to **research objective 1**. In this publication we evaluated the current practice of sustainable forest management with respect to the Lore Lindu National Park in Central Sulawesi, Indonesia. We analysed the role of formal and informal institutions governing protected area management at the local level. This publication sought to explore which policies foster sustainable resource utilization and, hence, facilitate conservation success.

The idea for this publication dates back to the SFB 552 in which I participated for the data collection and preparation for my master thesis in 2007/2008 and the collaboration with the GoBi (Governance of Biodiversity) research group from the University of Greifswald, Germany. The publication was written in 2009/2010 by Marion Mehring, Christina Seeberg-Elverfeldt and me as leading authors. Each of us focused on a different perspective. My focus was laid on the analysis of the role of village institutions with respect to forest management at the local level. We compared state-induced formal rules with traditional informal rules regarding natural resource utilization.

The main results of the study show that the human environment interaction in case of the local population at the forest margins of the Lore Lindu National Park and their surrounding environment is characterised by unsuccessfully implemented state-induced official conservation rules. Informal, traditional rules and regulations – referred to as informal institutions – are more successful in terms of conservation. They are more respected by the local people due to their adaptation to traditional use related rights and sanctions.

This publication provides the locally relevant scientific background for further analysis on subjective theories, perceptions and knowledge of Indonesian university students regarding sustainable resource management. It shows how open-access natural resources could be used sustainably through the establishment of local institutions, as suggested by the Ostrom school (see above).

Subjective Theories of Indonesian Agronomy and Biology Teacher Students on Environmental Commons Dilemmas

Koch, S., Barkmann, J., Sundawati, L. & S. Bögeholz (accepted): Subjective Theories of Indonesian Agronomy and Biology Teacher Students on Environmental Commons Dilemmas. *International Research in Geographical and Environmental Education.*

Based on the aforementioned scientific background publication on the role of local, formal and informal institutions on governance of natural resources in a sustainable manner, this publication focuses on research **objective 2**. As an associated project to the SFB 552, the interviews used in this analysis had been conducted by Stephanie Rüter – a former colleague at the Division for Biology Education at Göttingen University – at the same time when I was conducting the interviews with village authorities (Objective 1). I was given the raw interview material for analysis.

In this publication we explored subjective theories of 19 biology teacher students and agronomy students at Universitas Tadulkao, Palu, on rattan extraction in the Lore Lindu region as a local commons dilemma example. As future educators, environmental multipliers or agricultural advisers, these students are likely to influence knowledge, perception, and awareness of future generations on issues concerned with resource utilization. The identification of subjective theories served as an evaluation of the current situation with regard to Indonesian university students' understanding of the complexity of local commons dilemmas. We chose a qualitative research approach to reconstruct subjective theories. This approach provides a deeper insight into the university students' understanding of commons dilemmas, often occurring in forest frontier areas.

Key results were illustrated using a simplified network of causal links structured according to the **D**rivers, **P**ressures, **S**tates, **I**mpacts, and **R**esponses (DPSIR) approach (EEA, 1999). The results demonstrated severe deficits, specifically regarding socio-economic and institutional aspects of the rattan commons dilemma situation. In addition, possible solution strategies concerning commons dilemma situations were mostly restricted to state regulations. The effectiveness of local, formal or informal institutions – as proclaimed in the Ostrom school – was not mentioned.

University Students' Perceptions of Environmental Commons Dilemmas – The Need for Adjusted Curriculum in Indonesia

Koch, S., Barkmann, J., Sundawati, L. & S. Bögeholz (in print): University Students' Perceptions of Environmental Commons Dilemmas – The Need for Adjusted Curriculum in Indonesia. *Book-Chapter: Biology Education for Social and Sustainable Development. Editors: Kim, M. and C.H. Diong. Rotterdam. Sense Publishers.*

In addition to the aforementioned publication on subjective theories of Indonesian university students, this publication also contributes to **research objective 2** since it explores the students' prior knowledge and perceptions on the rattan extraction commons dilemma. This publication relies on the same qualitative interviews as the publication on subjective theories. The idea leading to this publication is based on an oral presentation at the 23rd Biennial Conference of the Asian Association for Biology Education (AABE), held on October 18th-20th 2010 in Singapore.

We identified gaps in prior knowledge and perception of the 19 interviewed biology teacher students and agronomy students at Universitas Tadulako, Palu, with respect to the intensive extraction of rattan in the Lore Lindu region. On this basis, we developed a knowledge model based on de Jong and Ferguson-Hessler (1996) to differentiate types and domains of knowledge as a prerequisite to understand and possibly solve commons dilemmas. The knowledge model involves three types of knowledge (situational, conceptual, and procedural) (de Jong & Ferguson-Hessler, 1996) in the knowledge domains; (i) ecological knowledge, (ii) socio-economic knowledge, and (iii) institutional knowledge (Bilharz, 2004; Ernst, 1994, 2008; Gräsel, 1999; Kalland, 2000).

The results of this qualitative investigation reveal that a comprehensive understanding of ecological, socio-economic, and institutional interrelations hardly exists. We observed a knowledge gap in the understanding of the consequences of the commons dilemmas. The future educators and agricultural advisers lack the competencies required to understand the complex coherencies in commons dilemmas themselves.

Biodiversity and Sustainable Development Education: A Lack of Socio-economic and Institutional Perspectives

Koch, S., Barkmann, J. & S. Bögeholz (prepared for submission): Biodiversity and Sustainable Development Education: A Lack of Socio-economic and Institutional Perspectives.

This publication contributes to **research objective 3**. It critically evaluates current international guidelines on 'Education for Sustainable Development' (ESD) in light of the essential knowledge required to solve commons dilemma situations. The idea of this publication first emerged as a document analysis. Later, our argumentation was confirmed with empirical results when data of our joint collaborative research project on 'Biodiversity Education in Indonesia – University Students Knowledge of Environmental Commons Dilemmas' between the Department of Forest Management at Institut Pertanian Bogor (IPB), the Division for Biology Education, and the Division of Environmental and Resource Economics at Göttingen University were available.

Largely unnoticed by the general public, the United Nations General Assembly proclaimed the years 2005-2014 as the United Nations 'Decade of Education for Sustainable Development' (DESD). One central task of this decade is the promotion of values and lifestyles required for a societal transformation towards a 'sustainable' future. In this publication, we point to a critical gap in most educational frameworks and curricula addressing the tasks of ESD: The lack of an institutional perspective. Rarely addressed in environmental education are specifically the rather informal, often unconscious institutional arrangements underlying the socio-economic settings of human communities. It is saddening for environmental and institutional economists to recognise that neither Hardin's 'Tragedy of the Commons' (1968) nor Ostrom's ingenious analyses of cooperative solutions to the problem of public and open access goods (Ostrom, 1990) are being applied as pivotal points of an education for sustainable

development. No matter whether the extraction of non-timber forest resources, the conversion of natural ecosystems, or the fight against the emission of greenhouse gases are at stake, an informed citizenry needs a functional understanding of the socio-economic mechanisms that underlie the issues – and of the institutional means that can potentially solve them.

The results of our empirical study from Indonesia show that profound institutional knowledge is hardly available. Although the first half of the DESD has just passed, 'Education for Sustainable Development' itself may still have to learn a lot.

Knowledge of Indonesian University Students on the Sustainable Management of Natural Resources

Koch, S., Barkmann, J., Strack, M., Sundawati, L. & S. Bögeholz (prepared for submission): Knowledge of Indonesian University Students on the Sustainable Management of Natural Resources.

This publication manuscript contributes to **research objective 4.** The study aimed at an evaluation of knowledge with respect to sustainable resource management. In line with the formerly developed knowledge model based on de Jong and Ferguson-Hessler (1996) and on the basis of the formerly conducted qualitative in depth interview studies (Research Objective 2 / Chapter 3 & 4), expert consultations, and literature review, we assessed knowledge in three types of knowledge (situational, conceptual, and procedural knowledge) and three domains of knowledge (ecological, socio-economic, and institutional knowledge).

Within the frame of our collaborative research project on 'Biodiversity Education in Indonesia – University Students Knowledge of Environmental Commons Dilemmas' (see above), we surveyed 882 university students from the 3rd and the 7th semester in natural resource related programmes at Institut Pertanian Bogor, Indonesia, in 2010. This quantitative investigation consisted of a multiple-choice questionnaire and Likert scale questions. In the questionnaire, we used intensive rattan extraction in the Lore Lindu region and overfishing (dynamite-fishing) in the Sunda Sea, Indonesia, as examples of characteristic commons dilemmas.

We analysed knowledge increases in types and domains of knowledge between 3rd and 7th semester university students. Analysis of Variance (ANOVA) results show that situational knowledge did not increase significantly from the 3rd to 7th semester. The university students could increase their ecological and socio-economic knowledge between the 3rd and 7th semester significantly in the conceptual knowledge type. However, student judgements on solution strategies – referred to as procedural knowledge – differed strongly from expert judgements.

Learning for Sustainability - A Comparison of Higher Education Programs in Indonesia concerning Sustainable Resource Management

Koch, S., Barkmann, J., Strack, M., Sundawati, L. & S. Bögeholz (submitted for publication): Learning for Sustainability - A Comparison of Higher Education Programs in Indonesia concerning Sustainable Resource Management.

As the previous publication manuscript evaluated knowledge of university students with respect to types of knowledge and domains of knowledge, this publication manuscript focuses on domains of knowledge and the area of study of the university students. In contributing to research **objective 5**, we compared Indonesian higher education programmes in this publication manuscript. We used the same sample of 882 university students from Institut Pertanian Bogor as for both previous publication manuscripts (Research Objective 3 & 4 / Chapter 5 & 6). In this publication manuscript, we evaluated if the university students increase their knowledge between the 3rd and the 7th semester not only in their area of study but also in other sustainable resource management relevant domains of knowledge. This approach aims at the provision of possible starting points for curricula development regarding sustainable resource management in Indonesia.

The main results of the study show that students with an ecological area of study significantly increased their knowledge in the ecological knowledge domain. However, we did not find significant increases either in the socio-economic or the institutional knowledge domain. Likewise, students with a focus on a social area of study showed a significant increase solely in the socio-economic knowledge domain and not in the ecological or the institutional knowledge domain. With regard to the environmental

economics area of study, we found significant increases not only in the institutional knowledge domain but also in the ecological knowledge domain. However, no significant increase was found in the socio-economic knowledge domain.

Globale Einflüsse in tropischen Frontierzonen: Kakao-Boom contra Naturschutz in Sulawesi/Indonesien

[Global Impacts on Tropical Forest Frontier Zones: Cacao Boom versus Conservation in Sulawesi, Indonesia]

Faust, H. & **S. Koch** (accepted): Globale Einflüsse in tropischen Frontierzonen: Kakao-Boom contra Naturschutz in Sulawesi/Indonesien. *Geographische Rundschau 9/2012*

The first publication (Research Objective 1 / Chapter 2) shows that sustainable resource management is possible through the establishment of local institutions, both formal and informal. The following studies (Chapter 3-7) focused on subjective theories, prior knowledge and perception, and increases in knowledge between beginners (3rd semester) and graduates (7th semester) as future educators, agricultural advisers, and decision makers in the field of natural resource management in general. This publication contributes to research **objective 6**. Here, we focused on courses of actions for the sustainable utilization of forest resources in Central Sulawesi's Lore Lindu Region. We examined current international efforts in biodiversity conservation at forest frontier areas. In addition to solution strategies concerning open-access resource commons dilemmas as a prerequisite for sustainable resource management, decision makers in the field of sustainable resource management also need knowledge of adapted farming methods in favour of biodiversity conservation and current international mechanisms to connect biodiversity conservation with human needs.

The frontier zones of Central Sulawesi's mountainous rainforests are particularly threatened due to forest conversion into agricultural land, mainly into cacao plantations. In order to meet the challenge between conservation and utilization, an economically and ecologically balanced concept needs to be developed. We show that there is no way around to compensate local famers for conserving biodiversity and carbon sequestration through cultivation in less profitable agroforestry systems. Payments for Environmental Services (PES) are a promising option.

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CHAPTER 2:
Local Institutions: Regulation and Valuation of Forest Use – Evidence from Central Sulawesi, Indonesia

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Marion Mehring[a], Christina Seeberg-Elverfeldt[b], Sebastian Koch[c], Jan Barkmann[d], Stefan Schwarze[e], Susanne Stoll-Kleemann[a]

[a] Ernst-Moritz-Arndt Universität Greifswald, Institute of Geology and Geography, Applied Geography and Sustainability Science, Friedrich-Ludwig-Jahn-Str. 16, D-17487 Greifswald, Germany

[b] Natural Resources Management and Environment Department, Food and Agriculture Organization of the United Nations (FAO), Rome, Italy

[c] Georg-August-Universität Göttingen, Albrecht-von-Haller-Institute for Plant Sciences, Didactics of Biology, Göttingen, Germany

[d] Georg-August-Universität Göttingen, Department of Agricultural Economics and Rural Development, Environmental and Resource Economics, Göttingen, Germany

[e] Georg-August-Universität Göttingen, Department of Agricultural Economics and Rural Development, International Food Economics and Rural Development, Göttingen, Germany

Abstract

Forest management poses particular challenges as the pressure on forests is huge due to deforestation. In this context, the establishment of protected areas is a common conservation measure where institutions are put in place and sanctions regarding forest use are enforced. This paper focuses on the practice of sustainable forest management and the associated perspectives of local institutions at the rainforest margins of Lore Lindu National Park (LLNP) in Central Sulawesi, Indonesia.

Our case study applies a qualitative social science research approach. Interviews and group discussions with relevant actors such as farmers, village authorities, the National Park authority, and non-governmental organization members were conducted. The Institutional Analysis and Development (IAD) framework served to structure the study and to provide a set of questions to be considered concerning rules, participants, and conservation outcomes. State-induced formal rules are compared with traditional informal rules regarding natural resource use. Our results suggest that the current state-imposed formal rules have not been successfully implemented in the past. Insufficient boundary demarcation, and a lack of congruence between rules and local conditions have been identified as main reasons. Traditional informal rules are rather more respected by local people since they are adapted to traditional use rights and sanctions at the village level. Community conservation agreements (CCAs) are considered a promising tool to mediate between National Park conservation interests and local people's needs integrating traditional informal rules. However, the CCAs implemented in the LLNP area do not address existing differences in perception and behavior of indigenous people and migrants in the area. We argue that this is a central aspect in terms of successful CCA implementation and forest management. Thus, we recommend that the National Park authority should take the cultural diversity of the area seriously into consideration and integrate flexible and distinct socio-cultural strategies into its management processes.

Keywords: Institution, Indonesia, Protected area, Community conservation agreement, IAD framework, Deforestation

2.1 Introduction

Among the major tropical forest regions, South-East Asia exhibits the second-highest rate of deforestation (FAO, 2006). In particular, Indonesia has a history of high forest loss in excess of 1 million hectares per year (Holmes, 2002). Forest management is faced with substantial challenges in this densely populated country where rural settlements with a high degree of dependence on agricultural land and/or forest products dominate. To tackle these problems and in keeping with worldwide practice, several protected areas (PAs) – for example national parks – have been established in the tropical forest areas of Indonesia.

Usually, institutions are required to safeguard the long-term ecological integrity of the PAs. Ostrom (1990) defines institutions as sets of working rules that are used to determine who is eligible to make decisions in some arena, what actions are allowed or constrained. In South-East Asia, complex traditional, religious and ethnicity-specific forest institutions often overlap with top-down state regulations that may or may not involve the local communities (Sundar et al., 2001). The extent to which such top-down rules are respected varies. Thus, having established a PA in legal terms does not automatically result in real protection (Ghimire and Pimbert, 1997).

Lore Lindu National Park (LLNP) in Central Sulawesi is an important core habitat for the forest biota of the global Wallacea biodiversity hotspot (Myers et al., 2000). LLNP forest ecosystems are mainly threatened by the illegal expansion of cacao agroforestry systems (Maertens et al., 2006; Erasmi and Priess, 2007). Although the area is also an UNESCO Biosphere Reserve, the implementation of this PA has not followed participatory principles, as e.g. required by the Seville Declaration on the establishment of Biosphere Reserves (UNESCO, 1996). In contrast, LLNP was externally imposed by the national Indonesian Suharto government. If, however, relevant stakeholders and the local people cannot get their voices heard and their legitimate interests respected in PA planning and implementation, the local acceptance of the PA is likely to be and remain low (cf. Stoll-Kleemann and Welp, 2008). In contrast, international experiences suggest that local institutions hold out more promise. This is particularly the case when institutions with goals differing from community interests have been externally imposed by government (such as national parks) (Kumar, 2002; Sunderlin, 2006).

Using the case study of Central Sulawesi's LLNP, this paper seeks to explore which policies foster sustainable resource use and facilitate PA conservation success. To do so, we first investigate which village institutions govern natural-forest-resource use, and secondly, we analyze the prevailing patterns of human forest utilization.

2.2 Theoretical Background

2.2.1 Institutions

In times of rapid destruction of natural ecosystems – such as the conversion of tropical rainforests into farmland – the search for appropriate natural resource management institutions is one of the greatest challenges in the realm of environmental protection (McCay and Acheson, 1987; Berkes, 1989; Ostrom et al., 1999). Institutions are likely to be a mix of complementary and competing arrangements tailored to specific historical, economic, social, and environmental features (Ostrom et al., 1999). While organizations are material entities and include political, economic, social and educational bodies such as political parties, firms, churches, and PA administrations, institutions are the rules of the game. They consist of both formal legal rules and the informal social norms that govern individual behavior and give structure to social interactions, thereby providing an institutional framework (North, 1990). In the definition used in the present work, institutions include any form of constraint that human beings devise to shape human interaction. Sometimes institutional rules are violated, resulting in punishment (sanctions). Clearly defined boundaries of management units, well-fitting rules, and appropriate participation in collective choice have long been recognized as important institutional design principles for sustainable collective resource use (Ostrom, 1994a). Furthermore, local monitoring and sanctioning are critical components of effective forest institutions.

2.2.2 Framework for Analysis

In the 1980s, Kiser and Ostrom (1982) devised an interdisciplinary conceptual tool to explain how institutions affect individual incentives for action and resultant behavior, the Institutional Analysis and Development (IAD) framework. The framework was further developed into a theory of common pool resource management that offers a robust analytical paradigm for comparative studies (Clement, 2009). Typical common pool resources include forest land or forest products in sparsely populated areas where it can be both difficult and very costly to prevent potential users from consuming the resource (McKean, 2000). According to Ostrom (1994b), the term common pool resource refers to resource systems regardless of the property rights involved. When resource users interact without the benefit of effective rules that limit access and define rights, fundamental free-riding in two forms is likely: overuse without concern for the negative effects on others and a lack of investment in maintaining and improving the common pool resource itself (Ostrom et al., 1999).

A range of common pool resources settings can appear. One possibility is a quasi open-access situation without governing institutions, which is likely to result in over-exploitation. Another scenario is the existence of joint management institutions with clearly defined rules regarding access and use in a common property situation (e.g. community forests, community-based irrigation schemes). In this context, institutions – formal or informal – are an important mediator between the interaction of humans and their environment (Aggarwal, 2006).

The IAD framework helps to identify key variables that structure the situations that individuals face and how rules and communities affect these situations over time. The focal level of this framework is known as the action arena. In the action arena, two entities – participants and an action situation – interact while being affected by exogenous variables at the time of analysis (interaction). Outcomes of this interaction evolve that in turn affect the participants, the action situation, and at times even the exogenous variables (Ostrom, 1994b). Evaluative criteria are used to assess the interaction as well as the outcomes with respect to applicability to sustainable resource use.

2.3 Methods

2.3.1 Research Design

A qualitative research methodology was chosen to provide detailed insights into processes, influences, and the background of resource management as required by the IAD framework (Miles and Huberman, 1994; Berg, 2007). The attitudes of different local actors involved in forest management and shaping management institutions were examined. Different types of triangulation were applied such as data source and technique triangulation (cf. Theis and Grady, 1991). In our study, data source triangulation implies the usage of different sources of data such as personal interviews in addition to literature-based research. In terms of technique triangulation, an intensive literature review was followed by semi-structured in-depth interviews with key actors. Furthermore, methods also used in participatory rural appraisals (PRA) (Standa- Gunda et al., 2003) such as focus group discussions and participant observation were applied.

2.3.2 IAD Framework Application

From an IAD perspective, the administrative bodies of PA as well as all other involved stakeholders are seen as participants within an action arena. In this arena, each participant interacts with the natural resource forest in a different way. For example, the forest use of local people differs from the forest conservation activities conducted by National Park officers. In the context of the establishment of national parks in general and particularly with regard to LLNP, regulations on forest use are implemented often by the government without the involvement of the local people. This can lead to local difficulties such as illegal extraction of natural resources or the rejection of PAs (Ostrom et al., 1999). Experience suggests that in order to ensure sustainability of natural resource management, all stakeholders must be involved transparently, and their customary rights need to be recognized (Ostrom, 1990). In addition, the participation of local communities can support the compliance with regulations and lead to a reduction in management costs (Hanna, 1995).

In the case of LLNP, negotiations for community conservation agreements (CCAs; Indonesian: Kesepakatan Konservasi Masyarakat) were promoted by international and national nongovernmental organizations (NGOs) and the Central Sulawesi Integrated Area Development and Conservation Project (CSIADCP) in the late 1990s. The negotiations were usually conducted by the village elders and the traditional customary organization (Indonesian: Lembaga Adat), who both signed the agreement. The agreements aim at reconciling the discrepancies between the livelihood requirements articulated by local people and conservation needs perceived by the National Park administration. The CCA with the village of Toro, for example, defines itself as a "[. . .] negotiated agreement between community representatives and the National Park management that constitute part of a co-management strategy. Their objective is to find a balance between the goals of nature conservation and the objectives of the local communities to secure self-determined, sustainable livelihoods" (Toro CCA, 2003; cited in Mappatoba, 2004).

According to Palmer (2007) 49 villages around LLNP had negotiated or were in the process of negotiation for a CCA in 2006. The LLNP authority had acknowledged and recognised more than three quarters of the agreements by 2006. Nearly half of the CCAs were initiated by the village or village leader (49 percent). To a lesser extent, NGOs (22 percent), CSIADCP (19 percent) and the LLNP director (1 percent) were the initiator. The negotiation process for all agreements were supported and handled by one or more NGOs. In fact, it has been documented, that the contents of the CCAs reflect the motivations and philosophies of the NGOs involved (Mappatoba and Birner, 2004). Of the three most active NGOs, one focused on nature conservation (The Nature Conservancy, TNC), one on sustainable development (CARE), and one on the empowerment of indigenous groups' rights (Yayasan Tanah Merdeka, YTM; English: Independent Earth Foundation).

While Mappatoba and Birner (2002) investigated the potential of CCAs in the LLNP area from an environmental economics and policy analysis perspective, we seek to explain the underlying patterns of human behavior with reference to the IAD. In doing so, we invoke social–psychological observations in addition to purely economic arguments. In our study, these agreements are interpreted to be the outcome of the interaction among the participants (LLNP authority, villagers, NGOs) and the action

situation (forest use/conservation). Furthermore, in contrast to Mappatoba and Birner (2002), we assess the CCA impacts on the action situation and on the exogenous variables such as the environmental status of the forest.

2.3.3 Case Study Area

The study area (722,000 ha) is located on the island of Sulawesi, Indonesia in the province of Central Sulawesi. The study area consists of LLNP and the five administrative sub-districts to which LLNP belongs (Fig. 1): Sigi Biromaru, Kulawi, Lore Selatan, Lore Utara, and Palolo. The sub-districts belong either to the Donggala or Poso regencies. In the year 2000, the region comprised 119 villages. The LLNP region is topographically very diverse and characterized by rift valleys with rainfall variations from 500 to 2500mm per year. LLNP encompasses 229,000 ha of mountain cloud and monsoon forests ranging from about 200 to 2610m above seal level south of the provincial capital Palu (Erasmi et al., 2004).

In addition to the high biological diversity within LLNP, there is also high socio-cultural diversity around LLNP (Waltert et al., 2004) with several distinct ethnic groups living in the area. The indigenous ethnics (the Kaili, the Kulawi, and the Lore) are descendents of ancient kingdoms situated primarily in the Kulawi, Lore Utara, and Lore Selatan districts. Spontaneous migrants from Kulawi did not inhabit Palalo until the 1950s (Faust et al., 2003). Between the late 1960s and the 1990s, the central government's transmigration programs led to the establishment of four villages, mainly in Palolo and Lore Utara, for Javanese, Sundanese, and Balinese settlers. Most transmigrants, however, have left the research region in the meantime. Since the early 1980s, the immigration of Bugis from South Sulawesi has been the main source of immigrant socio-ethnic influence. The Bugis settled mainly in Palolo and Lore Utara due to the availability of land. Bugis migrants introduced cacao (Theobroma cacao) cropping to the Lore Lindu area. The influx of migrants was encouraged through road construction between Palu, Palolo, and Lore Utara in 1982 (Weber, 2006).

The Lore Lindu area was declared a UNESCO Biosphere Reserve in 1977 and has been nominated as a World Heritage site for its cultural legacy of ancient stone megaliths.

The core area of the biosphere reserve was designated as a national park in 1993 by the Indonesian Ministry of Forestry (Shohibuddin, 2008). However, the permanent borders of LLNP were not fixed until the end of the 1990s (Weber, 2006). The national park was established by merging three nature reserves: (i) Lore Kalamanta Wildlife Sanctuary founded in 1973; (ii) Danau Lindu Recreational and Protection Forest established in 1978; and (iii) Sungai Sopu and Gumbasa Wildlife Sanctuary declared in 1981 (Mappatoba, 2004). The LLNP authority manages the national park from its administrative office in Palu and directly reports to the Ministry of Forestry in Jakarta.

Approximately 136,000 citizens, mainly agricultural smallholders, live in the villages around LLNP (Maertens, 2003; Erasmi et al., 2004). About 87 percent of the households undertake farming as their primary source of income. Paddy rice is the most important staple food, whereas cacao and coffee are the predominant cash crops (Maertens et al., 2006). To a small extent, other crops such as coconut, vanilla, pepper, clove, corn, upland-rice, peanuts, cassava, vegetables, and soybeans are cultivated.From1980 to 2001 the area has undergone an agricultural expansion of cacao and coffee associated with population growth – partially caused by migration – and improved market conditions first for coffee and later for cacao. The expansion mainly took place in the uplands, and to a considerable extent at the margins of the LLNP forest. Today the most important threat to the forests of LLNP is the ongoing agricultural expansion of cacao including associated deforestation and forest degradation. To a lesser extent, some poorer local households illegally collect forest products, such as rattan (Maertens et al., 2006).

2.3.4 Data Collection and Analysis

All interviews were conducted with the aid of an Indonesian assistant in the local language between 2006 and 2008 and were recorded. In a second step, the material was transcribed and finally translated into English. Computer-based text analysis was carried out with Atlas.ti and MaxQData. Altogether, 49 interviews were included in the analysis. One set of interviews or focus group discussions targeted the role of village institutions

in forest and natural resource access, and a second set addressed the efficacy of community conservation agreements.

To investigate the role of village-level institutions such as the traditional customary organization; the village representative body (Indonesian: Badan Perwakilan Desa); and the mayor (Indonesian: Kepala Desa), three villages (Toro, Bulili and Lempelero) were purposively selected.

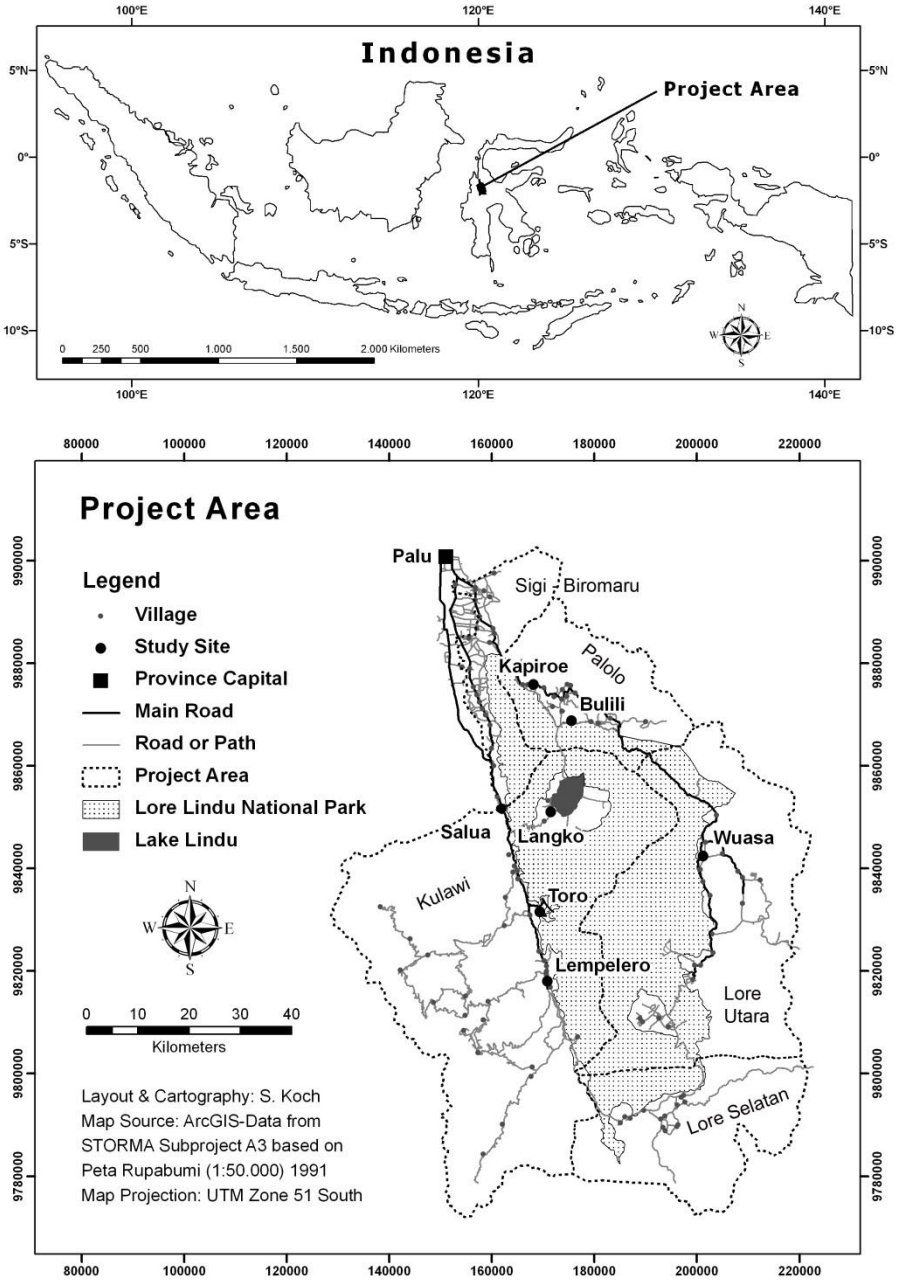

Fig. 1. Project area, including Lore Lindu National Park, in Central Sulawesi, Indonesia.

These villages differ significantly in regard to land-use, demographic development, emphases on traditions, and local impact of NGOs (Weber and Faust, 2006). Toro represents a relatively static village with low immigration and a high proportion of indigenous people. In 2001, Toro was granted a far-ranging right to regulate and monitor the utilization of about 2300 ha of community forest land. Access to forest resources in the area had officially been suspended in 1982 (Burkard, 2002; Fremerey, 2002). Bulili is located in the dynamic region of Palolo on the northern edge of the LLNP. In the past the village has experienced a high influx of migrants, mostly Bugis from South Sulawesi. This influx has perturbed the former socio-economic stratification of the village (Barkmann et al., 2010). Lempelero represents an intermediate type. Its population has doubled within the last ten years caused by recent immigration. Like in Bulili, Bugis migrants are mostly attracted by the abundance of easily accessible forest and agricultural land (Weber and Faust, 2006). In each of these three villages, problem-centered interviews (Witzel and Reiter, 2010) on institutions regulating resource access were conducted with ten key informants.

Based on information from local NGOs and experts and complemented by a literature review on CCAs (community conservation agreements), three main selection criteria were used to select villages: the state of CCA negotiations, the ethnic composition of the village, and village location (see Table 1).

Table 1: Selection criteria for CCA villages (status as in 2006).

	Wuasa	**Salua**	**Kapiroe**	**Langko**
State of CCA negotiation	August 2002 signed	Not signed	Not signed	March 2005 signed
Ethnic composition	Majority indigenous	Mixed	Mixed	Majority indigenous
Location (with respect to LLNP)	east	west	northeast	centre

Source: village survey 2007 by Reetz (2008) and Seeberg-Elverfeldt (2009).

To assess the CCAs, we carried out focus-group discussions in four villages (Wuasa, Salua, Kapiroe, Langko). Farmers were randomly selected for participation, while decision makers were purposively chosen. We conducted separate focus groups for farmers and decision makers in order to avoid the domination of discussion by members of the local elites. We also wanted to make sure that the farmers felt free to speak out without being inhibited by the presence of their leaders.

The discussions focused on the institutional setting of the CCA and on the impact the CCAs have on natural resource management. The data on the CCAs were analyzed with respect to whether the agreement:

- can provide the institutional structure for a natural resource management process,
- allows for the active involvement of local stakeholders,
- fosters monitoring and enforcement of sanctions and rules, and
- has an impact on the environment.

To assess the impact of CCAs from NGO and National Park authority perspectives, semi-structured interviews and group discussions were conducted. Individual interview partners were identified by snowball sampling. Respondents representing different institutional levels vis-à-vis CCAs were interviewed (LLNP authority staff, forest police staff members, various NGOs). In order to cover the variety of NGOs that facilitated CCAs, a mixture of national and international NGOs was chosen:

- TNC(The Nature Conservancy; international, focusonnature conservation)
- YTM (Yayasan Tanah Merdeka [Independent Earth Foundation]; national, focus on human rights),
- KARSA ("initiate"; national, focus on nature conservation), and
- Jambata ("bridge"; national, focus on nature conservation).

2.4 Results

The analysis of the interviews allowed for a detailed representation of various issues and patterns in relation to natural resource management in the area of LLNP. Applying the IAD framework to our study (Fig. 2), the issues are collated under two main themes.

- *Interaction* of forest and its users with respect to natural resource management (local institutions) and its valuation.
- *Outcome*: Community conservation agreements as an instrument for natural-resource management and its valuation.

When considered appropriate, major findings are underpinned with direct quotes from the interviews. The origin and/or employment status of the interview partner are indicated. To track the quotes from the interviews, the quotation numbers automatically assigned by the computer program Atlas.ti (e.g. 2:41) or MaxQData (e.g. 263) is depicted.

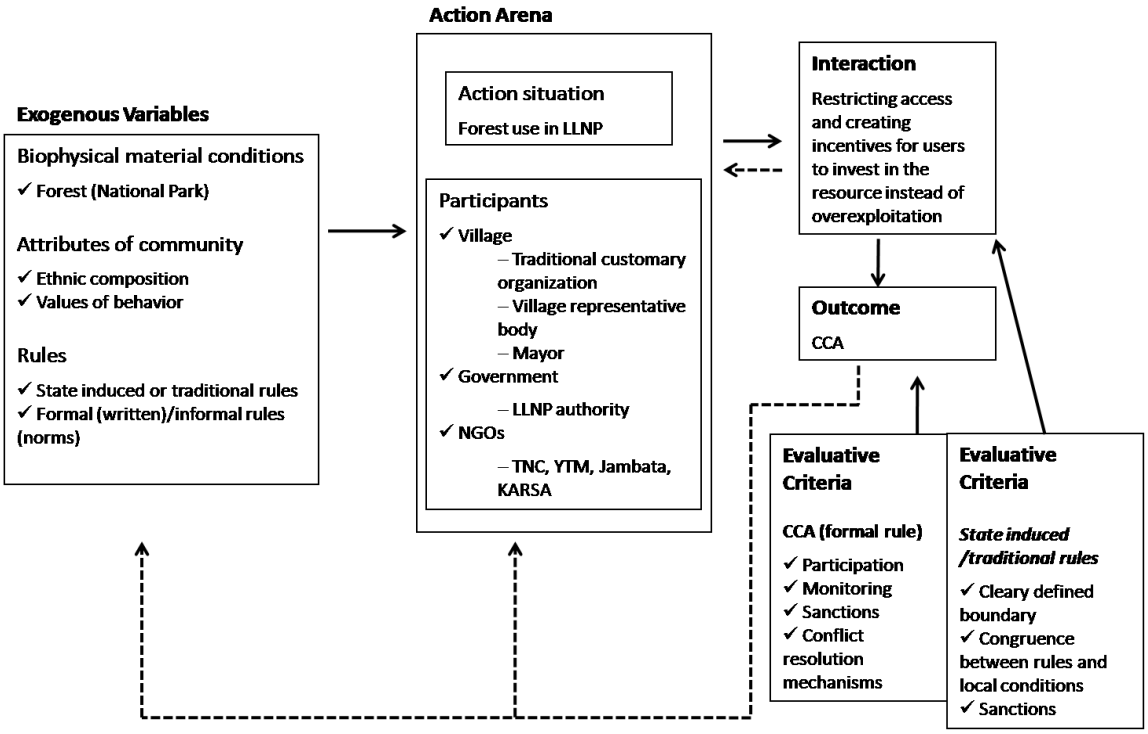

Fig. 2. Institutional Analysis and Development framework applied to study.

Table 2: Attributes of community from the point of view of NGOs and LLNP.

Attributes	**Values of behavior**	**Ethnic composition**
positive	- **Protection value**: traditional ties to forest - **Functional value** of the forest	- **Indigenous people**: maintenance of traditional values/ties to the forest - **Indigenous people and government**: recognition of functional value of the forest
negative	- **Lack of protection value**: loss of traditional ties to forest - **Economic value** of the forest: cacao plantations - **Personal autonomy**: after political change around 2000, significant forest exploitation	- **Migrants and groups of indigenous people**: lack of traditional values/ties to the forest

2.4.1 Exogenous Variables

Attributes of Community

Two different community attributes, values of behavior and ethnic composition, as well as their positive and negative evaluation can be distinguished regarding forest use in the LLNP area from the point of view of NGOs and LLNP authority (Table 2). One NGO member said that the indigenous people are well aware of the value of protecting the forest. Traditionally, the indigenous see the forest as "a part of their social life" (NGO, 5:18). In contrast, a LLNP officer remarked that many locals even claim to identify culturally and spiritually with the National Park (LLNP, 1:2). Furthermore, the indigenous people value the protective function of the forest against flood and erosion (LLNP, 1:28). "Most of [the people] think that it is very important for them to protect the national park because it provides many environmental services for them" (NGO, 2:41). On the other side, immigrants lack traditional ties to the forest. There are "different perspectives about the forest. The indigenous people [. . .] see that the forest

is a part of their social system. [. . .] The immigrants usually don't have the basic culture like that" (NGO, 5:14). The immigrants mostly see the economic value of the forest land in terms of cacao plantations.

However, this point of view articulated by NGOs and LLNP authority cannot be generalized. The interviews with farmers reveal a more complex perspective. Most of the indigenous people in the traditional village Toro have a strong traditional tie to the forest as described above. Many indigenous people in Bulili are also aware of the protective value of the forest against landslides and floods. However, the people in Bulili are still converting forest into arable land within LLNP. The immigrants, mostly Bugis, dissociate themselves from being the group responsible for forest conversion and the resulting environmental problems because they are rarely involved directly in forest conversion.

Furthermore, pro-environmental attitudes in the indigenous population did not prevent the widespread appropriation of LLNP resources after the end of the Suharto era in 1998. "The whole area got the trouble, wood taking and damaging the forest happened at that time. Before the reformation time, nobody dared to take rattan [. . .]. But after the reformation time, the people took rattan in front of our face, and we couldn't do anything because there were many people there" (LLNP, 11:5). "At the time, the people became more powerful and stronger compared to before". NGOs were forced to stand by and to try to initiate dialogue with the people (NGO, 2:28).

