



ASSESSING THE ENVIRONMENTAL AND SOCIAL IMPACT OF DIFFERENT LAND USE STRATEGIES IN KARA ATAS

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Abstract

Over the past decades, Sarawak has undergone notable changes in its agrarian landscape, primarily due to the expansion of palm oil cultivation, which has led to the decline of traditional agricultural practices like swidden cultivation and smallholder farming of cash crops such as rubber and pepper. Government policies have encouraged this shift towards large-scale agriculture and logging, though concerns about environmental impacts, particularly regarding peatland conversion, have arisen. Our research in Kara Atas, aims to evaluate the environmental and social effects of land use strategies, encompassing past and present practices, livelihoods, and future trajectories. Using a mix of quantitative and qualitative methods, including informal conversations, participatory observation, transect walks, biodiversity and soil assessments, surveys, interviews, focus group discussions, and livelihood rankings, we sought to gather comprehensive data. Results revealed that the land in Kara Atas has undergone constant changes influenced by external factors such as fluctuating rubber and pepper prices and rising fertilizer costs, impacting both livelihoods and land use patterns. Despite plans for large-scale oil palm plantations being abandoned, community members still have hopes for such ventures. Alternative land use strategies face challenges, leaving forest restoration or carbon credits as viable options in the absence of investors. In conclusion, achieving a balance between economic opportunities and environmental conservation is crucial, with initiatives like Forest Landscape Restoration and carbon offset offering potential avenues for sustainable development. Collaborative efforts and exploration of alternative approaches are vital to ensure a future that supports both livelihoods and ecosystem health in the region.

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otherwise. Moreover, we had the pleasure to work together with students from the University of Malaysia Sarawak to whom we also owe a big thanks for a good and productive collaboration on the research.

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Preface

The field research was carried out as part of the course “Practicing Interdisciplinary Field Research on the Environment”. The aim of the course is to apply an interdisciplinary approach and employing a variety of qualitative and quantitative methods on a real-world scenario. Before going to the field, the research questions were formulated, and the research design was prepared (see appendix I & appendix II). The work in the field took place from the 4th of March until the 15th of March with students from University of Malaysia Sarawak with the support of professors from both the University of Copenhagen and University of Malaysia Sarawak. After coming back from the fieldwork, the gathered data was analysed, and the findings were presented in form of a written report and an oral examination.

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1. Table of concepts

Beduruk	Helping each other
Benit	Hardwood
Damun	Paddy field left fallow for a year
Nyatu	Hardwood
Penghulu	Chief
Pintu	Doors
Pulau galau	Reserved forest
Shirt buri	Skirt with cowie shells
Tanau galau	Reserved land
Temuda	Land shifts
Tuai Rumah	Head person
GHG	Greenhouse gases
MSPO	Malaysian sustainable palm oil
NCR	Native customary rights
NGO	Non-governmental organization
ROPA	Rejected oil palm area
RSPO	Roundtable on sustainable palm oil

2. Table of Authors

<p>Introduction</p> <ul style="list-style-type: none"> • Empirical context 	<p>Freja</p> <ul style="list-style-type: none"> • Alexander
<p>Methodology</p> <ul style="list-style-type: none"> • Explorative methods • Assessing the environment • Survey & interviews • Focus group & Livelihood Ranking 	<p>Methodology</p> <ul style="list-style-type: none"> • Nethe and Alexander • Alicia and Andrea • Alexander • Freja and Nethe
<p>Results and analysis</p> <ul style="list-style-type: none"> • Land Use Change • Livelihoods • Impact of land use on the Environment <ul style="list-style-type: none"> Impact of land use on Biodiversity Impact of land use on Soil quality Carbon storage • Future expectations for land use 	<p>Results and analysis</p> <ul style="list-style-type: none"> • Alexander and Freja • Nethe • Alicia and Andrea <ul style="list-style-type: none"> Alicia Andrea Alicia and Andrea • Alexander and Freja
<p>Discussion</p> <ul style="list-style-type: none"> • Environmental vs. Social impact • General expectation for future land use • Possible future land use of ROPA <ul style="list-style-type: none"> Development on peat soil Possible uses without drainage 	<p>Discussion</p> <ul style="list-style-type: none"> • Alicia • Freja • Andrea and Nethe <ul style="list-style-type: none"> Andrea and Nethe Andrea and Nethe
<p>Limitations</p> <ul style="list-style-type: none"> • Limitations of Methodology <ul style="list-style-type: none"> Biodiversity and Soil assessment Questionnaire Ethnobotany • Language barriers • Working interdisciplinary 	<p>Limitations</p> <ul style="list-style-type: none"> • Limitations of Methodology <ul style="list-style-type: none"> Alicia Nethe Alexander • Freja • Andrea
<p>Conclusion</p>	<p>Alexander and Andrea</p>

3. Introduction

Over the past four decades, Sarawak has experienced a radical transformation of its agrarian landscape. The rapid expansion of palm oil cultivation, especially on large-scale commercial level, has played a key role in these transformations, making Sarawak one of the top states in Malaysia in oil palm plantation hectareage (Cramb & Sujang, 2011; Varkkey, 2020).

Agriculture has traditionally been dominated by a large indigenous population engaging in swidden cultivation for subsistence, growing swamp or hill rice. Many cultivators incorporated smallholder farming of cash crops by converting portions of their fallow lands into rubber and pepper plots (McCarthy & Cramb, 2009). Although swidden cultivation is still being practiced in some areas, it has been diminishing since the 1970s when the cash crop economy took off. As large-scale plantations expanded in the 1990s, so did the transition towards cash crops (Mertz et al., 2013). With the decreasing prices of rubber in the 90s and early 2000s, rubber was almost abandoned, and pepper took over as the most important crop (ibid.).

