Socioeconomic Dynamics and Land Use Change of Rural Communities in the Vicinity of the Lore-Lindu National Park

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1. Introduction

The Lore Lindu National park (LLNP), situated in Central Sulawesi, Indonesia, hosts a unique collection of endemic species that are notably important for biodiversity and natural conservation issues. The expansion of the agricultural area is, however, threatening the integrity of the park. Since the year 2000, STORMA (Stability of Rainforest Margins), a collaborative interdisciplinary research project, has conducted research to analyse, from different vantage points, the destabilization process in this area. As part of this interdisciplinary research, a village-level survey was conducted in the year 2001 and in 2007. This paper describes the land-use as well as socioeconomic changes, which occurred in the villages of the research area.

The organisation of this paper is structured as follows. The following section describes the data collection. In section three, the results of the study concerning land-use and socio-economic characteristics will be presented. The conclusions of the study will be discussed in section five.

2. Data

The observation unit of this study are the 119 villages surrounding the LLNP. In the first phase of STORMA, 80 out of 119 villages had been randomly selected (Zeller *et al*, 2002). Village representatives of the selected villages have been interviewed in 2001 and 2007 using basically the same formal, standardised questionnaire. Moreover, secondary data from various institutions at village, district, and provincial level were collected to provide additional information.

3 Results

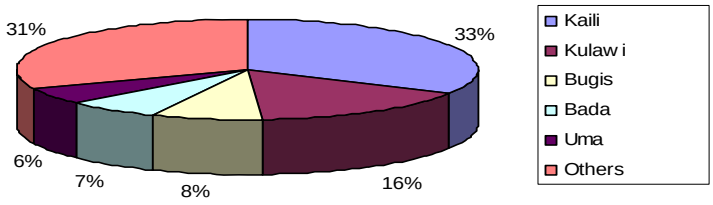
3.1 Demography

From 2001 to 2007, the population increased by 14.1 percent, which is equivalent to a mean annual growth rate of 2.2 percent. The growth rate is higher than at the provincial level (2.1 percent) as well as at the national level (1.3 percent) indicating a higher population pressure in the research area.

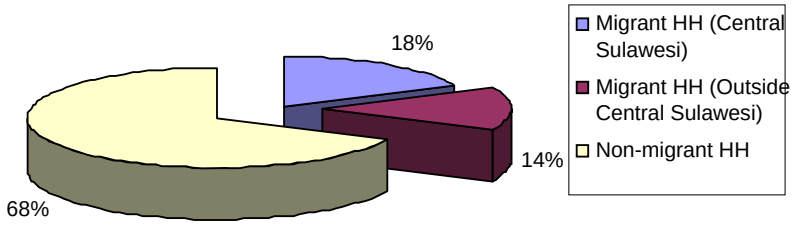
The two most important religious groups are Protestants and Moslems with a share of 58.1 and 40.6 percent, respectively. Furthermore, the main ethnic groups residing in the area are Kaili and Kulawi. The most important non-indigenous ethnic group are the Buginese (Figure 1a). 32 percent of the total population are migrants who came from inside (18 percent) and outside of the province of Central Sulawesi (14 percent) as indicated by Figure 1b. In this study, a household is considered a migrant household if the household head was not born in the current dwelling village. Migration rates between 2001 and 2007 slowed down and only 6.7 percent of the total migrant households came during this period.

A transmigration program over long periods of time has been promoted and arranged by the Indonesian central government. This had originally been initiated by Dutch colonial rule during the early 20th century. This program aimed to overcome the population pressure in the densely populated islands (Java, Madura and Bali) and was designed to distribute the population into the less densely populated islands. In accordance with this goal, Sulawesi island became one of the destinations for the resettlement. In the study area, most of the transmigrant households already left the area again. In 2007, only one transmigrant household was documented , while in 2001 there were still 113 households.