Rules in Use: Village Institutions

In regard to access to forest resources, we found strong differences among village institutions (Table 3). In the traditional village Toro, all individuals interviewed highlighted the strong influence of local institutions, mainly exerted by the traditional customary organization (Lembaga Adat). A clan of families belonging to the first settlers dominates almost all positions in the formal village leadership. Besides the traditional customary organization, its members also occupy the positions of the mayor and dominate the village representative body. To become a member of the village government (traditional customary organization, village representative body, mayor)

candidates must be indigenous. "[. . .] the members of village government should be the indigenous people of Kulawi" (Teacher; indigenous, Toro; 263). Although the members are elected, positions are often passed on from one family member to another, especially, positions in the traditional customary organization. Furthermore, only indigenous people are allowed to participate in the elections. Generally, non-indigenous inhabitants are merely informed about the results. Migrants who want to settle in Toro and practice agriculture will appear at a traditional customary organization meeting, present their request, and hope for the assignment of a forest plot. However, immigration by members of non-local ethnic groups is strictly discouraged, e.g. by restricting land purchases and land assignments. The land potentially assigned to an applicant stems from the community forest located inside LLNP. The traditional customary organization also grants permission for the extraction of timber and non-timber forest products such as rattan or dammar. Since the fall of Suharto and the decentralization efforts of the government, the traditional informal institutions, in particular rules and sanctions imposed by the traditional customary organization, have gained more importance in Toro.

Table 3: Perception of local institutions of the natural resource management process from the point of view of the village.

Village-level institutions	**State-induced formal rules Village representative body**	**Traditional informal rules Traditional customary organization**
positive	– (should) consist of representatives of all groups of the village society	– Strictly enforce rules, regulations, and sanctions concerning sustainable utilization of forest resources
negative	– Rules, regulations and sanctions are rarely adopted by the villagers	– Mainly works in traditional communities – Fosters discrimination against migrants – Stronger risk of local nepotism

Table 4: Evaluation of interaction between rules in use (state induced and traditional) and participants concerning forest use regulations.

Criteria	State-induced formal rules		Traditional informal rules	
	positive	**negative**	**positive**	**negative**
Boundary	Zoning	Opposing opinion concerning boundary between government and locals		
Sanctions	Positive experience of law enforcement of national law from government	Contradicting rules between LLNP and local institutions	Sanctions for residents and non-residents of a village	
Congruence between rules and local conditions		Unsuitable national regulations	Positive impact of traditional customary organization	Difficulty with migrants in the implementation of local rules

These informal institutions, however, are undergoing a process of formalization, including the formulation of written rules and regulations, encouraged by certain NGOs.

In Lempelero, a village regulation concerning natural resource use was drawn up by the mayor and the traditional customary organization. However, it has neither been committed to writing nor completely implemented yet. This regulation deals with issues concerning the appropriation of forest products as well as regulations about converting forest into agricultural land. Since timber trade is officially prohibited, forest products can only be taken as fuel wood or construction timber for auto-consumption. They are not allowed to be offered for sale. Furthermore, it is prohibited to cultivate steep slopes (>45°) because of the risk of landslides, and in order to preserve the headwaters to

secure village water supply. However, population pressure prompts some poorer local households to commercially collect rattan, which forms their major source of income. Rules and regulations are inadequately monitored, and sanctions – if they exist at all – are rarely enforced.

In Bulili, the ethnically most diverse village, the traditional power relationships are replaced by economic power structures. This is mainly due to Bugis migrants, who are substantially more prosperous than indigenous households as they usually grow and market cacao more successfully. The mayor and the village representative body can be seen as the leading formal organizations; the traditional customary organization is not very powerful. Although it is possible for migrants to hold a position in the village government, its legal representatives are not known by many villagers be it migrants or indigenous people. Indigenous as well as Bugis interviewees agree that a widespread laissez-faire attitude on natural resource use prevails. Every household is regarded as responsible for itself: no specific written and implemented village regulations exist. "The problem in this village is that even if we already have regulations, they have not yet been implemented" (Mayor, Bulili; 348). Official rules and regulations set by LLNP authorities stem from the sub-national or even national level. For these regulations, too, neither monitoring nor sanctions have been implemented. "It is common here that everybody goes to the forest without permission" (Local, Bulili; 219). Because of the absence of forest resources and available agricultural land outside LLNP, Bulili's community has no alternative to using LLNP to extend their agricultural land holdings. Virtually without institutional restrictions, Bugis migrants, as well as some better-off indigenous households, have acquired land via purchase from poorer, local households outside LLNP. This aggravates pressures on LLNP, as the landstripped indigenous households, in turn, acquire new land by illegally clearing primary forest inside LLNP. These new plots are of inferior land-use quality and of a highly precarious tenure status. In contrast to Toro and Lempelero, newly converted plots are reported to the mayor only after deforestation. Even this reporting is not done to acquire an ex-post permission, but in order to guard against competing claims to the same land by other villagers.

2.4.2 Evaluation of Interaction

Analysis of the interviews with the National Park and NGOs revealed various relevant factors – such as boundary, sanctions, and congruence between rules and local conditions – that can be examined to help evaluate the situation of forest use in LLNP (Table 4). An appropriate zoning of LLNP is seen as important to guarantee traditional access to the forest for local people. "There are areas inside the National Park that already became hunting areas, coffee farming areas, and rattan-taking areas a long time ago. So, when it's accepted by the National Park, [.] they [the local people] have to respect the National Park" (NGO, 5:32). In this context, the establishment of a living boundary (trees as border demarcations instead of poles and fences) around the National Park is discussed to fulfil both targets, such as clear boundary demarcations and to benefit local people in regard to their use of the products (NGO, 9:14).However, even where such trees were planted, the LLNP authority and local people still hold opposing opinions about the National Park boundary due to traditional use rights before LLNP establishment (LLNP, 6:10, NGO 7:5).

The importance of effective sanctions at the village level for residents and non-residents is emphasized (NGO, 9:15). But contradictions between rules of LLNP and local institutions have caused confusion because people were caught by the forest police in an area where – in their opinion – forest product harvesting was allowed (NGO, 3:20, 5:22). By LLNP personnel, the national law and its enforcement are valued positively. Good results are reported in terms of less illegal wood extraction (LLNP, 8:8), and a learning effect has been observed among the people caught by the forest police (LLNP, 8:9).

Concerning traditional informal rules, a positive impact of the traditional customary organization can be observed in several places (LLNP, 4:10). However, migrants still manifest difficulties in implementing traditional informal rules, and even indigenous people continue to demonstrate deficiencies in obeying the state induced laws. Illegal land cultivation inside the National Park remains problematic (NGO, 5:20), and resistance to LLNP management is observable that can be attributed to the

government's indifference to cultural and social diversities in the Park's implementation (NGO, 10:15). One interview partner even stated that "[. . .] the National Park itself is the main problem" (NGO, 5:13).

2.4.3 Outcome: CCAs as an Instrument to Support Sustainable Forest Use

The negotiations for the CCAs between the LLNP authority, NGOs, and village representatives started in the late 1990s. TNC and other NGOs have established dedicated village conservation councils (Indonesian: Lembaga Konservasi Desa: LKD) for the supervision and co-ordination of the CCAs.

Table 5: Perception and valuation of CCA by villagers, LLNP, and NGOs.

CCA	Formal CCA rules	Impact of CCA
positive	– **Participation**: traditional rules included – **Monitoring**: application of different techniques (transects, photographs, GIS) – **Income generating activities** – **Sanctions** for residents and non-residents of a village	– **Participation**: minimizing gap between LLNP and local people considering traditional rules – **Capacity building** – **Rule adherence**: better adherence to CCA rules than to LLNP rules imposed by government
negative	- **Participation**: not all villagers involved in CCA design - **Monitoring**: weak realization (no financial support, little formal training) - **Conflict** between LLNP and villagers over usage of resources	

The village conservation council can only become active in the designated CCA zone within LLNP as the other areas of the national park are under the sole jurisdiction of the LLNP administration (Village Secretary of Wuasa, pers. Comm., 2006). The functions of the village conservation council typically include (Desa Wuasa, 2002):

- to provide an umbrella for communication between the community and the National Park authority,
- to socialize the CCA to the local community,
- to carry out participatory planning with villagers and the National Park authority,
- to supervise the implementation of the CCA,
- to evaluate the CCA,
- to report the evaluation results of the CCA to the mayor.

The village conservation council organizes the monitoring activities. Council members meet between twice per month to every six months. Usually, there is no established schedule. Meetings are held in accordance with the personal time schedules of the council members or if there is a specific reason to convene one. Members are often also members of other village organizations, especially in the traditional villages. In some villages, the LLNP authority has trained the monitoring team, some of which have received financial support from NGOs. However, the members are not paid and work on honorary basis in most cases.

The villages have all agreed to specific CCA commitments. The rules and sanctions of the agreements are listed in a forest management plan and address various issues: the amount of timber that may be harvested; the use and sale of timber; forest conversion for agriculture and plantation development; the collection, sale, and use of rattan and other non-timber forest products; hunting. The village conservation council has the capacity to punish or sanction perpetrations of the CCA. The execution of such measures relies on the official village organizations, however. The sanctions differ from village to village but are usually based on the traditional customary rules. In some village

regulations, precise monetary fines are defined. In other villages, fines are stipulated in kind. The money from the fines is received by the traditional customary organization and is meant to be used for village development.

2.4.4 Evaluation of CCA

Valuation of CCA

The knowledge and understanding of CCAs by the villager respondents varied among and within villages. The village leadership was the primary participant in the CCA negotiations and was informed about its purpose and structure. Many ordinary villagers have never heard of the agreements, stating to know nothing of their details or purpose. Communication between LLNP administration and community members was reported to be not very good, neither during the negotiation of the CCAs nor with respect to other conservation activities: "So you have no suggestion for the [government] apparatus that creates better approaches to the community and not only threatens the villagers; because it only triggers conflict amongst villagers and forest guards" (Decision Maker, Wuasa, 391–392). Some NGOs worked alongside in the same villages, but the coordination among the NGOs was not very strong, each often promoting only its own particular CCA. This caused confusion among the villagers, and many were not certain which organization initiated and carried out which activity.

During the interviews with LLNP and NGO personnel concerning CCAs (Table 5), the importance of the integration of local people and local rules at different steps in the process was highlighted. The CCAs are made "[. . .] in the context of collaboration management. That basic concept [. . .] is to minimize the gap between the national park management and the people" (NGO, 7:11). "There are already rules in the society, and they write the rules down and that becomes the agreement between the people and the office" (NGO, 7:29). These rules are seen to be "[. . .] more powerful than the national rules" (NGO, 2:29). It can be said that the people respect the local rules better than the national ones imposed by government because the CCA rules are "more practical" when locally adapted (NGO, 2:29). The incorporation of income-generating possibilities in the

CCA document is also positively valued, especially for "[. . .] the places that have no resources outside" LLNP where "nothing is allowed to be taken out" (NGO, 2:32). Sanctions adapted locally at the village level (NGO, 9:15), as well as various monitoring techniques (NGO, 2:18) are also part of CCA.

Impact on Natural Resource Management

All villager respondents agreed that extensive illegal resource extraction inside LLNP, such as rattan collection, or forest conversion to agricultural land took particularly place after the end of the repressive Suharto government. Farmer respondents said that in

the past, the increasing illegal human use of natural resources has had an impact on the environment. Nowadays, less illegal resource extraction occurs or it is more controlled, but the consequences of previous human activities are felt with a higher intensity of floods, erosion, and other environmental disasters. NGO respondents attribute this at least in part to the success of the CCAs. Where there are no CCAs, the ecological situation is perceived as still worsening by them (Fig. 3).

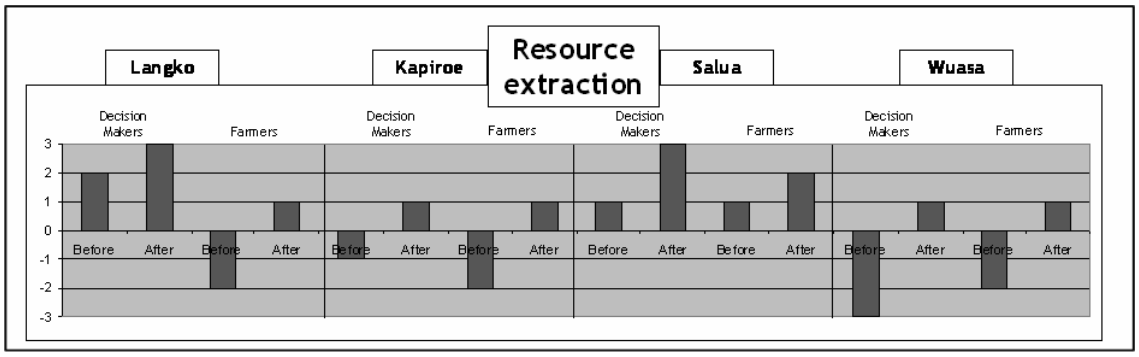

Fig. 3. Evaluation of the topic resource extraction before and after the CCA implementation (participants used scores −3 (very bad) to +3 (very good)).

2.5 Discussion

Managing natural resources in the form of state-induced Pas is a common tool to counteract global deforestation and forest degradation. Analysis of formal and informal institutions from our case study in Lore Lindu National Park documents different factors that restrict or facilitate access to forest resources for local users. Overall, our results show that the implementation of state-induced formal rules executed by village representative bodies and the LLNP authority were not effective in the past. However, traditional informal rules on resource use were at least partly incorporated into several community conservation agreements. These CCAs reflect previous implementation problems at least partly, and demonstrate substantial potential to mitigate the conflict of interests between conservation objectives and local livelihood needs.

Rules and regulations from the national or sub-national level without effective monitoring are regarded as inadequate for nature conservation by NGOs and villagers. The governance situation has generally improved in comparison to the Suharto era with the introduction of the new village representative body in Central Sulawesi, a local system implemented by the national government (Weber, 2006). However, our results illustrate that the introduction of the village representative body does not necessarily result in more legalistic, participatory, or democratic resource management procedures. In fact, the village representative body system is too weak to prevent deforestation, undemocratic social exclusion, and discrimination. This overall situation in the LLNP area is in line with Clement and Amezaga (2009) who found great discrepancies between policy intentions and outcomes in national afforestation programs in northern Vietnam. They relate this gap to the lack of clarity and poor adequacy of the policies designed at the national level. In our study of LLNP management, discrepancies in boundary demarcation and contradictory rules regulating the relationship between LLNP and local institutions play a major role. Such a lack of congruence hampers successful natural resource management. National regulations adopted by village representative bodies and the LLNP authority are perceived as being unsuitable ignoring traditional local rules. Consequently, we found resistance to LLNP and its regulatory system as imposed by the central government. From studies in Indonesian Borneo, we know that massive environmental degradation and impoverishment of local people can be observed when

central governments have exerted sole authority over resources (Curran et al., 2004). Based on such examples Dietz et al. (2003) claim that too many strategies for governance of natural resources are designed at national levels ignoring local conditions. Our findings are further in line with Ostrom et al. (1999), who point out that if rules are imposed by outsiders without consulting local actors, these local actors may exhibit severe resistance to externally imposed institutions. From this perspective, the LLNP authority can be described as an external entity that constrains the behavior of the locals concerning forest use. The fact that individuals react with resistance when their freedom to behave as they feel entitled to is being abolished or is threatened is in detail described by "psychological reactance theory" (Brehm, 1966).

Several design principles for cooperative natural resource management have been suggested (Ostrom, 1994a). Such principles are regarded as critical components of effective institutions dealing with forests as a common pool resource. In our study, deficiencies with reference to relevant principles include insufficient boundary demarcation, and a lack of congruence between rules and local conditions. By means of these principles we found that implementation of state-induced formal rules was not effective in the past. Coupled with a much lower population pressure and much lower market incentives for cacao cropping, the LLNP authority exerted substantial repressive power during the Suharto era even without local participation in resource management. Thus, positive effects of LLNP establishment can be observed with respect, e.g., to reduced deforestation (Schwarze et al., 2009). Later on, the state-induced formal rules on LLNP conservation proved largely ineffective as central government power largely dissolved. Consequently, the villagers rejected rules, regulations, and sanctions perceived as unfair limitations as soon as they physically could.

Our results further demonstrate that the long-term failure in the implementation of state-induced institutions has already been recognized by the LLNP authority, as it has been actively engaged in implementing CCAs for the past decade. CCAs can be interpreted as part of a co-management strategy between the LLNP authority, NGOs, and the local people. Thus, resource management in the research area has followed the worldwide trend towards decentralizing responsibility among the stakeholders within Pas (Borrini-Feyerabend, 2003). Given the management complexity and impending global changes that PAs are facing, it is increasingly recognized that the governance

arrangements that were considered appropriate in the last century may no longer be appropriate in the future (Borrini-Feyerabend, 2003). Thus, cooperation not only provides a more democratic approach, but could also lead to more effective and economically efficient conservation by avoiding costs associated with conflicts (Vermeulen and Sheil, 2007).

In the case of LLNP, the major pillars of CCAs are the participation of local inhabitants, and integration of local rules. According to reactance theory (Brehm, 1966), the most effective measure to reduce reactance is the re-introduction of freedom of behaviour through, e.g., incorporation of traditional local rules in PA management. Thus, the implementation of CCAs can be seen as a necessary and potentially useful step for improved management of LLNP (cf. Ostrom, 1990; Mappatoba and Birner, 2002; Stoll-Kleemann and Welp, 2008). Overall, monitoring and enforcement structures have benefited from the implementation of the CCAs. In most cases, they provide a good framework for rules and regulations. This finding is backed by the villager perceptions of reduced resource extraction of LLNP after implementation of CCAs. Chun and Tak (2009) also conclude that traditional institutions used for forest management in ancient Korea were effective and forests under this management system were better protected than those designated as 'forbidden forests' where utilization was forbidden by the government.

However, in those villages around LLNP that have a rather weak traditional customary organization – usually in the more ethnically mixed villages – the acceptance of traditional rules is weak. Consequently, the successful incorporation at least of traditional local rules is more difficult. In more static villages with low immigration in recent decades, the traditional customary organization enjoys unchallenged supremacy, whereas the traditional customary organization does not play this type of role in more dynamic villages dominated by migrant households. Ostrom et al. (1999) tie the development of norms that shape natural resource use to group identity: a set of people identifying as one group is more likely than a set of strangers to develop effective resource management institutions. The clear differentiation of migrant and indigenous people in our study deviates from findings by Sah and Heinen (2001) who identified conservation attitudes in Nepal to be influenced by education and resource-use patterns rather than by ethnicity. However, Burkard (2002) observed – similarly to our study –

that in ethnically mixed villages next to LLNP, the traditional customary organization does not play a significant role in the management and utilization of natural resources. In the past, much illegal forest resource extraction took place in these villages, and neither official nor informal institutions have appeared to reduce them.

Overall, CCAs show great promise for success in terms of minimizing the gap between the LLNP and the local people through integration of traditional, informal rules (cf. Mappatoba and Birner, 2002). However, this aspect in particular might produce a problem in the future as those traditional, informal rules are still difficult to implement for migrants. Migrants usually do not share the same traditional value-belief system and ties to the forest as the indigenous people. Thus, migrants' rejection of CCAs can be expected, analogous to what has been observed in regard to their lack of adherence to the traditional customary organization rules. On the other hand, it might also be possible that migrants manifest better respect for the formal CCA rules than the traditional, informal ones due to their lower social capital (less contact to traditional village elites). Thus, migrants often conform more readily to formal laws and regulations potentially including the CCAs (cf. Barkmann et al., 2010).

The fact that various NGOs with different backgrounds negotiated CCAs in the area was identified by Mappatoba and Birner (2002) as an advantage, provided they coordinate and combine their activities, especially if working in the same village. Our analysis revealed that this did not happen. The NGOs worked independently, did not coordinate, and even promoted their own individual CCAs with differing goals, resulting in confusion among villagers.

The lack of opportunity for all village groupings to participate in CCA negotiations – rather than only the village elite – clearly constitutes a problem that has yet to be solved. Mappatoba and Birner (2002) pointed out the potentially problematic nature of this issue, and our study confirms their findings. Still considerable progress has to be achieved here in order to actualize the potentials of the introduction of CCAs. So far, the problem of migrants' lack of adherence to rules has been primarily tackled by the traditional customary organization through strict rule enforcement of traditional informal rules in the traditional villages. This results in a stronger risk of local nepotism and discrimination against the newcomers. Excluding certain groups of the population

from managing natural resources is also known from other studies in South Asia, for example, where women were discriminated against (Agarwal, 2001). Concerning sustainable resource-use patterns in the LLNP area, the ethnically homogenous village Toro, for example, preserves its natural resources effectively through the establishment of powerful local institutions. However, with regard to land distribution and equal access to natural resources, strong power inequalities indeed exist. Recent poor migrants are discriminated against, most obviously in cases of smaller land appropriations and lack of access to village leadership positions.

Discrimination against migrants cannot be the way to go for CCAs. Such a policy would violate basic human rights and thwart potential societal benefits from migration, such as economic advancement and technological innovation. In the LLNP area, these benefits include the introduction of economically successful cropping technologies for cacao (Faust et al., 2003). With more and more migrants living in close proximity to the world's Pas (Sanderson et al., 2002), efforts must be undertaken to understand how demographic shifts such as migration may affect economic development as well as conservation success. As the migrants do not share the traditional value-belief system of the indigenous population, a different strategy must be applied alongside local participation in CCA design that relies on traditional rules alone. A sound information policy and education regarding sustainable development in terms of the functional and protective values of the forest might be a useful tool in this respect. This recommendation is supported by findings from Nyhus et al. (2003) who related better wildlife and conservation knowledge among migrants in southern Sumatra to higher educational attainment and past experience.

2.6 Conclusions

From the discussion presented above, it can be concluded that state-induced institutions implemented by the village representative body and National Park authority as well as traditional institutions mediated through the traditional customary organizations are of major relevance in regard to forest use at the village level in the LLNP area.

Overall, our results show that the local human forest interaction is characterized by ineffective state-induced official conservation rules. Flaws in major design principles known from previous institutional analyses have been identified such as insufficient boundary demarcation, and a lack of congruence between rules and local conditions. Thus, we recommend that the LLNP management should particularly focus on these aspects in the future.

To overcome these deficits, community conservation agreements between the National Park and the villagers were implemented as a co-management strategy to foster sustainable resource use. Generally, our institutional analysis assessed these agreements to be a promising strategy to promote adequate, locally specific management of forest resources. These existing agreements, however, still lack appropriate options to tackle disparities in the participation of certain groups of villagers, e.g. migrants.

Compared to the indigenous people, the migrants do not have the same traditional ties with the forest and the same value belief system resulting in a negligence attitude towards the social and spiritual importance of LLNP forests. This finding is of high relevance for conservation activities in the tropics as many conservation activities rely on traditional local knowledge and participation of local people. As more and more migrants settle next to PAs, a sound understanding of their values of behavior is essential to ensure sustainable resource management. If the more legalistic behavior of migrants lacking strong ties with the police and indigenous village leaders leads to a long-term acceptance also of CCA regulations remains to be seen.

We further conclude that NGOs have not yet taken advantage of their opportunity to acquire more influence by combining their strengths through coordination of their activities, especially when working in the same village. Rather, they continue to work independently, causing confusion and skepticism among the villagers. This is the case

for not only national but also international NGOs financed by developed country donors. Better coordination among NGOs can thus not only result in achieving conservation goals but also result in financial effectiveness.

Finally, we can conclude that cultural diversity, one of the reasons for the Lore Lindu region to be nominated as conservation area (national park as well as biosphere reserve), still constitutes a challenge for the park management. At present resistance at the local level is obvious, even almost ten years after the introduction of community conservation agreements.

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CHAPTER 3:
Subjective Theories of Indonesian Agronomy and Biology Teacher Students on Environmental Commons Dilemmas

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Sebastian Koch[1], Jan Barkmann[2], Leti Sundawati[3] & Susanne Bögeholz[1]

[1]*Albrecht-von-Haller Institute for Plant Sciences, Biology Education, Georg-August-Universität Göttingen, Germany*

[2]*Department of Agricultural Economics and Rural Development, Environmental and Resource Economics, Georg-August-Universität Göttingen, Germany*

[3]*Faculty of Forestry, Department of Forest Management, Institut Pertanian Bogor (IPB), Indonesia*

Abstract

Fostering the cognitive skills to analyse environmental 'commons dilemmas' is an urgent task of environmental education globally. Commons dilemmas are characterised by structural incentives to overexploit a natural resource; their solution is particularly pressing in threatened biodiversity 'hotspot' areas. Solutions to these dilemmas require local actors who command knowledge on the social, ecological, economic, and institutional aspects of resource utilisation. This study investigates subjective theories that future Indonesian teachers and agricultural advisors bring to a representative local commons dilemma, the extraction of the non-timber forest product rattan.

Based on 19 structured qualitative interviews, we identified prior knowledge concerning rattan extraction. University students expressed subjective theories on the ecological consequences of rattan extraction such as landslides or flooding. In addition to education, students mentioned more effective state administrations to conserve rattan stocks. The need to institutionally balance short-term individual exploitation profits with long-term interests in the preservation of a productive resource at community level, was hardly recognised.

While Indonesia strives to include environmental education in its school curricula, the results highlight that future educators themselves are not well-equipped to address pressing issues of resource and biodiversity loss.

Keywords: Education for Sustainable Development; Commons Dilemma; Prior Knowledge, Subjective Theory, University Education, Indonesia

3.1 Introduction

Agronomy students and biology teacher students often become decision-makers or educational 'multipliers' in the area of natural resources. Thus, they are in a key position with respect to the sustainable utilisation of natural resources in the future (Wong, 2001; Wallis & Laurenson, 2004). This is especially true for many developing countries where the rural population depends on the utilisation of natural resources (cf. Hayami & Gōdo, 2005, p. 116f). University students have to be prepared adequately in order to meet these challenges (Goldman, Yavetz, & Pe'er, 2006; Esa, 2010).

To improve prospects for sustainable development in the face of multiple social and ecological challenges (e.g., Dirzo & Raven, 2003), a set of environmental 'commons dilemmas' need to be solved. A situation can be characterised as involving commons dilemmas if multiple individual and collective rationalities collide with regard to the utilisation of limited natural resources (Ernst, 2008; Gordon, 1954; Hardin, 1968). The identification and implementation of solutions requires local actors who possess knowledge on the social, economic, ecological, and institutional aspects of such dilemmas. The paramount importance of understanding the interplay of these factors to solve resource use dilemmas has long been recognised in institutional economics (Ostrom, 1990).

In spite of the importance of the topic (cf. Kassas, 2002), only a few educational science studies on socio-ecological aspects of biodiversity utilisation and conservation exist (Menzel & Bögeholz, 2009). Educational science studies regularly cover issues such as sustainable development, global warming, or renewable energies (Çakır, İrez, & Doğan, 2010; Esa, 2010; He, Hong, Liu, & Tiefenbacher, 2011; Ocal, Kisoglu, Alas, & Gurbuz, 2011; Tuncer, 2008; Vlaardingerbroek & Taylor, 2007). These studies do not address the dilemmatic character of individual decision-making facing these challenges, however. To our knowledge, there is only one additional study (Koch et al., *under revision*) on university student prior knowledge concerning environmental commons dilemmas.

Article 13 of the Convention on Biological Diversity (CBD) requests all signatories to distribute information on the importance of biological diversity and to foster environmental awareness (cf. UNESCO, 2005). In the spirit of the CBD, fostering knowledge on commons dilemmas should be a prime task of environmental education

(Tilbury, 1995; Gayford, 2000). Indonesia is a high-biodiversity signatory of the CBD with several threatened biodiversity 'hotspots' located in rural areas and subject to severe commons dilemmas (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000; Mehring, Seeberg-Elverfeldt, Koch, et al., 2011). In absence of respective studies for Indonesia (cf. Sudarmadi, Suzuki, Kawada, et al., 2001), an investigation into knowledge on local commons dilemmas suggests itself as an option for an in-depth case study. Against this background, we examine how Indonesian agronomy and biology teacher students perceive the exploitation of the commercially important non-timber forest product rattan. First, we sketch the status of environmental education in Indonesia, and outline the rattan extraction dilemma. Methodically, we rely on semi-structured interviews from which subjective theories (Groeben, Wahl, Schlee, & Scheele, 1988) are reconstructed. The term 'subjective theory' is explained in a theoretical background section.

Key results are illustrated using a simplified network of causal links structured according to the DPSIR approach (EEA, 1999). The subjective theories demonstrate severe deficits, specifically regarding socio-economic and institutional aspects. To remedy such deficits, we proposed more locally and more interdisciplinary oriented curricula for agronomy and biology teacher education in Indonesia.

3.2 Environmental Education in Indonesia

The Indonesian Environmental Management Act of 1982 mandates the government to use education to raise public awareness with regard to environmental management (Sudarmadi et al., 2001). Official guidelines for environmental education from 2004 focus on knowledge improvement and consciousness to preserve nature. They aim at changing behaviour via changing attitudes (Kementerian Lingkungan Hidup, 2004).

The national guidelines for the development of higher education demand the improvement of student abilities to use natural resources in a sustained manner (Direktorat Jenderal Pendidikan Tinggi, 2003). However, Indonesian Universities are only *advised* to integrate Education for Sustainable Development (ESD) into their curricula (Direktorat Jenderal Pendidikan Tinggi, pers. comm., 2010). The Indonesian

system of higher education does not, yet, provide training on more demanding ESD conceptions (Direktorat Jenderal Pendidikan Tinggi, pers. comm., 2010; Rudebjer & Del Catello, 1999).

The Indonesian Competency Based Curriculum (CBC) for primary and secondary education consists of two parts: a core curriculum and a local content curriculum. Environmental education is not an independent subject (Nomura, 2009). The local content curriculum provides schools with the opportunity to include locally relevant subjects, e.g., real-world environmental issues (Power & Cohen, 2005).

Socio-economic and institutional dimensions of natural resource utilisation do not play any major role in primary and secondary education. Instead, the official focus is on educational interventions aiming at influencing individual environmental action via changing individual values, perceptions, and attitudes (Kementerian Lingkungan Hidup, 2004; Direktorat Jenderal Pendidikan Tinggi, 2003).

According to the Indonesian guidelines for environmental education (Kementerian Lingkungan Hidup, 2004), a teacher should not only convey knowledge but also assume the role of a facilitator. Nevertheless, day-to-day school life and university education in Indonesia is still dominated by teacher lectures, note-taking, and rote learning (Thair & Treagust, 1997; Wahyudi & Treagust, 2004). This pattern is to this day wide-spread elsewhere in Southeast Asia (Lim, 2010). Particularly with regard to environmental commons dilemmas, which require political, administrative or grassroots action, a reliance on these methods is most unfortunate (cf. Kyburz-Graber, Hofer, & Wolfensberger, 2006).

The material resources to improve the situation within the educational system are highly scarce. This is particularly the case for universities located outside of Java – i.e., on the 'outer islands' –, which have limited resources and often low academic standards (Sutjipto, 2008). Among other impediments, an improvement of ESD in primary and secondary education is limited by too few teachers and inadequate teacher training (cf. Firman & Tola, 2008).

3.3 Theoretical Background

In this background section, we briefly review the concepts of prior knowledge and subjective theories. Prior knowledge is an essential learning prerequisite; its investigation offers valuable information for instruction (Dochy, De Ridjt, & Dyck, 2002). Based on prior knowledge, humans perceive the environment and the threats to it in distinct ways (de Young, 1999). In this study, we use the term 'prior knowledge' as defined by Jonassen and Grabowski (1993, p.417) as "[…] *the knowledge, skills, or ability that students bring to the learning process*." Prior knowledge includes both correct understandings of a certain knowledge object as well as incorrect understandings of it ('misconceptions'; Dochy et al., 2002). Misconceptions need to be identified to apply or design adapted teaching strategies (Abd-El-Khalick & Akerson, 2004).

The identification of subjective theories has proved to be useful in the field of education, learning, and instruction (Menzel & Bögeholz, 2009). Subjective theories are "[…] *complex aggregates of concepts whose structure and function is parallel to scientific theories […] and contain (cognitive) concepts which are connected in their argumentation structure, […] hence, 'subjective theories' are relatively stable mental structures"* (Groeben et al., 1988, p. 18). Concepts, in contrast, refer to terms rather abstractly and without complex relations (Groeben et al., 1988, p. 17f.).

In a broader sense, Groeben et al. (1998, p. 19) define subjective theories as (1) cognitions of the conception of the world, as (2) complex aggregates of (at least implicit) argumentation structures, as (3) having functions similar to scientific theories, and as (4) individual explanations and projections. Subjective theories are more complex than cognitions because subjective theories regularly include an argumentative structure. The argumentative structure consists of if-then relations that allow for drawing conclusions on the issue at hand (Dann, 1992, p.161). In this investigation, we are interested in subjective theories that organise university student beliefs regarding the causes and effects of intensive rattan extraction.

3.4 Rattan Extraction as an Environmental Commons Dilemma

In this section, the core attributes of environmental commons dilemmas are introduced. Next, we provide the necessary background on rattan extraction in Indonesia, and reconstruct rattan extraction as a commons dilemma. The section ends with a definition of the ecological, socio-economic and institutional knowledge necessary to understand the most important aspects of the local rattan extraction dilemma.

3.4.1 Environmental Commons Dilemmas

Environmental commons dilemmas describe situations in which individual and collective rationalities collide. While individual rationality tends to favour unrestrained resource exploitation, collective rationality suggests restrictions in favour of the long-term utilisation of the resource in favour of a larger group of resource users. This clash of rationalities contributes to environmental problems, such as depletion of non-timber forest resources, air-pollution or over-fishing (e.g. Dietz, Dolsak, Ostrom, & Stern, 2002).

Hardin (1968) gives a classical description of this clash of rationalities in his article "The tragedy of the commons". Consider a collectively owned village pasture to grow one's own sheep or cattle. From the perspective of a rational, narrowly self-interested individual, it appears as a promising strategy to appropriate as much as possible of the scare pasture biomass. While the profits from intensive utilisation of the pasture accrue completely to the individual via his/her animals, negative effects of grazing are borne by the whole community of pasture users. If such behaviour is widespread, it easily leads to over-exploitation and finally to a severe degradation of the pasture – with negative long-term effects for everyone. Consequently, group rationality would suggest that all individual animal owners restrict pasture use to sustainable levels.

This divergence between individual rationality and group rationality characterises common pool resources (cf. Schlager, 2004). With respect to the members of a group eligible to access a common pool resource, the resource has the characteristics of an open-access resource. This means that prospective users cannot be excluded from using a scarce resource.

Ernst (2008) reviewed commons dilemma situations from a psychological point of view. Summarizing work by other authors, he highlights the importance of a social trap, a temporal trap, and a spatial trap. The social trap focuses directly on the core of the commons dilemma: individual incentives for over-exploitation are at odds with social rationality. The temporal trap refers to the fact that negative consequences of today's action may only become visible in the long run or impacting future generations. Finally, the spatial trap describes situations in which the consequences of resource utilisation at a certain place affect individuals or groups elsewhere. Economists usually refer to consequences of human action that do not affect the actor negatively but someone else as negative externalities (Tullock, 2005).

In natural resource management, a paradigm shift took place during the past two decades. Formerly, resource managers regularly focused on government-centred approaches relying on formal regulations and state repression. This approach has often failed – and even contributed to environmental degradation itself (Schlager, 2004). In contrast, careful analyses of successful resource management showed that local, rather informal institutions[1] can be successful in governing common pool resources (Dietz, Ostrom, & Stern, 2003).

Thus, the focus is now on the specific conditions that foster sustainable resource management. For example, management regimes need to address the closely related issues of resource supply, user commitment, and monitoring (Ostrom, 1990, p.42ff.): Resource appropriators have to devise and adopt a set of rules, i.e. institutions, to coordinate their use of the resource within the limits set by the natural supply of the resource. Because there is often low commitment to these rules, effective monitoring (and sanctions) are needed. In turn, monitoring and general rule obedience feed back and further support commitment to resource management rules (Ostrom, 1990).

[1] In technical language, institutions are not organisations, they are "[…] *the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction*" (North, 1990, p.3).

3.4.2 Rattan Extraction

In Indonesia, 68% of the total population of about 245 million inhabitants (CIA, 2011) live in rural areas. Many rural inhabitants are agricultural smallholders who supplement household income by collecting non-timber forest products (NTFP). For example, NTFP are a main source of income for the poorest, land-constrained households around Lore Lindu National Park (LLNP), Central Sulawesi/Indonesia (Schwarze, Schippers, Weber, et al., 2007).

In Central Sulawesi, the climbing palm rattan is the most important NTFP. Intensive rattan extraction – mostly of the species *Calamus zollingeri* – began in Central Sulawesi in the 1980s. Rattan extraction has been discussed as a conservation problem for more than two decades (Bynum, 1999). Indonesia supplies about 90% of global rattan demand for the furniture industry; much of that rattan stems from Central Sulawesi. Usually, wild rattan stocks in primary forests are exploited (Dransfield & Manokaran, 1994). Without effective regulations in place, current rattan extraction rates exceed growth rates (cf. Siebert, 2004). If collectors continue current exploitation patterns, rattan stocks are likely to become severely degraded. First signs of over-exploitation can already be observed in the LLNP area (Gonzales, pers. comm., 2011).

Figure 1a shows a simplified causal network of intensive rattan extraction illustrating the commons dilemma character of the situation. In the figure, the nodes of the network are organised according to the DPSIR approach of the European Environmental Agency (EEA, 1999)[2]. Rural poverty and the lack of income alternatives for many households is the fundamental *driving force* of intensive rattan extraction. For the rattan stocks within LLNP, neither private nor community property rights are defined. At the same time neither the provincial forest police nor the national LLNP authorities enforce existing regulations on rattan extraction effectively. Because of the environmental *pressure* of intensive rattan extraction, rattan stocks decline. Certain endemic rattan species are threatened with extinction. This negative *state* results in negative ecological and socio-economical *impacts*. Ecologically, rattan species may actually become extinct.

[2] The DPSIR approach is an established tool used by the EEA and other environmental bodies to organise lists of environmental indicators. With a similar intention, we use the frame here for organising the most important elements of the reconstruction of the rattan extraction dilemma (Figure 1a) and of the respective subjective theories of the students (Figure 1b).

From a social-economic point of view, a loss of income opportunities results even without extinctions. As a further impact, social conflicts evident in violent clashes over illegal deforestation and agricultural encroachments into LLNP may worsen (see Dongi-Dongi incident below).

Within the DPSIR framework, these impacts induce a societal or administrative *response*. Elements for a solution to the rattan extraction dilemma include cooperative behaviour based in mutual agreements to reduce rattan collection. Local communities can often use prevailing – and sometimes revive – traditional institutions restricting resource extraction. Also property rights could be assigned to individuals or to communities that induce a more immediate interest in the continued commercial viability of rattan stocks. Educating rattan collectors with respect to non-destructive harvesting techniques and replanting of valuable rattan species can also contribute to an amelioration of the situation. In principle, the provincial system of rattan collection permits could be made more efficient including a more efficient monitoring of illicit and illegal rattan exports from the LLNP area.