Shifting cultivators have also faced difficulties in the light of the expanding palm oil industry as the government has tended to favour large-scale plantation agriculture and logging activities (Cramb, 2011; Mertz et al., 2013). Shifting cultivation has been viewed as “backwards” and a hindrance for development, which is why multiple policies have been implemented to incentivise people to abandon swidden cultivation and to increase the productivity of smallholder agriculture (Varkkey, 2020). Joint venture (JV) schemes were ways of ‘developing’ rural areas while freeing-up land that was under customary forms of tenure.

The state has later moved on to converting peatland by draining it for agricultural use (primarily for palm oil), but this is not without concerns as drainage of peat soils is associated with multiple negative environmental impacts. Peatlands are poorly suited for agriculture and even local exploitation has been limited up until recently, because of the high costs of drainage (Varkkey, 2020).

While palm oil production has become associated with deforestation, greenhouse gas emission (GHG), biodiversity loss and land-conflicts (Koh & Wilcove, 2008; McCarthy & Cramb, 2009), it has also brought employment opportunities and investments in infrastructure and agriculture (Hasan & Hidayat, 2018). For some communities in Sarawak, large-scale plantations and JV schemes are also seen as a way to earn income from otherwise unused land (Andersen et al., 2016; Cramb & Sujang, 2011).

3.1 Empirical Context

Our fieldwork was conducted in the community of Kara Atas which consists of 22 pintu (doors). Kara Atas is one of four kampongs in Kara: Kara Asal, Kara Atas, Kara Tingting, and Kara Baru. The community have started to transition away from agricultural activities, like rice cultivation and cash crops like pepper, and rubber. These crops, once essential for household consumption and income, have declined over the past decade due to dropping market prices and demographic changes. Limited land use activities persist in Kara Atas, leaving vast areas of fallow lands and forest around the longhouse.

While there have been plans to have a large-scale plantation in Kara, it was rejected due to alleged peat soil in the area. The area is on Native Customary Rights land (NCR) and used to be a *pulau galau* (reserved forest). The size of the area is 761 ha and was logged 30 years ago. Before that, people of Kara Atas used it for hunting, fishing, and collecting timber. The community no longer uses it for cultivation or collecting natural resources. For clarity, we will refer to this area as ROPA (rejected oil palm area). Palm oil seems to be an important part of the livelihoods in other communities, however since plantation development in Kara Atas is hindered by changes in RSPO certification standards for sustainable palm oil as of 2018, the community considers other options (RSPO, 2020).

Taking into consideration the complex context of land use transitions happening on small-holder level, rapid oil palm expansion and the implications of these on the environment and livelihoods in Kara Atas, our research objective for this study is to assess the environmental and social impacts of different land use strategies in Kara Atas and investigate possible trajectories for future land use.

Through a case study of Kara Atas, we will first look at past and present land uses in Kara Atas and the main livelihood strategies of the community. Afterwards the current land use strategies and their influence on the environment will be assessed. This will be followed by asking the people for their expectations for future land use in Kara Atas. In the end future possible land use strategies for the rejected oil palm area will be investigated.

3.2 Research Questions

To guide the research, we developed the following research question:

How does land use transitions impact the livelihoods and the environment in Kara Atas?

To answer the main research question, we developed the following sub questions:

- What are the past and current land use strategies in Kara Atas?
- What are the main means of livelihood in Kara Atas?
- How do the current land use strategies in Kara Atas impact the environment?
- What are people's expectations for future land use in Kara Atas?
- What are the future possible land use strategies for the rejected oil palm area?

3.3 Clarification of Terms

The term livelihood strategies might not be the right term to use when describing the changing ways of sustaining livelihoods in Kara Atas. As described by Natarajan et al. (2022) in their work on the Sustainable Livelihood Framework for the 21st century, the word 'strategy' implies planning and something that is at least to some degree fixed. However, livelihoods are constantly changing and evolving due to short term events like the increase or decrease in crop prices or demographic and structural transformations. They are constantly in flux. Therefore, we will refer to it as livelihoods in flux because it is more fitting given the ongoing changes that affect the community.

4. Methodology

To obtain adequate data for answering the research question, both quantitative and qualitative methods (Appendix III) were applied with the intention of following an interdisciplinary approach to field research (Krishnan, 2009). Throughout the field study, methods like **informal conversations** and **participatory observation** were conducted to familiarise ourselves with the field through a more relaxed and informal approach to data collection (DeWalt & DeWalt, 2010). While these methods did not provide us with specific data, we were able to understand some of the dynamics between community members which informed our approach and ways of engaging with people during interviews and focus group. For all other methods we applied, we made sure that both students from UNIMAS and KU were present as to ensure all had knowledge of what was shared during data collection.

4.1 Explorative Methods

The first method we used in the research project was **participatory mapping**, conducted by groups of four with one facilitator. We asked the five informants to draw a community map of Kara Atas. During the session, notes were taken on the discussions among the participants and the group dynamics (Chambers, 1997). This gave us more knowledge of the community, where they live and how they use the land around the village which was then complemented by transect walks to four different sites.

Through **transect walks** in a fruit orchard, to a paddy field, a small-scale palm oil plantation and the ROPA, we got a better understanding of Kara Atas, how the land has changed and possible plans for the future. Although we asked to see specific sites, the transect walks were quite unstructured and more explorative.