Figure 1. Ethnic Composition and the Share of Migrants



(a)



(b)

N = 24,665 HH

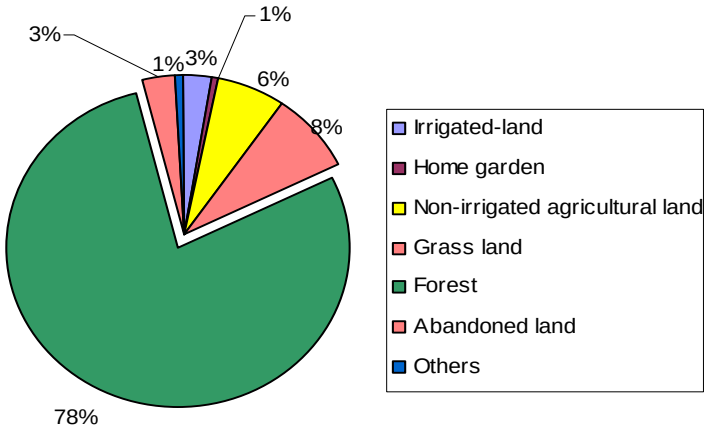
Source: Own calculations

3.2 Land use change

The largest portion of land is still covered by forest which constitutes 78 percent of the total area in the 80 villages (Figure 2). 8 percent of the area is covered with grassland, and the remaining land is allocated to agriculture (irrigated and non-irrigated agricultural land), home gardens, abandoned land and other uses. The latter category consists of land for local markets, hospitals, schools, government offices and religious buildings.

Between 2001 and 2007, the land allocated to home gardens, agriculture, and other uses increased by 8.0, 2.6 and 58.8 percent, respectively (Figure 3). The population growth might have induced the demand for these three land categories, since they are directly related to support human needs. Forest cover has decreased by 4.8 percent during the same time period. Households in the villages converted on average 1.95 hectares of forest to agricultural land and 12 percent of the households are involved in this activity. The cacao boom is the main cause of deforestation in this forest margin area as the availability of fertile land became limited to village communities. The forest area, as an “abandoned” resource has strongly attracted encroachment leading to deforestation and land use change. The ambiguity of the national park border tends to make the protected area more vulnerable to common access, and creates tensions between the involved parties. The reason for this is that the border of the national park as set by the national park administration differs from the boarder as claimed by the rural communities.

Figure 2. The Land Allocation

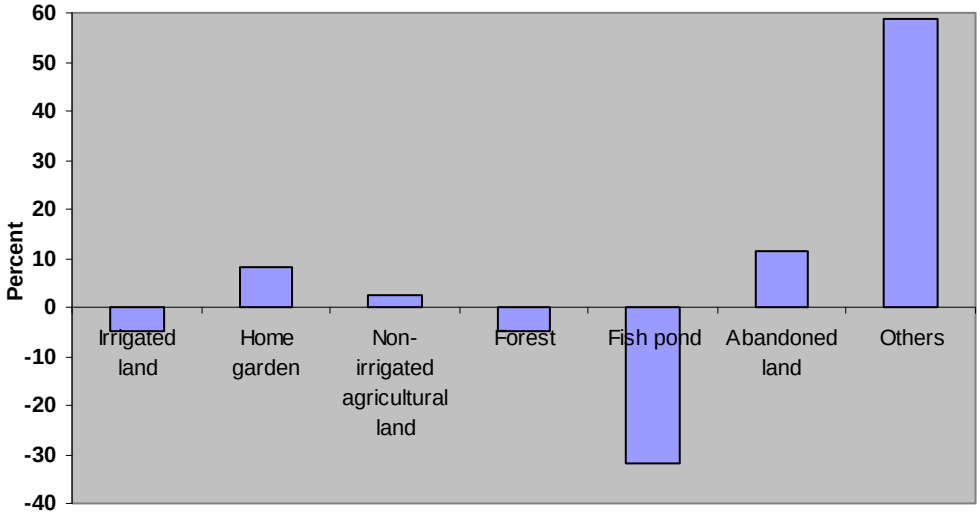


N = 559,354.24 Ha

Source: Own calculations

The acreage of the most important annual crops has decreased during the last two periods (Figure 4). Wetland rice as the most important food crop is mainly grown in the lowland area using irrigation and agricultural inputs. The acreage of wetland rice has declined by 4.8 percent over the last six years. Dryland rice is also grown because of the limited availability of irrigated land in some villages. In contrast to wetland rice, dryland rice is mainly grown with simple farming methods and without using agricultural inputs. The acreage of dryland rice has been reduced by 21.2 percent and that for maize by 16 percent between 2001 and 2007.