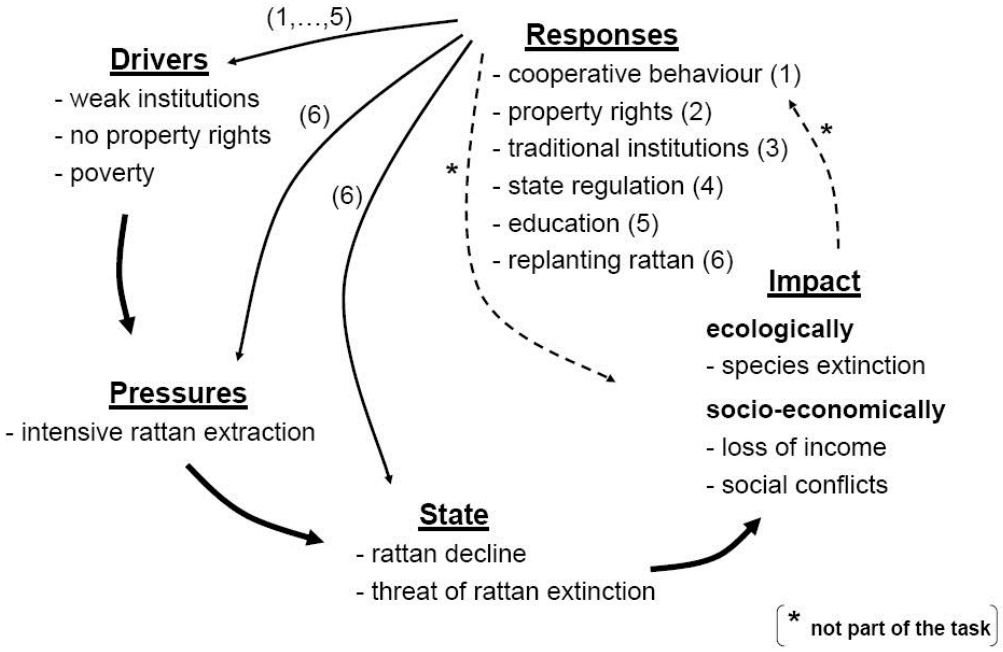

Figure 1a

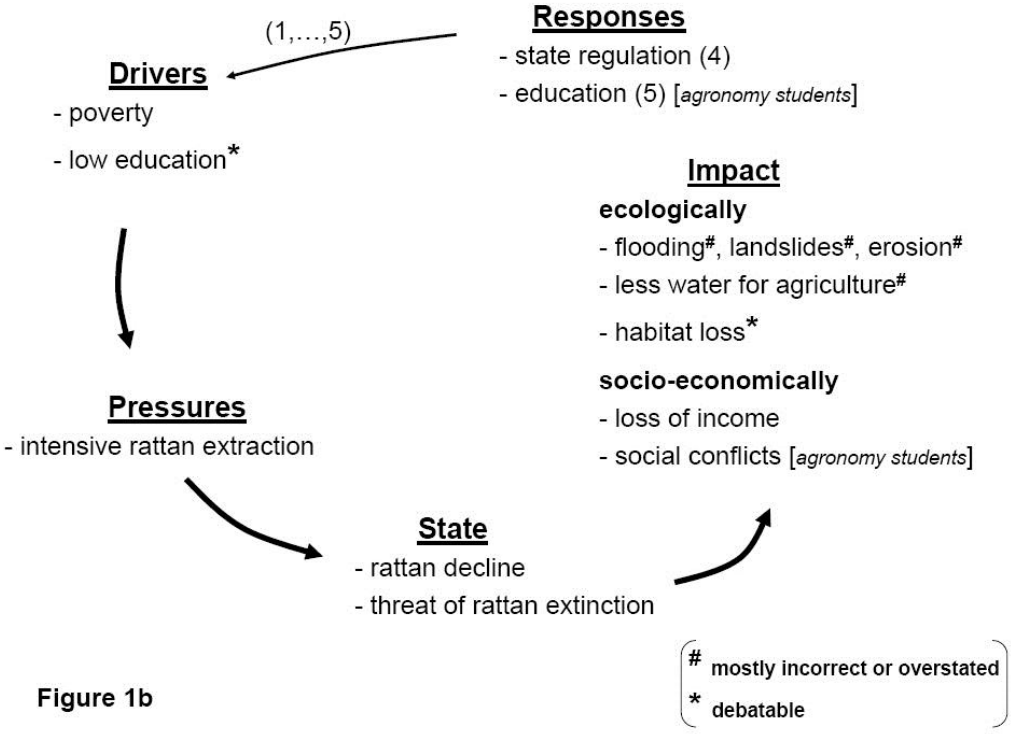

Figure 1b

Figure 1: (1a) DPSIR framework applied to intensive rattan extraction in Central Sulawesi; (1b) DPSIR framework applied for illustrating subjective theories of Indonesian University students on intensive rattan extraction in Central Sulawesi.

3.5 Research Questions

The present study examines the subjective theories of Indonesian agronomy and biology teacher students with respect to a representative local environmental commons dilemma, the rattan extraction dilemma. We address the following research questions:

- From which elements of prior knowledge do Indonesian agronomy and biology teacher students form their subjective theories?
- Which subjective theories do they hold regarding social, temporal and spatial traps regarding intensive rattan extraction?
- Which subjective theories regarding potential solution to the rattan extraction dilemma do they hold?

3.6 Data and Method

At Universitas Tadulako (UNTAD) in Palu, the province capital of Central Sulawesi, 20 qualitative, semi-structured in-depth interviews with agronomy and biology teacher students were carried out between May and June 2007. One participant did not finish the interview; thus, 19 interviews were analysed. Ten of the interviewees were biology teacher students (five female and male students each). Nine interviewees studied agronomy (four female, five male students). The biology teacher students were between their 2nd and 12th semester, and the agronomy students were between their 4th and 8th semester. The biology teacher students were between 18 and 24 years old; the agronomy students aged between 20 and 23 years.

Seventeen of the interviewees had completed courses in Environmental Analysis (Kajian Lingkungan Hidup, KLH) or in Environmental Science (Pengetahuan Lingkungan, PL). PL is an introductory course attended by all biology teacher students. PL shall facilitate basic knowledge on people, natural resources and the environment, on general aspects of ecosystems and ecology, and on nature conservation. A focus is on the conservation of tropical forests and water as well as on strategies for sustainable development such as the Agenda 21.

Thirteen students had already attended KLH, a course compulsory for agronomy and biology teacher students. According to the syllabus, KLH deals with the interaction between the environment and social development. Topics include environmental degradation, sustainable development, environmental management and its instruments. In addition, the course is designed to discuss human-environment interactions in Central Sulawesi, including agricultural, socio-cultural, economic and educational aspects. Part of KLH involves practical work on community development and resource conservation that often takes place in LLNP villages. Thus, more than half of the interviewees had been to the LLNP region; one student grew up in the region. Even interviewees who had not been to LLNP had already heard or read about the region. In particular, the Dongi-Dongi incident, during which ~1,300 ha of forested land inside LLNP were illegally cut in 2001(Adiwibowo, 2008), was well known. Three biology teacher students had taken part in private environmental protection activities organised by the 'Biology Conservation Club' (BCC).

Most of the biology teacher students stated that they wanted to become a teacher. Some of them expressed disillusionment about the 'book-focused' way they learned to teach. Of the agronomy students, several aspired to become a civil servant (Pegawai Negeri Sipil [PNS]) or wanted to become involved in agricultural extension.

Because this study was conducted in association with an Indonesian-German Collaborative Research Centre on the 'Stability of Rainforest Margins in Indonesia', established contacts to UNTAD university lecturers could be used to recruit interview participants. UNTAD lecturers from the Biology and Agronomy Departments invited all students of their courses to participate in the study. Typical for Indonesian university culture, nearly all students 'volunteered' to participate. The students entered their names into lists. Because more students volunteered than were feasible to interview, ten agronomy and ten biology teacher students were randomly chosen from the list. The selection yielded a nearly even distribution with regard to gender and years of study.

The interviews followed the problem centred interview approach (Witzel & Reiter, 2010) which uses semi-structured interview guides. In pre-study interviews, it had turned out that the university students knew very little about rattan extraction in the Central Sulawesi hinterlands of Palu. Thus, we crafted a short information text (Figure

2) that provides factual background for questions on the rattan extraction dilemma. At three instances, additional short textual stimuli were used to prompt comments on certain facets of the dilemma. In the analysis of the interviews, statements of the students that only repeat the information given in the handout were not considered as prior knowledge. For an overview of the sections of the interview, see Figure 3.

First, interviewees answered questions on their study background, motivations, career aspirations, and experiences in the LLNP region. Then, students were asked about their prior knowledge on local resource utilisation issues in general (research question 1). When an interviewee could not add anything on his/her own, the information text was handed out to stimulate the conversation. Subsequent questions focused specifically on rattan.

Intensive utilisation of Rattan

Rattan (Calamus sp.) is a type of palm tree of which the trunk can be used to produce furniture. There are 340 different species of Rattan. Rattan grows back after being harvested if the root of the plant stays; but this requires time. Depending on the quality of Rattan, growing back takes between 1 and 7 years.

Indonesia is the largest exporter of Rattan in the world. A few years ago, Rattan was harvested so intensively in Kalimantan that hardly any Rattan grows there today. Following the depletion of the Rattan resources in Kalimantan, Sulawesi has become Indonesia's largest current Rattan source.

The Lore Lindu National Park in Central-Sulawesi contains many indigenous Rattan species. By regulations, no Rattan collection is allowed in the park. However, reality looks different and a lot of farmers living close to the park collect Rattan illegally for daily usage and even for trading with companies in huge amounts. Controls and punishments by the forest police are not enough to stop most of the illegal collection.

Prior to the establishment of the national park, the land was divided into traditional areas. Each area had exclusive utilisation rights for the harvest of Rattan only near the margins of the park. Now that these rights have been removed everybody has (illegal) open access to the entire park.

The current open access situation means that each Rattan collector is in fierce competition with the other. Such competition means that Rattan collectors don't see any need to protect the existence of Rattan, because each collector assumes that somebody else will collect the Rattan instead. As a result, the collection of Rattan has tripled during this time of open access and the forest is being depleted of Rattan more and more.

The harvesting of Rattan is physically demanding and is carried out by many members of the population. However, the commercial cultivation of Rattan is not profitable, because it takes several years to grow it again. Besides this, Rattan has a very low international market price because of its illegal over-utilisation.

Figure 2: Information text on intensive rattan extraction in the Lore Lindu region.

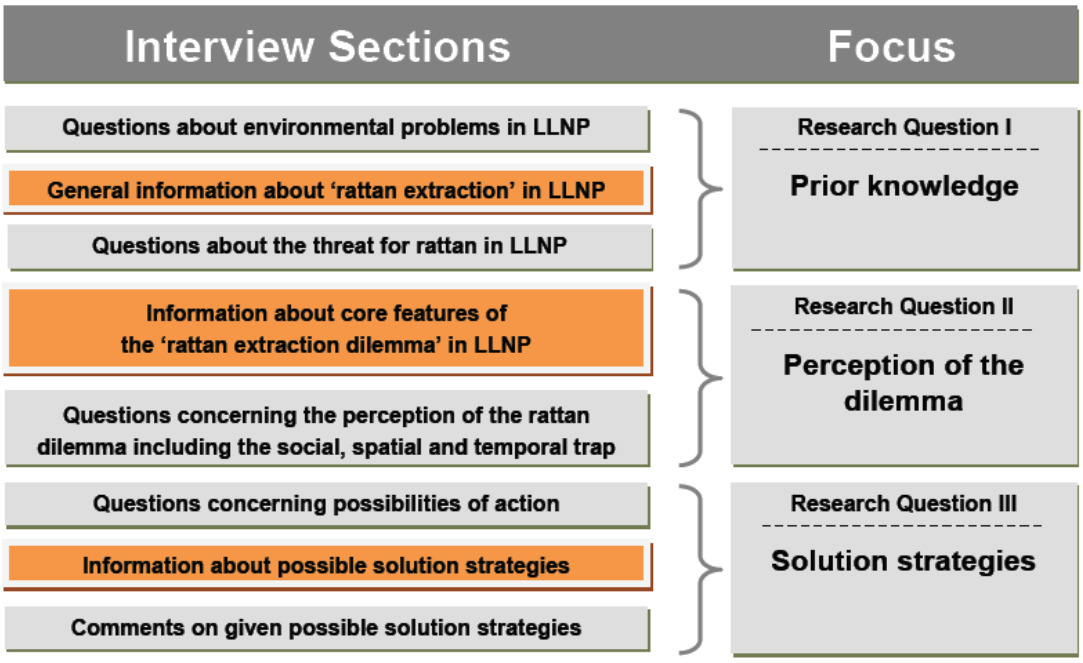

Figure 3: Overview of the interview procedure[3].

Next, the students were exposed to a short textual stimulus on poor rural households that need to collect rattan to make a living (research question 2). The rattan collectors have to walk to rattan stocks farther and farther away from their village. The price they are paid for the rattan does not improve, though. Here, we were interested in the question, if students were able to relate this description to the fiercely competitive rattan extraction on part of poor rattan collectors that (i) keeps prices low, and that (ii) results in dwindling stocks. Furthermore, the students were informed that an entire village community had decided to stop collecting rattan temporarily in order to let the rattan grow again. However, one villager had broken the rule and had secretly started collecting rattan again. This part of the stimulus addresses an institutional core aspect of the commons dilemma: Collective/community action is necessary to potentially solve the social trap situation but these actions are susceptible to social implementation challenges. To prompt comments on their perception of the situation, the university students were asked to imagine who was affected by this violation of the rules and how they were affected.

[3] The complete interview guideline is enclosed as appendix 1 (page 208ff). Questions 13 to 19 focus on research question 1. Questions 20 and 21 focus on research question 2. Given possible solution strategies regarding research question 3 can be found on page 219f.

Finally, in order to answer the third research question, an in-depth look was taken at potential solution strategies for the rattan over-extraction problem. After soliciting some first comments, the students were given a list of suggestions of solution strategies, and asked for comments (see page 219f).

All interviews were conducted in Indonesian supported by an Indonesian assistant. The interviews took from 90 to 120 minutes each and were recorded in full. Shortly after each interview, relevant outcomes and specifics of the interview situation were discussed with the Indonesian assistant and documented. Unclear parts of the interview or potential misunderstandings were immediately clarified. All interviews were transcribed and translated into English for final analysis.

Since we are interested in subjective theories with specific aspects of natural resource use problems, we applied Mayring's (2000) qualitative content analysis approach. A formal coding system was developed based on an interplay of inductive and deductive procedures. Each code was explicitly defined in a coding agenda with examples and coding rules (Mayring, 2000).

In order to ensure interrater-reliability (Miles & Huberman, 2004), a second independent researcher check coded the interviews. Disagreements were discussed and respective text passages were recoded until a consensus coding was achieved. Codings were summarised for each category and finally abstracted.

Following Menzel and Bögeholz (2009) we used 'subjective theories' as the analytical framework to examine the interviews. The interview material was analysed for agronomy and biology teacher students together. However, we mention noticeable differences in the results section.

3.7 Content Analysis Results

The content analysis is structured according to the three research questions. In each section, we identify subjective theories, include typical direct citations, and briefly summarise the findings if appropriate.

3.7.1 Subjective Theories on Rattan Extraction (Research Question 1)

Many students perceived rattan as important for the environmental stability of Central Sulawesi. They described rattan as a plant that absorbs water and protects the area against floods. Its roots protect against soil erosion. "*The function of rattan for the National Park might be water absorption; to protect the soil*" (Dedy S, 162-163)[4]. Thus, a disappearance of rattan will result in more frequent floods, erosion and landslides. These impacts will affect the whole society in the long-run; Susiati: "*Rattan is a species that has the same function as other plants such as the prevention of erosion and water storage, as well*" (149-151). Also water supply and biological diversity is thought to be affected negatively: "*[…] it will affect the biodiversity and the water supply around the Lore Lindu region"* (Fifin, 721-722).

Several interviewees stated that animal populations – of which some, according to the students, are identified as endemic to the Lore Lindu region – will decrease and lose their habitat as a result of uncontrolled deforestation – in part caused by intensive rattan extraction. In the end, rattan itself will become extinct. One student regarded rattan extinction as a loss of a bequest value: "*Our grandchildren, for example, will never know about rattan; about its shape. They will only know it from pictures*" (Fifin, 91-93).

The prior knowledge on the economic and socio-economic consequences of rattan extraction was limited to general statements on the dependency of local households on rattan as a source of income: "*they need it [rattan collection] to make a living*" (Wiwid, 133-134). The most elaborated statement was by Fifin: *For example, if there is no rattan, they will do illegal logging and take woods out of the forest […] they can use it [wood] as fire wood as well as sell it to Palu to earn some money for their daily needs"* (Fifin, 153-156).

[4] The numbers in brackets indicate the line numbers in the original transcript.

Most students recognised that if rattan disappears, the households depending on rattan have to look for alternative sources of income. Several students believed that such sources of income (planting rice or cacao, fishing, converting new land for agriculture) would be readily available.

The general discussion of rattan extraction already prompted some considerations on social and spatial traps. Some students were aware that floods and landslides affect not only those who are involved in forest conversion but also other community members. Likewise, they believe that forest conversion results in reduced water availability for agriculture, specifically for paddy rice production. In consequence, local productivity decreases. The possibility of emerging social conflicts was pointed out by some students, especially agronomy interviewees, if income from rattan extraction dwindles.

Low education was identified as a particular problem in the area. Agronomy students, for example, stated: "*The knowledge of the people in such an area is generally low*" (Ferlina, 370-371). "*There are not only environmental problems but also educational problems*" (Wiwid, 271-272). Several students think that the local population is not able to utilise the available resources properly, e.g., local smallholders were ignorant about useful plants such as corn. In addition, most students think that the local population does not have an understanding of ecosystem interrelations and, moreover, is not educated about the national park and its function.

3.7.2 Subjective Theories on the Social, Temporal and Spatial Trap (Research Question 2)

Subjective Theories on Social Traps

Most students recognised that rattan is an important source of income, while intensive rattan collection is a threat for collectors' livelihoods because intensive collection damages the forest ecosystem – which will cause natural disasters. If rattan or other forest products disappear near one village, the villagers will move to other places near other villages to collect forest products.

Most students identified a free-rider situation and its inherent problems when prompted by the textual stimulus: "*One person breaks the rules and other persons will follow if there are no*

further control mechanisms" (Ahmad S, 399-400). Consequently, people would collect rattan, although they had agreed to local rules and regulations to the contrary.

The students picked and repeated much information from the provided texts. In most cases, however, they did not indentify the underlying socio-economic and institutional structures that were described. For example, the first information text had already included a clear hint to the competitive pressures in open access rattan collection (Figure 2). Still, only a few students directly picked up this hint: "*All collectors compete with each other and harvest as much as possible; in the end rattan will disappear*" (Rahmat, 198-200). Most importantly, several main aspects of the social trap are only mentioned by a few students, such as Adriani, although strongly suggested in the text: "*The person who collects forest products only thinks about him and not about the interest of all the people*" (Adriani, 374-376).

Subjective Theories on Temporal Traps

Some of the university students recognised a temporal trap concerning possible effects of intensive forest resource extraction. Rattan harvesting or deforestation – as the students explained – leads to natural disasters that may impact future generations: "*For example if we cut trees off now, there won't be any flood. But flooding will happen in the next couple of years. If we take rattan now, our grandson will get the effect, not us*" (Budiman, 293-296). In a similar manner, several interviewees added that the rural population does not realise the effects of its actions. They would act only considering immediate positive impacts today without thinking about the future.

Subjective Theories on Spatial Traps

The predominant subjective theories on spatial traps comprised two major aspects. First, natural disasters, for instance floods, landslides or erosion, might result from intensive rattan extraction. Second, if such natural disasters occurred, the whole community would be negatively affected. "*There is a dilemma concerning rattan collection here because rattan is the main source of income for me [as a villager], however, it is a threat not only for me but also for other villagers since forest degradation causes natural disasters*" (Darma, 346-348).

In general, people will be affected by the occurrence of natural disasters even if they do not collect forest products such as rattan, most biology teacher and agronomy students held. They were not able to explain possible linkages at any detail.

Misconceptions and Deficits

The interviewed students appear to possess seemingly elaborated subjective theories on the rattan extraction dilemma (see figure 1b). Unfortunately, several of the included elements of the subjective theories are based on misconceptions.

First of all, students think that ecological effects of rattan extraction are mostly identical to those effectuated by deforestation. Deforestation effects may indeed include an increased frequency and intensity of landslides, erosion and flooding. Even if a few forest trees are cut in rattan extraction, the actual impact of rattan extraction on forest structure is very small. In this respect, rattan extraction is not similar to deforestation. Second, several students did not see that the need to look for rattan extraction sites deeper in the forest (and deeper into LLNP) is a direct result of over-exploitation in village proximity: "*I think [the distance is far] because the distance between their houses and the area with plenty of rattan is far. That's what I first thought, that it was not near*" (Wulan, 366-369).

Furthermore, it was difficult for many students to recognise the social trap aspect. Asked who was disadvantaged by a single offender against a community consensus not to collect rattan, several interviewees argued that the offender is at a disadvantage. "*The farmers who collect rattan will be affected by themselves; if they get caught, they will get punished* (Afdalia, 326-330). Negative effects on the community are not recognized: "*I'm confused how the people who do not collect rattan will be affected*" (Ahmad S, 396). The social trap-like structure that most students actually identified related to the alleged but absent impact of rattan extraction on landslides, flooding and erosion.

3.7.3 Subjective Theories Regarding Solution Strategies (Research Question 3)

In order to use rattan sustainably, interviewees most commonly called for state regulations (see figure 1b). Most students mentioned that the Indonesian government should strictly implement laws on rattan collection: "*The government has to be more strict about prohibitions, punishments, penalties and has to make the community be more aware of how to protect rattan […] but it won't be effective without being accompanied by punishments*" (Afdalia, 402-404 & 503-504). Likewise, the forest police staff should also be more strict and diligent in carrying out their duties – e.g., not take bribes. In addition to more effective state repression, some of the students called for new jobs or additional agricultural land for the rattan collectors.

Some university students emphasised that the traditional law (*hukum adat*) and the council of traditional leaders (*Lembaga Adat*) have much power in remote areas such as the LLNP region. However, *adat* institutions were not considered to be potential key factors for a solution: "*I don't think a clear explanation by the Lembaga Adat will be enough to solve this problem*" (Wiwid, 476-477). "*If somebody is found guilty and the head of Lembaga Adat is his relative, the punishment will not be strict; or the head of Lembaga Adat himself collects rattan illegally*" (Afdalia, 541-543).

With regard to the educational sector, several students highlighted the importance of education for the village population (see figure 1b): "*We should give the people an understanding about the importance of the environment […] so they will know that the environment is precious for their life and for sustaining their life*" (Ayu, 200-204). Concerning improvements to environmental education, the students suggested to integrate 'practical learning' into university and school curricula to foster sustainable resource management.

3.8 Discussion and Implications

We reconstructed subjective theories of 19 agronomy and biology teacher students from a Universitas Tadulako, Palu (Central Sulawesi, Indonesia) on a locally relevant environmental commons dilemma. Via a comparison of the subjective theories with

scientifically accepted views on the causes and potential solution strategies for such dilemmas, we hope to identify starting points for improvements in environmental education in Indonesia.

With respect to our first research question on prior knowledge, the interview material indicates massive knowledge gaps. Prior ecological knowledge as well as prior socio-economic knowledge on the impacts of rattan extraction is low. Predominant subjective theories feature poverty and the relatively low educational level in Central Sulawesi's LLNP region as driving forces of intensive rattan extraction (pressure). Further effects frequently included in the subjective theories are a decline in rattan stocks, and potentially rattan species extinction (state; see figure 1b).

Concerning ecological impacts, flooding, landslides or soil erosion were – erroneously – believed to be caused by rattan extraction. The result is a hybrid concept in the sense of Vosniadou & Brewer (1992): The students knew which effects are commonly related to one type of forest resource utilisation, namely to deforestation by logging or agricultural forest conversion. Then they applied this knowledge to the utilisation of the non-timber forest resource rattan, which does not lead to deforestation, however.

Regarding socio-economic impacts, most students recognised the dependency of the local population on natural resources such as rattan, and even saw the possibility of emerging social conflicts if rattan became very scarce. In combination with beliefs that the local population was largely uneducated, some students have overstated the availability of income alternatives such as the cultivation of cacao or paddy rice. Agriculture requires land but it is mostly the poorest, already land-constrained households that engage in the toil of rattan extraction.

Given the fact that nearly all students had been to the LLNP area for practical training or had at least heard of the region, and that Palu and UNTAD are located only a few dozen kilometres from one of the main international rattan extraction regions, knowledge on rattan, rattan extraction and its problems was very low. Most likely, rattan extraction is seen only as a minor resource management issue compared to deforestation in Central Sulawesi. Consequently, rattan extraction is neither addressed in school nor in university curricula.

Reflecting national guidelines for environmental education as well as higher education, the PL and KLH courses include resource management and sustainable development topics. Providing substantial factual information on rattan extraction during the interviews (see figure 2), gave students an opportunity to relate prior knowledge on other resource management issues to the rattan case. However, this transfer was only partly successful. The importance of rattan extraction for the generation of income was clearly understood, also that rattan over-extraction can lead to a loss of biodiversity. Regarding ecological impacts, several hybrid concepts (misconceptions) were formed, however. Furthermore, there was no evidence that the information text prompted the activation of tacit prior knowledge regarding the commons dilemma characteristics of rattan extraction. This result was obtained although the KLH syllabus explicitly includes local resource management issues.

An understanding of the institutional dimension of the dilemma was largely absent (research question 2). Some students emphasised aspects of the temporal trap as over-exploitation of natural resources may result in problems later on. Aspects of the social trap were identified only with regard to the misconception that rattan extraction results in erosion and flooding – resulting in incongruence between advantaged and disadvantages individuals. The social trap at the core of commons dilemmas, i.e., the need to institutionally balance short-term individual exploitation profits with long-term and community interests in the preservation of a productive resource stock, was not recognised at all.

Subjective theories concerning potential solutions (research question 3) were mostly restricted to state regulations and more education. Solutions based on institutional economics insights into commons dilemmas were not mentioned (see figure 1b). If governance is "weak" – as frequently encountered in rural Indonesia –, citizens should demand better professional performance by the police or other state administrations. Still, strengthening of cooperative behaviour, e.g., based on traditional village rules, or the introduction of individual or community property rights in rattan stocks are also important potential solutions. These solutions are likely to induce local, de-centralised interest in the sustainable utilisation of the resource. Particularly under the conditions of weak governance, such solutions are often more appropriate (cf. Dietz, Ostrom, & Stern, 2003). In sum, student subjective theories appear as severely limited with respect

to solution strategies. In fact, this result could be expected as adequate subjective theories on the social trap at the core of the commons dilemma were also absent.

Our study is based on a small sample of students from one Indonesian university located in one of the Indonesian outer island provinces. Thus, we cannot make statements on the general state of environmental education at Indonesian universities. A number of previous results from high-school and university students support the conclusion, however, that there is a deficit in educational practices regarding core issues of local, contextualised commons dilemmas.

Our study, for example, corroborates results by Menzel and Bögeholz (2009) who found that subjective theories of Chilean high-school students on real-world commons dilemmas (collection of the NTFP Boldo) were very restricted, particularly regarding socio-economic dimensions of the problem. The same result was found by Dervisoglu et al. (2009) for high-school students in Turkey regarding the wild collection of wild Salep. Likewise, Tuncer's (2008) quantitative survey showed that Turkish university students did not have a sufficient background concerning issues of sustainable development.

One of the major problems concerning education on sustainable development is a focus on ecological knowledge in teaching (cf. Menzel & Bögeholz, 2009). For example, Hsu and Roth (1998) highlighted that environmental education of secondary teachers in Taiwan focused on ecological knowledge and awareness-raising. As a point in case, the concept of sustainable development is mostly taught in natural sciences. Thus, socio-economic, institutional or political aspects are rarely included (cf. Lindemann-Matthies, Constantinou, Junge, et al., 2009). Esa (2010) analysed a sample of pre-service teachers in Malaysia and found good environmental knowledge only at the level of declarative knowledge regarding definitions for concepts such as 'the greenhouse effect', 'the ozone layer' or 'sustainable development'. Particularly with the biology students in our sample, a similar tendency was clearly present. The agriculture students incorporated slightly more socio-economic elements into their subjective theories (see figure 1b). Finally, first results of a quantitative study with students from Agricultural University Bogor (Java/Indonesia) indicate that ecological knowledge on natural resource management issues is higher than socio-economic and institutional knowledge (Koch et al., *under*

revision). The above cited studies suggest that deficits in prior knowledge as described in this paper are likely to be widespread.

Indonesia strives to include environmental education in its curricula. Based on the above discussion, we fear that future multipliers of environmental education in Indonesia are insufficiently prepared to face a highly important set of local resource management dilemmas. This fear is supported by the fact that only the integration of rather general environmental education and ESD topics into the official curricula is progressing. The principles in environmental education in Indonesia itself are – at present – based on teaching ecological knowledge (Soerjarni, 1998, cited in Sudarmati et al., 2001; Kementerian Lingkungan Hidup, 2004).

The results of our case study highlight that an exclusive focus on ecological knowledge is misguided. Ecological knowledge does not foster the understanding of the institutional and socio-economic structure of commons dilemmas. Without appropriate subjective theories themselves, educational multipliers will not be able, however, to equip their future students with the skills to solve real-world resource use dilemmas. This task is particularly urgent in rural biodiversity 'hotspot' areas with an active colonisation frontier such as commonly encountered in Indonesia, e.g. in Central Sulawesi.

Improvements may have to overcome deeply rooted structures in the Indonesian educational system. For example, deficits in student knowledge reflect deficits in primary and secondary education. Teacher-centred approaches dominate science education in developing and emerging countries such as Indonesia. Teachers have absolute authority, and only little time is devoted to questioning or discussion (Lim, 2010; Wahyudi & Treagust, 2004). Furthermore, poor quality of teaching, inadequate textbooks and a low standard of post-secondary institutions such as vocational schools, colleges and universities are widespread. In part, these problems must be explained by the low per capita spending in education in Indonesia, which has traditionally been one of the lowest in Asia and Oceania (Tobing, 2003).

A number of strategies can be used to improve higher education regarding environmental commons dilemmas in Indonesia and elsewhere. First, fostering the cognitive competencies to analyse and – if possible – solve environmental commons

dilemmas should be a prime task of environmental education and biodiversity education. An understanding of the institutional core issues of resource management dilemmas in open access situations requires factual knowledge beyond striving for a 'balanced view' of the social, economic, and environmental dimensions of sustainable development (cf. Vargas, 2000; Kyburz-Graber et al., 2006). Particularly, students need to learn about the underlying socio-economic mechanisms as well as about the institutional restrictions to individual action. The educational system of biodiversity-rich countries with a rural population relying on natural resources should urgently reconsider the training of their future decision-makers and educational multipliers in this respect. Otherwise, it will be difficult to successfully implement sustainable resource management regimes.

Environmental education should be tailored to local issues and, in line with sustainability concerns, consider local cultural contexts (cf. Glasson, Mhango, Phiri, & Lanier, 2010; Vargas, 2000). Addressing real-life human environment interactions should be an essential (Kyburz-Graber et al., 2006; Pearson, Honeywood, & O'Toole, 2005). Such active science approaches could enhance the personal capacity of students to think critically and systematically (Kusmawan, O'Toole, Reynolds, & Bourke, 2009). As conflicts between local communities and state or provincial administrations over natural resources are frequent, such conflicts could be analysed (Saberwal & Kothari, 1996). Furthermore, teacher students could generate local and socially relevant knowledge themselves to look for potential solutions that balance conservation efforts and human needs (Corney, 2006).

Thus, we argue for educational interventions that promote the understanding of real-world commons dilemmas, e.g., using interdisciplinary case study projects on locally relevant resource use dilemmas. Such real-world case studies are ideal to foster the flexible application of textbook knowledge (cf. Cognitive Flexibility Theory; Spiro et al., 2003). If real-world case studies cannot be integrated into a programme, working with a number of contextualised, authentic descriptions of real-world commons dilemmas may be an alternative.

Identifying und understanding commons dilemmas in local real-world situations is crucial for teaching and learning in biodiversity education and ESD. Fostering the

acquisition of the respective skills and cognitive competences has implications on the development of curricula for all disciplines involved in development and conservation. Ultimately, stakeholders need to be enabled to interact effectively with their peers and with policy makers (cf. Clark, 2001). This requires a more applied, more cross-disciplinary curriculum development that highlights ecology-society linkages including environmental commons dilemmas.

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CHAPTER 4:
University Students' Perceptions of Common-Resource Dilemmas – The Need for Adjusted Curriculum in Indonesia

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Sebastian Koch[1], Jan Barkmann[2], Leti Sundawati[3] & Susanne Bögeholz[1]

[1] *Albrecht-von-Haller Institute for Plant Sciences, Biology Education, Georg-August-Universität Göttingen, Germany*

[2] *Department of Agricultural Economics and Rural Development, Environmental and Resource Economics, Georg-August-Universität Göttingen, Germany*

[3] *Faculty of Forestry, Department of Forest Management, Institut Pertanian Bogor (IPB), Indonesia*

Abstract

Many of Indonesia's forest resources are degraded by over-utilisation due to *de facto* resources that are common property in the open-access areas. Consequences include social, economic, ecological, cultural as well as worldwide repercussions on resource degradation. The purpose of this study is to examine the pre-concepts of Indonesian biology teacher students and agronomy students on local resource conservation issues – overexploited common-resource dilemmas in Central Sulawesi, especially of the non-timber forest product, rattan. Nineteen future teachers and agricultural advisors at Tadulako University were interviewed. Qualitative results showed that students' pre-conceptions of resource depletion of rattan use were widely erroneous. Socio-economic impacts of over-exploitation on rural livelihoods were also not emphasised. The students do not recognise the need to balance short-term individual exploitation benefits with long-term community interests in resource conservation. Education is a long-term solution to solve this common-resource situation (in open-access situations) in order to ensure sustainable long-term resource utilisation. We conclude that socio-economic and institutional aspects of rural forest use need to be stressed in adjusted curricula development.

Keywords: education, natural resource, common resource, sustainable, Indonesia

4.1 Introduction

Indonesia has the world's third largest tropical rainforests (FAO, 2006) but is responsible for two-thirds of forest loss in South and Southeast Asia (Achard *et al.*, 2002). Its deforestation rate at 2.0% per annum is also one of the highest worldwide. Over-exploitation of forest products, expansion and intensification of agriculture by smallholders, expansion of industrial agriculture, commercial lumbering and international oil and gas operations contribute to the high rate of deforestation (Butler & Laurence, 2008). The importance of the non-industrial, individual appropriation of forest land and forest products suggest that the solution to biodiversity loss points to a substantial local factor.

Common-resource dilemmas are characterised by the use of an accessible natural resource (limited) by competing users (Musgrave & Musgrave, 1984). Short-term incentives exist that prompt the single users to seek the advantages of exploitative resource use. Hardin (1968) highlighted that such competition often leads to an over-exploitation of the resource that could principally be avoided. Environmental psychologists explain the apparent irrationality of resource over-exploitation with three so-called *traps;* the social trap, the temporal (or time delay) trap, and the spatial trap. The *social trap* (Platt, 1973) focuses on the unequally distributed costs and benefits of resource appropriation. The benefits of resource appropriation accrue to the individual while the costs are borne by the whole community. The *time delay trap* (Messick & McClelland, 1983) refers to the fact that some of the consequences of today's action – such a sudden breakdown of a resource stock following excessive resource extraction – may manifest themselves in the future only. Finally, the *spatial trap* (Vlek & Keren, 1992) describes situations in which the consequences of actions at a certain place affect other people or groups elsewhere. For example, the rattan over-exploitation dilemma (cf. Siebert, 2004) in the open-access Lore Lindu region, Central Sulawesi has negative consequences for the community; the social trap where the individual users benefit solely from the selling of rattan; the time trap as these exploitation leads to rattan loss; the spatial trap where other groups of individuals are affected by the decreasing rattan resources.

Solutions to such common-resource dilemmas cannot rely on the actions of individual users alone. Institutional changes should include governmental regulations (e.g. hunting bans, assignment of property rights), binding voluntary commitments (*Community Conservation Agreements)*, effective recourse to generally accepted traditions of resource use, or the introduction of economic incentives (Ostrom, 1990; Ostrom *et al.*, 2002). However, these changes require a strong government backing to enforce these regulations and commitments.

Indonesia is a member of the Convention on Biological Diversity (CBD) (UNCED, 1992). Article 13 of the CBD requests that all signatory countries to distribute information and raise public awareness about the importance of biological diversity (UNESCO, 2005). Many reports (e.g. Gordon, 1954; Edney & Harper; 1978; Ernst, 2008) suggest strong institutions, an educational system and personal capacity to propose potential solutions to the loss of biodiversity. However, there are indications the respective competences are lacking.

In particular, little is known about the knowledge of environmental issues in Indonesia, especially its future educational multipliers (Sudarmadi *et al.*, 2001). Multipliers of an *education for sustainable development* (ESD) need integrated knowledge and competences on the economic, ecological, social and institutional factors that shape the complexity of the utilisation and degradation of natural resources (Kassas, 2002). Hence, students graduating from universities are likely to become educational multipliers or key decision makers (Wong, 2001) and thus, likely to have a decisive impact upon the development of natural resources in the future (Wallis & Laurenson, 2004).

Stagnancy of the Indonesian educational system (including tertiary education) on uses of natural resources has already been noted a decade ago (Rudebjer & Del Castillo, 1999). Higher education needs to educate learners of the need to use natural resources in a sustainable manner (General Directorate of Higher Education, 2003). It is not surprising that single concepts of ESD are included only occasionally in the curriculum (Supriatna, 2007). Currently, Environmental Education is not an independent subject at primary and secondary education; it is integrated into existing subjects (Nomura, 2009). At the university level, natural resource management is provided in undergraduate courses only in some programmes. For example, University of Indonesia (UI) and Institut Pertanian

Bogor (IPB), include environmental education components only in the graduate courses. In addition, teacher colleges only attempt to include environmental components in their training (Nomura, 2009).

The purpose of this study is to examine the pre-concepts of Indonesian biology teacher students and agronomy students on local resource conservation issues – overexploited common-resource dilemmas in Central Sulawesi, especially of the non-timbre forest product rattan. The research questions are: (i) How do students perceive the common-resource dilemma situation concerning intensive rattan extraction in the Lore Lindu region? (ii) Which of the courses of action do the students envision to solve the dilemma? and (iii) What kinds of knowledge should future environmental educators and decision makers in relevant fields of natural resource management possess, concerning common-resource dilemmas?

4.2 Data Collection and Methods

Nineteen problem-centred in-depth interviews (Witzel & Reiter, 2010) were conducted with agronomy and biology teacher students from Universitas Tadulako, Palu, Central Sulawesi. The interview guide was based on extensive consultations with local and international experts on resource use issues in Central Sulawesi, and included short interventional materials on several aspects of rattan utilisation. It operationalised values, risks and coping appraisal constructs from Protection Motivation Theory (Rogers & Prentice-Dunn, 1997). Responses were analysed following qualitative content analysis (Mayring 2000), and coded with MaxQDA. To verify the inter-subjectivity of coding, check-coding was conducted by a second researcher.

4.3 Results

Qualitative results of the interview reported all participants recognised government action was rarely a sufficient means to solve the common-resource dilemma. However,

most participants reported government actions were still one of the key factors to solve the dilemma.

Findings of this study also indicated that participants did not have prior knowledge of the ecological and socio-economic problems of rattan extraction. Most cited exclusively ecological, and often largely irrelevant problems of rattan extraction. While the majority of the participants referred to a loss of the resource, only a few mentioned the consequences for future generations. Socio-economic impacts on living conditions of the local population were also not emphasised. Participants did not recognise the need to balance short-term individual exploitation profits with long-term community interests in the resource conservation.

When asked what the courses of action to improve the implementation of ESD in the university curricula should be, participants only highlighted the need to integrate 'practical learning' (e.g. field practicals). There was no mention of any need to identify how the local population was dependent on the resource use, nor was there any suggestion on ways to help the people to be less dependent on the common resource.

A model to examine 'knowledge'

Based on De Jong & Ferguson-Hessler (1996), a knowledge model (Fig. 1) concerning common-resource dilemmas was used to understand the factors contributing to open-access situations. The model involves three types of knowledge (situational, conceptual and procedural) in the knowledge domains; (i) ecological knowledge, (ii) socio-economic knowledge, and (iii) institutional knowledge. Situational knowledge covers information that has to be screened from a certain problem description. Conceptual knowledge comprises additional knowledge beyond information scrapped from the problem description. The additional knowledge has to be integrated with the problem situation in order to classify the specific type of problem – this helps in recognising an open-access resource use problem. Based on the problem description, procedural knowledge accomplishes the transition from one problem state to another state, e.g. a state that allows for the identification of potential solutions.

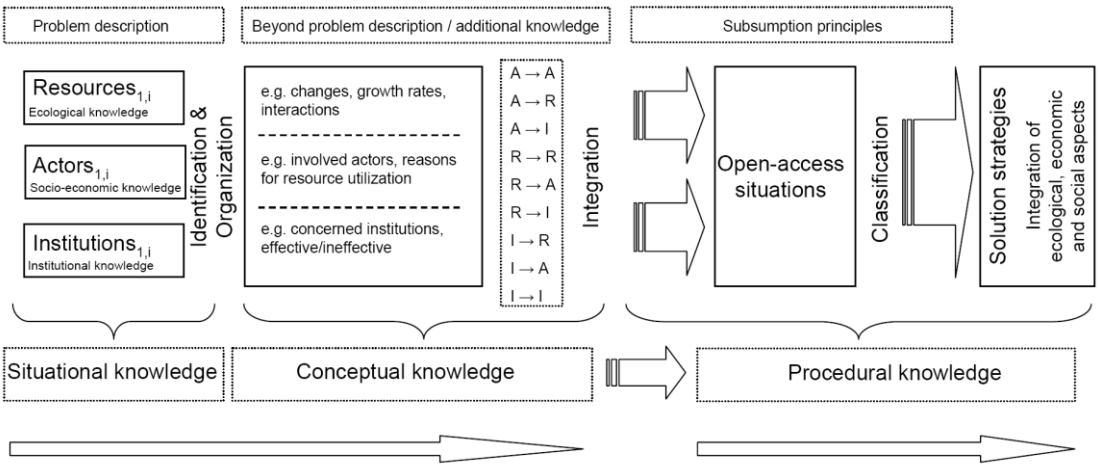

Figure 1. Knowledge model concerning common-resource dilemmas.