4.2 Assessing the Environment

The information gathered from the above-mentioned methods was used to identify relevant areas for our **biodiversity assessment** and **soil sampling**. Biodiversity and soil quality are important indicators of the environmental condition of an area. In total, we assessed three different sites on mineral soil (Fig. 1). Two of the sites are plantations: the Tuai Rumah's orchard and the Pengulu's

smallholder palm oil plantation. Furthermore, to obtain baseline data for comparison, we selected an over 60-year-old forest on mineral soil next to the longhouse as our baseline, since there is no primary forest in Kara Atas' land.

In the plantations we delimited two representative areas of 10 x 10 m and in the forest, we sampled

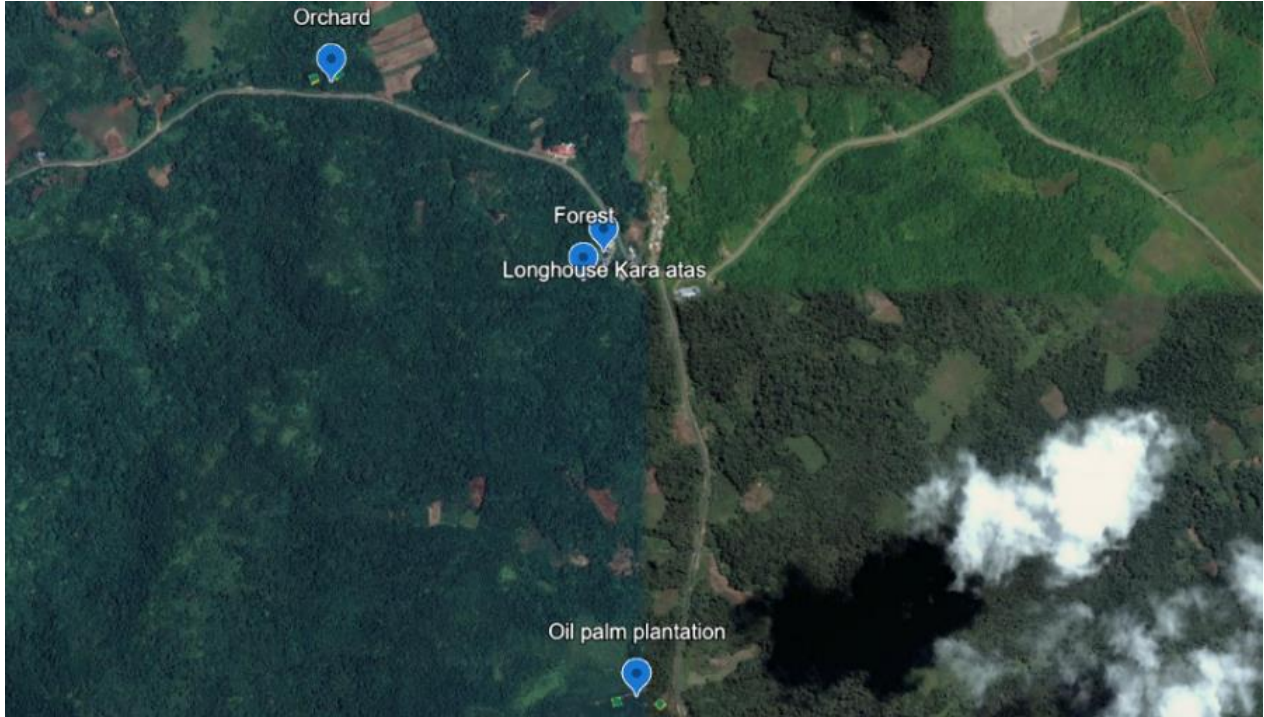


Figure 1 Sampling points for biodiversity and soil assessment.

four 10 x 10 m areas (Hill, 2005, pp. 201–208). For the biodiversity assessment, the trees in the 10 x 10 m plots were identified and counted to later calculate the carbon stored in the above-ground biomass and the biodiversity in trees. Within the 10 x 10 meters plots, each two 2 x 2 m subplots (Fig. 2) were defined to count the abundance of different herbaceous plant species and determine the biodiversity of herbaceous plants in the area using the Shannon Index (Hill, 2005, pp. 222–224). To calculate the carbon storage, we used two different equations. For the tropical forest and the orchard, we used the following equation:

$$C_{deciduous\ tree} = AGB \cdot 0.5$$

$$AGB = W_s + W_b + W_l$$

$$W_s = 0.313 \cdot DHB^{0.9733}$$

$$W_b = 0.136 \cdot W_s^{1.07}$$

$$W_l = \frac{125 \cdot 0.124 \cdot W_s^{0.794}}{0.124 \cdot W_s^{0.794} + 125}$$

Where DBH = tree diameter in cm

To calculate the carbon stock in oil palms we needed a different equation due to the different proportion between palms diameter and height (Asari et al., 2013):

$$C_{oil\ palm} = 71.797 \cdot H - 7.0872$$

H= Height of trees in m.