Figure 3. Land Use Change from 2001 to 2007



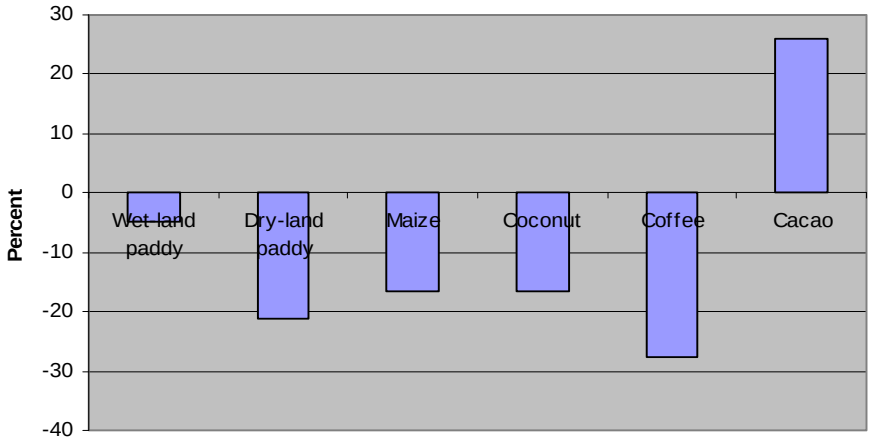
N = 80 Villages

Source: Own calculations

With the exception of cacao, the cultivated land for the most important perennial crops has decreased. The acreage of cacao increased by 26 percent, meanwhile, coconut and coffee cultivation, which are considered the two other important perennial crops after cacao, have been reduced by 16.6 and 27.8 percent, respectively, during the last six years. The decrease in

the cultivation of the perennial crops is particularly striking for coffee which has been the most important cash crop in the upland area over the past decades. Nowadays, most coffee plots have been abandoned since the price of coffee has been steadily declining. On the other hand, cacao cultivation gives more profits to the farmers, and as a result, farmers prefer to grow cacao rather than coffee. However, the farmers predict that coffee cultivation in the upland area will increase in the future since the coffee price is currently increasing, while on the contrary, the cacao production will most likely decline because of pests, diseases, and soil fertility problems.

Figure 4. Land Use Change for the Most Important Crops from 2001 to 2007

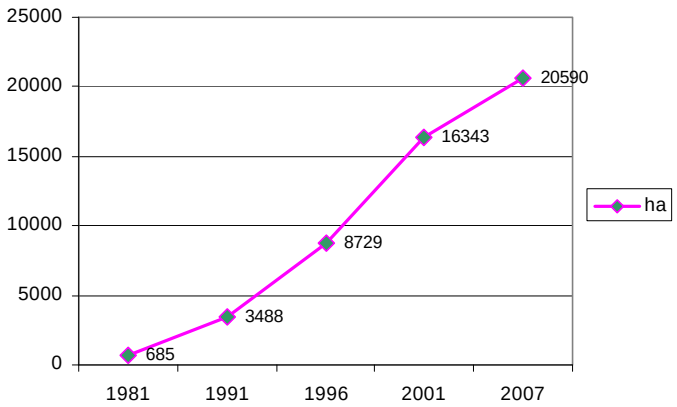


N = 80 Villages

Source: Own calculations

Coconut is the most important perennial crop in the lowland area. Most trees in the coconut plots, however, have not been replanted even though they are no longer in the productive age, as a result, the coconut yields keep declining. There are two factors why the farmers are reluctant to renew their coconut plots. Firstly, most farmers did not establish their own plots because they had inherited them. The inherited plots are mostly grown with local varieties that require up to 15 years to reach the optimum harvest age. Secondly, despite the use of hybrid coconut varieties, which just need 3 to 4 years until the first harvest, farmers are reluctant to apply them because of their very high costs.