4.4 Discussion

This study shows that a comprehensive understanding of ecological, economic, social, and institutional interrelation hardly exists. The future educators and advisors lack the needed competencies themselves. The qualitative results suggest that a more applied cross-disciplinary curriculum development that highlights ecology-society linkages (Menzel & Bögeholz, 2009) and natural resource depletion is necessary. For example, environmental education curriculum needs to evolve towards more interdisciplinary ESD (Fien & Tilbury, 2002). In addition, fostering of knowledge in each of the knowledge domains (i) ecological knowledge, (ii) socio-economic knowledge, and (iii) institutional knowledge is of major importance, to deal with common-resource dilemmas adequately.

In conclusion, the findings reveal a knowledge gap on the consequences of common-resource dilemmas. Consequences of this knowledge gap include social, economic, ecological, cultural as well as worldwide repercussions on resource degradation. Education is a long-term solution to solve this common-resource situation (in open-access situations) in order to ensure a more sustainable long-term resource utilisation. All students need to eventually acquire the knowledge of these consequences on forest resource utilisation and perhaps, come up with sustainable solutions.

Therefore, the education curriculum should be tailored to include current local issues reporting on sustainability concerns. In addition, it would be best to allow students to interact with affected stakeholders and policy makers for authentic case studies (Clark, 2001). In this way, learners are educated on local and socially relevant knowledge and would hopefully be able to explore adequate measures to balance human needs and conservation efforts. It is a concern that traditional teaching methods are still predominant in much of Southeast Asia (Lim, 2010; Wahyudi & Treagust, 2004). Therefore, once the adjusted curriculum is in place in the Indonesian education system, the next step is an adjustment of educators' teaching methodology.

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CHAPTER 5:
Biodiversity and Sustainable Development Education: A Lack of Socio-economic and Institutional Perspectives

Manuscript prepared for submission

Sebastian Koch[1], Jan Barkmann[2] & Susanne Bögeholz[1]

[1]Albrecht-von-Haller Institute for Plant Sciences, Biology Education, Georg-August-Universität Göttingen, Waldweg 26, 37073 Göttingen, Germany

[2]Department of Agricultural Economics and Rural Development, Environmental and Resource Economics, Georg-August-Universität Göttingen, Platz der Göttinger Sieben 5, 37073 Göttingen, Germany

Fostering the sustainable utilization and the conservation of biological diversity has been a globally stated political goal for at least two decades. Chapter 36 of the Agenda 21 and Article 13 of the Convention on Biological Diversity (CBD) see education as a central instrument for conservation success. Because of the importance of education for sustainable development, the United Nations proclaimed the years 2005-2014 as the "UN Decade of Education for Sustainable Development" (DESD; UNESCO 2006). Halfway through DESD, it has become clear, however, that the 2010 targets for halting biodiversity loss were missed (Secretariat of the CBD 2010). In this communication, we claim that biodiversity education and education for sustainable development suffer from a lack of socio-economic and institutional perspectives: (i) Recent policy documents ignore crucial knowledge on the socio-economic and institutional dimensions of biodiversity conservation and related resource use issues, (ii) several empirical studies suggest that high school student knowledge in this area is low (Menzel and Bögeholz 2009; Dervişoğlu et al. 2009; Koch et al. under revision), (iii) a finding for which we provide additional original data here from Indonesian university students. Indonesia is a tropical low-income country with several global biodiversity 'hotspots', i.e. areas rich in endemic species threatened by habitat loss (Myers et al. 2000).

It is one of the explicit tasks of the DESD to promote values and lifestyles that facilitate a societal transformation to a 'sustainable' future. It is well known that ecological textbook knowledge hardly influences pro-environmental action (cf. Bögeholz 2006). Knowing the definition of 'ecosystem' neither helps a low income country smallholder nor a high income country consumer in making more ecologically benign production or consumption choices. In contrast, specific knowledge necessary to judge a conservation problem at hand does influence pro-conservation choices (e.g., Barkmann and Zschiegner 2010). Do the current official curricula and educational frameworks equip learners facing the biodiversity crisis with the right type of knowledge?

For one important facet of the answer, we need to look at the theory of public goods (Musgrave & Musgrave 1984). Consider the enjoyment in knowing that a certain set of species or ecosystems continues to exist. Environmental economists call this the 'existence value' of biodiversity. Regarding its existence value, biodiversity has one characteristic defining of a public good - *non-excludability* – because no-one can be

excluded from this enjoyment. As a consequence, market forces do not conserve biodiversity well. A particularly problematic case are biological resources that are non-excludable but where exploitation tends to degrade the resource (subtractability). Examples include the conversion of pristine ecosystems for which there are no effective land titles, or exploitation of timber or non-timber forest resources which are not effectively regulated. These goods are called open access goods.

The appropriation of open access goods is often characterized by an incongruity between resource appropriators and those burdened with the negative impacts of a specific resource use. For example, spiritual and educational biodiversity benefits of biodiversity are often accrued by individuals in high-income countries while the costs of conservation are born by local communities in low-income countries in the form of forgone agricultural income (Bawa et al. 2004; Balmford and Whitten 2003). Likewise, the benefits of physical biodiversity utilization and ecosystem conversion are regularly exploited by some local individuals with preferential access while less competitive individuals lose out. Any attempt to improve the situation will have to face the socio-economic dilemmas regarding the sustainable utilization and conservation of public goods.

Without accompanying changes in the institutional setting of the dilemmas, solutions are unlikely to be forthcoming. In institutional economics terms, institutions are not merely organizations. Institution is defined as "*the rules of the game in a society*", technically they are defined as the "*humanly devised constraints that shape human interaction*" (North 1990:3). In the past twenty years, four Nobel Memorial Prizes in economics were awarded to researchers in the field of institutional economics: Ronald Coase (1991), Douglass C. North (1993), and - most recently - Elinor Ostrom and Oliver Williamson in 2009. Among the priority issues analyzed is the question under which circumstances individuals either tend to save or tend to degrade a public good such as biological diversity.

Consequently, local as well as national and international discourses on biodiversity conservation focus much on the relative merits of different instruments affecting the institutional setting. Among the instruments are additional legal action, intensified monitoring, tax or incentive schemes, village conservation agreements, educational

programs, etc.. For any of these instruments, an informed citizenry needs a functional understanding of the socio-economic mechanisms and institutional restrictions that influence individual choices in situations of resource scarcity and resource use conflicts (cf. Sadler et al. 2007).

Unfortunately, a critical deficit exists here in most educational frameworks for an 'Education for Sustainable Development' (ESD), most notably in the official 'International Implementation Scheme' for the DESD (UNESCO 2006). At the level of problem identification, the implementation scheme mentions institutional issues such as legitimate access to and control over natural resources (p. 14). "*Education for sustainable development is a process of learning how to make decisions that consider the long-term future of the equity, economy and ecology of all communities*", acknowledges the document (p.16). Surprisingly, it ignores a wealth of knowledge that is critically important to this learning process. Without the intention to diminish the issues explicitly mentioned from HIV/AIDS to corporate responsibility: It is a clear deficit that the insights of classics in the field from Hardin's 'Tragedy of the Commons' (1968) to Ostrom's analyses of cooperative solutions to natural resource use dilemmas (Ostrom 1990) are not being made pivotal points of an education for sustainable development.

Evidence from low income countries (Indonesia), emerging economies (Turkey, Chile) as well as from high income countries (Germany) is starting to emerge that the described deficit in the ESD documents may be symptomatic also for deficits in the practice of biodiversity education. Several studies indicate that learning outcomes with respect to the socio-economic and institutional dimensions of ESD are rather low. For example, German and Chilean high school students had problems to identify the social and economic dimensions regarding the wild collection of Boldo (*Peumus boldus*) in Chile and Devil's claw (*Harpagophytum procumbens*) in Namibia (Menzel and Bögeholz 2009). The same result was found regarding the Turkish students with respect to the exploitation of wild Salep (*Orchis mascula*) in Anatolia (Dervişoğlu et al. 2009). Likewise, agronomy and biology teacher students in Central Sulawesi (Indonesia) did not recognize the most important resource use dilemmas regarding Rattan (*Calamus spp.*) collection (Koch et al. *accepted*).

Against this background, we compared knowledge of beginners (3rd semester) and of graduates (7th semester) of students enrolled in several different bachelor (S1) programs at Bogor Agricultural University (IPB), Indonesia. IPB is the leading national institution of higher education in the field of agronomy, forestry and rural land use research; it is the 134th ranked university in Asia and the 6th ranked university in Indonesia (http://www.topuniversities.com/university-rankings/asian-university-rankings/2011). "Managing utilization of biodiversity" is one of its four "thematic pillars". The sample consists of nearly all IPB students of Forest Management, Forest Resource Conservation and Ecotourism, Biology, Fishing Resource Utilization, Living Aquatic Resource Management, Environmental and Resource Economics as well as Communication and Community Development (n=882). Many of the students are likely to become decision makers or educational multipliers dealing with biodiversity utilization and/or conservation.

For the study, an extensively pretested and validated multiple-choice questionnaire was used (LISREL; Jöreskog and Sörbom 1996) differentiating three knowledge domains: (a) ecological knowledge, (b) socio-economic knowledge and (c) institutional knowledge. The questionnaire does not require technical specialist knowledge (see appendix). The results show that socio-economic and institutional knowledge was much lower than ecological knowledge ($p < .001$; $p < .001$) at the start as well as at the end of the programs ($p < .001$; $p < .001$; see figure 1). A second result is even more important: On top of being already lower in the first place, institutional as well as socio-economic knowledge acquisition was also lower (no effect according to Cohen's *d* effect measure) than ecological knowledge acquisition (small effect). Compared to other students, students from programs with a stronger economics or social science orientation (Communication and Community Development, Environmental and Resource Economics) perform slightly better in this regard ($p = .02$; $t = 2.317$) while their ecological knowledge is lower ($p = .001$; $t = -3.208$; data not shown).

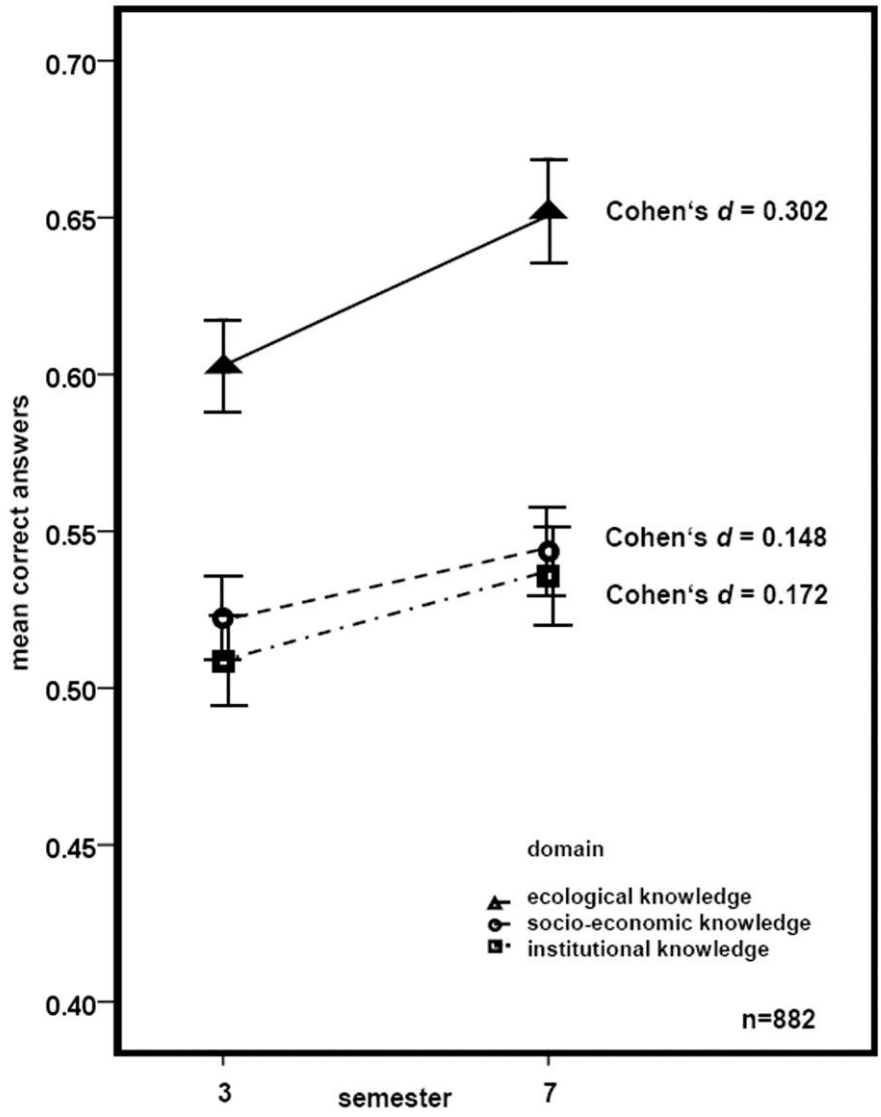

Figure 1: Comparison of domain specific knowledge on resource use dilemmas of university students at different educational stages in Indonesia (error bars indicate +/- 2 SE).

With vastly differing educational systems across the globe, authoritative statements on the global outcomes of biodiversity education cannot be based on the few empirical results available to date. If preparations were to start soon, comprehensive results would be available before the end of the DESD. Even without comprehensive empirical results, however, we suggest that UNESCO complement its core documents for the DESD by a clear socio-economic and institutional focus. Among other advantages, such

a focus may contribute to overcoming an outright denial of environmental risks that characterizes many citizens of high income countries who hold a white male world view (cf. McCright and Dunlap 2011).

Given the deficits in the highest level documents of ESD, we regard the fact that all studies conducted so far point at a pronounced underachievement on socio-economic and institutional knowledge as highly problematic. The comparison of student achievements across different programs indicates that higher achievement here may be acquired at the expense of achievements in ecological knowledge. This lack of interdisciplinarity is likely to be expressed also in other educational systems that tend to organize curricula strictly along disciplinary lines (cf. Fazey et al 2007; Ryan et al. 2010). With respect to concrete educational interventions that promote socio-economic and institutional knowledge, the analysis of case studies on locally relevant resource use dilemmas as well as resource management games (e.g., Fishbanks) should be considered.

In sum, national curriculum planners and educational institutions including UNESCO may wish to check – and potentially adjust – the contents of conservation-relevant initiatives and programs. Otherwise, the second half of the UN Decade of Education for Sustainable Development may pass without equipping learners – and their future teachers - with some of the most crucial knowledge needed to conserve biological diversity.

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CHAPTER 6:
Knowledge of Indonesian University Students on the Sustainable Management of Natural Resources

Manuscript prepared for submission

Sebastian Koch[1], Jan Barkmann[2], Micha Strack[3], Leti Sundawati[4] & Susanne Bögeholz[1]

[1]*Albrecht-von-Haller-Intitute for Plant Sciences, Biology Education,*
Waldweg 26, 37073 Göttingen, Germany
Georg-August-Universität Göttingen

[2]*Department of Agricultural Economics and Rural Development,*
Platz der Göttinger Sieben 5, 37075 Göttingen, Germany
Georg-August-Universität Göttingen

[3]*Georg-Elias-Müller-Institute of Psychology,*
Gosslerstr. 14, 37073 Göttingen, Germany
Georg-August-Universität Göttingen

[4]*Faculty of Forestry, Department of Forest Management,*
Jalan Lingkar Akademik, Kampus IPB Darmaga, PO Box 168, Bogor, 16680, Indonesia
Institut Pertanian Bogor (IPB)

Abstract

The graduates of university programs in natural resource utilization are likely to become the decision makers that shape the sustainable or non-sustainable use of biological diversity in the future. The adequate preparation of these university students needs to foster an understanding of the interdisciplinary challenges of natural resource management. This study investigated university students' understanding of natural resource management challenges. We used a knowledge model to differentiate situational, conceptual, and procedural types of knowledge and three domains of knowledge (ecological, socio-economic, institutional knowledge). We sampled beginners (3rd semester) and graduates (7th semester) of seven natural resource related programs at the leading Indonesian higher education institution in the degree programs of agriculture, forestry and the marine sciences (Institut Pertanian Bogor; n=882). Our questionnaire consisted of multiple choice and Likert scale items covering locally relevant open-access resource use issues (e.g., the extraction of non-timber forest resources and near-shore fisheries). A confirmatory tau equivalent LISREL model assessed construct validity. The ANOVA results show that situational knowledge did not increase between the 3rd and 7th semesters. Conceptual knowledge increased in the ecological and socio-economic domains, although the effect was small. Conceptual knowledge in the socio-economical and institutional domains tended to be lower than ecological knowledge. In the 3rd and 7th semesters, the student judgments of the efficacy of institutional solution strategies to address the dilemmas of natural resource use (procedural knowledge) differed strongly from expert judgments. We conclude that the sampled university students do not appear to be well prepared for solving complex, real-world natural resource management problems that include a substantial institutional component. Therefore, the social and institutional aspects, concerned with the utilization and conservation of natural resources, need to be thoroughly integrated into university curricula.

Keywords: Education for Sustainable Development, Environmental Education, Higher Education, Indonesia, Knowledge, Sustainable Resource Management

6.1 Introduction

International agreements, such as the Agenda 21 or the Convention on Biological Diversity (CBD), highlight the pivotal role of education in the conservation of biological diversity and sustainable natural resource management (UNCED 1992a, b; WCED 1987). One key aspect is the education of well-informed decision makers (Secretariat of the Convention on Biological Diversity 2010; Esa 2010; Tàbara & Pahl-Wostl 2007) that are qualified to apply specialized knowledge taught by higher education institutions including universities. Many university graduates from natural resource management programs become decision makers that influence future resource use decisions (Wallis & Laurenson 2004). To adequately prepare these students, we must foster an understanding of the interdisciplinary challenges of natural resource management (cf. Clark 2001; Saberwal & Kothari 1996). The inadequate institutional and governmental framework of natural resource management frequently encourages these resource management challenges. Without institutional changes that address specific natural resource issues, e.g., the causes underlying biodiversity loss (e.g., Bradshaw et al. 2009; Meyfroidt & Lambin 2011), it is often impossible to design and/or implement successful long-term solutions (cf. Ostrom et al. 1999). With universities becoming the focus for the production and conveyance of specialized knowledge, the performance of university education has a pivotal role for providing future decision makers with the skills required to generate institutional changes (cf. Godin & Gingras 2000).

There are virtually no studies that investigate the formation of the cognitive skills necessary to meet the challenges of natural resource management. During the past fifteen years, several studies have investigated the perception, awareness, attitudes, and knowledge of university students regarding environmental problems (e.g., Çakır et al. 2010; Esa 2010; He et al. 2011; Holl et al. 1995; Sudarmadi et al. 2001; Tuncer 2008). Even if environmental knowledge was addressed, none of the cited studies examined the cognitive skills necessary for solving more complex environmental problems in real-world settings. These cognitive skills include understanding the situation, applying additional conceptual knowledge, and proceeding to assess the interactions and causal relations (cf. Anderson 1982). Real-world issues of the sustainable utilization of natural resources typically involve complex settings such as socio-economic resource use

dilemmas. One prominent set of socio-economic dilemmas consists of the (over-) exploitation of open-access goods (Janssen et al. 2008). The studies cited above merely focused on the assessment of concepts and definitions in the environmental sciences. It is well known that this type of ecological knowledge hardly influences pro-environmental action (cf. Jordan et al. 2011; Kollmuss & Agyeman 2002). Knowing the definition of 'ecosystem' or 'regional species' neither helps a low-income country smallholder nor a high-income country consumer in conducting more ecologically sound production or consumption choices. In contrast, the profound knowledge necessary to solve environmental problems or to judge an imminent conservation problem influences pro-conservation choices (e.g. Barkmann & Zschiegner 2010). Therefore, we address the following research question: do the current official curricula and educational frameworks equip learners with the knowledge required to face biodiversity crises?

Unfortunately, there is reason to surmise that there are severe gaps in both high school and university education with respect to the socio-economic and institutional dimensions of natural resource management. For example:

(i) key documents of the United Nations 'Decade on Education for Sustainable Development' (2005-2014) virtually ignore the body of knowledge in environmental and institutional economics of the socio-economic and institutional dimensions in biodiversity conservation and related resource use issues,

(ii) empirical studies have documented low rates of socio-economic and institutional knowledge of upper secondary school students from countries as diverse as Chile, Turkey and Germany (cf. Dervişoğlu et al. 2009; Menzel & Bögeholz 2009), and

(iii) a qualitative interview study surveying biology education students and agronomy students from Indonesia – which serves as a qualitative pre-study to this contribution – suggests similar knowledge gaps (Koch et al. accepted).

A lack of the respective socio-economic and institutional expertise on the part of the citizens, professionals and decision makers can be particularly problematic in countries

such as Indonesia, which harbors several severely threatened biodiversity hotspots (Brooks et al. 2006). Indonesia's biological diversity is currently pressured by the over-exploitation of forest and marine resources, the expansion and intensification of agriculture, and oil and gas operations (Butler & Laurance 2008; Sodhi & Brook 2006). We investigate different types of Indonesian university students' knowledge on the interdisciplinary challenges of sustainable resource management and take into consideration the qualitative evidence for problematic knowledge gaps and Indonesia's ecological background.

For the systematic investigation of student knowledge, de Jong and Ferguson-Hessler (1996) provides a suitable framework that differentiates situational, conceptual, and procedural knowledge. The study highlights that students need to connect additional conceptual knowledge to non-technical real-world resource management dilemma descriptions (situational knowledge) to effectively define classes of problems. The proper assignment of a description to a problem class enables students to search for potential solutions or to evaluate proposed solutions (procedural knowledge). With respect to situational and conceptual knowledge, we assess student knowledge in three knowledge *domains*: ecological, socio-economic, and institutional knowledge. In the operationalization chosen for this study, procedural knowledge always includes the analysis of contextualized solution strategies that comprise an institutional dimension.

6.2 Methods

6.2.1 Instrument development

We developed a quantitative questionnaire[5] that was informed by a qualitative in-depth interview study of university students' subjective theories on resource use dilemmas (Koch et al. in press). The questionnaire was piloted in Indonesia with 5th semester students from the Institut Pertanian Bogor (IPB) (n=409) and then slightly revised. The final questionnaire consisted of 33 multiple-choice questions, 12 Likert-type scale items and socio-demographic and general education-related questions, e.g., Grade Point Average (GPA), motivation and career aspirations. The full questionnaire was translated

[5] Please find the complete quantitative questionnaire as appendix 3 (page 240ff).

from English into Indonesian, then back translated into English by an independent researcher and revised if necessary.

6.2.2 Knowledge Model

The design of the survey questionnaire was based on the knowledge model (see Fig. 1) published by de Jong and Ferguson-Hessler (1996). This model demonstrates that situational knowledge includes information that must be extracted from a given problem description. Conceptual knowledge comprises the additional knowledge beyond the reconstructed information from the problem description. The additional knowledge must be integrated into the problem reconstruction to assign the problem to a suitable scientific problem class. Based on the problem description, the integration of additional conceptual knowledge about the problem classification and procedural knowledge can foster the identification and evaluation of potential solutions to the problem. In our implementation of the knowledge model, correct procedural knowledge indicates the necessary cognitive skills to understand and potentially solve tropical biodiversity-related resource use dilemmas.

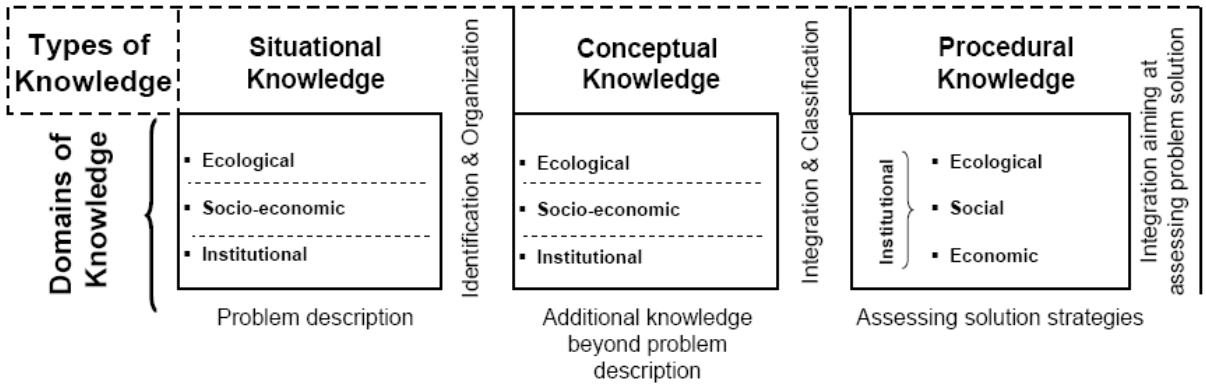


Figure 1: The knowledge model, which combines the three types of knowledge (de Jong & Ferguson-Hessler 1996) and the three domains of knowledge that are necessary to form the required cognitive skills (Mayer 2011).

6.2.3 Situational and conceptual knowledge

Thirty-three multiple-choice items were designed according to a 2*3 factorial design (see Fig. 2). The items evaluate situational knowledge (18 items) and conceptual knowledge (15 items). Eleven items of the total thirty-three items each address one of the three knowledge domains: *ecological*, *socio-economic*, and *institutional* knowledge.

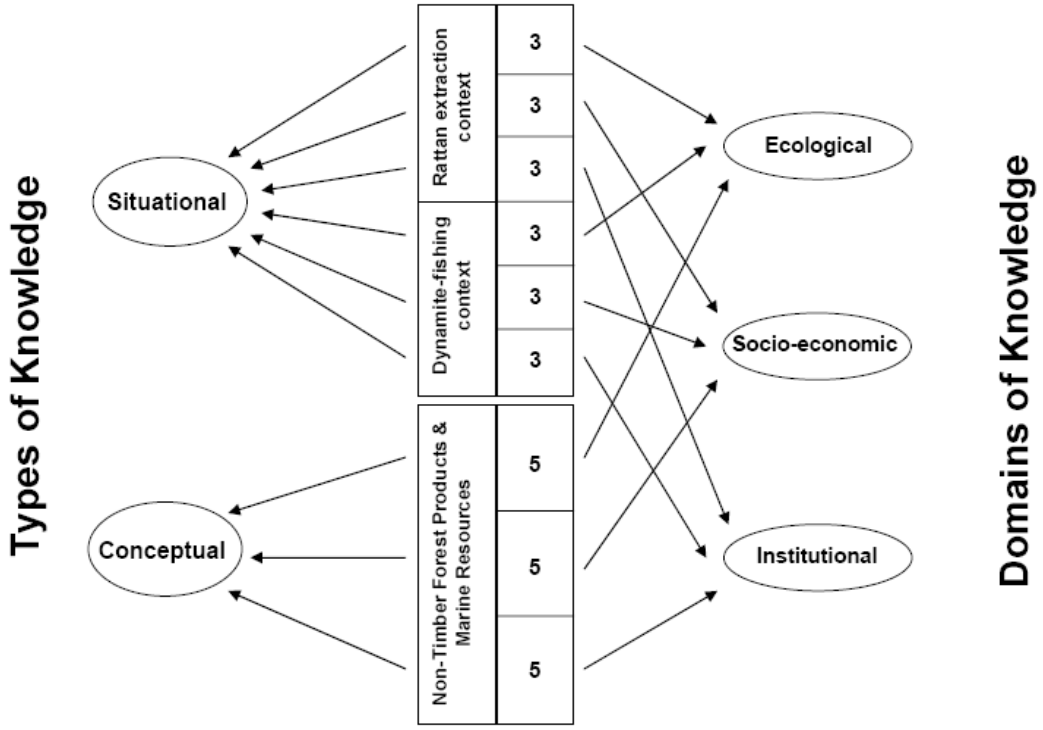


Figure 2: The factorial design to assess situational and conceptual knowledge. The numbers in the middle-boxes depict the items in each combination of type and domain of knowledge.

The 18 situational knowledge items refer to two problem descriptions of resource over-utilization in an open-access situation. The given problem descriptions consist of short and hypothetical but science-based stories of local families involved in a commons dilemma situation (for an example, see Fig. 3). The problem descriptions avoid technical language and were written in a colloquial style. The initial description concerns the over-exploitation of rattan (*Calamus spp.*), an internationally traded non-timber forest resource found in Central Sulawesi, Indonesia (Siebert 2004). The second problem describes near-shore dynamite over-fishing in the Sunda sea, Inonesia (Pet-Soede & Erdmann 1998).

The 15 conceptual knowledge items cover the additional knowledge that allows students to reconstruct the ecological, socio-economic and institutional settings of the two problem descriptions in more abstract terms. Specifically, conceptual knowledge enables students to recognize that both problem descriptions address the utilization of limited, renewable resources (*ecological domain*) in de facto open-access situations that are threatened by over-exploitation and poor governance (*institutional domain*). The appropriators of the resources are poor villagers with limited alternative income sources (*socio-economic domain*) competing for the resource.

6.2.4 Procedural knowledge

In our study, procedural knowledge refers to the cognitive skill of identifying and judging potential solutions ('strategies') to the two resource management problems presented. Both the rattan and the fishing problem described commons dilemmas that are typical for natural resource management under de facto open-access. Both problems are described in their institutional context. Consequently, the judgments of a proposed solution's effectiveness require at least an implicit judgment of institutional effectiveness. Thus, all student procedural knowledge responses refer to knowledge in the institutional domain. Still, the effectiveness of the proposed solutions can be judged with respect to the different dimensions of sustainable development:

(a) Is the strategy effective for the protection of the rattan or fish stocks? (Ecological dimension)

(b) Will the strategy improve or stabilize the livelihoods of the concerned villagers? (Social dimension)

(c) Is the strategy effective with respect to the general economic development in Indonesia? (Economic dimension)

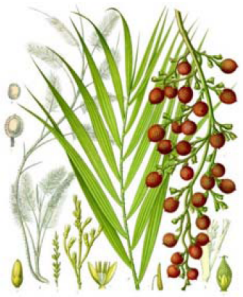
Student judgments were compared to the judgments from academic and professional experts in the field (see Analysis section) to assess the appropriateness of the responses. Students judged 12 provided solution strategies using a four-point Likert scale, which ranged from '*absolutely ineffective*' to '*very effective*' (see page 256f).

Rattan Information Text (Part 1a)

Bapak Suardi owns a small hut in the village of Salua close to Lore Lindu National Park (LLNP) in Central Sulawesi. He has planted a few cacao plants between the trees of a local forest that he does not officially own. Like many of his neighbours, Bapak Suardi's family cannot make a decent living with this little land.

One day, Bapak Suardi is sitting in front of his hut, smoking kretek and waiting for the cacao to ripen. "Suardi, we are running out of supplies for our young children!" his wife complains. But what can Bapak Suardi do? Fortunately, a 'Bos Rattan' suddenly shows up, and approaches Bapak Suardi. "One of my trucks will be in Salua in two weeks and pick up a load of rattan." Immediately, Bapak Suardi volunteers to help fill the truck. He knows some good places where rattan grows. In the past they found much rattan close by in the community forest west of Salua village, today the best places to collect rattan are deep inside the primary forests of Lore Lindu National Park.

A few days later, Bapak Suardi and a few other poor villagers meet for a rattan collecting expedition. They are all young and experienced rattan collectors. "We will easily find enough rattan to fill Bos Rattan's truck in a few days", Bapak Suardi thinks. However, their expedition takes longer than expected. In some places where they had seen much rattan just a few months ago, all good rattan canes were gone.



After one week of physically exhausting work, Bapak Suardi and his colleagues float a large load of peeled rattan canes down a small creek to a collecting point where the truck can pick up the rattan.

Eventually, the truck arrives. But there is one more disappointment. The Bos Rattan complains "Why did you cut canes that are so thin and so young? You cannot make good furniture from these canes. No-one will pay me a good price for these canes." Bapak Suardi and his friends know that the Bos Rattan is right – the quality of the canes was bad this time. So after a long discussion, they accepted a very low price for the rattan.

Driving back to town in the truck, the Bos Rattan tells his driver: "These villagers have no clue what is going on in the business". This year, business is very tough because the Bos Rattan cannot sell to the export traders from Singapore or Malaysia who always made him a very good price. "And our local furniture makers, they simply do not pay much. How shall I pay the villagers a good price then if they bring poor stuff?" – "Is this the fault of the Indonesian export ban on unprocessed rattan?" his driver asks. "I do not know", the Bos Rattan says. "But next month, we go to a different village farther down the road where the people live deeper in the forest." A few minutes later, the truck slows down at the check point of the forest police. The guard on duty approaches the truck reluctantly in order to check the rattan collection permit, but then greets friendly and hastens to open the gate. "Hope to see you soon again!" that guard says.

Figure 3: The rattan over-exploitation fictive story based on informal on-site interviews.

6.2.5 Survey administration

We administered the survey to university students of IPB, the leading Indonesian institution of higher learning in the field of agronomy, forestry and rural land use research. "Managing utilization of biodiversity" is one of IPB's four "thematic pillars." The survey sample consists of nearly all IPB students in the departments of Forest Management, Forest Resource Conservation and Ecotourism, Biology, Fishing Resource Utilization, Living Aquatic Resource Management, Environmental and Resource Economics, and Communication and Community Development. Many of the students are expected to become decision makers or educational multipliers in biodiversity utilization and/or conservation.

In the first two semesters, IPB students attend general classes without scientific specialization. In the 3rd semester, students begin a specific program. In the 8th semester, the students typically perform field research and prepare a thesis. We sampled the entire population of 3rd and 7th semester students, excluding the absentees due to illness or similar reasons, enrolled in the above-mentioned seven natural resource-related programs. In general, the questionnaire took between 45 and 60 minutes to complete.

6.3 Analyses

6.3.1 Situational knowledge and conceptual knowledge

To demonstrate construct validity in the situational and conceptual knowledge measures, the 33 multiple-choice answers were coded as either incorrect (zero) or correct (one) and then analyzed using confirmatory factor analysis (CFA). For the proposed tau-equivalent measurement model, see Figure 2. Data were input in a tetrachoric correlation matrix for binary data (Kubinger 2003) generated by TETMAT (Uebersax 2007), and the model was run with LISREL 8.80 (Jöreskog & Sörbom 1996). We used the Goodness of Fit Index (GFI), the Adjusted Goodness of Fit Index (AGFI; target value: >0.8; Sharma 1996), the Parsimony Goodness of Fit Index (PGFI), and the

Root Mean Square Error of Approximation (RMSEA; target value: <0.08; Browne & Cudeck 1993: 144) as fit indices.

CFA apportioned the variance of the items into the type of knowledge and the domain of knowledge (see Fig. 2). The variance of the two latent variables for situational and conceptual knowledge was restricted to be equal. Likewise, the variance of the three latent knowledge domain variables was restricted to be equal. In addition, a general factor (general knowledge) was assumed to affect all items equally. With the model estimating only three estimators (general knowledge, type specificity, domain specificity), we expect the goodness of fit statistics to be lower than the convention, whereas the PGFI should be at least 0.50 (Byrne 1989).

The CFA of the measurement model showed small but consistent variance sources. General knowledge was the source of 4.3% of the item variance (SE = 0.0042; t = 10.24; p< 0.001). The type of knowledge accounted for 0.7% of the variance (SE = 0.0031; t = 2.15; p< 0.05), and the knowledge domain accounted for 1.2% of the variance (SE = 0.0033; t = 3.49; p< 0.001). Due to the binary character of the data, the estimators were small (4.3%, 1.2% and 0.7%). According to Cohen (1988), this corresponded to small effects. The three-parameter tau-equivalent model generated reasonable global fit indices (df = 525; GFI = 0.821, AGFI = 0.801, PGFI = 0.768, and RMSEA = 0.0757). We concluded that we adequately assessed the variance of the types and the domains of knowledge.

PASW 18 (SPSS Inc. 2009) was used to test for an increase in knowledge between the 3rd and 7th semester university students. A repeated measures Analysis of Variance (ANOVA) with repeated measures on knowledge type and domain was conducted to compare the semester (2) * knowledge type (2) * knowledge domain (3) design. Cohen's *d* values were calculated to indicate effect sizes for the semester effect.

The surveyed data for the Grade Point Average (GPA) were significantly but weakly correlated with the female sex (r = 0.121, n = 848; p< 0.01). GPA was significantly correlated with the general knowledge score (r = 0.258, n = 848; p< 0.01). No correlation emerged between the general knowledge score and gender. Therefore, the gender variable was dropped from further analyses.

6.3.2 Procedural knowledge

The Likert-type judgments of solution strategy effectiveness were given to nine scientific experts from Indonesia and Germany. All of the experts were engaged in tropical research projects in sustainable resource utilization and biodiversity loss for several years. A reliability analysis was performed comparing the effectiveness judgments of the three sustainable development dimensions (ecological, social, and economic), which yielded Cronbach's α values for the nine experts across the 12 solution strategies. The Cronbach's α values are reasonably high with values of 0.738 for the ecological dimension, 0.754 for the social dimension, and 0.751 for the economic dimension, indicating substantial homogeneity among the expert judgments. As expected, the expert judgments are considerably more consistent than the student judgments (see appendix b).

The expert judgments were averaged for the three dimensions and 12 solution strategies (see appendix a). This expert answer profile served as a standard to assess the quality of student procedural knowledge. For this assessment, the individual answer profile for each student was correlated with the expert profile. A repeated measures ANOVA with domain as the repeated factor was applied to the Z-transformed correlations to examine the increase in procedural knowledge between the 3rd and 7th semester.

6.4 Results

6.4.1 Sample description

The main study sample consists of 882 university students. The average age in the 3rd semester (n = 447) was 19.0 years (SD = 0.675); in the 7th semester (n = 405), it was 21.0 years (SD = 0.522). Two-thirds (66.4%) of the total sample were female students, which reflected their over-representation in the sampled programs.

6.4.2 Assessing increases in situational and conceptual knowledge

A repeated measures ANOVA, where the types and domains of knowledge were the repeated measures factors and semester was the group factor (3rd versus 7th semester), was performed. Significant effects were observed for the three main variables and between the two-way and three-way interactions (see Table 1).

Table 1: An ANOVA revealed increases in knowledge from semester 3 to semester 7. The type of knowledge (situational knowledge and conceptual knowledge) and domain of knowledge (ecological knowledge; socio-economic knowledge; institutional knowledge) are the repeated measures factors, and semester (3; 7) is the group factor.

Source of Variance	df_w	df_b	F	p	eta²
Type	1	880	62.08	<.001	.066
Domain	2	1760	150.19	<.001	.146
Semester	1	880	23.59	<.001	.026
Type*Domain	2	1760	316.67	<.001	.265
Type*Semester	1	880	20.54	<.001	.023
Domain*Semester	2	1760	3.01	.049	.003
Type*Domain*Semester	2	1760	6.97	.001	.008

Figure 4 shows that situational knowledge – specifically in the ecological and socio-economic domains – was already reasonably high in the 3rd semester with correct responses between 64 and 65%. The mean scores for institutional knowledge tended to increase from 0.455 to 0.484, which departed from a substantially lower score in the 3rd semester.