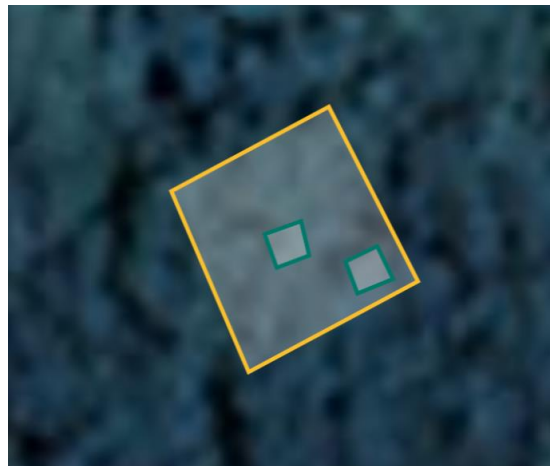


Figure 2 Scheme of how the areas were delimited

Within each 2 x 2 m plot we did a soil assessment. For each site we took a bulk density measurement with a 100 cm³ core cylinder, 10 cm below the organic horizon (Anderson & Ingram, 1993). In each plot, we took 3 samples from different points with a gouge auger. Firstly, we took a sample of the upper 20 cm of the soil in all 3 spots and homogenized them. Thereafter, the gouge auger was reintroduced at the same point to extract the next 20 cm. The bulk density was measured by our colleagues from UNIMAS. After taking the soil back to Copenhagen, we measured the soil for carbon, NH₄, NO₃, phosphor, and pH, following the protocols for Olsen phosphorus (Plantedirektoratet, 1994) and Danish standard for soil for pH, NH₄, NO₃, and Carbon. We calculated the carbon storage in the areas in tons per hectare, using the percentage of soil carbon in the samples and the bulk density, according to the following equation.

$$Carbon = \left[\frac{t}{ha} \right] = soil\ depth\ [m] \cdot 10000\ [m^2] \cdot bulk\ density\ \left[\frac{t}{m^3} \right] \cdot C\%$$

All samples were analysed in the laboratory according to different established protocols. To compare the results, a two-way ANOVA test was performed to see if there were significant

differences between the chemical composition of the soil in different areas. For all parameters that showed significant differences, a Tukey test was conducted to calculate to what extent they differ.

Within the forest an **ethnobotany assessment** was conducted. This was done in one site on 2 x 10 m together with a professor from UNIMAS (Carthy 2005). All useful plants to his knowledge were identified and their abundance and uses within different categories were noted down. Furthermore, the Shannon index for ethnobotany was calculated. The categories can be seen in appendix IV.

4.3 Surveys & Interviews

The obtained knowledge from the previous methods was used for the **survey**. The questionnaire (appendix V) was conducted with 17 out of 22 households of Kara Atas. We intended to do a full census sampling, but this was not possible because some were unavailable or did not want to participate (Bryman, 2012, p. 187). We split into four groups consisting of an interviewer, translator, and notetaker. Two groups had an interpreter, while the other two groups had a Iban-speaking student from UNIMAS. The answers from the questionnaires were transferred to SurveyXact to create and extract a dataset (Bryman, 2012, p. 348). For the data analysis, we did basic descriptive statistics to give an overview of the population Kara Atas and conducted statistical ANOVA, chi-square and fisher's exact tests which will be elaborated on in section 5.4.

We used the questionnaires to find potential key informants for the **semi-structured interviews** through a convenience sampling strategy. In total four semi-structured interviews with a duration of 40 – 50 minutes were conducted with members of the community. This interview form allows for in-depth exploration of the participants' experiences, perspectives and knowledge with more flexibility than the questionnaire (Brinkmann, 2020, pp. 438–440). It allowed us to pose follow-up questions on insights gained from the other methods. We divided us into three groups consisting of an interviewer, translator and notetakers and were all following the same interview guide (see appendix VI). An interview with the Tuai Rumah was also conducted following a different guide. All interviews were recorded and transcribed, but we do not have the full transcriptions, as we were only able to transcribe the parts in English.

4.4 Focus Group & Livelihood Rankings

To facilitate discussion amongst people and gain insights on opinions and dynamics among community members, we conducted a focus group, and livelihood rankings.

As there was only a limited amount of people available during the fieldwork, we decided to conduct one **focus group** discussion and use a convenience sampling strategy to recruit participants. The group consisted of seven women between the age of 41 to 77, which were appointed by the Tuai Rumah as they were available at the time. All women were permanent residents of Kara Atas and had experience with land use. Our guiding questions for the discussion followed similar topics as the questionnaire, but as we were looking to facilitate a discussion among the participants, we framed some questions by setting up scenarios, asking for opinions or referring to knowledge we had gained through transects walks, mapping, and conversations with people (see Appendix VII). Rather than looking to gain specific information from the group, we wanted to gain knowledge on the ways certain topics related to land use practices and land development are being discussed collectively (Caillaud et al., 2022). The discussion was facilitated by an Iban-speaking student from our group as to not disturb the flow of the conversation too much by having everything translated.

The last method to be conducted were the **livelihood rankings**, which provided us with knowledge on the importance of different means of livelihoods and how they are being valued against each other. The ranking was conducted with two groups divided by male and female to observe whether gender has an impact on how livelihoods are ranked. Three participants were selected for each group based on convenience sampling. The participants were asked to rank the importance of different ways to create livelihoods based on criteria such as ‘income’, ‘own consumption’, ‘social value’ etc. (see Appendix VIII). Each criteria had 30 stones that could be distributed across the different strategies. The different indicators for the matrix ranking were not chosen by the participants, however the indicators were modified from knowledge we gained in Kara Atas (Mikkelsen, 2005). The same groups were also asked to fill out a **seasonal calendar** with the same livelihood strategies to get an overview over what time of the year the community is dependent on the different livelihood strategies (see Appendix IX).

The notes taken during participatory observation, questionnaires, interviews, focus group, livelihood rankings and transect walks as well as the transcription from the interviews were coded in NVivo to structure the data around topics relevant for answering the research questions.