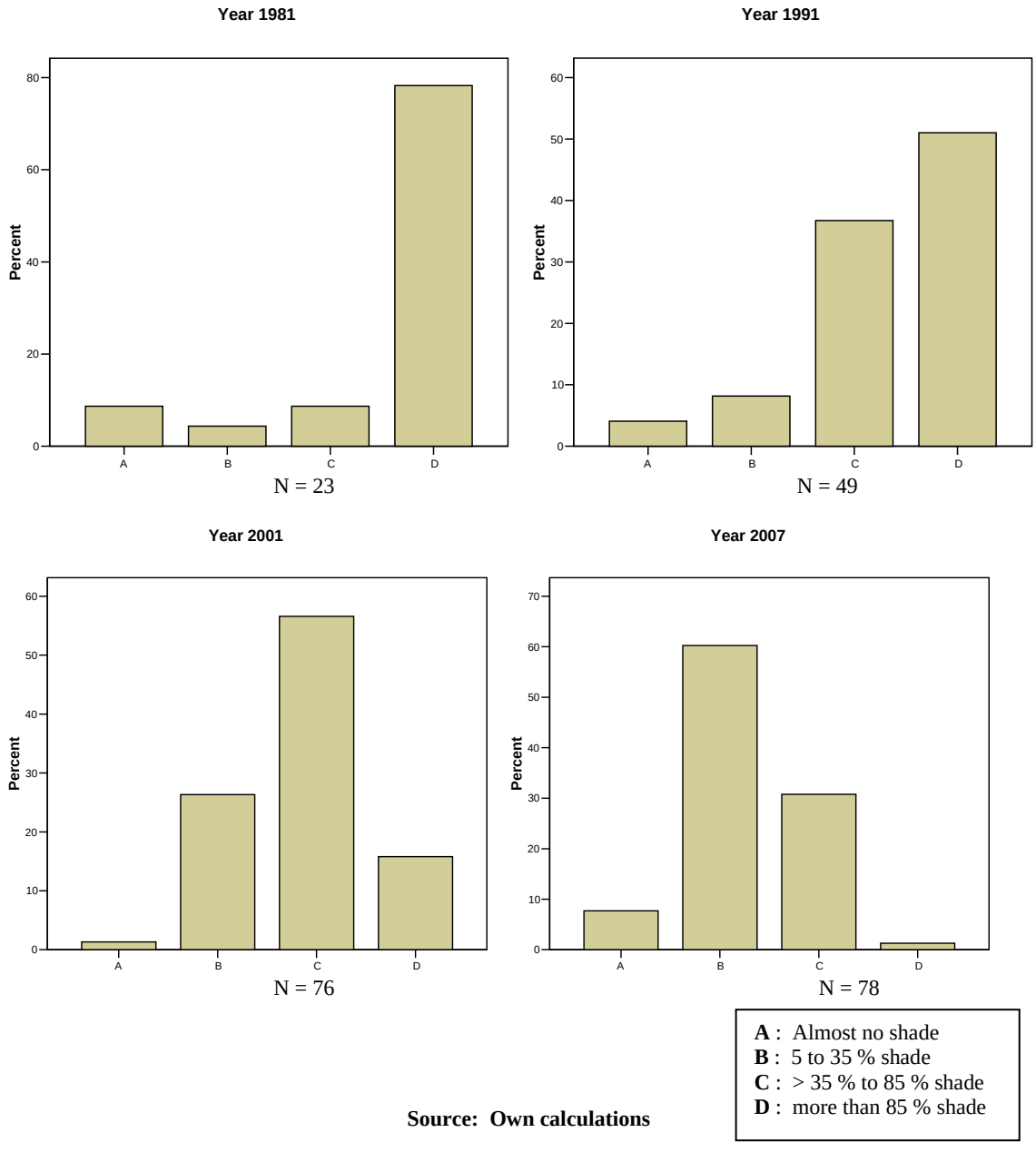
Figure 5. The Change of Acreage of Cacao (Ha) between 1981 and 2007



Source: Own calculations

In the last 26 years, the cultivated area of cacao has expanded from 685 ha to 20,590 ha (Figure 5). The expansion of the total area was accompanied by an intensification of the production, particularly by a reduction in the shade cover (Figure 6).

Figure 6. Pattern of Cacao Cultivation



Source: Own calculations

Cacao cultivation is categorized into four types (A, B, C, and D), which indicate an increase in shade tree cover from A to D. In case of type A, there are almost no shade trees left, while the D type is characterised by more than 85 percent shade cover. The latter type represents cacao cultivated under a rich variety of forest and planted shade trees. In 1981, 78 percent of the cacao cultivated was of type D. Within ten years, the number of villages growing cacao increased by 63 percent, and the area of the D type declined by 51 percent. By 2007, just 1 percent of the total cacao was cultivated on plots with more than 85% of shade tree cover (D). This development illustrates the change in the way cacao is cultivated in the study area. When cacao was first introduced, only a few farmers directly converted their land to start growing

cacao, which is represented by the low share of the A type. Most farmers started to cultivate cacao on plots inside the forest as it requires less labour. In addition, they could continue to grow their usual food and cash crops as a source of income and for food security. Since the yield of cacao increases with less shade trees, farmers started to intensify their cacao production by cutting shade trees and by cultivating more cacao trees per area.