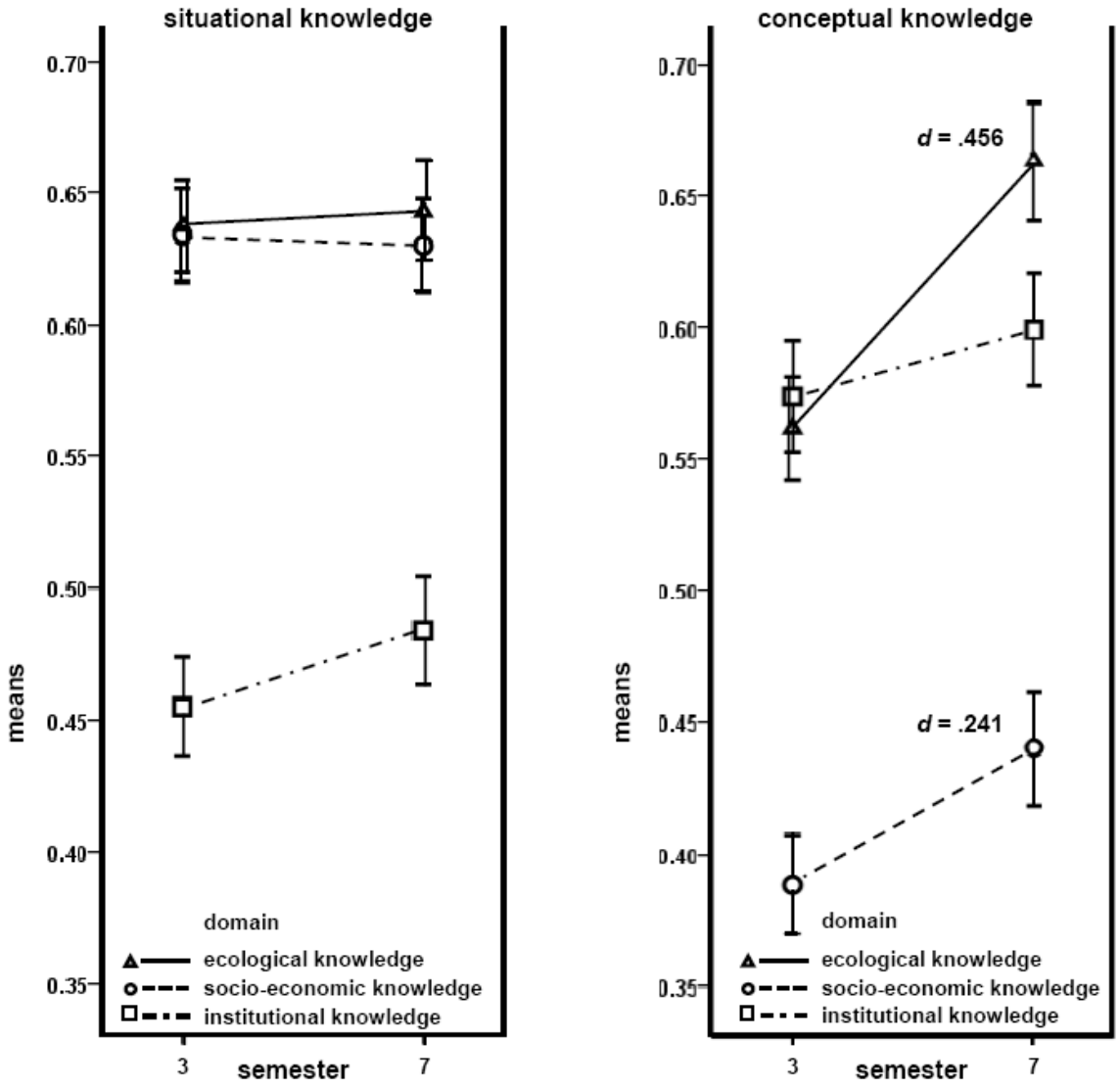


Figure 4: The mean knowledge change (error bars indicate 95% confidence intervals).

The conceptual knowledge increased the most with respect to the ecological knowledge domain (56.1% to 66.3% correct; near to medium effect size; Cohen's d = 0.456). The socio-economic knowledge domain also showed a significant increase from 38.9% to 44.0% (small effect size; Cohen's d = 0.241). Institutional knowledge, in both knowledge types, increased the least of all.

6.4.3 Procedural knowledge

Table 2: An ANOVA of the procedural knowledge with the sustainable development dimension (ecological, social, economic dimension) as a repeated measures factor and semester (3; 7) as a group factor.

Source of Variance	df_w	df_b	F	P	eta²
Sust Dev Dimension	2	1756	75.27	<.001	.079
Semester	1	878	53.82	<.001	.058
Sust Dev Dimension*Semester	2	1756	6.43	.002	.007

Procedural knowledge differs with respect to the sustainable development dimension, the semester and the interaction between the sustainable development dimension and semester (see Table 2). The solution strategy judgments of 7th semester students were more in line with the experts than with the 3rd semester students. Concerning the social dimension, the judgments of the 3rd semester students were correlated with the expert mean profile (r = 0.157), whereas the judgments of the 7th semester students were correlated (r = 0.317) with the expert mean profile (see Fig. 5). The ecological and economic dimension judgments of the 3rd semester students had virtually no correlation with the expert mean profile (r = 0.067 for ecological and r = 0.080 for economic). The 7th semester university students' correlations increased to r = 0.172 (ecological dimension) and r = 0.165 (economic dimension).

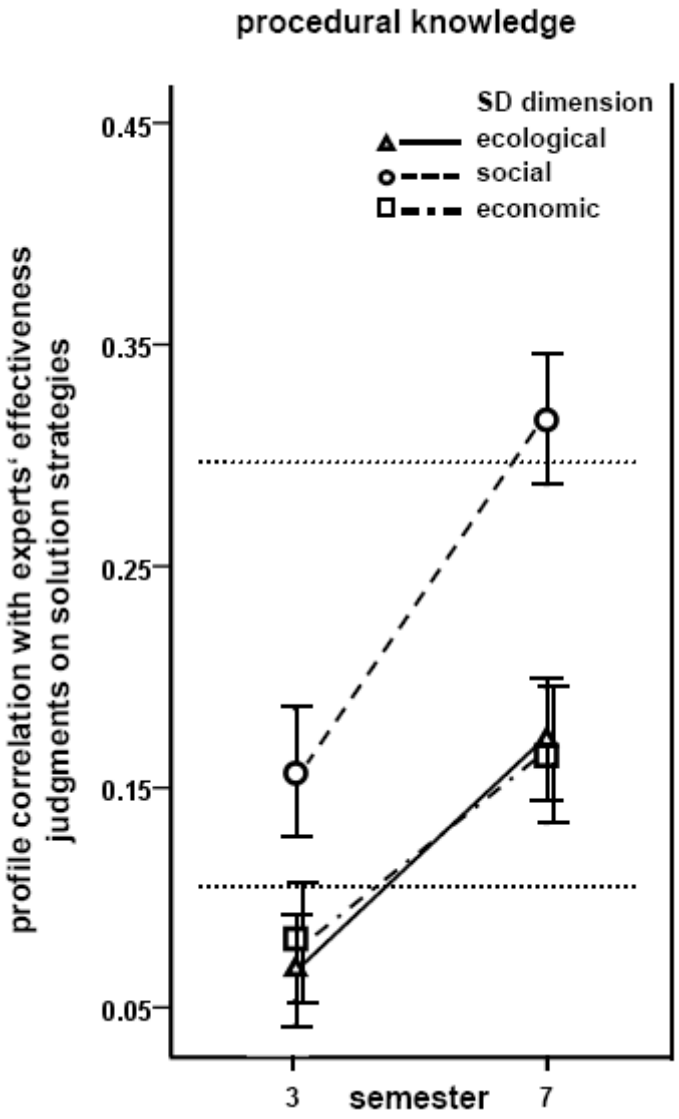


Figure 5: The procedural knowledge profile correlations (Pearson product moment correlations) of student and mean expert judgments on the effectiveness of solution strategies. According to Cohen (1988), r > 0.1 = weak correlation and r > 0.3 = medium correlation. The error bars indicate 95% confidence intervals.

6.5 Discussion

Our study aimed to investigate university students' knowledge concerning sustainable resource management in Indonesia. Based on a knowledge model, we differentiated situational, conceptual, and procedural types of knowledge and three domains of knowledge (ecological, socio-economic, and institutional knowledge).

We sampled nearly all 3rd and 7th semester students enrolled in the most relevant degree programs offered by the leading Indonesian educational institution of higher learning in natural resource management (IPB; n=882). Both prime field access and the high overall number of participants provided the foundation or the applied and methodological results discussed below.

This contribution advances over previous studies by presenting psychometrically elaborated and validated scales for measuring situational and conceptual knowledge. We have connected educational investigations in the emerging interdisciplinary field of biodiversity sciences to the state of the art in science education and environmental psychology. Furthermore, the items on these scales refer to ecologically, socio-economically and institutionally contextualized descriptions of resource management issues composed in non-technical language. This study approach is likely to yield more reliable results for assessing the future performance abilities of the sampled students than will an assessment of environmental knowledge via the reproduction of textbook definitions (cf. de Haan 2006).

The numerical differences in knowledge scores across the domains are not superficial. For situational and conceptual knowledge, the initial development of the item pool focused primarily on the creation of small groups of items that were similar in language and complexity across knowledge domains. Several items were deleted during the design process of the test instrument due to low reliability with their respective scales or to floor or ceiling effects in the pilot study. A focus on internal reliability and the ability to detect learning effects from the 3rd to the 7th semester may have impacted the comparability of student knowledge across type * domain groups of items. For this pioneering study, we accomplished an explicit normative standard only with respect to the analysis of the procedural knowledge. Here, we assessed student performance in

relation to expert judgments. Consequently, we regard the measurement of educational effects and the results on procedural knowledge as a priori and more valid than the absolute knowledge scores for the situational and conceptual knowledge types.

We observed high scores in ecological and socio-economic situational knowledge. This result reflects the student's ability to extract the relevant information from the non-scientific problem descriptions ("stories"). These scores did not substantially increase from the 3rd to the 7th semester. The knowledge score was considerably lower for the institutional domain with less than 50% of the items answered correctly. Obviously, these items were more difficult to answer. Although a bias in the construction of the knowledge items cannot be excluded, the magnitude of the effect suggests that students had particular problems in the recognition of institutional knowledge. Again, scores for the conceptual knowledge items were relatively high in the ecological domain. There was also substantial knowledge of institutional aspects. However, only ecological and socio-economic knowledge increased from the 3rd to the 7th semester, whereas institutional knowledge merely remained stable. Nevertheless, absolute differences may also be an effect of general item difficulties. Therefore, we restrict the interpretation of changes in knowledge between the 3rd and 7th semester students.

With respect to procedural knowledge, student judgments of the effectiveness of solution strategies converged between the 3rd and the 7th semester students and the expert mean profiles. However, the starting point for the convergence was low. Even in the best performing judgments (the social sustainable development dimension), 10% of the variation in student judgments can be explained by a variation the expert and 7th semester student judgments. The correlations are even lower for the other two dimensions.

We summarize the findings as follows: It was obviously difficult for students to identify relevant institutional aspects from the resource management problem descriptions, and there was little evidence of improvement between the 3rd and the 7th semesters. The necessary conceptual knowledge to understand the problems was satisfactory in the institutional and ecological domains. While there were improvements in the comparison of the 3rd and 7th semester students in the ecological and socio-economical domains, improvements in the institutional domain were not significant. For the procedural

knowledge implicit in addressing institutional knowledge, student and expert judgments continue to differ widely, even for slightly improving 7th semester students. In sum, the sampled university students do not appear to be well prepared for solving complex, real-world natural resource management problems that include a substantial institutional component.

The results are in line with the small number of studies that investigate learning outcomes with respect to the socio-economic and institutional dimensions of natural resource use problems. For example, Menzel and Bögeholz (2009) found that German and Chilean high school students had problems identifying the social and economical dimensions of wild Boldo (*Peumus boldus*) leaves in Chile and bulbs of Devil's claw (*Harpagophytum procumbens*) in Namibia. With respect to Turkish students the same result was observed concerning the exploitation of wild Salep (*Orchis mascula*) in Anatolia (Dervişoğlu et al. 2009). Likewise, but with a much broader thematic focus, Tuncer (2008) evaluated a sample of university students from Turkey and showed insufficient cognitive backgrounds concerning issues of sustainable development.

The qualitative precursor-study (Koch et al. accepted) took place at Universitas Tadulako in Central Sulawesi, i.e., at a public Indonesian university located on an 'outer island'. The rattan problem used in the study is situated near Palu, the capital city of Central Sulawesi. Although we used a more interactive form of semi-structured interviews, the local agronomy and biology education students did not recognize the specific institutional characteristics or the majority of the rattan open-access (commons dilemma) problems. The sample investigated in this contribution is enrolled in a leading higher education Indonesian institution that educates future natural resource management professionals and decision makers. However, the results of the two studies are similar. The results show that it appears unlikely that Indonesian students with substantially better performance scores can be found outside of IPB.

National and international high-level documents about educational policies are lacking in the socio-economic and institutional dimensions of the conservation and utilization of biological resources. Relevant examples from UNESCO and Indonesian documents are examined in detail by the Author (unpublished). Although the number of studies in the field is still limited, a troubling pattern emerges. The disregard for the state of the art

in institutional and ecological economics is mirrored by the low educational achievements in this highly relevant field.

The low performance is likely related to an overly strong focus on mere ecological knowledge in teaching natural resource use issues and/or sustainable development (cf. Menzel & Bögeholz 2009; Hsu & Roth 1998). Even the broad interdisciplinary concept of sustainable development is taught mostly in the natural sciences. Socio-economic, institutional or political aspects are rarely included (cf. Lindemann-Matthies et al. 2009). Indonesia strives to include environmental education in university curricula. However, only the integration of general environmental education and education for sustainable development (ESD) topics into the official curriculum is progressing. The principles of environmental education in Indonesia are still based on teaching ecological knowledge (Kementerian Lingkungan Hidup [Ministry of the Environment] 2004).

Improvements may have to overcome the embedded characteristics of the Indonesian and similarly structured educational systems. For example, teacher-centered approaches dominate science education in many developing and emerging countries. Teachers tend to teach ex cathedra while only little time is appropriated to critical discussion (Lim 2010; Wahyudi & Treagust 2004). The poor quality of teaching, the inadequate textbooks and a low standard of the post-secondary institutions, including many universities, are widespread. In part, these problems depend on low per capita spending on education. Indonesia has traditionally featured one of the lowest per capita spending on education in Asia and Oceania (Tobing 2003).

We cannot formally extrapolate the results of our study to other universities in Indonesia. Nevertheless, the following suggestions for improvements in environmental education regarding biological resource use problems are likely to be useful beyond IPB.

6.6 Implications for Practice

The fostering of cognitive skills to analyze and – if possible – solve problems of the conservation and sustainable utilization of biological resources should be a prime task of all university programs that educate future professionals, educational multipliers or decision makers in the field. An understanding of the institutional core issues of resource dilemmas in open-access situations requires factual knowledge beyond striving

for a 'balanced view' of the social, economic, and environmental dimensions of sustainable development (cf. Kyburz-Graber et al. 2006; Vargas 2000). Particularly, students need to learn about the underlying socio-economic mechanisms and the institutional restrictions of individual actions. Even the identification of the institutional issues at the level of reading comprehension (cf. situational knowledge) may have to be addressed. The educational systems of biodiversity-rich countries with a rural population relying on natural resources should reconsider university curricula in these respects.

Second, the curriculum should focus on examples that consider local livelihoods and local cultural contexts (Glasson et al. 2010; Vargas 2000). Addressing real-life human-environment interactions should be essential (Kyburz-Graber et al. 2006). Conflicts between local communities and the state or provincial administrations over natural resources are frequent, and such conflicts could be analyzed (Saberwal & Kothari 1996). Furthermore, students could generate local and socially relevant knowledge themselves to look for potential solutions that balance conservation efforts and human needs. If real-world case studies cannot be integrated into a program (cf. Scholz et al. 2006), working with a number of contextualized, authentic descriptions of real-world biological resource use issues may be an alternative. Ultimately, students need to be able to appropriately interact with policy makers and affected stakeholders to facilitate improvements to urgent conservation problems (cf. Clark 2001).

We conclude that the low knowledge of Indonesian university students on the sustainable management of biological resources is indicative of a widespread deficit of the educational systems to adequately address the institutional and related socio-economic dimensions of biological resource management. In this respect, we must repeat and extend the call by Saberwal and Kothari (1996) for a more thorough integration of the "human dimension" into curricula for conservation biology. A sufficiently large body of applicable scientific knowledge and detailed suggestions for educational improvements are, however, available to achieve this ambitious task. Considering the structural challenges of the educational systems in countries such as Indonesia, it would be particularly helpful if international organizations such as UNESCO updated their respective policy documents and policy practice. Otherwise, the emerging field of "biodiversity education" is unlikely to live up to the expectations placed upon it by the Agenda 21 and the CBD.

Appendices

Appendix a: The expert mean profile on the four-point rating scale (1=absolutely ineffective – 4=very effective) (The criteria for procedural knowledge) (n=9).

	Ecological dimension	Social dimension	Economic dimension
1. The central government should provide more Rangers/Forest Police to prevent rattan collectors from illegal harvesting.	2.11	1.67	1.44
2. The Ministry of Marine Affairs and Fisheries (or another organization which is responsible) should develop a strategy for the sustainable near-shore fishing closely related to community interests.	3.44	2.89	3.11
3. The government should strictly implement monitoring and punishments of using illegal fishing techniques.	3.22	2.78	2.67
4. Certification schemes ("ecolabels") should be developed to support sustainable fish harvesting practices.	2.44	2.44	2.22
5. Penalties from the *Lembaga Adat* should be strictly applied if a villager extracts too much rattan or unnecessarily damages forest vegetation and wild animals.	3.78	3.00	2.67
6. Tenure rights should be given to local communities because traditional forest dwellers have successfully managed rattan and other Non-Timber Forest Products (NTFP) as common property for centuries.	3.22	3.22	2.78
7. Fishing village meetings should be arranged where all habitants develop rules how to manage local fish stocks.	3.44	3.56	3.11
8. The government (i.e., The Ministry of Forestry) should make a plan to strictly enforce a permit system for all NTFP. The permits would only be valid for a specific area.	2.33	2.00	2.11
9. The government should strictly implement a ban on the export of unprocessed rattan.	3.00	2.33	2.89
10. The government should implement and strictly monitor fishing quotas for the Indonesian near-shore fisheries.	3.56	2.75	2.75
11. The government should implement and monitor national and international fish-trade regulations.	2.89	2.66	2.55
12. Regional cooperations should be established concerning NTFP management.	3.00	2.89	2.89

Appendix b:

To further test the internal validity of the expert judgments, we require that the expert judgments are more homogeneous than the student judgments. Cronbach's α is sensitive to the number of experts (or students) in this specific analysis, so we use an alternative measure, profile correlations, to compare homogeneity between the experts and the students. Profile correlations measure the correlation between the answers of an individual expert (student) and the answers of the other experts (students). In this appendix, we present the results of the profile correlation analysis.

The mean correlations for the students were 0.115 (SD = 0.283) for the ecological sustainable development dimension, 0.229 (SD = 0.320) for the social sustainable development dimension, and 0.119 (SD = 0.307) for the economic sustainable development dimension. The mean correlations for the experts were 0.438 (ecological), 0.466 (social), and 0.437 (economic). Thus, the mean values of the student profile correlations were above zero but were smaller than the profile correlations of the experts. Consequently, the expert judgments were more homogeneous that the student judgments as was required.

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CHAPTER 7:
Learning for Sustainability? Comparing Higher Education Programs Concerning Sustainable Resource Management in Indonesia

Manuscript submitted for puplication

Sebastian Koch[1], Jan Barkmann[2], Micha Strack[3], Leti Sundawati[4] & Susanne Bögeholz[1]

[1] *Albrecht-von-Haller-Intitute for Plant Sciences, Biology Education,*
Waldweg 26, 37073 Göttingen, Germany
Georg-August-Universität Göttingen

[2] *Department of Agricultural Economics and Rural Development,*
Platz der Göttinger Sieben 5, 37075 Göttingen, Germany
Georg-August-Universität Göttingen

[3] *Georg-Elias-Müller-Institute of Psychology,*
Gosslerstr. 14, 37073 Göttingen, Germany
Georg-August-Universität Göttingen

[4] *Faculty of Forestry, Department of Forest Management,*
Jalan Lingkar Akademik, Kampus IPB Darmaga, PO Box 168, Bogor, 16680, Indonesia
Institut Pertanian Bogor (IPB)

Abstract

Halfway through the 'Decade of Education for Sustainable Development' (DESD), we can begin to reflect on 'Education for Sustainable Development' (ESD) in Indonesia with regard to some of the challenges in higher education. Decision makers concerned with natural resource management and multipliers for environmental education need to be knowledgeable about the ecological, socio-economic, and institutional factors that affect the use and overutilization of natural resources. In this study, we show that while Indonesian university students in the field of sustainable resource management grow knowledgeable about their particular area of study, as tomorrow's decision makers, their education level is not well balanced enough to meet the needs of ESD.

Keywords: Education for Sustainable Development, Natural Resources, Higher Education, Indonesia

7.1 Introduction

The United Nations General Assembly proclaimed 2004-2014 as the 'Decade of Education for Sustainable Development' (DESD), with 'Education for Sustainable Development' (ESD) referring to the educational aspects of sustainable development (Selby, 2006). The issue of sustainable development has been on the United Nations' political agenda since the Brundtland report (WCED, 1987) and the United Nations Conference on Environment and Development (UNCED) held in 1992. International declarations such as the Convention on Biological Diversity (CBD) and Agenda 21, the program of action for sustainable development, emerged from the conference (UNCED, 1992a, 1992b), highlighting the pivotal role of education in preserving biodiversity and using natural resources sustainably. While interdisciplinary approaches are essential, sustainable development can only be attained through the integration of ecological, social, and economic factors (Eilam & Trop, 2010; Herremans & Reid, 2002; Marcinkowski, 2009).

Education is the most important factor in acquiring knowledge and raising awareness about future development (Esa, 2010). Because universities are at the forefront of knowledge (Godin & Gingras, 2000), higher education plays a major role in sustainable development throughout the decade (Jones, Selby, & Sterling, 2010). Because many university graduates from programs related to natural resource management are likely to become decision makers in the field (Wong, 2001), they will influence the utilization of natural resources in the future (Wallis & Laurenson, 2004). Therefore, university graduates must be adequately prepared to meet these challenges (Goldman, Yavetz, & Pe'er, 2006; Jones, et al., 2010).

Decision makers dealing with natural resource management and multipliers for environmental education need to be knowledgeable about the ecological, socio-economic, and institutional factors that affect the usage and overutilization of natural resources (Clark, 2001; Saberwal & Kothari, 1996). Without such knowledge, they will not be able to implement strategies for the sustainable utilization of the natural resources that provide many poor, rural populations their livelihoods but need to be preserved for biological diversity.

There has long been a need to integrate the social sciences and conservation through increased interdisciplinary approaches (Mascia, et al., 2003). Many environmental problems are characterized by the interplay of ecological, socio-economic and political factors (Martinez R, Gerritsen, Cuevas, & Rosales A, 2006). Thus, university students must be knowledgeable about these fields to understand and resolve complex issues regarding the use of natural resources (Bögeholz & Barkmann, 2005; Wiek, Withycombe, & Redmen, 2011), such as open-access resource overutilization situations, often referred to as commons dilemmas (Dietz, Dolsak, Ostrom, & Stern, 2002). Commons dilemmas occur, for example, in Indonesia, a country with severely threatened biological diversity (Brooks, et al., 2006). Over-exploitation of forest and marine resources, the expansion and intensification of agriculture, and oil and gas operations exert pressure on Indonesia's aquatic and terrestrial biodiversity (Butler & Laurance, 2008; Sodhi & Brook, 2006). A lack of understanding of the respective ecological, socio-economic, and institutional factors can be particularly problematic.

Now that we are more than halfway through the DESD, we must consider how interdisciplinary approaches have been integrated into higher education in the field of natural resource management. The propagation of international declarations are not sufficient to change long-lasting disciplinary practices (Bekessy, Samson, & Clarkson, 2007; Ryan, Tilbury, Corcoran, Abe, & Nomura, 2010). Therefore, empirical research on the potential performance of university students with respect to sustainable resource management is essential. Only a few educational science studies have been conducted on the socio-ecological aspects of biodiversity utilization and conservation (e.g., Menzel & Bögeholz, 2009). For example, Hansmann et al. (2010) evaluated the usefulness of sustainable development programs (such as the environmental science program at ETH Zürich, Switzerland) with respect to the professional activities of the graduates of these programs. They found that interdisciplinary education was advantageous to the graduates' professional skills. Most studies concerning education and sustainable development, however, merely assess concepts and definitions (Çakır, İrez, & Doğan, 2010; Corney, 2006; Tuncer, 2008), failing to address real-world environmental problems occurring in open-access natural resource overutilization situations. To date, no in-depth studies in higher education have been conducted in developing and emerging countries, which harbor the vast majority of the world's biodiversity.

Instruments for measuring students competence concerning sustainable development are hardly available or under development. For example, Yang et al. (Yang, Lam, & Wong, 2010) developed an instrument to identify teachers' beliefs about Education for Sustainable Development in China. Ideally, the choice of the items should be validated against an explicit normative standard and/or against a larger international sample of peers from which Rasch-modeled scales were developed (e.g., PISA procedures: OECD, 2003). For that reason, we decided not to measure the competence or performance of the university students but rather the prerequisites for performance. This approach means that the test person should be able to assess a situation involving resource overutilization properly. Hence, in our study, we plan to measure the knowledge of university students in three domains relevant to sustainable resource management: ecological, socio-economic, and institutional domains.

In a previous study, Authors (submitted) differentiated between situational, conceptual, and procedural types of knowledge and the three knowledge domains. Situational knowledge with university students did not increase from the 3rd to the 7th semester. Conceptual knowledge increased in the ecological and socioeconomic knowledge domain but not in the institutional knowledge domain. Student judgments on the efficacy of institutional solution strategies for dilemmas regarding the use of natural resources (procedural knowledge) differed strongly from expert judgments. They concluded that the social and institutional aspects of natural resource conservation need to become more thoroughly integrated into university curricula.

The purpose of this study is to explore whether students and graduates in natural resource management programs in Indonesian universities have a well-balanced education to meet the needs of sustainable development, possessing knowledge not only in the their specific areas of study but also in other relevant fields concerning sustainable development.

7.2 Methods

7.2.1 Sample

The sample consisted of nearly all 3rd and 7th semester university students in seven programs related to natural resources at the Faculty of Forestry, Faculty of Fisheries and Marine Sciences, Faculty of Mathematics and Natural Sciences, Faculty of Economics and Management and the Faculty of Human Ecology at Institut Pertanian Bogor (IPB) (n=882). IPB is the leading Indonesian institution of higher education in the field of agronomy, forestry and marine sciences, and managing the utilization of natural resources and biodiversity is one of their four pillars of strategic focus. Many of the students are likely to become decision makers or educational multipliers in the field of sustainable resource management and conservation after graduation. The 3rd semester university students (n=447) were on average 18.97 (SD =0.675) years old, and the 7th semester university students (n=405) were on average 21.01 (SD =0.522) years old. Reflecting the over-representation of female students in the sampled programs, two thirds (66.4%) of our sample were female.

7.2.2 Data Collection

On the basis of a previously conducted qualitative, in-depth interview study (Authors, 2012), expert consultations, and literature review, we developed a quantitative questionnaire. The questionnaire was translated into Indonesian, translated back by an independent researcher, and then revised with respect to language. It was then pretested in Indonesia with university students in their 5th semester (n=409) and slightly revised. The final instrument presented two problem descriptions of resource overutilization in an open-access situation, one terrestrial and one aquatic. The two problem descriptions involved short, hypothetical, and science-based textual stimuli of local families finding themselves in a commons dilemma situation. The descriptions were written in a colloquial style that avoided technical language. The first description addressed the overexploitation of rattan (*Calamus spp.*), a non-timber forest resource occurring, for

example, in the Lore Lindu region of Central Sulawesi (Siebert, 2004). Rattan is traded internationally, most commonly in the furniture industry. Overfishing aggravated by dynamite fishing near the shore of the Indonesian Sunda Sea was the basis of the second problem description. Nine multiple-choice items referred to each problem description with three items per knowledge domain. In the second part of the questionnaire, 15 more generally formulated items beyond the problem description (but still involving the typical characteristics of commons dilemmas) addressed non-timber forest products and marine resources, with five in each knowledge domain. Hence, eleven items were assigned to each of the three knowledge domains (ecological, socioeconomic, and institutional knowledge). All 33 items covered ecological, socioeconomic or institutional factors. The results of a third part of the questionnaire were presented elsewhere (Authors, submitted). The survey was conducted in 2010 and took between 45 and 60 minutes to complete.

All university students in seven programs related to natural resources were selected to participate. Each program was associated with a department. First, we assigned each of the seven study programs, or departments, to one of the following areas of study: ecological focus (*Eco*), social focus (*Soc*), and environmental economics focus (*Env*) (see table 2). Due to the focus of IPB on agronomy, forestry and marine sciences, most of the study participants were assigned to the ecological focus area of study. All participating university students at the Faculty of Forestry (Department of Forest Management, Department of Forest Resource Conservation and Ecotourism), the Faculty of Fisheries and Marine Sciences (Department of Fisheries Resource Utilization, Department of Living Aquatic Resources Management) and the Faculty of Mathematics and Natural Sciences (Department of Biology) were grouped as students with an ecological focus (*Eco*). Students enrolled at the Faculty of Human Ecology studying Communication and Community Development were assigned to social aspects (*Soc*), i.e., socioeconomic knowledge. Finally, university students at the Faculty of Economics and Management who were enrolled in the Environmental and Resource Economics program were assigned to environmental economics (*Env*), i.e., institutional knowledge.

Table 1: IPB departments and hypothesized knowledge domain.

Area of Study	**Study Programs (IPB Departments)**
Ecological (Ecological Knowledge)	Forest Management, Forest Resource Conservation and Ecotourism, Fisheries Resource Utilization, Living Aquatic Resources Management, Biology (n=580)
Social (Socio-economic Knowledge)	Communication and Community Development (n=161)
Environmental Economics (Institutional Knowledge)	Environmental and Resource Economics (n=141)

We surveyed 3rd and 7th semester university students because, due to regional differences in high school curricula in Indonesia, all students at IPB had to study the same subjects without specialization in their first year in order to bring them to the same educational level. While students begin their specific programs in the 3rd semester, the 8th semester is generally reserved for carrying out field research and final thesis preparation.

We therefore hypothesized that students in their 3rd semester started with more or less homogeneous knowledge concerning the ecological, socioeconomic, and institutional domains depending on their interest, whereas students in their 7th semester showed knowledge gains only in their specialized fields of study. Table 1 documents the a priori categorization of departments (i.e., areas of study) within knowledge domains.

7.2.3 Analysis

The 33 multiple-choice items were coded as either incorrect (zero) or correct (one) and analyzed using confirmatory factor analysis (CFA) to show the construct validity of the assessment of three domains, namely, ecological, socio-economic, and institutional knowledge with satisfactory fit indices (Authors, submitted).

To test for differences in knowledge increases between 3rd and 7th semester university students, an Analysis of Variance (ANOVA) was applied to examine the items' domain of knowledge (3) * participants' area of study (3) * the semester (2) variance sources, with repeated measures on the first factor by PASW 18 (SPSS Inc., 2009). In addition, Cohen's *d* values were calculated for the mean value differences between both semester groups.

7.3 Results

Of the total sample, 580 university students were grouped as having an ecological focus, 161 had a social focus, and 141 had an environmental economics focus. Across all participants and the three knowledge domains, the correctness was moderate (mean 0.56, SD = 0.11) and symmetrically distributed (skewness = -0.048, SE =0.048, n=2646 cases). The minimum reached mean score was 0.21, and the maximum reached mean score was 0.88.

Repeated measures ANOVA with the domain of knowledge as a repeated measures factor and area of study and semester as group factors revealed all three main effects; the interaction effects of (i) area of study*domain and (ii) area of study*domain*semester were significant (see table 2).

Table 2: ANOVA of knowledge in a 3*3*2 design: Domain of knowledge (ecological knowledge; socio-economic knowledge; institutional knowledge) is a repeated measures factor, area of study of the participants (ecological focus; social focus; environmental economics focus, see table 1) and semester (3rd, and 7th) are group factors.

Source of Variance	df_w	df_b	F	p	eta²
Area of Study	2.00	876.00	5.99	.003	.016
Domain	1.99	1746.07	74.47	<.001	.078
Semester	1.00	876.00	17.54	<.001	.020
Domain*Semester	1.99	1746.07	.73	.481	.001
Area of Study *Semester	2.00	876.00	.60	.548	.001
Area of Study *Domain	3.99	1746.07	8.48	<.001	.019
Area of Study *Domain*Semester	3.99	1746.07	3.90	.004	.009

Note: Because Mauchly's test indicated a violation of sphericity (chi-square = 9.61, p < .008), degrees of freedom were corrected using Huynh-Feldt estimates of sphericity (epsilon = 0.997).

7.3.1 Ecological area of Study

Confirming our hypothesis, university students enrolled in study programs with an ecological focus—i.e., the investigative departments at the Faculty of Forestry (Department of Forest Management, Department of Forest Resource Conservation and Ecotourism), the Faculty of Fisheries and Marine Sciences (Department of Fisheries Resource Utilization, Department of Living Aquatic Resources Management) and the Faculty of Mathematics and Natural Sciences (Department of Biology)—showed a substantial increase in the ecological knowledge domain from 0.616 (SD =0.157) to 0.670 (SD =0.167; Cohen's d =0.337). However, they did not increase their knowledge, either in the socioeconomic knowledge domain (0.523, SD =0.149 compared to 0.532, SD =0.140, Cohen's $d < 0.1$) or in the institutional knowledge domain (0.509, SD =0.156 compared to 0.538 SD =0.154, Cohen's $d < 0.2$).

7.3.2 Social Area of Study

University students with a social study focus (area of study), i.e., students enrolled at the Faculty of Human Ecology and the Department of Communication and Community Development, were the only group showing a significant increase from the 3rd to the 7th semester in the socioeconomic knowledge domain from 0.509 (SD = 0.157) to 0.584 (SD = 0.149) with a virtually medium effect size (Cohen's d = 0.495). However, they showed no significant increase in the ecological knowledge domain (0.556 (SD = 0.154) to 0.573 (SD = 0.148); Cohen's $d < 0.15$) nor in the institutional knowledge domain (0.503 (SD = 0.165) to 0.494 (SD = 0.181), Cohen's $d < 0.1$).

7.3.3 Environmental Economics Area of Study

University students with a focus on environmental economics, i.e., students enrolled at the Faculty of Economics and Management (Department of Environmental and Resource Economics), showed a significant increase in the institutional knowledge domain from 0.518 (SD =0.160) to 0.587 (SD = 0.122) with a medium effect size (Cohen's d = 0.515). In addition, they also showed a significant increase in the ecological knowledge domain from 0.602 (SD = 0.179) in the 3rd semester to 0.674 (SD = 0.162) in the 7th semester with a small effect size (Cohen's d = 0.428). However, there was no significant observable increase between 3rd and 7th semester students majoring in environmental and resource economics in the socioeconomic knowledge domain (0.534 (SD = 0.126) to 0.544 (SD = 0.130), Cohen's $d < 0.1$).

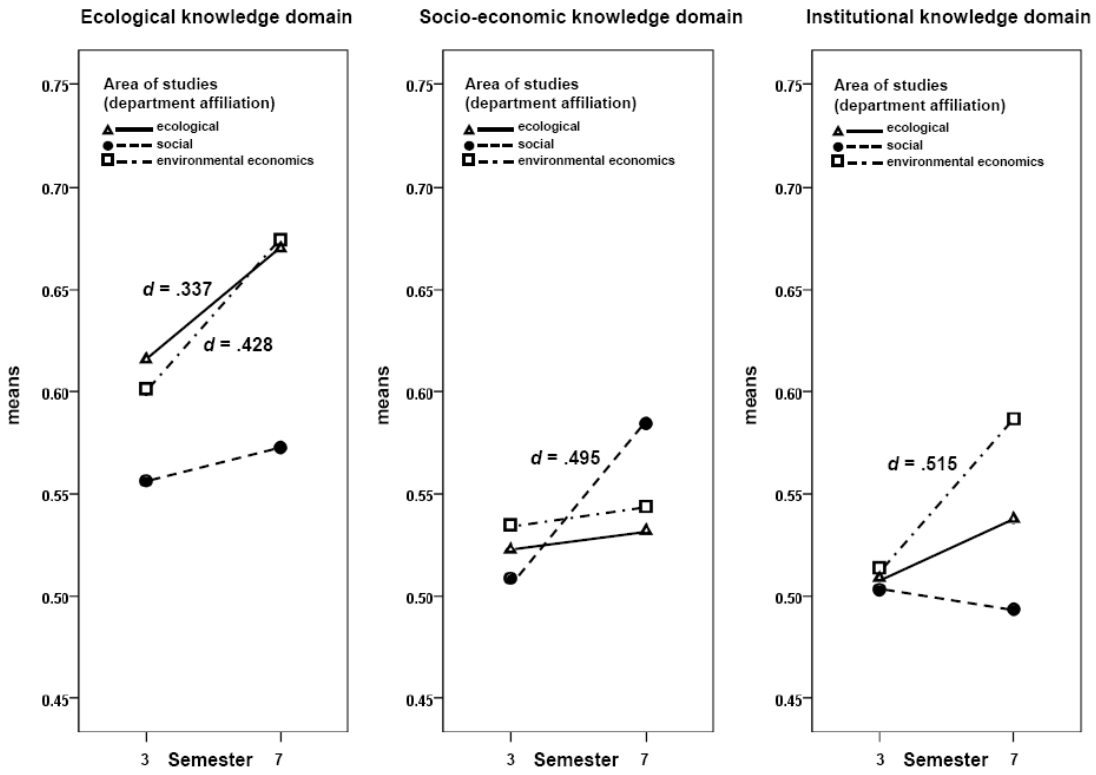

Figure 1: Mean knowledge change between 3rd and 7th semester university students in knowledge domains and area of study. Relevant differences are shown with Cohen's *d* effect size.

7.4 Discussion and Conclusion

This study was aimed at investigating knowledge of university students in programs related to natural resource management at IPB, the leading Indonesian institution of higher education in the field of agronomy, forestry and marine sciences. We focused on three knowledge domains relevant to sustainable resource management: ecological knowledge, socioeconomic knowledge and institutional knowledge. Comprehensive knowledge of all three domains is a prerequisite for being able to assess resource overutilization problems in their entirety. Thus, we examined whether the university students increased their knowledge between the 3rd and 7th semester, not only in their specific study programs but also in other domains relevant to sustainable development.

7.4.1 Methodological Reflection

We applied a quantitative multiple-choice item approach to measure the increase in the knowledge of university students in three knowledge domains. The questionnaire used non-technical language to address ecologically, socio-economically, and institutionally contextualized resource management issues. The goal was to yield results with regard to the prerequisites for sustainable resource management that would be more reliable than assessing knowledge via the reproduction of concepts and definitions (de Haan, 2006).

The increase in knowledge in students' related area of study between the 3rd and 7th semester is essential for discussing the results. In other words, for students with an ecological focus (area of study), there should be a significant increase between beginners (3rd semester) and graduates (7th semester) in the ecological knowledge domain. University students with a social focus should at least show a significant increase in socioeconomic knowledge. Lastly, university students with a focus on environmental economics should at least show a significant increase in the institutional knowledge domain. Though not surprising, these observations are important for further discussing the results.

From a methodological perspective, we could conclude that our instrument is effective, as it measures what it should measure, particularly domain-specific knowledge. However, in terms of transferability, we were limited because we only surveyed one university. Nevertheless, IPB is the leading institution of higher education for natural resource management, and it accepts only the most qualified students from Indonesia and abroad. It is unlikely that students better educated in natural resource management could be found anywhere else in Indonesia.

7.4.2 Interpretation of Results

Depending on the area of study and the three knowledge domains, we found differences in the increase of knowledge between 3rd and 7th semester university students. Students with an ecological area of study significantly increased their knowledge in the ecological knowledge domain. However, we did not find significant increases either in the

socioeconomic or the institutional knowledge domain. Likewise, students with a focus on social area of study showed a significant increase solely in the socioeconomic knowledge domain and not in the ecological or the institutional knowledge domain. With regard to the environmental economics area of study, we found significant increases not only in the institutional knowledge domain but also in the ecological knowledge domain. However, no significant increase was found in the socioeconomic knowledge domain.

In summary, we found differences in the increase of knowledge depending on university students' areas of study. Not surprisingly, university students showed significantly higher increases in the knowledge domain related to their particular area of study. However, the vast majority of the students exhibited an interdisciplinary gap. Students with an environmental economics focus were the exception, though they did not show significant increases in all of the three knowledge domains. Nonetheless, we referred to university students' prerequisites to appropriately assess natural resource overutilization situations with regard to sustainable development but not to the performance of the university students themselves. However, without an adequate prerequisite, adequate performance would not be possible. Critics may contend that focusing on environmental economics directly addresses the typical characteristics of environmental commons dilemmas, and as a consequence, students who study environmental economics are better prepared to address natural resource overutilization problems. However, the other investigated departments or disciplines also claimed to contribute to such problems in fostering sustainable resource management.

Our results are in line with the few existing studies that focus on learning outcomes with regard to natural resource overutilization situations. For example, German and Chilean high school students had problems identifying the social and economic dimensions in the wild collection of Boldo (*Peumus boldus*) and Devil's claw (*Harpagophytum procumbens*; Menzel & Bögeholz, 2009). With a broader focus, Tuncer (2008) showed that university students from Turkey did not have a sufficient understanding regarding issues concerning sustainable development, whether they were enrolled in an environmental-related program or not.