5. Results and Analysis

5.1. Land Use Changes in the Past and Present

This section will answer our first research question: *What are the past and current land use strategies in Kara Atas?*

Small-scale farming for subsistence or cash income has been the primary land-use strategy in Kara Atas for many years and are intricately linked. When presenting data on land use changes in this section, we focus on transitions shaped by shifting livelihood choices and those changes that have been inflicted upon Kara Atas due to external factors like logging.

The past land use of Kara Atas has been quite diverse, however there are some shifts in land use strategies that are similar. Most respondents (58.8 %) from the questionnaire have either grown swamp or hill paddy in past with only three continuing this practice, while many have also cultivated rubber, fruit trees and pepper.

It is important to mention that the majority have not specialized in one crop but have been cultivating multiple crops over the years. According to one of the interviewees, people in Kara Atas have previously depended on shifting cultivation. A woman from the focus group explained how her family would practice shifting cultivation, leaving plots of land fallow after harvesting paddy, replanting it with fruit and growing paddy in a different plot of land. However, sometimes people undergo changes in their crop cultivation not by choice but due to other factors.

70.5 % of the respondents pointed out that they had to stop cultivating certain crops because it had become impossible for them to continue utilizing the land. In the questionnaire and interviews, people connected this to a lack of people to care for the land because those who cultivate have grown old, unwell, or because people have moved away to work in the city. Decreasing market prices for cash crops like rubber and pepper were frequently mentioned, together with increasing costs of pesticides and fertilizers.

However, when doing an ANOVA-test to see if there is a difference in reasons for changing cultivation patterns across age, there was no statistical significance with a p-value of 0.37. Thus, age is not the reason people alter their cultivation practices, even though it is mentioned several times. Nevertheless, it should also be noted that our sample size is quite small and that the average age of the respondents is 59. Furthermore, another category we tested for was health, which can be closely related to peoples' age and might be another explanation why the test turned out to be not statistically significant.

Besides the small plots of land people use for cultivation, the ROPA is shared among people in Kara. According to a key informant, 19 household of Kara Atas own parts of the land, which is divided equally among them with the Tuai Rumah, the Penghulu and one other person (who helped measuring the land) having a larger share. Before it was logged, the area was a reserved forest and, according to an informant, used by the people of Kara Atas.

“So actually, not the community but [...] the logging company just came in because that land used to be for them to plant paddy, for them to fishing, hunting.” (Resident of Kara Atas)

According to the women of the focus group, the *pulau galau* was traditionally used for foraging and gathering hardwood. The company that started logging activities in the area in the 90s was interested in the valuable hardwood and cut down the larger slow-growing trees and left behind only the smaller ones. When asked about the importance of the area for people in Kara Atas, one informant explained that it has “no economic value because there are no more big trees.”

The community was compensated by the company, and while it was initially well received because the money was needed, some later felt the decision was not wise as the valuable hardwood can no longer be sourced in the area.

Today, the old and untapped rubber trees standing in between fruit trees and the wooden poles for pepper by the roadside are reminiscent of past land usages that have been abandoned, either permanently or temporarily by the community. A few people have turned to more profitable cash crops, such as palm oil, while others grow swamp paddy, vegetables and a variety of fruits on plots of land scattered around Kara.

While many households engage in small-scale cultivation, the findings indicate that these land use strategies are somewhat declining as many community members seek to create other means of livelihoods that are less labour intensive and more profitable. The community is also considering how to utilise their lands for large-scale cultivation with an external actor, either through private investors, companies or government schemes.

In Kara Atas, 76.4 % of respondents do some type of cultivation, but do not necessarily regard this as a main source of income. Only two respondents considered palm oil to be their most important source of income, while the rest of the respondents ranked non-agricultural practices, like pension, wage labour and remittances highest. Of those who cultivate, 76.9 % grow fruit crops in orchards or have a few trees on their land. While a few people will sell all or some of their produce, the majority grow fruits for their own consumption.

During interviews and the focus group, fruit trees were repeatedly mentioned as a land use strategy many have either resorted to after abandoning rubber, pepper or paddy cultivation, or something they cultivate alongside other crops. During the focus group discussion, when talking about the terminology for fallow lands, some of the older women referred to these types of shifts in land use as *temuda*. More specifically, they explained how *temuda* refers to a paddy field that has been left fallow for a year - which has then been planted with crops such as fruits or vegetables.

According to another interviewee, people will plant fruit trees on paddy fields that have been left empty to ensure the fields do not become unproductive, since this will make it harder to grow paddy again in the future. However, as previously mentioned, many in Kara Atas have stopped cultivating paddy very recently. From the survey, we see that only three respondents are currently cultivating paddy, while seven respondents have stopped cultivating within the past 10 years. While it is uncertain whether people will abandon paddy cultivation completely or only leave the land fallow for some time, people do express the need to find other, less labour-intensive and more profitable land use practices to pursue.

While many consider palm oil a profitable crop, few pursue it as a main source of income. In both livelihood rankings oil palm was ranked high in terms of expenditures and labour needed for cultivation. This could explain why small-scale palm oil farming has not become a more important land use strategy in Kara Atas, however one would also need to consider how processes of obtaining a certificate as a small holder could influence the ability to engage in this type of land use.

Land use in Kara Atas is diverse, has multiple purposes and is being shaped and revised by short-term conditions (e.g. changing market prices) and long-term changes (e.g. aging population and migration) (Natarajan et al., 2022). In the face of outmigration, aging and declining health people are seeking opportunities through large-scale land development and government schemes. However, many continue to create or maintaining the value (not necessarily monetary value) of their lands through changing cultivation patterns for own consumption, growing new cash crops, holding on to land as a 'financial security' or honouring the hard labour of their ancestors by preserving the crops they grew.