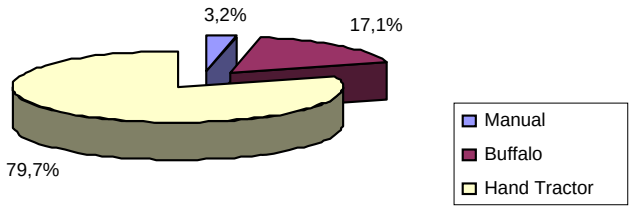
3.4 Agricultural technology

Agricultural inputs are mainly used for wetland rice. As reasons why they apply almost no agricultural inputs to other crops, farmers stated firstly, that the plots of all the other crops are usually much further away from the village road than the paddy plots. Thus, farmers would need much more time to transport the agricultural inputs from the road to the plot. The second reason mentioned is the strong focus of the Indonesian government on the achievement of rice self-sufficiency. Thus, less attention has been given to the development of other crops. As a result, the agricultural research and extension service mainly promotes wetland rice production. Because agricultural inputs are mainly used for wetland rice, the following description of the applied agricultural technologies is limited to wetland rice cultivation.

In the research area there exist technical, semi-technical, and simple irrigation systems for the production of wetland rice. The simple irrigation system is characterised by a water channel, which is built from hardened ground. Moreover, the simple irrigation system has no means to control the level of water volume. It is usually arranged by local farmers. The simple irrigation system still covers 40.5 percent of the total irrigated area. The share, however, has declined by 15 percentage points between 2001 and 2007, while the portion of the other irrigation systems has increased. In 2007, technical irrigation covered 28.3 percent and semi-technical irrigation covered 31.2 percent of the total irrigated area.

For land preparation, 79.1 percent of the farmers use hand tractors, followed by buffaloes with 17.1 percent. Only a few farmers still prepare their land manually with shovels (Figure 7).