Although the importance of interdisciplinary education has long been recognized (Barnett, Ellemor, & Dovers, 2003), the reason for the gaps in ESD is deeply rooted in the disciplinary aspects of education and curricula development (Raivio, 2011). In many current programs of higher education, the disciplinary focus leads to graduates possessing specific knowledge in their area of study, without a full understanding of the consequences or interrelations of other fields (Lozano, 2006). To counter this, we would argue that, for example, some programs show increases not only in their area of study but also in other knowledge domains. In addition, Hansmann et al. (2010) provides evidence that interdisciplinary education with regard to sustainable development has been proven to help students succeed in their professional careers.

The national guidelines for the development of higher education in Indonesia demand the improvement of student abilities in sustainable resource management (Direktorat Jenderal Pendidikan Tinggi [General Directorate of Higher Education], 2003). The Indonesian Government provides training in environmental education (Nomura, 2009), though Indonesian universities are only advised to integrate ESD into their curricula. Currently, there are no rules or regulations on the implementation of ESD in higher education (Direktorat Jenderal Pendidikan Tinggi [General Directorate of Higher Education], 2010).

The DESD progress report criticizes how most efforts towards ESD have been made at the primary and secondary school level. However, tertiary education is still lacking (UNESCO, 2009). Hence, we conclude that national curriculum planners in Indonesia may wish to check, and potentially adjust, the contents of programs related to natural resource conservation in higher education. Otherwise, the second half of the UN Decade of Education for Sustainable Development may pass without providing decision makers in the field of sustainable resource management and conservation some of the most crucial knowledge needed to use natural resources sustainably.

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CHAPTER 8:
Globale Einflüsse in tropischen Frontierzonen: Kakaoboom contra Naturschutz in Sulawesi, Indonesien

Geographische Rundschau (*accepted*)

Heiko Faust und Sebastian Koch

8.1 Einführung

Tropische Regenwälder und ihre Randzonen (*Frontiers*) treten in den Fokus der Weltöffentlichkeit, weil sie einerseits bedeutende globale ökologische Funktionen übernehmen, wie die Bewahrung der Biodiversität oder die Kohlenstoffspeicherung. Andererseits wecken sie in einem zusammenwachsenden Weltmarkt ökonomische Begehrlichkeiten für den Anbau agrarischer Rohstoffe, wie aktuell die Cash Crops Soja, Kakao oder Ölpalme. Indonesien besitzt nach Brasilien und der Demokratischen Republik Kongo die drittgrößten Bestände tropischer Regenwälder weltweit, zugleich ist das Land aber auch von sehr hohen Entwaldungsraten gekennzeichnet. Die Frontierzonen der tropischen Bergregenwälder in Sulawesi sind von der Umwandlung in Kakao-Agroforstsysteme besonders bedroht. Ein ökonomisch und ökologisch ausgeglichenes Schutz- und Nutzungskonzept dieser peripheren Region ist dringend erforderlich, es erscheint mit lokal angepassten internationalen Anreizstrategien nachhaltig umsetzbar.

8.2 Das Konzept der Frontier

Das Frontierkonzept beschreibt Grenzlagen des Siedlungs- und landwirtschaftlichen Erschließungsraums von Nationalstaaten, erweitert historische europäische Modelle der Eroberung und trennt die konstruierten Gegensatzpaare „Wildnis“ und „Zivilisation“ (*Doevenspeck* 2005, S. 20). Darüber hinaus ist die Frontier in mehrdimensionale Interaktionsketten eingebunden und wird als Verbindungsraum („connected space“) betrachtet. Damit bietet sie ein analytisches Konzept zur Untersuchung von sozioökonomischen Prozessen in peripheren ruralen Räumen. Dieses erfasst modellhaft deregulierte Räume mit schwacher Staatlichkeit, in denen beispielsweise naturnahe Wälder gerodet werden, um sie einer agroforstlichen oder agrarischen Nutzung zuzuführen (*Fold und Hirsch* 2009, S. 95f; vgl. *Foto 1*). In der Frontierzone treffen unterschiedliche und sich ständig wandelnde Naturkonstruktionen und Ressourcennutzungsmuster aufeinander. Konkreter gefasst: Lokale Subsistenzstrategien

treffen unter Bedingungen eines fehlenden oder schwachen Rechtsstaates auf unkontrollierte Formen der Ressourcenausbeutung. Im Zuge der Globalisierung verlieren Nationalstaaten und deren administrative Einheiten zunehmend ihr ordnungspolitisches Monopol (*Lee und Stokes* 2009, S. 3).

Foto 1: J. Steiner, Brandrodung innerhalb des Lore Lindu Nationalparks.

Die Frontier befindet sich nicht nur in einem ökonomischen Übergangsstadium der Landnutzung, sondern in ihr artikulieren sich auch politische Transformationen, die häufig von Spannungen und Auseinandersetzungen begleitet werden. Hier verschwimmen Grenzen zwischen Recht und Unrecht, zwischen Formalität und Informalität. Die Frontier ist folglich als dynamische Aushandlungsarena zu verstehen. Es konkurrieren bestehende Ressourcennutzungsmuster verstärkt mit marktbasierten internationalen Waldschutzmechanismen wie „Payments for Environmental Services" (PES) und „Reducing Emissions from Deforestation and Degradation" (REDD) (vgl. *Textbox 1*). Eine zentrale These des Frontierkonzeptes lautet, dass deren spezifische

Dynamik maßgeblich auch durch externe Prozesse, wie globale Marktpreisschwankungen, nationale Politiken oder neue internationale Regime, wie z.B. Klimaschutzmechanismen, beeinflusst wird (*Hecht* 2011, S. 215). Dadurch entstehen jeweils räumlich spezifische Frontierzonen, die aufgrund der regionalen gesellschaftlichen Kontexte und naturräumlichen Ausstattung unterschiedliche Veränderungsdynamiken und Sukzessionen zeigen (vgl. *Textbox 2).*

8.3 Die Kakaoanbau-Frontierzone

Transformationsprozesse in peripheren tropischen Regenwaldrandlagen sind eng mit globalen Nachfrageentwicklungen nach agrarischen Rohstoffen verknüpft, was hier am Beispiel der Kakaopflanze dargestellt wird. In Indonesien schreitet die Umwandlung von Primärwäldern in Kakao-Agroforstsysteme in einer Kakaoanbau-Pionierzone voran (vgl. *Clarence-Smith und Ruf* 1996). Die Ausdehnung der Anbaufläche für Kakao erfolgt zunächst unterhalb der Kronenschicht des Primärwaldes. Junge Kakaobäume ersetzten dabei das entfernte Unterholz, zum Teil in Kombination mit weiteren Kulturpflanzen. Das Voranschreiten der Kakao-Frontierzone in den Primärregenwald hinein ist von extensiver Bewirtschaftung mit hohen Gewinnen bei geringer Produktivität geprägt, aber auch von Abholzungen der Schattenbäume (vgl. *Foto 2*). Zudem wird es häufig von unklaren Landeigentumsverhältnissen und korrumpierbaren Strafverfolgungs-maßnahmen begleitet (vgl. *Koch et al.* 2008).

Foto 2: J. Steiner, Vorrücken der Frontier mit Abholzung der Schattenbäume.

Bedingt durch Schädlingsbefall und Krankheiten sowie rückläufiger Bodenfruchtbarkeit fallen die zunächst hohen Gewinne im Laufe der Zeit. Die Kakaobauern reagieren darauf mit der Ausdünnung und sukzessiven Rodung neuer Flächen im Primärwald. Darüber hinaus findet eine Intensivierung über den Einsatz von Pestiziden und Düngemitteln sowie über die Ausdünnung der Beschattung statt. Dies geht einerseits mit deutlichen Ertrags- und Gewinnsteigerungen einher, andererseits mit einem erheblichen Verlust an biologischer Vielfalt (vgl. *Steffan-Dewenter et al. 2007; Juhrbandt et al.* 2010). Die Frontierzone schiebt sich damit immer weiter in den Regenwald vor.

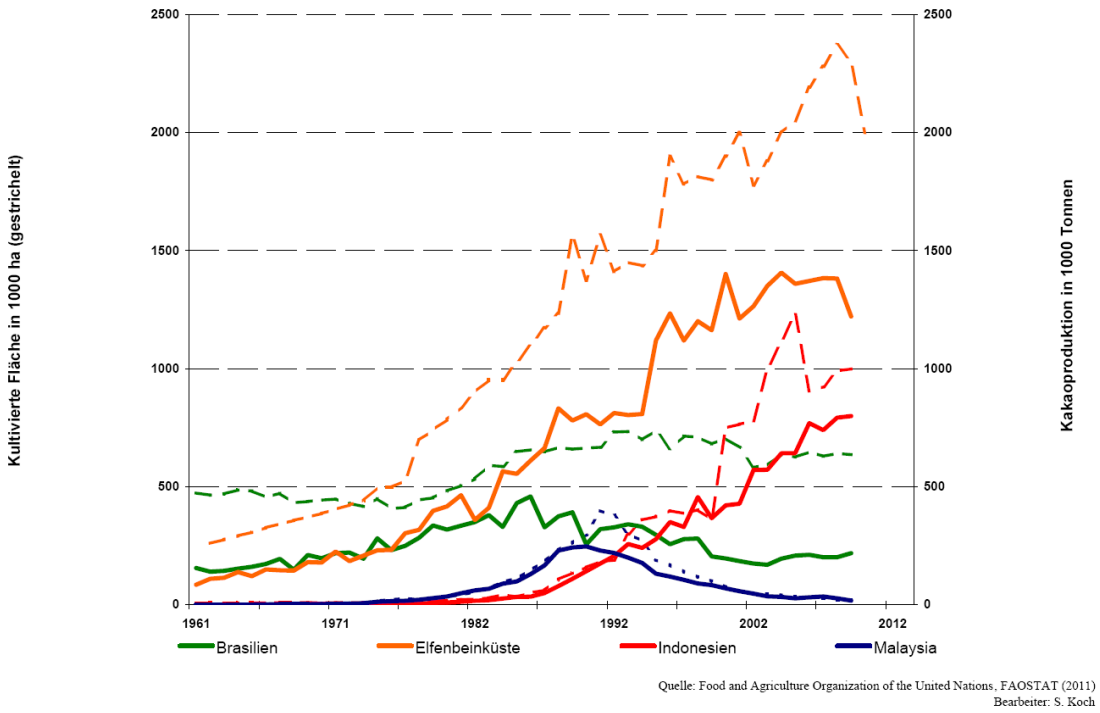

Abb. 2: Entwicklung der Kakaoproduktion in ausgewählten Staaten 1961-2012.

Weit verbreitete Kakaomonokulturen als Resultat des Kakaobooms haben sowohl in Brasilien als auch in Malaysia zu verheerendem Krankheits- und Schädlingsbefall geführt. („bust“, vgl. *Abb. 2*). Die Pionierfront verlagerte sich Ende der 1990er Jahren nach Indonesien in die noch wenig erschlossenen und dünn besiedelten Bergregenwaldregionen von Sulawesi, so dass Indonesien in wenigen Jahren zum zweitgrößten Kakaoprozenten nach der Elfenbeinküste aufstieg (vgl. *Clough et al.* 2009). Die Lage der Kakaoanbauregionen in und nahe an Hotspots der Biodiversität weist auf aktuelle und potentielle Konflikte über Schutz- und Nutzungskonzepte der Randzonen tropischer Regenwälder hin (vgl. *Abb. 3*).

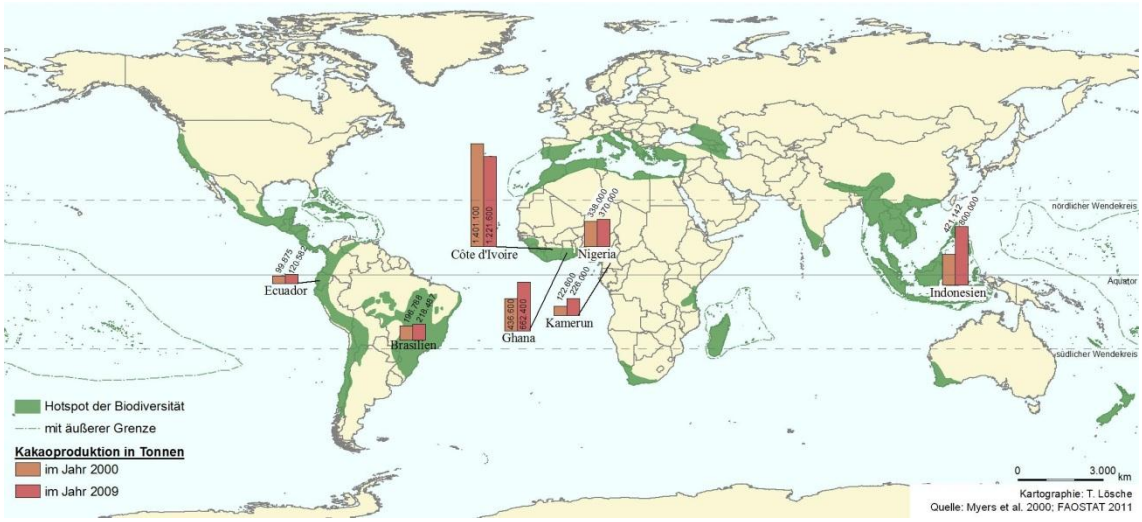

Abb. 3: Kakaoproduktion 2000 und 2009 sowie Hotspots der Biodiversität.

8.4 Die Lore Lindu Region in Zentralsulawesi

Die in Zentralsulawesi gelegene Lore Lindu Region um den gleichnamigen Nationalpark (vgl. *Abb. 4*) war, im Gegensatz zu anderen Gebieten auf den indonesischen Inseln Java und Bali, zunächst ziemlich abgeschieden. Zu Beginn des 20. Jahrhunderts wurden unter niederländischer Kolonialherrschaft Zwangsumsiedlungen von den schwer zugänglichen Bergregionen in leichter kontrollierbare Tal-Gebiete durchgeführt. Dort wurde im Rahmen eines subsistenzorientierten Wanderfeldbaus Cassava, Trockenreis und Mais angebaut Ab Mitte der 1960er Jahre betrieb die Regierung unter dem damaligen Präsidenten Suharto und dessen ‚Politik der Neuen Ordnung' die Mechanisierung und Intensivierung der Landwirtschaft, vorwiegend wurden der Nassreisanbau, aber auch Cash Crops wie Kaffee, Gewürznelken und Vanille gefördert. Der Wanderfeldbau wurde zwar schrittweise verdrängt, der landwirtschaftliche Mechanisierungsgrad blieb aber zunächst noch gering. Der Kakaoanbau verbreitete sich in Lore Lindu zu Beginn der 1980er Jahre durch eingewanderte Migranten aus Südsulawesi. Gute klimatische Bedingungen sowie die relativ große Landverfügbarkeit boten sehr gute Voraussetzungen hierfür. Kurze Zeit später kam es zu einem wahren Kakaoboom, was einen starken Bevölkerungszuzug aus anderen Regionen nach sich zog (vgl. *Weber et al.* 2007). Die Bevölkerung in der Lore Lindu Region stieg von ca. 44.000 im Jahre 1960

auf etwa 140.000 im Jahr 2006. Dies entspricht einem jährlichen Zuwachs von 2,5% und lag deutlich über dem indonesischen Durchschnitt von 1,87%pro Jahr für denselben Zeitraum. Damit erhöhte sich auch die Bevölkerungsdichte der Region von sechs auf 19 Einwohner pro km².Dieser Wert liegt allerdings immer noch deutlich unter dem indonesischen Gesamtdurchschnitt von 125 Einwohnern pro km² (*EIU* 2007).

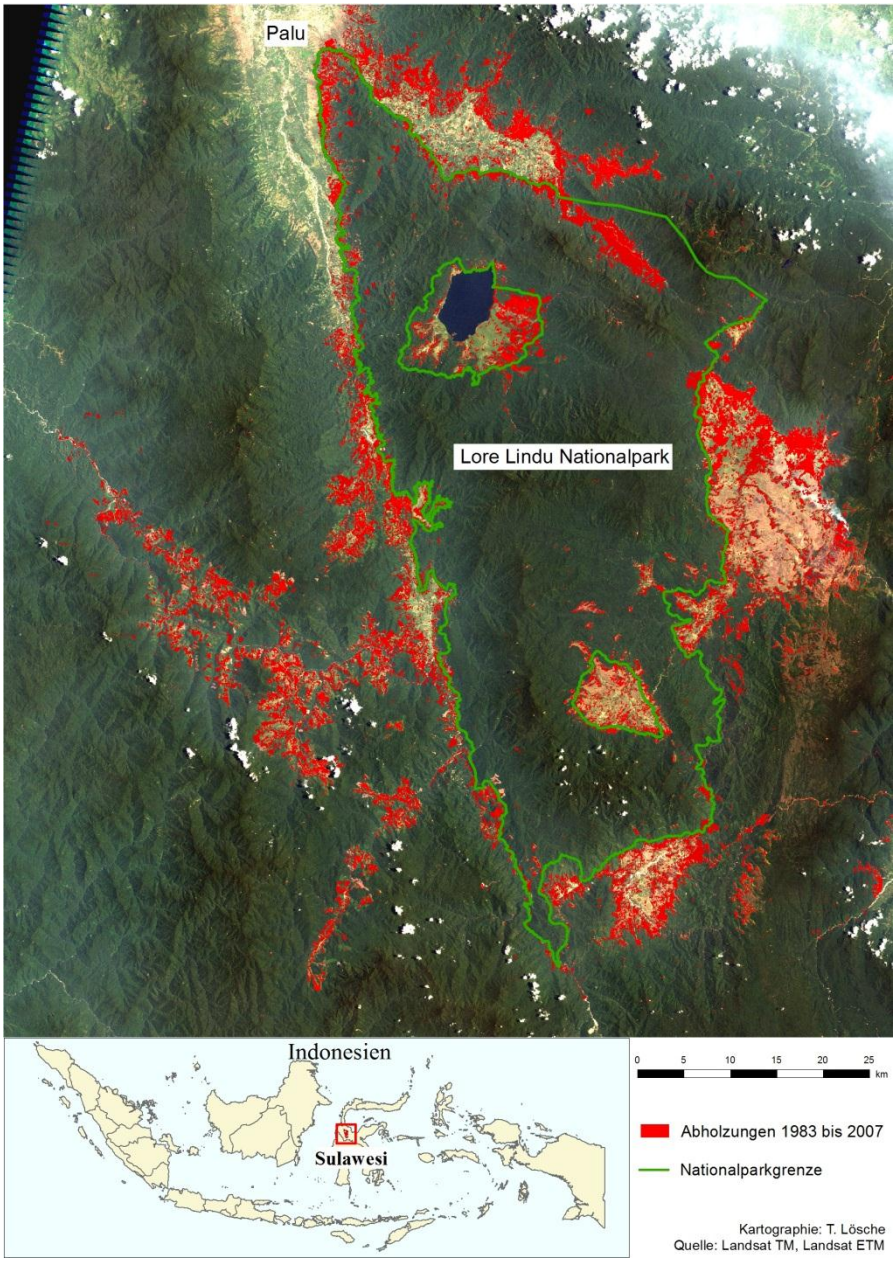

Abb. 4: Abholzungen in und um den Lore Lindu Nationalpark 1983-2007.

Zeitgleich zur Verbreitung der Kakaopflanze in Zentralsulawesi wurde im Jahr 1982 das bereits seit Ende der 1970er Jahre errichtete Biosphärenreservat Lore Lindu mit einer Fläche von ca. 2.300 km² zum Lore Lindu Nationalpark erklärt. Im Hintergrund stand die Erkenntnis und Einsicht, dass die Bergregenwälder in Zentralsulawesi eine entscheidende Rolle bei der Erhaltung der endemischen Flora und Fauna des globalen Wallacea Biodiversitäts-Hotspot spielen. Mit der Einrichtung des Schutzgebietes sollte die fortschreitende Frontierzone gestoppt werden (vgl. *Weber et al.* 2007). Innerhalb der zwei Jahrzehnte von 1980 bis 2001 hatte die landwirtschaftlich genutzte Fläche in der Region aber um 56%, hauptsächlich zu Lasten des tropischen Regenwaldes, zugenommen. Der Schutzgebietsstatus führte zwar zu einer Verlangsamung dieses Landnutzungswandels, konnte diesen allerdings bisher nicht stoppen (vgl. *Schwarze et al.* 2009). Die Flächen in der Lore Lindu Region, auf denen Kakao angebaut wird, sind von ursprünglich null ha im Jahr 1979 auf über 20.000 ha im Jahr 2007 gestiegen (vgl. *Reetz* 2008). Die Flächenausweitung erfolgte zunächst durch die Umwandlung von Anbauflächen in den flachen Tälern. Seit einigen Jahren lässt sich jedoch feststellen, dass die Flächenausweitung hauptsächlich durch Rodung außerhalb und innerhalb des Lore Lindu Nationalparks stattfindet (vgl. *Abb. 4)*. Die steigende Nachfrage nach Kakao ist damit zu einer treibenden Kraft bei der Abholzung des Bergregenwaldes in Zentralsulawesi geworden (vgl. *Barkmann et al.* 2010).

8.5 Der Lore Lindu Nationalpark als Frontierzone

Die Lore Lindu Region bietet beispielhaft die Merkmale einer Frontierzone: komplexe Konflikte zwischen den globalen Interessen zum Schutz tropischer Regenwälder mit dem Erhalt biologischer Vielfalt sowie der Kohlenstoffspeicherkapazität einerseits und den Interessen der zum Teil unterhalb der Armutsgrenze lebenden lokalen Bevölkerung andererseits. Zu den Hauptakteuren der Kakaoproduktion zählen nahezu ausschließlich lokale Kleinbauern (vgl. *Foto 3*). Vor dem Hintergrund des allgemein niedrigen Lebensstandards bietet der Kakaoanbau verbesserte Möglichkeiten ein auskömmliches Einkommen zu erwirtschaften. Zentralsulawesi gehört zu den ärmsten Provinzen

Indonesiens (vgl. *van Edig et al.* 2010) und hat – durch den einsetzenden Kakaoboom – mit 19% den größten Anteil an der indonesischen Gesamtkakaoproduktion (*Cocoa World News*, September 2010). Für die Kleinbauern ist es von großer ökonomischer Bedeutung, dass weder durch Ausfuhr-Restriktionen noch durch Exportzölle der produzierte Mehrwert ortsfremden nationalen Interessen zugeschanzt oder direkt abschöpft wird, und so erreichen bisher ca. 70% des Weltmarktpreises tatsächlich die lokalen Kakaobauern (vgl. *Juhrbandt et al.* 2010).

Foto 3: N. Munck, Kleinbauern trennen Fruchtfleisch und Samen (Bohnen).

Die Ausweisung besonders schützenswerter Gebiete als Nationalpark konterkariert jedoch die Entfaltungsmöglichkeiten der lokal ansässigen Bevölkerung. Die Ausweitung von Schutzgebieten in Ländern mit geringem Einkommen hat vor allem negative Auswirkungen für die lokale Bevölkerung, da dieser die Nutzungsmöglichkeiten entzogen werden. Wohingegen die Hauptnutznießer des Biodiversitätsschutzes Kosumentinnen und Konsumenten aus Ländern mit hohen Einkommen sind. (vgl.

Bawa et al. 2004). Um diesem Ungleichgewicht der Kosten und Nutzen des Erhalts der biologischen Vielfalt entgegenzuwirken, müssen einerseits Anreizsysteme entwickelt werden, um die lokale Bevölkerung für die entstehenden Kosten zu entschädigen. Andererseits müssen gleichzeitig Governance-Strukturen, d.h., die institutionellen Rahmenbedingungen geschaffen werden, die dieses ermöglichen und auch kontrollieren (vgl. *Mehring et al.* 2011).

8.6 Vom Boom zur Nachhaltigkeit

Nach Jahren des Booms gibt es in jüngerer Zeit erste Anzeichen für stagnierende oder sogar rückläufige Kakaoerträge. Bedingt durch Intensivierung des Kakaoanbaus breiten sich seit einigen Jahren Schädlinge und Krankheiten in der Region aus (vgl. *Clough et al.* 2009). In der ersten Hälfte des Jahres 2010 war die Erntemenge auf der gesamten Insel Sulawesi, welche einen Anteil von 65% an der indonesischen Gesamtkakaoproduktion hat, um über 40% – im Vergleich zum selben Zeitraum des Vorjahres – gesunken und die Jahresgesamternte in Indonesien könnte zukünftig auf ca. 420.000 t sinken. Gründe hiefür sind in erster Linie veränderte Wetterbedingungen und die dadurch verstärkte Ausbreitung von Schädlingen und Krankheiten (*The Jakarta Globe*, 19. Juli 2011).

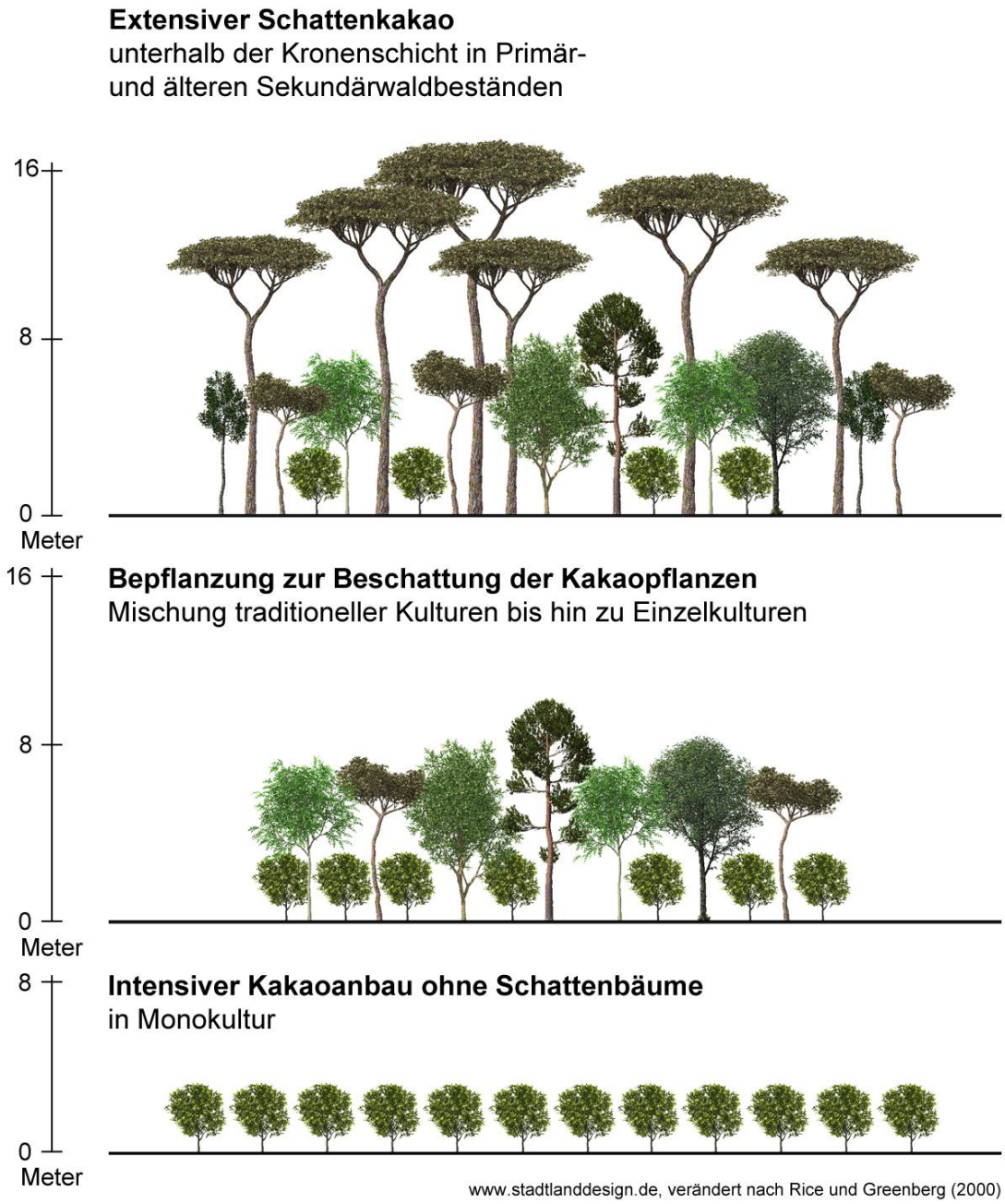

Abb. 5: Kakaoanbau und Schattenbäume.

Interdisziplinäre Untersuchungen der Universitäten Göttingen, Kassel, Bogor und Palu in Sulawesi zeigen aber, dass eine nachhaltige Perspektive sowohl ökonomisch als auch ökologisch möglich ist (vgl. *Steffan-Dewenter et al.* 2007). Vor dem Hintergrund der lokalen Bedürfnislage in Regionen mit hoher biologischer Vielfalt existieren Chancen und Wege moderate Lebensverhältnisse – wie etwa durch den wirtschaftlich reizvollen Anbau von Kakao – mit den globalen Zielen des Schutzes und Erhalts der biologischen Vielfalt zu verbinden. Ein angepasster Anbau mit einer ausreichenden Zahl an Schattenbäumen in der Frontierzone bietet einen Kompromiss zwischen ökonomischen Zwängen und ökologischen Notwendigkeiten (vgl. *Abb. 5*). Kakao-Agroforstsysteme, die die floristische Vielfalt und die strukturell-komplexen Beschattungssysteme bewahren, haben das Potenzial auch einen hohen Anteil an biologischer Vielfalt zu erhalten (vgl. *Tscharntke et al.* 2011, vgl. *Foto 4*).

Foto 4: B. Michalzik, Nachhaltige Kakaofrontier mit Kakaopflanzung unter Schattenbäumen.

Starke lokale Institutionen begünstigen eine nachhaltige Bewirtschaftung in den Übergangszonen des Regenwaldrandbereichs. Sie sind notwendige Voraussetzung zur Kontrolle ausgehandelter Schutz- und Nutzungskonzepte (vgl. *Mehring et al.* 2011). Allein sind sie aber noch kein Garant für den Kakaoanbau in extensiven Agroforstsystemen oder den Erhalt der Biodiversität. Deshalb sind zusätzliche Anreizinstrumente nötig, um die finanziellen Vorteile der Intensivierung im Kakaoanbau gegenüber extensiven Anbaumethoden auszugleichen. Ältere Mechanismen wie beispielsweise Aufschläge für fair gehandelte Produkte zielen zwar auf die Verbesserung der Lebensbedingungen der lokalen Kleinbauern, sie berücksichtigen aber den Schutz und Erhalt der Biodiversität nur indirekt über die Bedingung eines möglichst umweltschonenden Anbaus. Neuere Konzepte setzen verstärkt auf wirtschaftlicher Anreize, sogenannte „Payments for Environmental Services" (PES). PES ist ein aus der Umweltökonomie stammendes Instrument zum Schutz und Erhalt von Ökosystemdienstleistungen (Ecosystem Services), welches auf direkte Kompensationszahlungen ausgerichtet ist. So können beispielsweise lokale Kleinbauern am Regenwaldrandbereich dafür „entschädigt" oder kompensiert werden, dass sie durch angepasste Anbaumethoden, die jedoch nur geringe Gewinne abwerfen, aktiv Arten-, Habitat- und Biodiversitätsschutz betreiben, was wiederum einen globalen Nutzten darstellt (vgl. *Wunder* 2007). Zertifizierungssysteme erweisen sich als geeignetes Instrument des Monitoring. Das Label bird-friendly®, der sich dem Schutz von Zugvögeln und dem Erhalt ihrer Habitate in Kaffeeanbaugebieten verschrieben hat, liefert hierfür ein gutes Beispiel.

8.7 Anreizinstrumente im Kakaoanbau

Für den Kakaoanbau existiert seit 2003 ebenfalls ein Zertifizierungssystem unter dem Label „Rainforest Alliance Certified", welches u.a. einen Mindestwert der Beschattung durch unterschiedliche Baumarten von 40% voraussetzt (vgl. *Juhrbandt* 2011). Die Konsumenten von Kakaoprodukten könnten durch die Zahlung eines Preisaufschlags auf zertifiziert „Regenwald-freundliche" Produkte ihre finanzielle Verantwortung für ihren Naturschutzanspruch wahrnehmen (vgl. *Steffan-Dewenter et al.* 2007).

Grundsätzlich muss berücksichtigt werden, dass Schutzkonzepte häufig mit Landnutzungen verbunden sind, die weniger gewinnträchtig sind als nicht-nachhaltige Formen der Landnutzung. Über die REDD und REDD+ Mechanismen könnten lokale Kleinbauern dafür kompensiert werden, dass sie über den Erhalt von Kohlenstoffbeständen in Wäldern und der nachhaltigen Nutzung einen entscheidenden Beitrag zur weltweiten Reduzierung von Emissionen aus Entwaldung und Degradierung von Wäldern leisten. Obwohl das primäre Ziel auf die Reduzierung von Emissionen fokussiert, kann die Bewahrung der Biodiversität als ein komplementärer Nutzen angesehen werden. Bereits im Oktober 2010 wurde die Provinz Zentralsulawesi aufgrund der großen Flächen noch intakter Primärregenwälder als Hauptgebiet für ein REDD Pilotprojekt ausgewählt. Die indonesische Regierung wird bei der Umsetzung von REDD+ Projekten von einer Verbundinitiative (UN-REDD Indonesia), bestehend aus dem indonesischen Forstministerium, dem UNDP (United Nations Development Programme), der FAO (Food and Agriculture Organization) und dem UNEP (United Nations Environment Programme) unterstützt. Insgesamt steht für die Umsetzung von Projekten durch UN-REDD Indonesia bisher ein Betrag von 5,6 Millionen US-Dollar zur Verfügung.

Verschiedene Vorhaben, u.a. in Gemeinden um den Lore Lindu Nationalpark, wurden bereits mit Vertretern von lokalen Nichtregierungsorganisationen (NGOs) und ansässigen Dorfgemeinschaften diskutiert. Die tatsächliche Umsetzung des REDD+ Pilotprojekts ist bis Ende 2012 vorgesehen, wobei eine Vielzahl von Problemen hinsichtlich der Umsetzung den Projektbeginn wiederholt verzögert haben (*The Jakarta Post*, 22. Januar 2011). Festzuhalten ist dennoch, dass der REDD+ Mechanismus als ein vielversprechendes PES in der Lore Lindu Region angesehen werden kann. Über REDD+ Zahlungen an starke lokale Institutionen könnten lokale Kleinbauern bei extensivem Kakaoanbau und bei Verzicht auf das Vordringen in den Primärwald kompensiert werden. Ein Vorteil dieser PES für den Anbau in weniger profitableren Agroforstsystemen wäre zudem eine verminderte Abhängigkeit von Marktpreisschwankungen (vgl. *Feintrenie et al.* 2011). Als Voraussetzung müssen sowohl die Eigentumsverhältnisse als auch die Strafverfolgungsmöglichkeiten innerhalb und außerhalb des Parks geklärt werden (vgl. *Linkie et al.* 2008).

8.8 Fazit und Ausblick

REDD und PES sind politische Instrumente, die der bisherigen Logik der Frontier entgegengesetzt sind. Die bisher meist auf kurzfristige Einnahmen zielenden Nutzungsregime, die anfänglichen Boom-Phasen folgen, werden hinterfragt (*McGregor* 2010, S. 27). Gleichzeitig wird durch REDD die staatliche Politik der Frontierexpansion, die in Indonesien insbesondere mittels des Umsiedlungsprogramms Transmigrasi vorangetrieben wurde und heute über die Vergabe von Konzessionen erfolgt, in Frage gestellt. Denn nicht mehr die Nutzung natürlicher Ressourcen ist mit Einnahmen verbunden, sondern deren Schutz. Auf kurzfristigen Nutzen gerichtete marktbasierte Landnutzungspraktiken treffen auf marktbasierte Schutzkonzepte. Der REDD-Mechanismus könnte, wenn man den vorherrschenden Erwartungen der Klimaschützer folgt, die bisherigen Nutzungspraktiken ändern und eine klimagerechtere Landnutzung einleiten. Nicht die Nachfrage nach agroindustriellen Produkten würde die Entwicklung in Regenwaldregionen dann bestimmen, sondern die Nachfrage nach Emissionszertifikaten. Der internationale REDD-Prozess befindet sich noch in einer sehr frühen Phase. Aber bereits heute entstehen Bedingungen, die die Potenziale des Mechanismus auf Jahre hinaus beeinflussen können.

Textbox 1: Was heißt REDD und REDD+?

In jüngster Vergangenheit wird die Verminderung von Emissionen durch Entwaldung und Degradation „Reducing Emissions from Deforestation and Degradation" (REDD) als ein Erfolg versprechender Mechanismus in der internationalen Klimaschutzpolitik viel diskutiert. Im Rahmen dieses Programms werden Zahlungen für Umweltdienstleistungen vorgenommen „Payments for Environmental Services" (PES). So erhalten lokale Akteure beispielsweise Ausgleichszahlungen, wenn sie keine weiteren Waldrodungen vornehmen. REDD wurde erstmals 2005 auf der 11. *Conference of Parties* (COP 11) *of the United Nations Framework Convention on Climate Change* (UNFCCC) auf die Agenda gesetzt. Zwei Jahre später, auf der COP 13 der UNFCCC in Indonesien, erfolgte die Erweiterung REDD+ als Bestandteil der *Bali Roadmap*. Das Ziel der Reduzierung von Emissionen aus Entwaldung und Degradation von Wäldern wurde durch drei weitere Aspekte ergänzt: (a) der Erhalt von Kohlenstoffbeständen in Wäldern, (b) die Erhöhung von Kohlenstoffbeständen in Wäldern und (c) die nachhaltige Waldbewirtschaftung. Da ungefähr18% aller anthropogen beeinflussten Emissionen auf Entwaldung und Walddegradierung zurückzuführen sind, spielt REDD+ eine entscheidende Rolle im globalen Klimadiskurs. In Kopenhagen (Jahreszahl), auf der COP 15, wurde REDD+ als bedeutendes Mittel zur Reduzierung der Erderwärmung auf 2° Celsius deklariert. Auf der COP 16 in Cancun 2010 wurde REDD+ offiziell verabschiedet und soll nun als Mechanismus in das Kyoto-Folgeabkommen aufgenommen werden (vgl. *Miles* und *Kapos* 2008; vgl. *Danielsen et al.* 2011).