5.2. Livelihoods

In Kara Atas, people pursue several livelihoods which is not only limited to agriculture, although agricultural practices can be considered one of the main means of livelihood. This section will

therefore elaborate on these as to answer research question 2: *What are the main means of livelihoods in Kara Atas?*

The sustainable livelihoods framework for the 21st century is rather complex and contains several elements that impacts the livelihoods in flux (Natarajan et al., 2022). We are not able to cover all elements of the framework but will mainly focus on ways to generate income or sustain one's own subsistence.

When asked about main sources of income in the questionnaire, pension was mentioned most frequently (37 %) together with wage labour (19 %), see figure 3. Pensions are provided for people over the age of 60 if they have previously worked for the government. Therefore, not all households receive pensions, however all households that receive pension consider it their most important source of income.

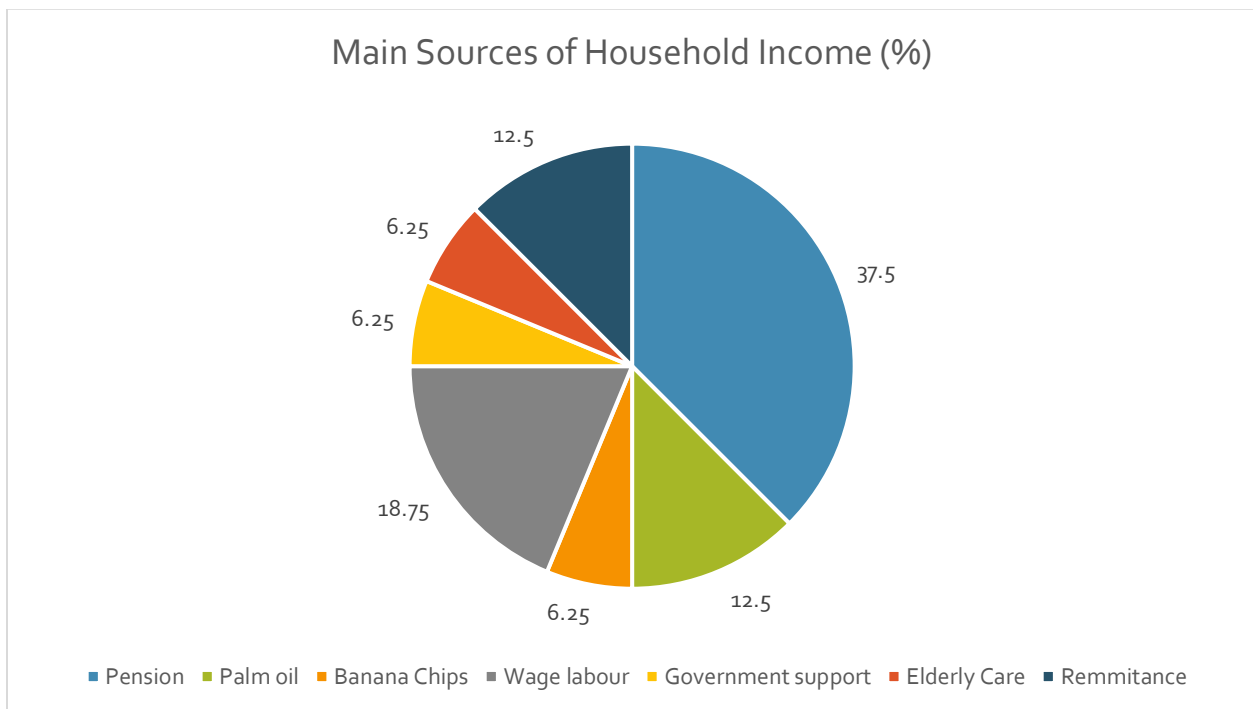


Figure 3 Main sources of income in Kara Atas. Results are based on 17 questionnaires.

Wage labour is often connected with rural-urban migration, a trend seen in Iban communities, where the families move to the city to get a job or study (Abdullah, 2016) In Kara Atas, this trend is most common among the younger generation. Several community members had been working in the city when they were younger and came back as they got older. However, it seems like the elder generation is doubting whether the younger people living in cities will come back to work the land. When testing for a relationship between having a wage job and whether one's main

residence is in Kara Atas or not, it shows there is no correlation ($P=0.64$). Sometimes migration is also connected with sending remittance to family members. Both groups in the livelihood ranking highlighted that remittance comes with expenditures. One informant mentioned that sometimes parents send remittance to their children. “Yeah, parents give them money, parents give them everything. So, they don't feel how hard life is”.

Some women in Kara Atas are selling handcrafts like traditional embroidered clothes, shirt *huri* (skirts they sew cowrie shells on), woven bags and mats, which they sell on Facebook and WhatsApp. The women would often sit together in the longhouse and do handcrafts, however during the livelihood ranking, no social value was given to handcrafts by the women. When asked how dependent the households are on selling handcrafts, the women ranked it higher than the men. Even though handcrafts generate an income for some only one household had handcraft listed as a job. This can indicate that handcrafts are not a primary source of income.

The questionnaires also showed that 76 % forage in the nearby area (less than 1 km from their home). As seen in figure 4, people mainly collect edible plants, mostly for own consumption, but some sell excess products.