Figure 7. Technology Applied for the Preparation of Wetland Rice



N = 71 Villages

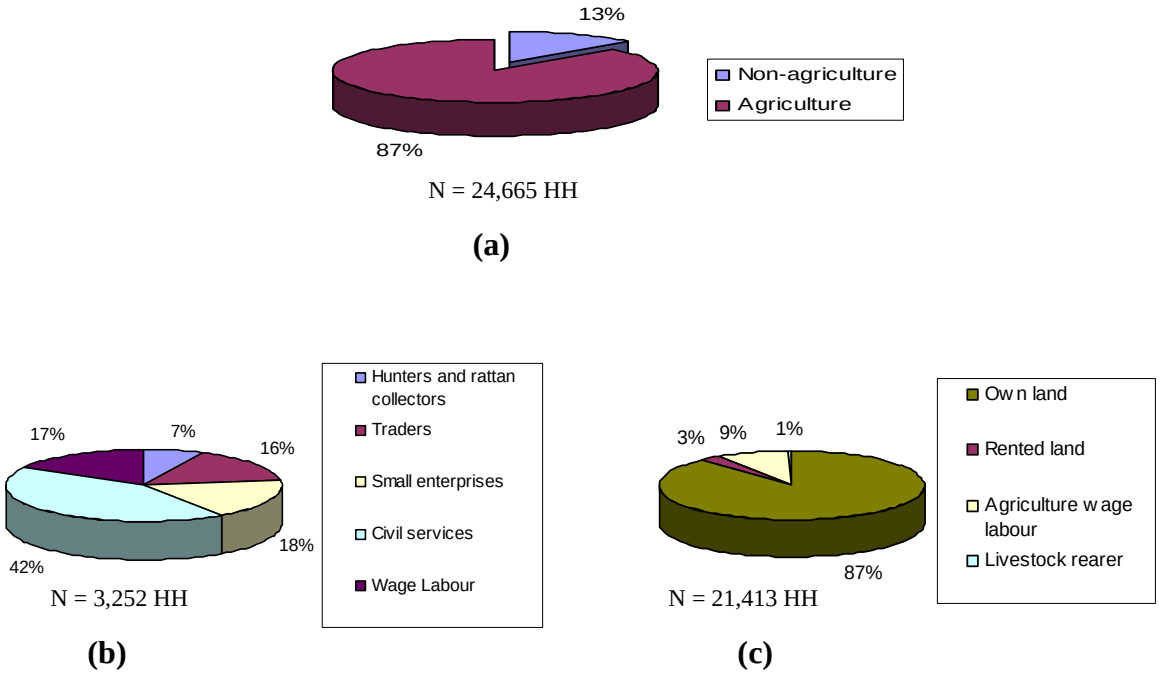
Source: Own calculations

The use of hybrid seeds is considerably low compared to the use of fertilizers and pesticides. The share of farmers using hybrid seeds is just 10 percent, while 62.3 percent use chemical fertilisers and 70.2 percent apply pesticides.

3.5 Occupation and land ownership

Farming is the major occupation of households in this area with 86.8 percent of them depending on agriculture activities. Only 13.2 percent of the households make their living mainly from non-agricultural activities (Figure 8a). Among the households who work mainly outside agriculture, 42 percent work as civil services, 16 percent as traders, 17 percent work as wage labours, and 1 percent work as rattan collectors and hunters (Figure 8b).Among the households who work in agriculture, 87 percent cultivate their own farmland, 9 percent work as agriculture wage labours and 3 percent rent the land from the other farmers (Figure 8c). 1 percent have their main occupation as livestock-keepers (see Figure 8c).

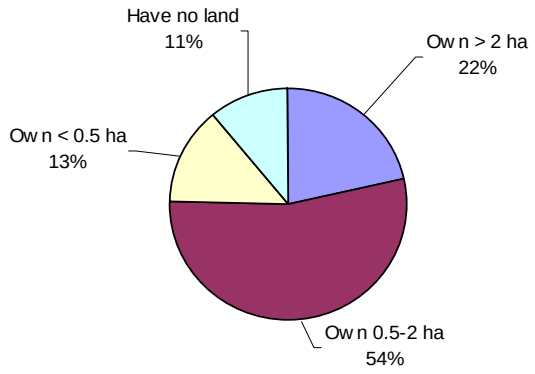
Figure 8. Occupations in 2007



Source: Own calculations

54 percent of the households in the research area own between 0.5 and two hectares of land. 13 percent own less than 0.5 ha, 11 percent have no owned-land, and only 22 percent of the households own more than 2 ha (Figure 9).

Figure 9. Land Distribution



N = 24,665 HH

Source: Own calculations

3.6 Public Services

This section describes the availability of different public services in the villages of the research area without exploring the quality and the function of the services (Table 1).
The state-owned electricity company PLN (Perusahaan Listrik Negara) provides electricity in 68 percent of the villages. In most of the remaining villages electricity is provided locally using generator, solar panels, or small hydro power plants. In just one village there is no electricity available at all. At the household level, 69 percent of the households in the research area have access to electricity. If the electricity is provided by the state company PLN, it is available for 24 hours per day in most of the villages. If it is provided locally, electricity is available only for four to six hours per day.

Table 1. Public Services in 2007

Description	Available (%)	Unavailable (%)
Electricity	68	32
Health Services		
Polindes (village delivery post)	88	12
Posyandu (village health post)	90	10
Pos KB (village family planning station)	80	20
Schools		
Elementary School	100	0
Junior High School	33	67
Senior High School	12	88
Post Office	3	97
Banking	5	95
Public Phone Shop	21	79

N=80

Source: Own calculations

The provision of health services in the research area is considerably poor. Polindes, small posts for delivery, are only available in 88 percent of the villages. Posyandus exist in 90

percent of the villages. They usually provide very simple general health services and they should be available in all the villages as the distances between can be large.
The education system in Indonesia is structured into three levels of schooling. The elementary school covers the classes 1 to 6, the junior high school the classes 7 to 9, and the high school the classes 10 to 11. In the study area, all villages have at least one elementary school. Junior high schools are only available in 33 percent of the villages and high schools in just 12 percent. According to the National Education Program, every Indonesian children should attend school for at least 9 years from elementary until junior high school. To reach this goal, every village in the research area should have at least one junior high school because of the long distances between villages. However, the government does not provide enough funds to establish a sufficient number of junior high schools.
The coverage of other public services is in general very low. Post offices, banks, and public phone shops are only available in 3 percent, 5 percent and 21 percent of the villages, respectively.