Textbox 2: Frontiermuster

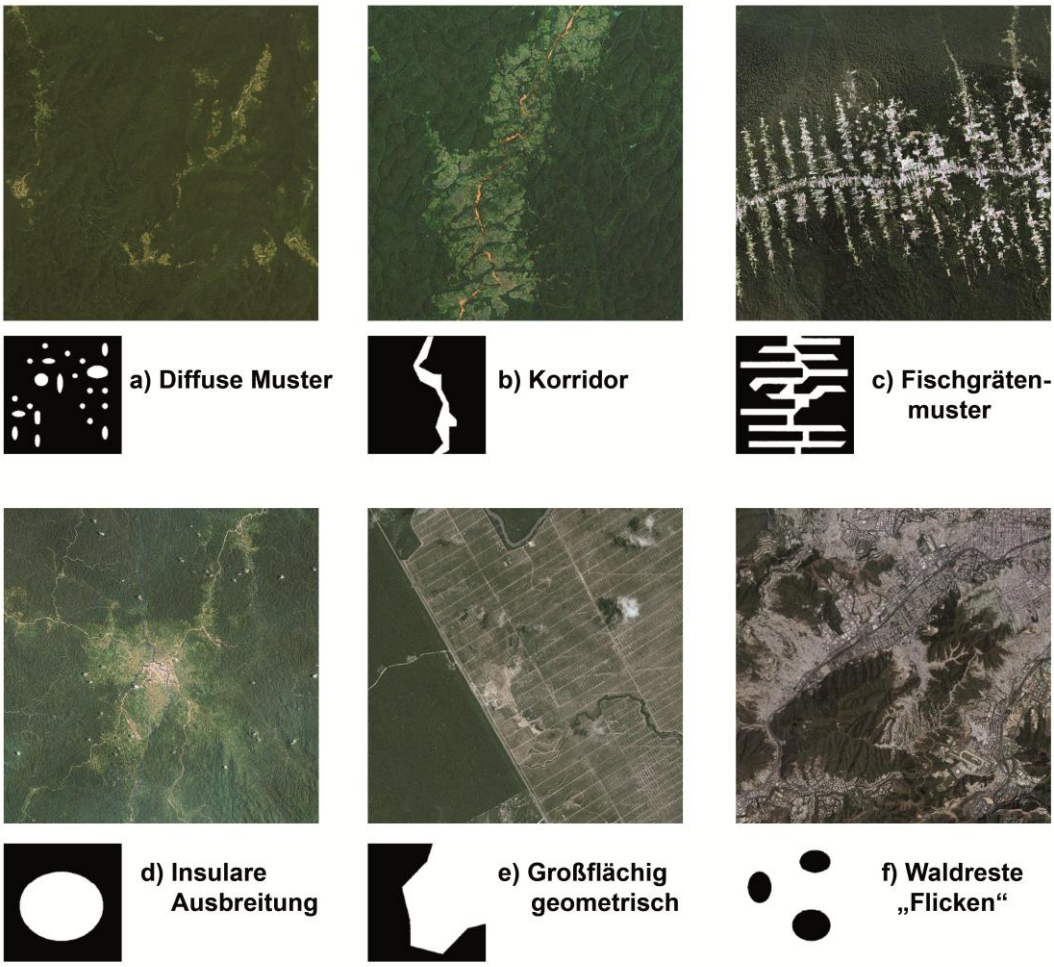

Abb. 1: Prototypen der Frontierzone

(Quelle: verändert nach *Mertens* und *Lambin* 1997; Google Earth 2012)

a) Die diffusen Muster der Kleinbauern und des traditionellen Brandrodungs-wanderfeldbaus. (Luftbild: Demokratische Republik Kongo)

b) Die Korridor-Form ist charakterisiert durch Landnahme entlang von neuen Straßen, wie bspw. im Amazonasgebiet Brasiliens, in den Waldzonen Kameruns, oder durch den Lore Lindu Nationalpark in Indonesien (vgl. *Abb. 4*). (Luftbild: Kamerun)

c) Das Fischgrätenmuster als geplantes Siedlungsprogramm, z.B. in Indonesien (transmigrasi), oder die Agrarkolonisation im Tiefland Boliviens, wo das Land den Siedlern in Streifen entlang einer Straße oder um einen Siedlungskernen zugeordnet ist. (Luftbild: Brasilien)

d) Insulare Ausbreitung der Frontier ausgehend von einem (städtischen) Zentrum. (Luftbild: Gabun)

e) Frontier als großflächige Rodung zu kommerziellen Zwecken, die als eine geometrische Form erscheinen kann, zum Beispiel im Falle des Ausbaus der Sojabohnen-Produktion im Flachland Brasiliens oder die Umwandlung von Wald in Palmölplantagen in Indonesien. (Luftbild: Indonesien)

f) Waldreste („Flicken“) in dicht besiedelten Gebieten, Post-Frontier, z.B. Sumatra, Indonesien oder städtischen Gebieten. (Luftbild: Venezuela)

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Autorenangaben

Prof. Dr. Heiko Faust, geb. 1961,
Geographisches Institut der Universität Göttingen,
Abteilung Humangeographie
Goldschmidtstr. 5
D-37077 Göttingen
Tel.:+49-551-39-8094
Fax:+49-551-39-12.140
E-mail: hfaust@gwdg.de

Arbeitsgebiete/Forschungsschwerpunkte: Kultur- und Sozialgeographie, Humanökologie, ländlicher Raum der Tropen, Südostasien, Pazifik

Dipl.-Geogr. Sebastian Koch, geb. 1981,
Georg-August-Universität Göttingen,
Abteilung Didaktik der Biologie
Waldweg 26
D-37073 Göttingen
Tel.:+49-551-39-14015
Fax:+49-551-39-4850
Email: skoch@gwdg.de

Arbeitsgebiete/Forschungsschwerpunkte: Humanökologie, Ressourcenmanagement, Südostasien, Südamerika

8.10 Summary

Tropical rainforests and their margins (frontier zones) gain centre stage within the international debate on biodiversity loss and climate change. On the one hand, tropical rainforests harbours the vast majority of the world's terrestrial biodiversity and provides significant ecosystem services such as carbon sequestration. On the other hand, it also serves as livelihood for millions of people living in such rural areas engaged in smallholder agriculture. Driven by international market forces, these areas play a central role in the production of the global cash crops cocoa, soybeans or palm oil.

The frontier zones of Central Sulawesi's mountainous rainforests are part of the Wallacea global biodiversity hotspot and particularly threatened due to forest conversion into agricultural land, mainly cacao plantations. In order to meet the challenge between conservation and utilization an economic and ecological balanced concept needs to be developed. There is no way around to compensate local famers for conserving biodiversity and carbon sequestration through cultivation in less profitable agroforestry systems. Payments for Environmental Services (PES) are a promising option.

CHAPTER 9:
Synthesis and Conclusion

The purpose of this research was twofold. Firstly, the project was aimed at elaborating current practice in the management of natural resources in Indonesia, including promising options for sustainable natural resource management (Research Objective 1 & 6). With Chapter 2 and Chapter 8, this forms the scientific basis of the thesis. Secondly, based on the scientific basis, the main body of research should examine the understanding of commons dilemmas and sustainable resource management of Indonesian university students enrolled in natural resource management related programmes, as tomorrow's educators, agricultural advisers or decision makers. In doing so, we examined subjective theories, prior knowledge and perceptions as well as knowledge increase between beginners (3rd semester) and graduates (7th semester) concerning sustainable resource management among Indonesian university students (Research Objective 2-5 / Chapter 3-7).

9.1 Summary of the Findings

With respect to current practices of natural resource management in Indonesia, we applied the Institutional Analysis and Development (IAD) framework (Kiser & Ostrom, 1982) to analyse the management of the Lore Lindu National Park in Central Sulawesi, Indonesia (Chapter 2). The Lore Lindu National Park harbours core ecosystems of the 'Wallacea' Biodiversity Hotspot (Mittermeier, et al., 2004; Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000). As common pool or open access resources, these ecosystems are severely threatened due to human activity (cf. Clough, et al., 2011; Steffan-Dewenter, et al., 2007). Frequently, commons dilemma situations account for habitat loss and over-exploitation of natural resources in the Lore Lindu region (cf. Clough, et al., 2010; Siebert, 2004).

We chose a qualitative research methodology in order to gain detailed insights into processes of resource management. We analysed the effectiveness of state-induced management institutions, community conservation agreements and village institutions in forest and resource management. State-induced rules or regulations either from the national or the sub-national level without effective monitoring proved to be inadequate in terms of conservation. The implementation of community conservation agreements, often complemented through the incorporation of traditional informal institutions, was

considered as an improvement with respect to both conservation efforts and needs of local people. Although traditional, formal and informal institutions are a promising option to connect needs of local people and sustainable resource management, the effectiveness varies with group identity, however.

On the basis of the results of the study on current practice in natural resource management that approved the role of local formal and informal institutions in effective sustainable resource management – also proclaimed by the Ostrom school (cf. Ostrom, 1990) – we laid the focus on the investigation of sustainable resource management education in Indonesia. As a starting point, we investigated subjective theories as well as prior knowledge and perceptions of 19 biology teacher students and agronomy students at Universitas Tadulako, Palu, Indonesia, near Lore Lindu National Park in Central Sulawesi qualitatively. We used intensive rattan extraction in the Lore Lindu region as a commons dilemma example (Siebert, 2004). The results show that university students' prior knowledge was limited to – widely erroneous – beliefs on ecological aspects such as landslides or flooding allegedly affected by rattan overuse. Socio-economic impacts of dwindling rattan stocks were not emphasized as problematic. The core of the commons dilemma, i.e., the need to institutionally balance short-term individual exploitation benefits with long-term and community interests in the preservation of a productive forest resource, was not recognised. These gaps in prior knowledge and misconceptions are firmly anchored in university students' subjective theories. For example, a widespread subjective theory is that rattan plants absorb water – like a tree – and protect the area against soil erosion and flooding. With respect to the traps characteristic of commons dilemma situations (Ernst, 2008; Messick & McClelland, 1983; Platt, 1973; Vlek & Keren, 1992), the university students were hardly able to fathom them. Solution strategies to commons dilemmas were restricted to state regulations, sanctions and punishments, whereas the effectiveness of traditional, formal and informal institutions was not emphasized.

The observed deficits in university students' prior knowledge and perception as well as the investigation of university students' subjective theories brought us to a document analysis of current international educational frameworks for an 'Education for Sustainable Development' (ESD). ESD key documents such as the official 'International Implementation Scheme' for the DESD (UNESCO, 2006) still ignores most of the

knowledge crucially important to implement sustainable resource management. Key topics in environmental and institutional economics, as addressed in Hardin's 'Tragedy of the Commons' (1968) or Ostrom's analyses of cooperative solutions to natural resource use dilemmas (Ostrom, 1990), go unnoticed.

In order to investigate the knowledge and knowledge increase of university students with respect to sustainable resource management in detail, we conducted a quantitative survey with 882 university students of the 3rd and 7th semesters involved in sustainable resource management relevant programmes at Institut Pertanian Bogor, Indonesia. The measurement instrument consisted of multiple choice and Likert scale questions on commons dilemma situations and possible solution strategies using rattan extraction and dynamite fishing as problem descriptions. Based on a formerly developed knowledge model (de Jong & Ferguson-Hessler, 1996) and on the basis of the formerly conducted qualitative in depth interview studies (Chapter 3 & 4), expert consultations, and literature review, we assessed knowledge in three types of knowledge (situational, conceptual, and procedural knowledge) and three domains of knowledge (ecological, socio-economic, and institutional knowledge).

Analysis of Variance (ANOVA) results show that university students did not increase their situational knowledge significantly from the 3rd to the 7th semester. They could increase their ecological and socio-economic knowledge between the 3rd and 7th semester significantly in the conceptual knowledge type. However, student judgements on solution strategies – referred to as procedural knowledge – differed strongly from expert judgements (see Table 1). The results reveal that the sampled university students do not appear to be well prepared for solving complex, real-world natural resource management problems that include a substantial institutional component.

Table 1: Summary of type and domain specific knowledge change from 3rd to 7th semester university students using quasi-longitudinal data. Situational and conceptual knowledge was examined using multiple-choice items and procedural knowledge was examined uisng Likert type scale items and students' profile correlations with expert judgements.

	Ecological knowledge domain	**Socio-economic knowledge domain**	**Institutional knowledge domain**
Situational knowledge	no increase fair level	no increase fair level	no increase poor level
Conceptual knowledge	medium increase fair level	small increase poor level	no increase fair level
Procedural knowledge	medium increase poor	medium increase barely acceptable	medium increase poor
	Ecological dimension	**Social dimension**	**Economic dimension**

Taking key components of sustainable development into consideration, i.e., an ecological, a social, and an economic perspective, we then analysed if the university students had increased their knowledge between the 3rd and the 7th semester not only in their area of study but also in other domains of knowledge relevant to sustainable resource management.

We found differences in the increase of knowledge depending on university students' areas of study. Not surprisingly, university students showed significantly higher increases in the knowledge domain related to their particular area of study. However, the vast majority of the students exhibited an interdisciplinary gap. Students with an environmental economics focus were the exception, though they did not show significant increases in all of the three knowledge domains.

Finally, to close the circle of the scientific perspective on natural resource use conflicts, we examined current international efforts in connecting biodiversity conservation and local livelihood needs. The analyses of resource governance structures lay the foundation for further efforts in order to promote sustainable resource management, particularly in common pool or open-access situations. If local institutions are effectively in place, there are additional international mechanisms to promote biodiversity conservation in due consideration of the needs of local people. With respect to the cacao boom in the Lore Lindu region, local farmers need to be compensated for cultivating cash-crops, such as cacao, in adapted extensive but less profitable

agroforestry systems. Payments for Environmental Services (PES), such as Reducing Emissions from Deforestation and Degradation (REDD) are a promising option (Angelsen, 2008). Central Sulawesi has been chosen for a REDD+ pilot project (UN-REDD, 2011). Future educators, agricultural advisers and decision makers in the field of sustainable resource management have to consider this too.

9.2 Limitations of the Study

The scientific case study research on current practice in natural resource management took place in Central Sulawesi's Lore Lindu region with the Lore Lindu National Park in its centre. It is a remote area characterised by mountainous topography, relatively low population density, and different ethnic groups (Weber, 2006). We highlighted the role of traditional, formal and informal institutions in governing commons resources. Although general outcomes of the study are applicable to other regions, such as the demand to integrate traditional rules and regulations on forest management into community conservation agreements, in each case a detailed institutional analysis is of importance since the situation may differ.

In order to examine subjective theories, prior knowledge and perceptions of Indonesian university students concerning commons dilemmas, we presented only data from one university in Indonesia. The qualitative interview study took place at Universitas Tadulkao, Palu. We interviewed 19 biology teacher students and agronomy students at this public Indonesian university located on an 'outer island'. For this reason the validity is somehow limited. We are not able to extrapolate our findings, such as the prevailing subjective theories, to other universities in Indonesia or elsewhere. We used extensive rattan extraction, occurring in the backyard of Universitas Tadulako, as example of a commons dilemma. Other regions in Indonesia and elsewhere in the world may have other environmental concerns or characteristic commons dilemma situations. However, our results indicate that the interviewed university students do not apprehend core characteristics, i.e., the traps of commons dilemmas.

With the results of the study on the role of local institutions in forest management as well as the university students' prior knowledge, perceptions, and subjective theories in

mind, we aimed at a detailed investigation of the knowledge increase between beginners (3rd semester) and graduates (7th semester) concerning sustainable resource management. In addition, we intended to survey future decision makers in the field of resource management. Therefore, we used the long lasting collaboration between Institut Pertanian Bogor (IPB) on the island of Java, Indonesia, and Göttingen University to conduct a quantitative survey at IPB. IPB is the foremost institution in Indonesia dealing with resource utilization issues; the sustainable utilization of biological diversity is one of the main 'thematic pillars' of IPB. Only the best performing students from all over Indonesia and elsewhere are being accepted for studying at IPB. It can be expected that the reported problems elsewhere are being more severe. However, we cannot provide formal data on the representativity of our sample from IPB for the rest of Indonesia.

With respect to the analyzed quantitative sample another limitation is the use of a quasi-longitudinal data set. The interviewed university students from the 3rd and 7th semester were not the same as we surveyed both groups at the same time. However, due to the sample size and the same underlying curricula, we did not expect any bias.

We cannot formally extrapolate the results of our study to other regions or universities in Indonesia or in other countries. Nevertheless, the following suggestions for improvements in sustainable resource management and education for sustainable development regarding resource use problems are likely to be useful beyond our specific case study areas.

9.3 Policy Implications

We highlighted the role of traditional, formal and informal institutions in governing commons resources. Solution strategies to connect biodiversity conservation and the needs of local people should lay a pivotal role in sustainable resource management education. Both investigations, qualitative and quantitative, on university students' understanding of sustainable resource management, commons dilemmas, and possible solution strategies reveal knowledge deficits. The low performance is likely related to an overly strong focus on mere ecological knowledge in teaching natural resource use

issues. In addition, the comparison of Indonesian higher education programmes on sustainable resource management shows an 'interdisciplinarity gap'. This could be explained by the rather strict disciplinary orientation of the curricula in Indonesian as well as in other Asian universities (Ryan, Tilbury, Corcoran, Abe, & Nomura, 2010).

Fostering cognitive skills to analyse and – if possible – solve problems of the conservation and sustainable utilization of biological resources should be a prime task of all university programmes that educate future professionals, educational multipliers or decision makers in the field. Social and institutional aspects of resource over-utilization need to get more thoroughly integrated into university curricula concerned with sustainable resource management. An understanding of the institutional core issues of resource dilemmas in open-access situations requires factual knowledge beyond striving for a 'balanced view' of the social, economic, and environmental dimensions of sustainable development (cf. Kyburz-Graber, Hofer, & Wolfensberger, 2006; Vargas, 2000) Particularly, students need to learn about the underlying socio-economic mechanisms and the institutional restrictions of individual actions.

With respect to concrete educational interventions that promote socio-economic and institutional knowledge, the analysis of case studies (cf. Scholz, Lang, Wiek, Walter, & Stauffacher, 2006) on locally relevant resource use dilemmas as well as resource management games (e.g., Fishbanks) should be considered. This, for example, could foster knowledge transferability.

In order to improve the higher education for sustainable resource management and capacity building in Indonesia – and elsewhere –, we plead for the strengthening of knowledge across all three knowledge domains. In particular, the knowledge about local open-access resource dilemmas and its consequences on the local population depending on the resources for their livelihoods and the institutional frame conditions in such situations should be reinforced (Saberwal & Kothari, 1996). Curricula development aimed at educating decision makers in the field of natural resource management should adequately consider this. This implies that the human and institutional dimensions – the dependency on natural resources and the institutional frame conditions – need to be integrated in order to enable students to appropriately interact with policy makers and affected people through conservation problems (cf. Clark, 2001; Mascia, et al., 2003). It

has already been recognised that natural and social sciences as well as the humanities have to be linked (Barnett, Ellemor, & Dovers, 2003). Fostering the competencies to analyse the coherencies of and possible solutions for resource over-utilization problems should be a prime task of higher education to adequately qualify tomorrow's decision makers. In addition, key documents that promote 'Education for Sustainable Development' should be complemented with a socio-economic and institutional economics focus.

9.4 Outlook

The studies presented in this thesis highlighted the importance of traditional, formal and informal institutions and explored current mechanisms in connecting biodiversity conservation efforts and the needs of local people. From a sustainable resource management education perspective the presented studies break new ground conceptually and should foster additional discussion, and even research into the topic.

Already Chapter 36 of the Agenda 21 and Article 13 of the Convention on Biological Diversity (CBD) emphasize the need for effective educational programmes and interventions in favor of biological diversity (UNCED, 1992a, 1992b). Although the United Nations General Assembly proclaimed the 'Decade of Education for Sustainable Development' (2005-2014) and recently the 'United Nations Decade on Biodiversity' (2011-2020), educational outcomes regarding sustainable resource management are disappointing.

Most studies concerning education and sustainable development fail to address real-world natural resource over-utilization problems. They merely assess concepts and definitions (e.g., Çakır, İrez, & Doğan, 2010; Corney, 2006; He, Hong, Liu, & Tiefenbacher, 2011; Tuncer, 2008). The cognitive skills necessary for solving more complex environmental problems, such as commons dilemmas, were not examined. These cognitive skills include understanding the situation, applying additional conceptual knowledge and proceeding to assess the interactions and causal relations (cf. Anderson, 1982). To date, only few empirical studies have been conducted in developing and emerging countries, which harbour the vast majority of the world's biodiversity (cf. Dervişoğlu 2007; Menzel & Bögeholz 2009).

Referring to the limitations of this thesis in terms of transferability, larger samples of students from different universities with a focus on sustainable resource management should be examined to be able to compare the outcomes and provide starting points for national policy action. As our questionnaire solely focused on commons dilemmas in terms of non timber forest product extraction and overfishing including solution strategies to such dilemmas, standardized questionnaires would be necessary to obtain conclusive comparable data and, hence, insights into other regions and countries.

In terms of the participants at Universitas Tadulako, we assumed that most of the interviewed university students will either work as educators or agricultural advisers, based on questions on their future career aspiration. Likewise, we assumed that most of the interview participants at Institut Pertanian Bogor (IPB) will be concerned with sustainable resource management, for example, as employees at administrative bodies, NGOs, etc. However, graduate analysis is likely to foster the assumptions empirically. At present, there is one study in preparation covering graduates from the Faculty of Forestry at IPB.

Another area of research, not covered by this thesis but of importance for sustainable resource management, is the question whether decision makers in the field of resource management make sufficient use of research based knowledge, and, whether decision makers change their practice over time in line with up to date research outcomes.

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Appendices

Appendix I: Interview Guideline (Qualitative Study)

Rüter, S., Barkmann, J., & S. Bögeholz 2007

Interview guideline

a) Introductory information, which is given by the interviewer

I am Stephanie from Germany. I am working in a research group dealing with environmental education and natural resource management. This is Ferri, my field assistant, who will conduct the interview with you.
Thank you for participating in this interview. We are exploring some of your opinions about aspects of environmental education. The aim of our research is to improve science and agroforestry education.
In this interview there are no wrong or right answers. We are interested in your personal opinions and all of your answers are very valuable to us. So, during the interview you would really help us a lot by saying everything that pops into your mind to each of the questions. All of your answers will be kept confidential and your identity will be kept anonymous. We also ask you to not talk about the content of this interview with anyone to make sure that the next students for this interview don't know about it. This is very important, because you could influence their answers.

(Please, note the name, tel.nr and sex of the person)

b) socio-demographic questions

1. How old are you?
2. What do you study? Why did you choose this subject?
3. What semester are you in?
4. What is your career aspiration? Give reasons.
5. Have you done any practical training at school/ extension service?
6. Are you in contact/are you a member of a group dealing with the protection of the environment?
7. Did you take part in any classes which included Environmental Education? If yes, what were the contents of the course?
8. Where did you grow up?
9. What do your parents do for a living?
10. How many sisters or brothers do you have?
11. Have you been to the LL area? Why did you go there?
12. Do you have friends or relatives (people which you have close contact with) who live in the LL area? What do they do for a living?

If the student has already been to the area:
→ go directly to question 13.

If the student has not yet been to the area:
"Do you know anything about the area from the media or friends?"

If yes:
→ go to question 13

If no:
→ go to text 1

c) Introductory Questions about environmental problems in the LL area

Research interest	Nr.	Question	Comments
Are resource-degradation problems mentioned among the perceived environmental problems in the LL area by the InComEE?	13. 13a. 13b.	"Do you see any environmental problems for the Lore Lindu area?" If the answer is positive: "Please describe them." If the answer is negative: "Do you know any problems concerning plants/animals/social problems?"	Hints about which environmental problems the InComEE know
Is Rattan a suitable example as a core dilemma within this project?	14.	"To what extent could the collection of Rattan be problematic for the LL area? Please, expand."	Hints about, if the InComEE regard Rattan as a central regional problem of the LL area and what they already know about it
What related ideas do InComEE have with the function of Rattan in the LL area?	15.	"What would happen, if there was no more Rattan in the LL area?"	

d) Information about the dilemma „Intensive Utilisation of Rattan"

"Please, read text 1 about the intensive utilisation of Rattan in the LL area carefully. Feel free to mark your text and please ask if anything is unclear to you."

e) Questions concerning the threat appraisal for Rattan in the LL area

Research interest	Nr.	Question	Comments
Do the InComEE appraise the existence of Rattan as being threatened in the LLNP?	16. 16a.	"How much Rattan will exist in 10 years in the LL area do you think?" If the student is insecure: "Please, comment on the following statement: The existence of Rattan in the LL area is threatened."	Ecological perspective
Do the InComEE regard the degradation of Rattan as a socioeconomic threat?	17. 17a. 17b. 17c.	If the student assumes a loss of Rattan in the future: "What impact does the loss of Rattan have on the people of the LL area?" If the student does not assume a threat of Rattan in the future: "Scientists predict that in 10 years there will be no Rattan in the LL area. What impact would this have on the population of the LL area?" "Are all groups of society affected by a loss?" If the answer is positive: "What kind of effect can you imagine for the different groups of society?" If the answer is negative: "Try to imagine an effect on the different groups."	Socioeconomic perspective

f) Questions concerning the sense of responsibility of the InComEE

Research interest	Nr.	Question	Comments
Who do the InComEE regard as responsible for the existence of the degradation of Rattan?	18.	"Which groups of people or institutions do you think are responsible for the loss of Rattan?"	
		<u>If the student does not mention the following:</u>	
		"Please, talk about:	
	18a.	Farmers?	
	18b.	People in Palu?	
	18c.	Industry?	
	18d.	Government?	
	18e.	The student him-/herself?"	
Who do the InComEE regard as responsible for taking action against the degradation of Rattan?	19.	"Which groups of people or institutions do you think are responsible for taking actions against the loss of Rattan?	
	19a.	Farmers?	
	19b.	People in Palu?	
	19c.	Industry?	
	19d.	Government? Forest rangers?	
	19e.	The student him-/herself as a future teachers/extension staff?"	

g) Questions concerning the perception of the dilemma

Research interest	Nr.	Question	Comments
" Now I would like you to imagine the following situation." *(Information-card "question20" is given to the student)*			
Do the InComEE understand that the utilisation of Rattan is a dilemma for Central-Sulawesi? Which features of the described situation constitute the dilemma? Do the InComEE understand that the dilemma includes ecological, economic and social aspects? How does the comprehension of the **economic trap** look like?	20. 20a. 20b. 20c.	"Imagine a household which is poor and collects a lot of Rattan. The household members have to cover more and more distance to collect Rattan and the benefit becomes less and less. What are possible reasons for this situation?" <u>If the student does not mention the following aspects:</u> "Please talk about - possible problems concerning the household - possible problems concerning the loss of Rattan - possible reasons that the benefit becomes less and less"	- there are competitive interests - there is no single solution - there are interrelationsships of ecological, economic and social aspects - The collectors will always harvest Rattan no matter what price is being offered, because they do not have a choice. The industry can use this fact to even lower the price. But the lower the price is the more have the collectors to harvest to earn enough money to secure their life.

"Now I want you to imagine another situation." *(Information-card "question 21" is given to the student)*			
How does the perception of the **social trap** look like?	21. 21a.	"Imagine a village whose entire community decided to stop collecting Rattan to let it grow again around their area. One farmer breaks the rules and secretly starts collecting Rattan again. Who is affected by this situation and how?" <u>If the student does not mention long-term effects:</u> "Please, talk about possible long-term effect you can imagine."	Can one person make a change here?
"Please, look at these three pictures."			
How does the perception of the **spatial** and **time trap** look like?	22. 23. 24. 25.	"How do you imagine the faces in the three pictures?" "On what factors does the situation in picture three depend?" "How do you imagine the situation in picture three? Please, draw and explain." <u>If the student does not draw a happy face for picture 2:</u> "Imagine the faces in picture two are happy. Why do you think are the people still happy?	

h) Questions concerning the possibilities of action for the InComEE

Research interest	Nr.	Question	Comments
Which possibilities of action do the InComEE see?	26.	"Please, talk about possibilities how you imagine that Rattan resources could be preserved."	
		<u>If the student didn't talk about the following aspects:</u>	
		"What kind of possibilities can you imagine in connection with changes in :	
	26a.	- law	
	26b.	- education	
	26c.	- financial support from the government for the farmers	
	26d.	- households	
	26e.	- village community	
	26f.	- industry	
	26g.	- forest police"	

i) Information about possible ways to act in the LL area

"Please read text 2 about possible ways to act to deal with the dilemma carefully. Feel free to mark your text and please ask if anything is unclear to you."…
The student reads text 2 and receives information cards.
"Please look at the following possibilities how to deal with the situation."

j) Questions concerning the coping-appraisal of the InComEE

Research interest	Nr.	Question	Comments
How successful do you appraise the presented possibilities to act?	27.	"To what extent do you think is each of the action promising? Please give reasons."	Underlying construct: perceived response efficacy (PMT)
Which costs and barriers do you see with the implementation of the actions?	28.	"Let's talk about possible difficulties of the action. What could interfere with each of the actions?"	Underlying construct: Costs and Barriers (PMT)

k) Questions concerning the intention of the InComEE to include resource dilemmas into their lessons

The student receives a questionnaire.

Research interest	Nr.	Question	Comments
How self-efficient do the IS of EE see themselves with the implementation of the actions?	29. 29a.	"Imagine that you are a future teacher / agricultural advisor in a LL village that contains many households which collect Rattan." <u>For future teachers:</u> "To what extent can you imagine to include the described actions in your classes? Please give reasons." <u>For future agricultural advisors:</u> "To what extent can you imagine to conduct programmes which include the described actions?"	Underlying construct: perceived self efficacy (PMT)

Text 1: Intensive utilisation of Rattan

Rattan (*Calamus sp.*) is a type of palmtree of which the trunk can be used to produce furniture. There are 340 different species of Rattan. Rattan grows back after being harvested, if the root of the plant stays, but this requires time. Depending on the quality of Rattan growing back takes between 1 and 7 years.

Indonesia is the largest exporter of Rattan in the world. A few years ago, Rattan was harvested so intensively in Kalimantan that hardly any Rattan grows there today. Following the depletion of the Rattan resources in Kalimantan, Sulawesi has become Indonesia's largest current Rattan source.

The Lore-Lindu National Park in Central-Sulawesi contains many indigenous Rattan species. By regulations no Rattan collection is allowed in the park. However, reality looks different and a lot of farmers living close to the park collect Rattan illegally for daily usage and even for trading with companies in huge amounts. Controls and punishments by the forest police are not enough to stop most of the illegal collection.

Prior to the establishment of the national park, the land was divided into traditional areas. Each area had exclusive utilisation rights for the harvest of Rattan only near the margins of the park. Now that these rights have been removed everybody has (illegal) open access to the entire park.

The current open access situation means that each Rattan collector is in fierce competition with the other. Such competition means that Rattan collectors don't see any need to protect the existence of Rattan, because each collector assumes that somebody else will collect the Rattan instead. As a result, the collection of Rattan has tripled during this time of open access and the forest is being depleted of Rattan more and more.

The harvesting of Rattan is physically demanding and is carried out by many members of the population. However, the commercial cultivation of Rattan is not profitable, because it takes several years to grow it again. Besides this, Rattan has a very low international market price because of its illegal over-utilisation.

"Question 20"

Please, imagine the following situation:

→ A household is poor and collects a lot of Rattan to earn some money.

→ The household members have to cover more and more distance to collect Rattan.

→ The benefit the household gets from the traders becomes less and less.

What are possible reasons for this situation?

"Question 21"

Please, imagine the following situation:

→ The entire community of a village has decided to stop collecting Rattan to let it grow again around their area.

→ One farmer breaks the rules and secretly starts collecting Rattan again.

Who is affected by this situation and how?

Text 2: Dealing with the „Intensive Utilisation of Rattan"

When considering the harvesting of Rattan, it is difficult to negotiate between the competitive interests of the collectors. On the one hand, Rattan contributes an average of 20% of the livelihood of the poorest members of the Lore-Lindu population. On the other hand, the collectors decrease the availability of Rattan by over-collecting it. This eliminates the chance of utilising Rattan in the future.
Therefore, a long-term solution involves taking both the preservation of the Rattan resources and the primary care of the collectors into account equally. There is no perfect solution, but there could be some possibilities for dealing with this challenge.

1. To introduce agreements and rules on community basis that stop the utilisation of Rattan for every farmer in the Lore Lindu territory in order to make sure that the resource has time to recover again.

2. To allow each household to collect a limited amount of Rattan per year in a certain area. Before or after collecting the Rattan each household has to report to the forest police. When collecting the Rattan, people are not allowed to cut any other tree with it, which means, that the quality of Rattan will not be as good as when cutting the tree it holds on to. The amount harvested in the first years has to decrease up to 70% of the amount being harvested at the moment. After the initial recovery of the Rattan, the collectors will be able to harvest a larger amount of Rattan but will still be required to comply with the other restrictions.

But, how can you make sure that the farmers only harvest the amount depending on what the permit allows? In this regard different actions can be taken:

a) The government could provide more Forest Police to be more able to control the actions of the people.

b) Penalties from the Forest Police and the *Lembaga Adat* (traditional laws which are still important for the regulation of the life in remote areas of the Lore Lindu area) could be applied in a stricter way, in case of harvesting exceeds the permitted amount and in case other trees are being cut as well.

c) Meetings could be arranged where all habitants of a village meet. Here they could be encouraged to improve their negotiation skills should disagreements arise etc. and to develop trusting relationships. Through this the community could control the process by communicating any permit violations to the Forest Police and the *Lembaga Adat*, who are responsible for penalising any guilty farmer.

d) The community could be provided with formal and informal education about how destructive the long-term effect of intense Rattan harvesting and cutting other trees can be in terms of a) biodiversity, b) erosion and c) water supply:
→ to strengthen a compliance to regulations to safe Rattan
→ to reach the whole community (children, adolescent and adults)

e) Demonstrations on how cooperative behaviour can overcome competitive behaviour when dealing with a natural resource could be given to the community.

Questionnaire:

Please, tick one of the five options given:

Nr.	Actions	very unlikely	unlikely	neither likely nor unlikely	likely	very likely
1	To introduce agreements and rules on community basis that stop the utilisation of Rattan for every farmer in the Lore Lindu territory in order to make sure that the resource has time to recover again.	☐	☐	☐	☐	☐
2	To allow each household to collect a limited amount of Rattan per year in a certain area. Before or after collecting the Rattan each household has to report to the forest police. When collecting the Rattan, people are not allowed to cut any other tree with it, which means, that the quality of Rattan will not be as good as when cutting the tree it holds on to. The amount harvested in the first years has to decrease up to 70% of the amount being harvested at the moment. After the initial recovery of the Rattan, the collectors will be able to harvest a larger amount of Rattan but will still be required to comply with the other restrictions.	☐	☐	☐	☐	☐
a	The government could provide more Forest Police to be more able to control the actions of the people.	☐	☐	☐	☐	☐
b	Penalties from the Forest Police and the *Lembaga Adat* (traditional laws which are still important for the regulation of the life in remote areas of the Lore Lindu area) could be applied in a stricter way, in case of harvesting exceeds	☐	☐	☐	☐	☐

	the permitted amount and in case other trees are being cut as well.					
C	Meetings could be arranged where all habitants of a village meet. Here they could be encouraged to improve their negotiation skills should disagreements arise etc. and to develop trusting relationships. Through this the community could control the process by communicating any permit violations to the Forest Police and the *Lembaga Adat*, who are responsible for penalising any guilty farmer.					
D	The community could be provided with formal and informal education about how destructive the long-term effect of intense Rattan harvesting and cutting other trees can be in terms of a) biodiversity, b) erosion and c) water supply: → to strengthen a compliance to regulations to safe Rattan → to reach the whole community (children, adolescent and adults)					
E	Demonstrations on how cooperative behaviour can overcome competitive behaviour when dealing with a natural resource could be given to the community.					

Appendix II: Coding Guideline

Coding Guideline 24.09.2009 (Sebastian Koch)

Main categories do not contain any codings and were marked grey.

Socio-Economic Aspects*

	Example	Definition	Differentiation
Origin			
Why did you choose this subject?			
Career intentions			
Practical training			
Classes about environmental education			
Involved in environmental protection			
Experience with LLNP			

* Only main categories are mentioned here; cf. the code-system for sub-categories.

Knowledge about Environmental Problems in the Lore Lindu Area

(before reading intervention text 1)

	Example	Definition	Differentiation
Sees problems in LLNP			
Human impact on the environment	"[…] the people use natural resources in the area of the national park. They use technological tools that could damage the ecosystem."	General statements about human impacts on the environment.	He/she mentioned just general aspects about human-environment interactions – instead of giving details.
Sees ecological problems	"[…] the utilization of pesticides is really disturbing. It damages the soil…"	Specific Statements about ecological problems/consequences.	He/she mentioned specific ecological problems/interferences.

Sees socio-economic problems	"Everyone has problems […] such as wood stealing […] they just care for themselves. If we are under pressure it is important to be open among the members of the society."	Specific Statements about social problems/consequences.	He/she mentioned specific social problems or consequences.
Sees other kinds of problems	*Not yet mentioned!*	Aspects which are not directly fit to one of the spheres.	
Advantages instead of problems mentioned		The respondents mentioned positive aspects, although it was asked about environmental problems in or around LLNP.	
Everything is fine in the village society	"I think that they are socially good enough. The people are very friendly. The relationships between villages are also good. The religion about their sense of tolerance is very good. I haven't seen [any social problems]."	He/she sees no social problems with regard to the village community.	
Conservation awareness (based on own experience)	"The people who live around LLNP really care for the environment […] my friend tried to catch a bird but the people prohibit it because it belongs to endemic species…"	People really care for the environment and endemic species.	
Status and condition for agriculture	"The soil is quite fertile."	Statements about the condition of agriculture.	NOT the socio-economic impacts on farmers (see socio-economic problems).
Rattan collection as regional problem	To what extend could the collection of rattan be problematic for the LL area?		
Economic Problems		Statements that are related to economic aspects of rattan collection.	

High demand for rattan	"The human need for it is strong."	From an industrial point of view; not from the farmers themselves.	
Rattan industry has to import rattan	"So, if there isn't rattan produced there, it means that rattan industries will have a lack of materials. As a result, they have to import it from overseas."	Economic problems resulting from the absence of rattan in the Lore-Lindu area.	
Socio-economic Problems		Statements that are related to socio-economic aspects of rattan collection; focusing on people.	
Assessment		Statements concerning the impact (assessment) of the consequences of environmental problems on humans.	
Human dependency on the environment		Statements concerning the human dependency on the environment.	
Collector reaction to scarcity	"[…] as a result the rattan collectors work even harder to get income."	Farmers have to work harder to make a living.	
Collector impact on scarcity	"When rattan is finished, the collectors will no longer have a permanent income."	People depend on rattan for their living.	
Ecological Problems		Statements that are related to ecological aspects of rattan collection.	
Inanimate nature (soil; water)		All statements that are related to the interference into the ecosystem.	
Soil	"[…]it has an effect on soil formation."	Mentioned aspects related to soil.	
Water	"Forest loss leads to reduced water supply."	Mentioned aspects related to water.	
Flooding and erosion	"There will be flooding and erosion and so on."	Mentioned flooding and erosion as ecological consequences of rattan collection.	
Forest fires	"Most of them only know to collect it and just leave the useless parts of rattan which get dry	Mentioned forest fires as ecological consequences of rattan collection.	

	fast and burn easily which could cause a huge scale forest fire."		
Animals & Plants		Consequences of rattan collection related to animals and plants.	
Future of rattan stocks	"The rattan will be finished if taken everyday."	Statements about the future of rattan.	
Impact of rattan collection on animals and plants (habitat)	"The more [rattan] they take the less [other plants and animals] will be."	Increased rattan collection leads to decreasing rattan stock.	
Ecosystem in general		Ecological consequences of rattan collection related to the ecosystem in general.	
Deforestation	"[…] as well as on the forest area, because its products are always taken away, that causes deforestation."	Statements related to deforestation.	
Unspecified negative impact	"[…] the ecology is very affected because there are animals, plants and other insects. The environment might be damaged."	General statements about the impact of rattan collection; he/she does not specify.	
Reasons for rattan harvesting			
Economic reasons	"I think poverty forced them to act that way, they don't really care about laws which are being implemented, because of the poverty."	HH-economic reasons for rattan harvesting.	
Other reasons	"I know that they collect rattan, because they are just being lazy. It doesn't mean that they don't want to work. They are just lazy to try harder."	Other reasons for harvesting rattan.	
Solutions			
Sustainable harvesting practices	"[…] this depends on the people who collect it, for example, if they really want to give it	He/she gives possible solutions with respect to sustainable harvesting.	He/she highlights the sustainability aspect.

	to their grandsons. They should use it efficiently."		
Harvesting practices	"Rattan collectors should not take other trees."	He/she gives possible solutions with respect to the harvesting practice.	
Harvesting regulation and sanctions	"If there has been an agreement, there must be rules as well. If someone gets punished, other people will think twice to break the rule."	He/she gives possible solutions concerning laws.	
Monitoring	"I think there has to be supervision for those people who collect rattan; especially on how and when rattan can be collected in order to prevent rattan being collected in large amounts."	He/she gives possible solutions with respect to a monitoring system.	

The respondents read intervention text 1.

Threat Appraisal

	Example	Definition	Differentiation
Assessment	"This is a warning for us, a very serious threat."	Evaluation of the consequences of rattan collection /over-harvesting.	Evaluation after reading intervention text 1.
Environmental Valuation	"I heard that the flora and fauna around LLNP is unique."	Aspects concerning the nature's value.	
Ecological Consequences of rattan collection			
Species / Habitat loss	"If one of its components is lost, it will affect other plants or other ecosystems. For instance, a rattan plant crawls vertically and sometimes becomes a medium for other small plants to be able to support each other."	He/she mentioned that species habitat (or species) will decrease or gett lost.	

Erosion or floods	"In addition there might be erosion or floods. "	He/she mentioned flooding and/or erosion as ecological consequences of rattan collection.	He/she mentioned ecological consequences of rattan loss **after** reading intervention text 1!
Impact on rattan stocks (general)	"[…] it is an imbalance between the amount taken and the one being replanted."	He/she mentioned aspects of over-harvesting.	See above
Status rattan stocks in 10 years	"In the next ten years rattan can be finished."	Answers to the question "How much rattan will exist in the Lore Lindu Area in 10 years?"	See above
Socio-economic consequences of rattan collection			
Social conflicts	"There is no forest and no free land so they will kill each other as in Aceh."	He/she mentioned that rattan over-harvesting will lead to social conflicts in the area.	
People will lose their job	"Most of the people will not have a job anymore."	He/she mentioned that people will lose their job when there is no possibility to collect rattan.	
Negative impact on living conditions (in general)	"The social condition will become worse because most of them depend on rattan for their living."	General statements about negative impacts on living conditions.	
People are threatened by erosion or floods	"[…] there might be erosion and floods which will affect all people."	Statements that projects consequences (erosion and floods) onto the humans.	He/She mentioned socio-economic consequences of rattan loss **after** reading intervention text 1!
Reduced income	"If rattan is their income source […], they have to find another job."	Statements concerning the reduced income of the collectors	See above
Looking for a new job		He/she mentioned that collectors have to find a new job for their living	
Group differentiation		Group differentiation of the socio-economic consequences of rattan loss.	
Rattan Industry	"And then the exported products will also decrease."		
Farmers	"The people move out not only because there is no rattan anymore but also because of the possibility of a flood."		