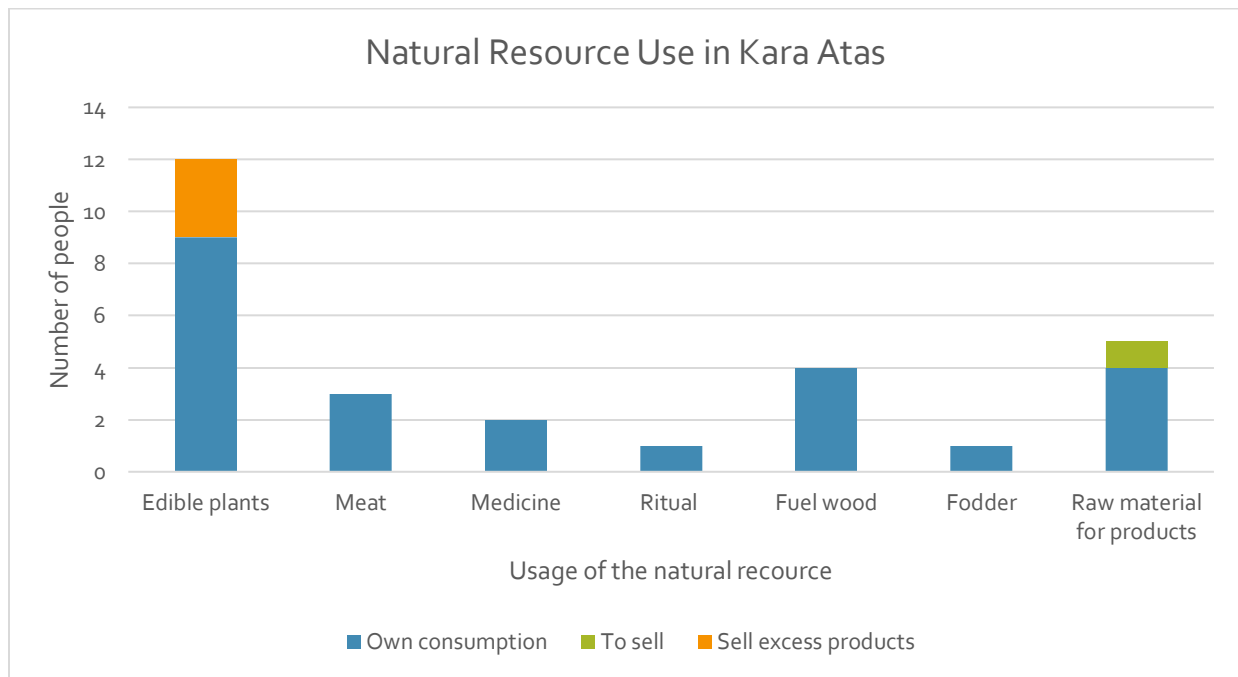


Figure 4: Natural resource use of people in Kara Atas. “Sell excess products” means that they mainly use it for their own consumption but sell if they have any excess products. Results are for the questionnaire.

Twenty-nine percentage of the respondents collect raw material for products but did not specify which products. According to the women doing handcrafts, it had become difficult to find the

materials they use for baskets, due to overexploitation. In the past ratan was used to weave mats, and although it can still be found around Kara Atas, the women who weave have grown too old to collect them and do not have someone to do it for them. In the livelihood ranking we found out that *beduruk* the act of helping each other no longer happens in Kara Atas, and instead people expect monetary compensation.

Looking further into ethnobotany there were a total of 72 plant species in the secondary forest with planted fruit trees. 23 species (32 % of total) were determined useful by a professor from UNIMAS, and the area under investigation has a Shannon index on 0.97. The plants are mainly used for food, but other possible forms of usage can be seen in figure 5. However, these plants were not identified by a local. Therefore, we are unable to determine how people in Kara Atas use the plants. It is also very likely that some people from the community are more knowledgeable about the usage of plants and therefore the ethnobotany could vary depending on who would be available as a guide (Boom, 1987).