3.7 Market access

Local markets, which are usually held weekly, exist in 16 villages. These local markets are linked to central markets. The city of Tentena serves as the central market for all villages located in the southern part of the research area and Palu is the central market for the remaining villages.
The road infrastructure plays an important role to improve access to markets. Since 2001, the road infrastructure has been improved considerably in terms of quality as well as quantity (Table 2). The share of villages, which can be reached by motorcycle increased from 85 percent to 100 percent. In this region, motorcycles are important not only for the transport of passengers but also for the transport of goods, like agricultural products, to the local or central market. Motorcycles are more resilient to the unfavourable climatic and geographical conditions and they also require the least operational time and cost compared to other vehicles. Moreover, the quality of roads has also improved since 2007. The share of villages connected by asphalt roads increased from 66 percent to 71 percent. The accessibility during the rainy season was also improved.

Table 2. Change of Accessibility and of the Number of Transportation Means 2001-2007

Road access	**2001 (%)**	**2007 (%)**	**Type of road**	**2001 (%)**	**2007 (%)**
Accessible by car	76	78	Asphalt	66	71
Accessible by motorcycle	85	100	Concrete	18	18
Only accessible by walking or by riding horses	15	0	Gravel	3	3
No problem to be accessed in the rainy season	63	86	Dirt road	13	8
Number of transportation means:	**2001**		**2007**	**Change (%)**	
Cars/jeeps/trucks	297		415	40	
Motorcycles	1993		5716	187	
Carts	899		728	-19	
Horses	891		427	-52	

N = 80 Villages
Source : Own calculations

As the road quality improved, the number of carts and horses declined by 52 and 19 percent, respectively. By contrast, the number of vehicles and motorcycles increased by 40 and 187 percent, respectively.

Since 2001, the access to market information has also been improved by the expansion of the cellular phone network. In 2001, only one village had connection to the cellular phone network, but in 2007 there were already 31 villages connected.

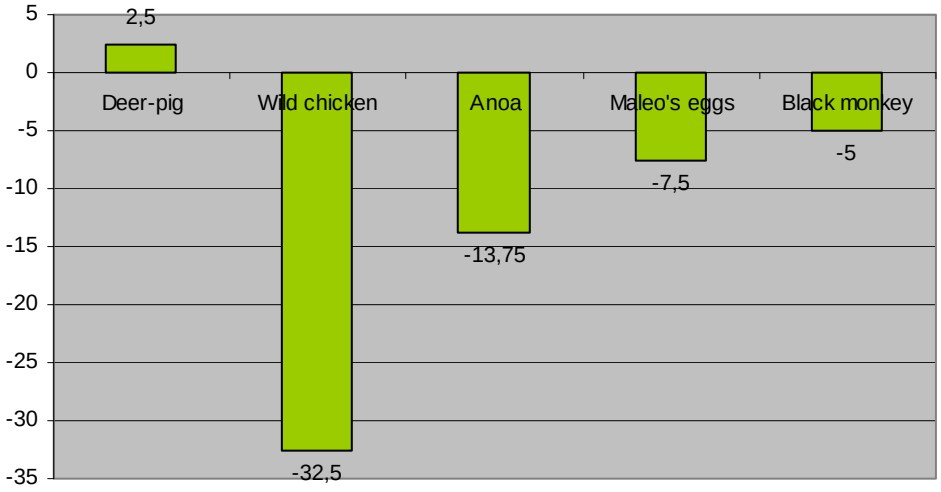
3.8 Forest and conservation issues

The integrity of the forests is not only threatened by the expansion of the agricultural area, but also by hunting and rattan collection.