People who like rattan products	"For example people that love rattan products. When they need it and it's not available it will be hard for them."		
Rattan collectors	"Especially on those whose income resource is rattan. They will be much affected."		Subseq: Negative livelihood impact
All groups	"Indirectly, all groups will be affected by the loss of rattan."		
Government	"[…] it will reduce the income of the government because of the decrease of rattan materials."	Statements concerning missing public revenues.	He/She mentioned economic consequences of rattan loss **after** reading intervention text 1!
People in Palu	"The effect [for the people in Palu is] maybe from the use of rattan in making rattan chairs or else. For example when they run out of rattan stock, they will have to get it from outside where the price might be more expensive compared to Palu which is a bit cheaper."		Subseq: higher prices

Sense of Responsibility

	Example	Definition	Differentiation
Responsible for the loss of rattan (in general)		Question 18: Which groups of people or institutions do you think are responsible for the loss of rattan?	
Everybody (all groups and institutions)		He/she mentioned that everyone has to be responsible.	
Can't say who is…			
Local farmers		Everything he/she mentioned about the responsibility of local farmers.	
People in Palu		Everything he/she mentioned about the responsibility of people in Palu.	
Government		Everything he/she mentioned about the government's responsibility.	

Students		Everything he/she mentioned about the students' responsibility.	
Rattan industry		Everything he/she mentioned about the responsibility of the rattan industry.	
Responsible for taking actions against the loss of rattan		Question 19: Which groups of people or institutions do you think are responsible for taking actions against the loss of rattan?	
All groups of the society are responsible			
Institutions of the society are responsible			
People around Lore Lindu		Everything he/she mentioned about what people around LL should do against the loss of rattan.	
Government		Everything he/she mentioned about what the government should do against the loss of rattan.	
People in Palu		Everything he/she mentioned about what people in Palu should do against the loss of rattan.	
Students		Everything he/she mentioned about what students should do against the loss of rattan.	
Forest Police		Everything he/she mentioned about what the forest police should do against the loss of rattan.	
NGOs		Everything he/she mentioned about what NGOs should do against the loss of rattan.	
Rattan industry		Everything he/she mentioned about what the rattan industry should do against the loss of rattan.	

The respondents receive information-card 20.

Perception of the Dilemma

	Example	Definition	Differentiation
General Aspects about the dilemma		Question 20: Imagine a household which is poor collects a lot of rattan. The HH have to cover more and more distance to collect rattan and the benefits become fewer and fewer. What are possible reasons for this situation?	
Misconceptions about the 'Dilemma'	"What I think why the distance to cover is far […] The distance is short, but they take rattan that's far."	He/she does not get the point about the meaning of 'dilemma' with respect to natural resources (externalities etc.)	
Low rattan revenues (due to illegality)	"Being illegal, it means that there is more available to be sold in the market, which causes the price to decrease."	He/she does not give detailed statements about the dilemma; just general aspects about the low revenues.	
Free-rider situation	"One person breaks the rules, the others will follow if there is no further control."	He/she does not give detailed statements about the dilemma; just general aspects about the free-rider situation.	
Causes of dependency	"They bring food from home. They run out of food on their way, and they sometimes have to borrow food from kiosks and at the end they only collect a small amount of rattan. When they get back they have to pay for their debt first, and they will only receive fewer benefits after all."	He/she does not give detailed statements about the dilemma; just general aspects about the causes of dependency.	
HHs depend on rattan for their living	"They earn their living by collecting rattan. So they don't think about the damage they have done. They only think how they can still make a living and the family can have enough food."	He/she does not give detailed statements about the dilemma; just general aspects about the households' dependency on rattan collection.	

Environment is getting damaged	"The environment is damaged, the forest is damaged, the ecology is damaged and the animals are gone."	He/she does not give detailed statements about the dilemma; just general aspects about environmental destruction.	
Ecology is very important for human beings [in general]	"[…] if the environment is damaged it will be a disadvantage for all."	He/she does not give detailed statements about the dilemma; just mentioned the importance of the environment for human beings.	
Economic, social, and ecological aspects are interconnected	All matters are always connected. If the ecology is good, it will always be productive and can be used for economic activities. This means that if the economy is good, automatically the social side will be good as well. Everything will be bad [then]. The social part will be bad; the economy will be bad and the ecology as well.	He/she does not give detailed statements about the dilemma; tries to explain the interrelation of the spheres.	
Natural disasters	"Ecologically, the decreasing number of rattan will cause floods, erosion and will affect people."	He/she does not give detailed statements about the dilemma; just general aspects about natural disasters as a result of intensive rattan collection.	
Lack of education	"There is something about the people: they lack of creativity and education"	He/she does not give detailed statements about the dilemma; just general aspects about the lack of education.	
Income loss for the government	"The decreasing number of rattan means that the Province Real Income is also decreasing as the peoples' income also decreases."	He/she does not give detailed statements about the dilemma; just general aspects about the decreasing revenues for the government.	
Economic aspects			

Economic driving forces	"I think for people the dilemma is more towards money, to the economic side, because this is a daily necessity. The price of goods is increasing more and more every day. On the other hand, the work that we do is not equal to the money we earn."	He/she points to increasing living prices (inflation) and inequalities with respect to payments (making money).	
Socio-economic aspects			
Competition as one reason of the dilemma	"People work hard, but they get payed less. Just like competition. Only one person becomes a champion, not ten persons. Rich people have more abilities than poor people."	He/she points to the competitive behaviour of human beings.	
Socio-economic consequences of the dilemma	"Their income will decrease and in turn they are not able to fulfil their family's needs."	He/she points to the negative socio-economic consequences of the dilemma.	
Spatial and time aspects	**The respondents receive information-card 21**	The three pictures of a village over time were shown to the respondents .	
Poverty over-harvesting vicious cycle	"Possible reasons why the benefits become fewer and fewer are that all people work on rattan because of the necessity factor."	He/she recognized that rattan oversupply leads to decreasing rattan prices.	Subseq: income dilemma realized
Short-term thinking	"Face number two could be smiling because he has a lot of money, but he doesn't think that the natural resources can be finished […] what is today is just for today."	He/she recognized a time trap that people often just think for today and not for the future.	
Have to move farther to collect rattan	"[…] they have to cover more and more distance everyday […] the rattan around the area has decreased, because rattan that grows in the margin areas has finished and what is left is on other parts. And it becomes farther everyday and the damages as well."	He/she recognized the time trap that rattan collectors have to move farther because rattan disappeared nearby.	

The respondents read intervention text 2 and later option cards a-e.

Coping Appraisal

	Example & Question	Definition	Differentiation
Action for Preservation	Please talk about possibilities how you imagine that rattan resources could be preserved?		
In general		These aspects were mentioned **before** they received option cards.	
NGOs			
LLNP council			
Support technological development			
Cooperation			
People's attitudes			
Do not collect rattan			
Concerning law and government	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning law and government.	
General positive aspects about law and government			
Support farmers with improved seeds, market institutions etc.			
Implement rules step by step			
Compensation payments for the reduction of rattan collection			
Local population should participate – cooperation (government with local population)			
Awareness rising			

Providing rattan collectors with agricultural land			
Giving the collectors a new job			
Strictly implementing laws about rattan collection			
Punishments			
Should be more supportive			
Making policies to decrease prices			
Limiting the amount of rattan which can be collected			
Processing rattan before export			
Supervising the forest police			
Concerning education	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning education.	
General positive aspects about education			
Informal education			
Repeat counselling again until all people will be reached			
Include into school curriculum			
Teaching about the importance of the ecosystem in school			

Giving advice about other sources of income			
Giving advice about effects of rattan loss (social & ecological)			
Teaching about human-environment interactions			
Teaching and practice about the importance of the ecosystem			
Teaching/Counsel-ling about the importance of rattan			
Teaching and practice about cultivation (plantation) methods			
Build new schools around LLNP			
Concerning financial support for local farmers	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning financial support for local farmers.	
General positive aspects about financial support for local farmers			
Financial support to start a business	„It could be, by giving them an assistance, maybe financial, assistance to establish a little business of their own so they will not depend on rattan as their income resources."		
Financial support to avoid over-harvesting			

Concerning collectors/farmers	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning collectors/farmers.	
General positive aspects about collectors/farmers			
Reporting rattan harvesting personally			
Awareness; take care and replant when collecting			
Rehabilitation			
Turning away from rattan as the main income source/ find a new job			
Taking rattan without damaging the environment			
Separating seeds and replanting rattan/ just take the big ones			
Rattan plantation			
Collecting rattan sustainably (limitations)			
Concerning village community	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning village community.	
General positive aspects about the village community			
Working together with the government			

Reporting violations to the forest police			
Adat Institutions			
Giving advice, discussions, village meetings etc.			
Implementing rules and agreements altogether, cooperative behaviour			
Depends on themselves			
Punishments			
Concerning forest police	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning forest police.	
General positive aspects about the forest police			
Should be paid good enough to avoid corruption			
Good communication / exchange with the villagers			
Should be punished if breaking the rules			
Making sure that people cannot enter LLNP			
Should built control stations			
Should take over educational functions such as giving advice…			

Being more careful and strict			
Strengthening forest police			
Should be chosen carefully			
Concerning rattan industry	What kind of possibilities can you imagine in connection with changes in…?		
Problems and difficulties		All mentioned problems and difficulties concerning rattan industry.	
Using other materials (wood or steel)			
Using rattan effectively			
Owning plantations / securing rattan existence			
Taking (buying) rattan from changing places			
Blaming companies in order to preserve rattan			
Thinking about the long term consequences			
Cost and barries			

Appendix III: Quantitative Questionnaire

Koch, S., Barkmann, J., Sundawati, L. & S. Bögeholz 2010

QUESTIONNAIRE (DECEMBER 2010)

In the joint collaborative research project between Department of Forest Management at Institut Pertanian Bogor (Indonesia) and Didactics of Biology and Environmental and Resource Economics at Göttingen University (Germany), we are working on 'Education for Sustainable Development' (ESD). We are interested in some of your perceptions related to human-environment interactions. Your answers will be anonymized and hopefully help to improve university education with regard to ESD.

Thank you very much for participating in this research study!

Sex: Female ☐ / Male ☐

Age:___

Semester:___

Major Study Programme:_____

Minor Study Programme:_____

or supporting courses:_____

GPA (Grade Point Average):__

Motivation for studying at IPB?

_____

_____

Career aspiration?

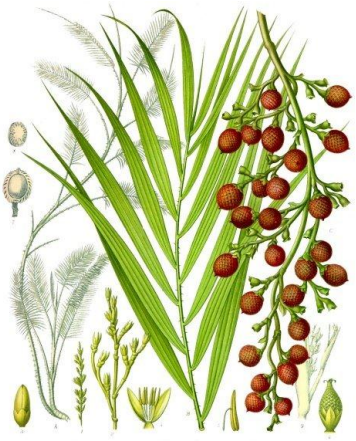
_____

Rattan Information Text (Part 1a)

Bapak Suardi owns a small hut in the village of Salua close to Lore Lindu National Park (LLNP) in Central Sulawesi. He has planted a few cacao plants between the trees of a local forest that he does not officially own. Like many of his neighbours, Bapak Suardi's family cannot make a decent living with this little land.

One day, Bapak Suardi is sitting in front of his hut, smoking kretek and waiting for the cacao to ripen. "Suardi, we are running out of supplies for our young children!" his wife complains. But what can Bapak Suardi do? Fortunately, a 'Bos Rattan' suddenly shows up, and approaches Bapak Suardi. "One of my trucks will be in Salua in two weeks and pick up a load of rattan." Immediately, Bapak Suardi volunteers to help fill the truck. He knows some good places where rattan grows. In the past they found much rattan close by in the community forest west of Salua village, today the best places to collect rattan are deep inside the primary forests of Lore Lindu National Park.

A few days later, Bapak Suardi and a few other poor villagers meet for a rattan collecting expedition. They are all young and experienced rattan collectors. "We will easily find enough rattan to fill Bos Rattan's truck in a few days", Bapak Suardi thinks. However, their expedition takes longer than expected. In some places where they had seen much rattan just a few months ago, all good rattan canes were gone.



After one week of physically exhausting work, Bapak Suardi and his colleagues float a large load of peeled rattan canes down a small creek to a collecting point where the truck can pick up the rattan.

Eventually, the truck arrives. But there is one more disappointment. The Bos Rattan complains "Why did you cut canes that are so thin and so young? You cannot make good furniture from these canes. No-one will pay me a good price for these canes." Bapak Suardi and his friends know that the Bos Rattan is right – the quality of the canes was bad this time. So after a long discussion, they accepted a very low price for the rattan.

Driving back to town in the truck, the Bos Rattan tells his driver: "These villagers have no clue what is going on in the business". This year, business is very tough because the Bos Rattan cannot sell to the export traders from Singapore or Malaysia who always made him a very good price. "And our local furniture makers, they simply do not pay much. How shall I pay the villagers a good price then if they bring poor stuff?" – "Is this the fault of the Indonesian export ban on unprocessed rattan?" his driver asks. "I do not know", the Bos Rattan says. "But next month, we go to a different village farther down the road where the people live deeper in the forest." A few minutes later, the truck slows down at the check point of the forest police. The guard on duty approaches the truck reluctantly in order to check the rattan collection permit, but then greets friendly and hastens to open the gate. “Hope to see you soon again!” that guard says.

Fishing Information Text (Part 1b)

Pulau Maginti is one of many small islands between Selat Kabaena and Selat Tiworo, Sulawesi Tenggara. For centuries, its inhabitants have been making a living from the fish they catch.

Bapak Hendral is one of the fishermen. After a long day on the water, he discusses his haul with his friends from the village. "Like all of last year, there were so few fish again today. And I really went out far - nearly to the next island with a fishing village. Maybe the fish has become smarter and hides between the coral." His neighbour agrees that fishing has become a hard business: "Thirty years ago when I was a small kid, my father's nets were always full - and we did not even have a motor boat. But today, we have nearly 1000 fishing boats; 30 years ago there were only 600." Bapak Hendral adds: "Yea. And isn't it unfair that the big trawlers out in the open sea - some of them from Japan, Australia or China - catch more and more?"

Bapak Hendral is in despair. His children need new clothes, his mother needs an expensive medical treatment, and the motor of his boat is becoming less and less reliable. He decides that he will start using dynamite to increase his haul. "Tomorrow I will try the dynamite I had bought last week." He had been thinking of using dynamite since he had seen some of the fishermen of the village using it a few months ago and he had seen that they had a big haul. And the last time that an officer of the Sulawesi Tenggara Fisheries Office checked their island was more than 10 years ago. "Hopefully the dynamite brings out the fish that hides between the corals".

Next day's haul was spectacular. He easily caught a large amount of dead fish after a series of dynamite blasts that blew up a small coral reef. Unfortunately, he had to discard much of the fish that cannot be sold in the market. Some of the fish belonged to species that cannot be eaten, taste bad or simply were much too small. "So much waste", he thinks but for the first time for weeks he makes enough profit to buy some medicine for his mother.

Part 1a *(Single Choice)*

With respect to the "Rattan Information Text" please check the box next to the correct answer. Please choose only one answer to each question!

(i)

1. Rattan collection in the Salua area is difficult because…

…it hides between the forest trees.	
…too much is already cut.	
…of the Indonesian export ban.	
…it is illegal.	

2. Which of the following statements is correct?

Currently, quite some rattan grows in the community forests of Salua village.	
Currently, the community forest of Salua village is a good place for collecting rattan.	
In the past, rattan grew only inside Lore Lindu National Park (LLNP).	
In the past, much rattan grew outside Lore Lindu National Park (LLNP).	

3. Which of the following statements is correct?

Peeled rattan canes are floated from the forest to collection points at the road.	
Rattan plants that grow near small creeks are floated to the village.	
Entire rattan plants are carried from the forest to collection points at the village.	
Rattan plants are floated to collection points and peeled at the road.	

(ii)

4. Who are the main rattan collectors?

International rattan trading companies.	
Villagers hiring temporal workers.	
Poor villagers with little income.	
National rattan furniture manufacturing companies.	

5. According to the text, Bapak Suardi is a poor villager because…

…he does not work always hard enough.	
…he cannot cultivate enough land.	
…of his relatively low education.	
…he smokes too much kretek instead of cultivating his land.	

6. Bapak Suardi goes collecting rattan because…

…he knows exactly where it can be found.	
…it is an easy way to get additional income.	
…he needs the income for his family.	
…he doesn't like the physically hard work in the cacao plantation.	

(iii)

7. It was more difficult to harvest rattan for Bapak Suardi because…

…the forest police are more vigilant this year because an export ban is in place.	
…he had already cut much rattan without a collection permit.	
…there is an export ban in place.	
…other collectors had cut much of the rattan.	

8. Why did Bapak Suardi not take better care for the rattan stand he knew about? Because…

…he thought that 'Bos Rattan' would take care for it.	
…it was (*deep*) inside the forest.	
…he did not own the stand and it was too far away.	
…he had a good relation to the forest police.	

9. What can you infer from the text with respect to a rattan management in Lore Lindu National Park and its surroundings?

High population growth and therefore higher demand for rattan as material in those rural areas where rattan occurs.	
Rattan harvesting is ill regulated.	
Rattan collection is allowed in Lore Lindu National Park (LLNP).	
The amount of commercial rattan plantations in LLNP decreases.	

!!! Please check carefully if you have already answered all 9 questions of Part 1a!!!

Part 1b *(Single Choice)*

With respect to the "Fisheries Information Text" please check the box next to the correct answer. Please choose only one answer to each question!

(i)

10. Where do Bapak Hendral and his colleagues go fishing?

Only close to the island with their home village.	
Close to their island and adjacent islands.	
At the open sea.	
Close to their island and the open sea.	

11. Fishing close to the shore of Pulau Maginti island is difficult because…

…all of the fish has started to hide in the coral.	
…trawlers from Austalia, China and Japan catch the fish.	
…fishing techniques have not improved much compared to the big trawlers from	
…of overfishing and destructive fishing techniques.	

12. Which of the following statements best describes the effects of dynamite fishing close to a blast at near-shore areas?

Dyamite fishing kills all fish.	
Dynamite fishing kills the coral and all fish.	
Dynamite fishing kills the cannot be eaten, taste bad and small fish.	
Dynamite fishing kills the coral and the marketable fish.	

(ii)

13. Who is fishing most fish close to the shore of Pulau Maginti island?

Bapak Hendral and his friends.	
Fishermen using dynamite.	
Big high-sea trawlers from China, Australia and Japan.	
Big trawlers from Indonesia as well as China, Australia and Japan.	

14. Bapak Hendral uses dynamite because…

. …he needs more income.	
...he hopes that there is not much damage to the corals.	
…it is unfair that big trawlers catch so much fish.	
...his friends do it also	

15. Why does Bapak Hendral catch some fish that cannot be sold at a good price?

Because the good paid fish species hide between the corals.	
Because the big trawlers cought much of the big fish.	
Because the dynamite killed all fish including small and untasty ones.	
Because there is too much competition among fishermen.	

(iii)

16. It was more difficult for Bapak Hendral to have a good haul because…

…the fish hide better in the coral this year.	
…he did not have a new reliable motorboat.	
…international trawlers showed up at the high-sea of Indonesia.	
…other fishermen from his home island and adjacent islands had caught too much fish.	

17. Why did the fishermen from Pulau Maginti island not take better care for their local fish stocks? Because…

…they thought that nobody else would take "their" local fish.	
…they did not fight overfishing and destructive fishing techniques well.	
…with their small motor boats they could not stop the big trawlers.	
…the Sulawesi Tenggara fisheries management plan did not indicate an overfishing problem.	

18. According to the text, it is difficult for Bapak Hendral to get good haul because…

…of the very bad fishing tools he is using.	
…at bad weather the fish hide in the corals.	
…there are so many fishermen around the sea.	
…of environmental pollution in the sea.	

!!! Please check carefully if you have already answered all 9 questions of Part 1b!!!

Part 2 *(Single Choice)*

Please check the box next to the correct answer according to your personal perception. Please choose only one answer to each question!

(i)

1. Which of the following statements is correct?

Too much uncultivated land is a problem around Lore Lindu National Park (LLNP).	
The conversion of rainforest around LLNP is forbidden.	
Increasing population pressure is a problem around LLNP.	
Too little uncultivated land is a problem around LLNP.	

2. Non-timber-forest-products (such as rattan) are mainly degraded due to…

…the absence of maintenance such as cutting and fertilizing.	
…climate change impacts.	
…intensive harvesting.	
…wild animals	

3. Marine near-shore fish stocks are mainly degraded due to…

…too high harvesting pressure.	
…inefficient fishing technology.	
…rapid changes in water temperatures due to El Niño Southern Oscillation (ENSO) climate effects.	
…environmental pollution.	

4. For a sustainable management plan for rattan one needs to know…

…time of the year when the rattan fruits mature.	
…mechanical properties of the rattan cane.	
…growth response to fertilizer.	
…status of rattan stocks and growth rate.	

5. What happens if nets with too small meshes are used?

Too much unwanted material - such as seaweed - is caught in the nets.	
The fish stocks collapse less fast as also smaller carnivorous fish are caught.	
The maximum sustainable yield of the fish species drops.	
Too many sexually immature fish are caught.	

(ii)

6. One of many under-employed farmers…

…will collect Non-Timber Forest Products (NTFP) at any price.	
…has low bargaining power over Non-Timber Forest Products (NTFP) prices.	
…will accept any off-farm work no matter how badly paid	
…will migrate to a different Indonesian island.	

7. A fisherman with little additional income sources and not member of a strong fishing co-operation...

…will most of the time to act as a price taker when negotiating with a fish buyer.	
…will have to joint the co-operation before he is legally allowed to fish.	
…will try to catch as much fish as physically possible.	
…will harvest at the maximum sustainable yield.	

8. While harvesting rattan…

…building forest access roads is a big problem.	
…a few forest trees may get damaged.	
…there is a big damage to forest trees.	
…the surrounding forest is severely damaged.	

9. Which of the following statements is correct with respect to rural Indonesia?

NTFP and fisheries management plans are a highly effective tool for ensuring sustainable development.	
A traditional community in legal control of their land and fishing grounds can often manage thier natural resource stocks effectively.	
The forest police and Fisheries Office personal mostly make sure that natural resource management plans and other regulations are respected.	
The administrative introduction of private property rights in wild NTFP and fish stocks is a simple and effective way to improve living conditions of the local resource users.	

10. Which of the following statements is correct for the waters around small Indonesian islands?

Few fish species exist but only some of them are paid a good price.	
Many fish species exist and most of them can be marketed for a good price.	
Few fish species exist, however, they are marketed for a good price.	
Many fish species exist but only some of them are paid a good price.	

(iii)

11. Which of the following statements is correct with regard to near-shore fisheries in Indonesia?

The abolishment of traditional use rights is a basis for effective fish management.	
A free-market system manages fish stocks effectively.	
Government interventions in natural resource management are more effective if traditional management institutions are included.	
The only reason for ineffective marine resource management is an ineffective state bureaucracy.	

12. Which of the following statements is most appropriate with respect to rural Indonesia?

The revolution of 1998 diminished the prospects of local communities to manage their traditional territories including the existing Non-Timber Forest Products (NTFP) stocks by themselves	
Non-Timber Forest Products (NTFP) had been conserved much better during the Suharto Era due to strong state command and control.	
Since the time of *Reformasi* provincial governments effectively implement natural resource management institutions to regulate Non-Timber Forest Products (NTFP) harvesting.	
The continuing devolution of Indonesian governmental power to provincial and local authorities introduces additional risks to the sustainable development of Non-Timber Forest Products (NTFP) stocks.	

13. The Indonesian government approved a ban on the export of unprocessed rattan in order to…

…favour the Indonesian rattan furniture industry.	
…increase foreign exchange earnings.	
…improve the situation of the rattan collectors.	
…to foster Foreign Direct Investment (FDI) in Indonesia's furniture industry.	

14. What is long-term rational behaviour of a co-operating group of people harvesting their private good?

In any case harvesting at maximum sustainable yield.	
Safe as much as possible from the resource for the future.	
Harvesting below maximum sustainable yield if the resource has important secondary benefits.	
Harvesting as much as possible in order to increase the income.	

15. What is long-term rational behaviour of a co-operating group of people harvesting an open access good?

Harvesting as much as can physically be harvested if the group can ensure excludability.	
Harvesting much below maximum sustainable yield.	
In any case harvesting at maximum sustainable yield.	
Harvesting at maximum sustainable yield if the group can ensure excludability.	

!!! Please check carefully if you have already answered all 15 questions of Part 2!!!

Part 3 *(Single Choice)*

With respect to the sustainable utilisation of natural resources such as depicted in the rattan and fishing examples: What needs to be recognized most urgently by regulators and resource appropriators according to your personal perception? Please mark one in each of the following boxes!

1.

There exists an unequal access to natural resources, for example, if some rattan collectors have trucks and some fishermen larger boats.	
Individual benefits of resource appropriation result in costs that have to be borne by the whole resource appropriator community.	
Natural resource stocks decline so all individual resource appropriators have to bear the costs of worsened harvest-per-effort ratios.	
The decline of individual moral standards with respect to natural resource appropriation is a root cause of the current natural resource problems.	

2.

Devising good natural resource management plans is difficult because unsustainably high rates of resource extraction are sometimes only visible after several years.	
Destructive harvesting techniques such as dynamite fishing destroy natural resources irreversibly for many generations even if used only once.	
Individual greed and egoism are the biggest dangers for the ability of future generations to harvest their share of natural resources.	
Due to climate change impacts in the future, it is quite diffucult to set up natural resource management plans.	

3.

The negative impacts of natural resource extraction actualise most strongly at places far away form the places of k extraction.	
It is very difficult to predict the consequences of NTFP and near-shore fish stock extraction as both resources are so-called "migratory resource stocks". (like "migratory birds").	
In both examples, upstream resource appropriators reduce the ability of downstream resource appropriators to obtain a fair share of the fish and rattan stocks.	
The extraction of NTFPs and of near-shore fish stocks has negative impacts mainly at the site of extraction but sometimes also in other places.	

4.

Poor users of natural resources should be encouraged to save more money so they are better prepared for declines in resource availability.	
Apropriators of natural resources are often poor and more vulnerable to a decline in the resource stocks than richer rural inhabitants or city dwellers.	
Poor users of natural resources are the direct agents of resource degradation and therefore need to be considered primarily.	
Apropriators of natural resources are often poor and less vulnerable to a decline in the resource stocks because they are willing to accept more different income options.	

Part 4

INSTRUCTIONS: ***Please mark the effectiveness of the following solution possibilities with a cross in the appropriate box.***

	How effective is this solution concerning the protection of the resource stocks?	***How effective is this solution concerning the improvement/stabilisation of the livelihoods of the local villagers?***	***How effective is this solution to contribute to economic development/growth in Indonesia?***
1. The central government should provide more Rangers/Forest Police to prevent rattan collectors from illegal harvesting.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
2. The Ministry of Marine Affairs and Fisheries (or another institution which is responsible) should develop a strategy for the sustainable near-shore fishing closely related to community interests.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
3. The government should strictly implement monitoring and punishments of using illegal fishing techniques.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
4. Certification schemes ("ecolabels") should be developed to support sustainable fish harvesting practices.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
5. Penalties from the *Lembaga Adat* should be strictly applied if a villager extracts too much rattan or unnecessarily damages forest vegetation and wild animals.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
6. Tenure rights should be given to local communities because traditional forest dwellers have successfully managed rattan and other Non-Timber Forest Products (NTFP) as common property for centuries.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective

INSTRUCTIONS: ***Please mark the effectiveness of the following solution possibilities with a cross in the appropriate box.***

	How effective is this solution concerning the protection of the resource stocks?	***How effective is this solution concerning the improvement/stabilisation of the livelihoods of the local villagers?***	***How effective is this solution to contribute to economic development/growth in Indonesia?***
7. Fishing village meetings should be arranged where all habitants develop rules how to manage local fish stocks.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
8. The government (i.e. The Ministry of Forestry) should make a plan to strictly enforce a permit system for all NTFP. The permits would only be valid for a specific area.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
9. The government should strictly implement a ban on the export of unprocessed rattan	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
10. The government should implement and strictly monitor fishing quotas for the Indonesian near-shore fisheries.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
11. The government should implement and monitor national and international fish-trade regulations.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective
12. Regional cooperations should be established concerning NTFP management.	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective	Absolutely ineffective □ □ □ □ Very effective

Part 5

Here we briefly describe some people. Please read each description and think about how much each person is or is not like you. Tick the box to the right that shows how much the person in the description is like you.

How much is this person like you?

1. Thinking up new ideas and being creative is important to him. He likes to do things in his own original way.	Not similar at all to myself	O O O O O O	Very similar to myself
2. It is important to him to be rich. He wants to have a lot of money and expensive things.	Not similar at all to myself	O O O O O O	Very similar to myself
3. He thinks it is important that every person in the world should be treated equally. He believes everyone should have equal opportunities in life.	Not similar at all to myself	O O O O O O	Very similar to myself
4. It's important to him to show his abilities. He wants people to admire what he does.	Not similar at all to myself	O O O O O O	Very similar to myself
5. It is important to him to live in secure surroundings. He avoids anything that might endanger his safety.	Not similar at all to myself	O O O O O O	Very similar to myself
6. He likes surprises and is always looking for new things to do. He thinks it is important to do lots of different things in life.	Not similar at all to myself	O O O O O O	Very similar to myself
7. He believes that people should do what they're told. He thinks people should follow rules at all times, even when no-one is watching.	Not similar at all to myself	O O O O O O	Very similar to myself
8. It is important to him to listen to people who are different from him. Even when he disagrees with them, he still wants to understand them.	Not similar at all to myself	O O O O O O	Very similar to myself
9. It is important to him to be humble and modest. He tries not to draw attention to himself.	Not similar at all to myself	O O O O O O	Very similar to myself
10. Having a good time is important to him. He likes to "spoil" himself.	Not similar at all to myself	O O O O O O	Very similar to myself
11. It is important to him to make his own decisions about what he does. He likes to be free and not depend on others.	Not similar at all to myself	O O O O O O	Very similar to myself
12. It's very important to him to help the people around him. He wants to care for their well-being.	Not similar at all to myself	O O O O O O	Very similar to myself
13. Being very successful is important to him. He hopes people will recognise his achievements.	Not similar at all to myself	O O O O O O	Very similar to myself

14. It is important to him that the government ensures his safety against all threats. He wants the state to be strong so it can defend its citizens.	Not similar at all to myself	O O O O O O	Very similar to myself
15. He looks for adventures and likes to take risks. He wants to have an exciting life.	Not similar at all to myself	O O O O O O	Very similar to myself
16. It is important to him always to behave properly. He wants to avoid doing anything people would say is wrong.	Not similar at all to myself	O O O O O O	Very similar to myself
17. It is important to him to get respect from others. He wants people to do what he says	Not similar at all to myself	O O O O O O	Very similar to myself
18. It is important to him to be loyal to his friends. He wants to devote himself to people close to him.	Not similar at all to myself	O O O O O O	Very similar to myself
19. He strongly believes that people should care for nature. Looking after the environment is important to him.	Not similar at all to myself	O O O O O O	Very similar to myself
20. Tradition is important to him. He tries to follow the customs handed down by his religion or his family.	Not similar at all to myself	O O O O O O	Very similar to myself
21. He seeks every chance he can to have fun. It is important to him to do things that give him pleasure.	Not similar at all to myself	O O O O O O	Very similar to myself

Thank you very much for your participation!!!

Appendix IV: Tetrachoric Correlation Matrix for the LISREL Measurement Model

RA_EK_1D RA_EK_2D RA_EK_3D
RA_SK_1D RA_SK_2D RA_SK_3D
RA_IK_1D RA_IK_2D RA_IK_3D
FI_EK_1D FI_EK_2D FI_EK_3D
FI_SK_1D FI_SK_2D FI_SK_3D
FI_IK_1D FI_IK_2D FI_IK_3D
CK_EK_1D CK_EK_2D CK_EK_3D CK_EK_4D CK_EK_5D
CK_SK_1D CK_SK_2D CK_SK_3D CK_SK_4D CK_SK_5D
CK_IK_1D CK_IK_2D CK_IK_3D CK_IK_4D CK_IK_5D[6]

Number of Decimals = 7

Correlation Matrix:
1.0000000
0.0758638 1.0000000
0.1106523 0.0703802 1.0000000
-0.0027980 -0.0390780 0.0297970 1.0000000
0.0514756 0.0156919 0.1381788 0.0512067 1.0000000
0.1146010 0.0181050 -0.0456663 -0.1248118 -0.0825016 1.0000000
0.4686476 0.0527438 0.1163830 -0.1343776 0.0858479 0.0895193 1.0000000
0.0862095 0.0762330 0.0617697 -0.0134547 -0.0653738 0.0088291 0.1149098 1.0000000
0.1789447 0.1326083 0.0641985 0.0706288 -0.0388585 0.1584434 0.2456908 0.0949734 1.0000000
0.0682145 -0.0011677 0.1493012 -0.0641923 -0.0249179 -0.0322263 0.0172891 0.0550796 0.1455647 1.0000000
0.2353141 0.0892298 0.0379383 -0.0229776 -0.1191889 0.0377013 0.1972659 0.1110399 0.1976979 -0.0440402 1.0000000
0.1351765 0.1272732 0.2379492 0.0492987 -0.0366082 0.1354198 0.1967551 0.1199590 0.2046648 0.1002980 0.2408221 1.0000000
0.0965295 0.0550722 0.1542237 0.0250920 -0.1051963 0.0459572 0.0014519 0.1253520 0.0672708 0.1377974 0.1887203 0.0851662 1.0000000
-0.0318648 -0.0475011 0.0002237 0.0599918 0.0649721 0.0722330 -0.0043677 0.0635921 -0.0220863 -0.0460185 -0.0239439 0.0337866 0.0266368 1.0000000

[6] RA = Rattan Items in Situational Knowledge
FI = Overfising Items in Situational Knowledge
CK = Conceptual Knowledge Items (NTFP & Marine Resoruces)
EK = Ecological Knowledge
SK = Socio-economic Knowledge
IK = Institutional Knowledge

-0.0185406 -0.0444114 0.0997134 0.0822167 0.0000988 0.0166263 -0.0439357
0.1117909 0.1223973 0.0110494 0.0492105 0.0722370 0.0139350 0.0907566 1.0000000
0.1489592 0.0956299 0.0191216 0.0812400 0.0408024 0.0405407 0.0649961 0.0135919 -
0.0258019 0.0959099 0.3384342 0.0751604 0.2960598 -0.0758701 0.0068797 1.0000000
0.0025975 -0.1234002 0.1110778 0.0483544 0.0451656 0.0006959 0.0028507 -0.0279662
0.0915483 -0.0627608 0.1354164 0.0044931 0.1697625 0.0105413 0.0413419 0.0323534
1.0000000
0.0920196 0.0947301 0.2029482 -0.1540036 0.0457620 0.1205967 0.1345174 0.0679306
0.0431852 0.0602623 0.2229845 0.1592002 0.0376617 -0.1474373 -0.1441492 0.3331305
-0.1126218 1.0000000
0.0814376 0.0973326 -0.0770805 -0.0129035 -0.2299644 0.0170356 -0.0061171 -
0.0264654 -0.0496581 -0.0140995 0.1100304 0.1175224 -0.0099890 -0.0018195
0.0674995 0.0569966 -0.0840833 0.1043579 1.0000000
0.0868480 0.0711196 0.0448552 0.0207066 0.0441727 -0.0479924 0.2264072 0.1471860
0.1731600 0.1138428 0.2128076 0.0715627 0.0058577 0.0364861 -0.0307411 0.1317107
0.0816402 0.1140072 0.0913434 1.0000000
0.1283115 0.0401979 -0.0231509 -0.0134089 -0.0536680 0.0573703 0.1699563
0.1286002 0.0566872 0.0934820 0.1365486 0.1206054 -0.0209959 -0.1183538 -
0.0114374 0.1624213 -0.0688123 0.4701489 0.0682592 0.2339671 1.0000000
0.1359464 0.0879756 0.1050634 0.0335793 -0.0555942 0.1862365 0.2710213 0.0684970
0.1911698 0.0881339 0.2365133 0.2369981 0.0026064 0.0147763 -0.0015601 0.1397925
0.0935035 0.1613154 -0.1039803 0.3314482 0.2074297 1.0000000
0.0291670 0.0209951 -0.0048685 -0.0132751 -0.0428777 0.0918906 0.0871389
0.1474513 0.0653966 0.0669111 0.1022144 0.1029437 0.0313377 -0.0096294 0.1230906
0.0538378 -0.0299252 0.0954171 0.1064991 0.1168055 0.0182378 0.0187065 1.0000000
-0.0248020 -0.0283862 0.0334159 0.0367295 -0.0688240 -0.0116659 -0.0173918
0.1278780 0.0152098 0.0230914 0.0039343 -0.0056632 0.0423325 -0.0168178 0.1018144
0.0597426 -0.0011467 -0.0323501 0.0076328 -0.0413809 0.0573537 0.0297199
0.2044529 1.0000000
0.0741885 0.0859248 0.0118034 -0.0423646 0.0946017 0.0083708 0.2017042 -0.0451024
0.0692144 0.0741488 -0.0365841 0.0715190 0.0961253 -0.0442453 -0.1406931 -
0.0159280 -0.0297391 0.0216261 -0.0678272 0.0718749 -0.0020291 -0.0794432 -
0.0708747 0.0062896 1.0000000
0.0292342 0.0360643 -0.0218791 -0.0337028 0.0761605 -0.0626167 0.0200687
0.0524813 0.1034072 -0.0163771 0.0192453 0.0303483 -0.0032021 -0.0082274
0.0443624 -0.1332739 -0.0645159 0.0317491 0.0234017 0.0564289 0.1385702 -
0.0495435 0.0878858 -0.0128896 0.0443625 1.0000000
-0.0873931 0.0618051 0.0875282 0.0682507 0.0259055 0.0433758 0.0519410 0.0969286
0.0120887 0.0218606 -0.0688514 0.0886340 0.0159479 -0.0046274 0.0131576 0.0934144
0.0142866 0.0275820 -0.0651943 -0.0236935 0.1085865 0.0681095 -0.0562615 -
0.0413869 -0.0316477 -0.1195896 1.0000000
0.1579382 0.0602217 0.2327378 0.0327724 0.0473726 0.1113822 0.1291113 0.0921363
0.2045453 0.0727986 0.1472365 0.2127441 0.1052220 -0.0376056 0.1243445 0.2275964
0.0254721 0.2024443 0.0025018 0.1515161 0.1577344 0.1423158 0.0983411 0.0573313
0.0708699 -0.0850254 0.0975070 1.0000000
0.1093468 0.0359688 0.1121444 -0.0135236 0.1589132 0.0689583 0.0378005 0.1177683
-0.0172382 0.1337037 -0.0882823 0.0818109 0.0001541 -0.0680201 0.0006026

0.0309151 0.0553654 -0.0139799 0.0184739 0.1259404 0.0356778 0.0022573 0.1053052
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0.0844488 0.0861320 0.0521268 0.0702386 0.0612964 -0.0314873 -0.0194272 0.1202544
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0.0711456 -0.0088924 0.0543834 0.0138880 0.0130594 0.1534244 0.0716260 -0.0147310
-0.1220736 -0.0458469 0.0635008 0.0566808 0.0613358 1.0000000
0.1978669 0.0641938 0.0145375 0.0445315 0.0573113 -0.0108854 0.1001618 0.0585995
0.1101709 -0.0183191 0.0763964 0.1727841 0.0525428 -0.0166156 -0.0626050
0.0154035 0.0142338 0.0981946 0.0656240 0.1572993 0.0484267 0.0605833 0.0549548
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0.0125726 -0.0479632 0.0638956 0.0746865 0.0889916 -0.0175412 0.0065696 0.0103997
-0.0668026 0.1170415 -0.0986950 -0.0130063 -0.0049123 0.0869769 -0.0755854 -
0.0229361 -0.0459085 -0.0394251 -0.1131706 -0.1096709 -0.0642402 0.0789184
0.0451181 0.0580027 -0.0535030 -0.0600346 0.1464099 -0.0093770 0.0751315
0.1018303 -0.0860618 0.1322521 1.0000000

Sample Size: 882