With the exception of deer pig, the hunting of all other important protected animals has decreased (Figure 12). Since 2007, the number of villages where households hunt wild chicken, anoas, maleo's eggs, and black monkey has decreased by 32.50 percent, 13.75 percent, 7.5 percent, and 5 percent, respectively. Even though these animals are protected, the empirical data indicates that the hunting of these protected animals is still practised in a considerable number of villages

Rattan collection is another activities that is usually conducted by rural communities in the research area. The number of villages collecting rattan declined from 59 percent in 2001 to 29 percent in 2007. The number of households involved in rattan collection has decreased even further by 68 percent, yet the amount of rattan harvested has increased by 16 percent. Furthermore, the average distance to access rattan from the villages has increased from 13.4 kilometres to 18.3 kilometres,. These results indicate that the rattan availability became limited in some villages, but this reduction was compensated by an increased harvest in the villages that still collect rattan. Moreover, the results show that rattan should be collected in a more sustainable way, so that future generations will also be able to benefit from rattan collection.

Figure 12. Change of Hunting Activities of Protected Animals from 2001 to 2007



N = 80 Villages

Source: Own calculations

The issues of forest encroachment with respect to land use change has already been raised in the beginning of this paper. Concerning encroachment of the LLNP, 40 percent of villages acknowledge that their village members own agricultural land inside the national park. The

share of households, who have land inside the LLNP, is 10.4 percent, of which 68.7 percent are indigenous households. The average land size inside the LLNP is 1.93 ha per household. The distance required to access the plots inside the national park is 2.2 kilometres on average. The total area of agricultural land located inside the national park is 4943 ha, which is equal to 2.3 percent of the total national park area.
The data indicates that the encroachment, which threatens the ecosystem services provided by the park, are still practiced although more than 90 percent of the respondents recognise the benefits of the park for their villages and for their future generations.

3.9 Community forest management

The conservation of the forest area to secure its benefits is not new to forest communities in the research area. Since long, harmony with nature is a crucial part of the customary law of local communities, In recent years, the recognition of the customary has, however, declined, particularly in villages with a high share of migrant households. To foster again forest conservation, community forest agreements have been introduced in many villages surrounding the park since 2000. These agreements have been initiated by NGOs like CARE and TNC and they are set up in a participatory process between the villages and the national park administration. The agreements regulate what type of uses are allowed in which area of the forest.
By the time of the survey, 59 percent of the villages have signed a community conservation agreement with the national park administration. The content of the agreements, however, varies between the villages (Table 3). Regulations concerning the amount of wood, which can be cut in the forest, are part of 91 percent of all agreements. In contrast, just 26 percent of the agreements contain regulations regarding the cultivation of crops. Whether the agreements have an effect on deforestation remains questionable. Nevertheless, the community forest agreements are a good starting point to empower forest communities to manage their forest resources in a sustainable way.

Table 3. The Type of Regulations in Forest Community Agreement

Type of agreement	In place (%)
Regulations about the amount of wood allowed to be cut	91
Regulation about the use and the selling of timber	85
Regulations about rattan collection	70
Regulations about the expansion of agricultural land	68
Regulation about hunting	66
Regulation about the use of non-timber products	43
Regulations about the cultivation of crops	26

N = 47 Villages
Source: Own calculations

4. Discussion and Conclusions

The results of this analysis illustrate the changes in land use as well as in the socio-economic environment that have taken place since the last village level survey conducted in 2001. Since that time, the acreage of all perennial crops except cacao was reduced. The cacao boom is the major cause of deforestation in this forest margin area. Cocoa production is in general characterised by a low capital intensity. When farmers use inputs, they mainly apply it for paddy production in the lowlands. Hand tractors, which are used for preparing the paddy

fields, are available in many villages, but the access to extension services is rather poor, particularly in the uplands.
Rural communities living at the national park's margin are still conducting many activities, which threaten the environment. However, with the exception of deer pig the hunting of protected animals has declined. The share of villages which collect rattan has also decreased since 2001. Nonetheless, more and more rattan is collected in the remaining villages
The rural communities in the research area have experienced severe droughts in the past decades caused by ENSO events. The households adapted several strategies to cope with the drought. Despite of these existing strategies, the communities adaptability needs to be improved since it is expected that droughts get more severe in the research area due to the global climate change. Yet, the ENSO problem in this area has not been handled by communal actions but individual endeavours.
For the future, it is planned to develop a spatial explicit land use model that combines socioeconomic and remote sensing data from different points in time in order to identify the underlying causes of land use change.

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