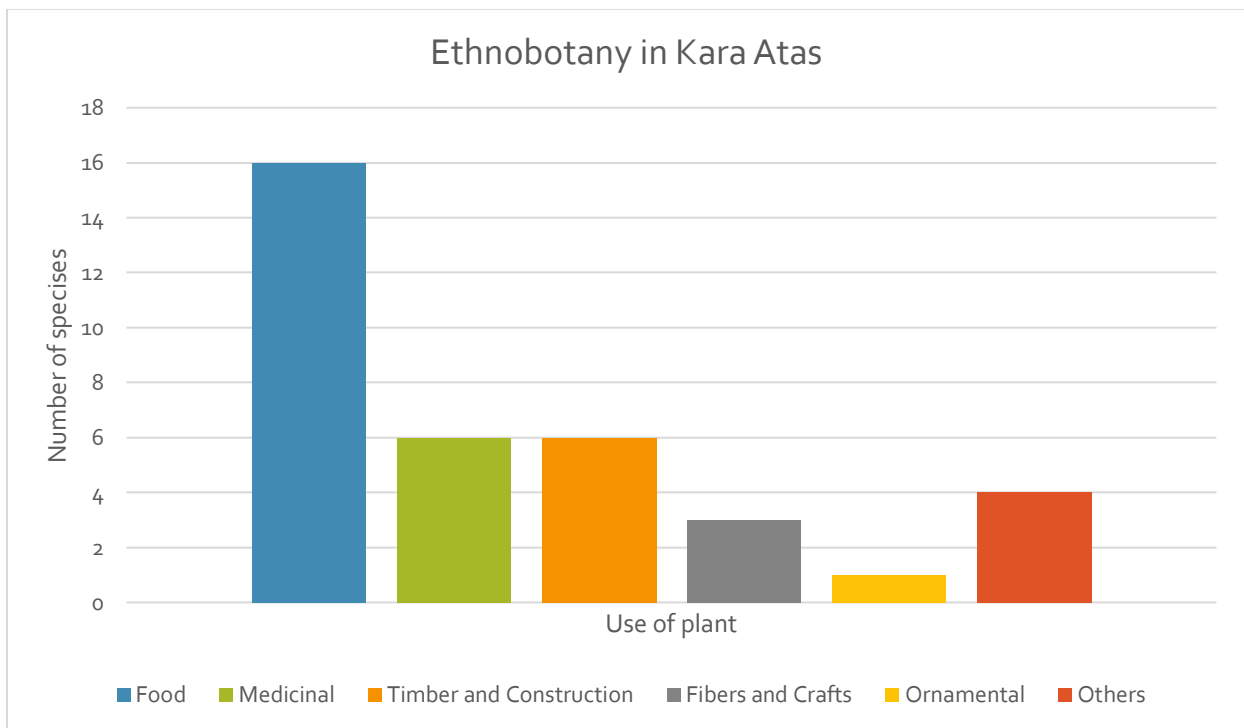


Figure 5: Overview of ethnobotany for a secondary forest in Kara Atas. Based on the biodiversity assessment.

In the livelihood ranking, both men and women rank palm oil and paddy as the highest overall. Interestingly, pension was the most important source of income according to the survey while it was not given a high value during the livelihood ranking. Instead, the women ranked palm oil,

swamp paddy and handcrafts higher than pension (Fig. 6). The men ranked wage jobs the highest and pension second together with palm oil (Fig. 7).

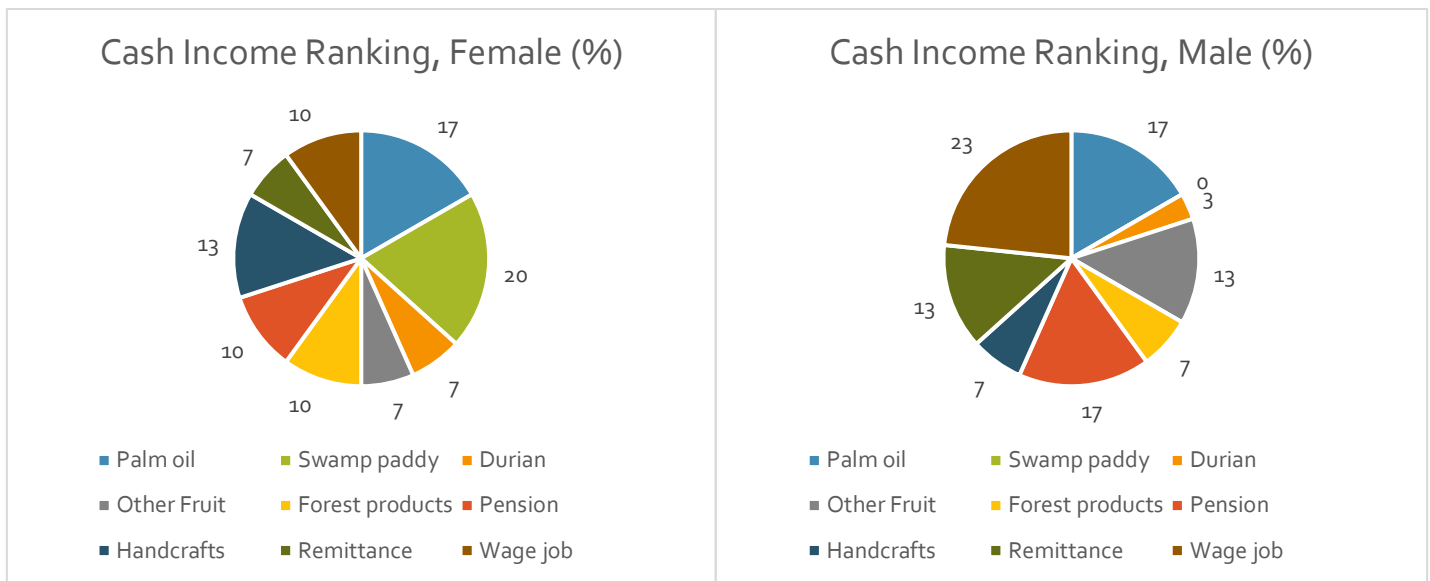


Figure 6: Shows how women rank the cash income, by distributing 30 stones across different strategies. Data is from livelihood ranking.

Figure 7: Shows how men rank the cash income, by distributing 30 stones across different strategies. Data is from livelihood ranking.

5.3. Impact of Land Use on the Environment

In the following chapter we analyse how the different land use strategies in Kara Atas influence the natural environment and thereby try and answer research question 3. *How do land use strategies in Kara Atas impact the environment?* Although, we realize that the condition of the environment is dependent on numerous factors, we limit ourselves in this project to biodiversity and soil assessment due to time constraints and limited access to the necessary equipment for taking soil samples in non-drained peat soil.

5.3.1. Impact of Land Use on Biodiversity

We used the data collected in the biodiversity assessment to calculate the Shannon index for both trees and herbaceous plants in the research areas. The biodiversity of herbaceous species is high in all areas and exceeds a Shannon index of 1. However, the biodiversity in the secondary forest is by far the highest with an index of 1.4 followed by the orchard with an index of 1.1 and the oil palm plantation with an index of 1.05. The difference in tree biodiversity between the forest and the plantations is even larger. In the secondary forest the biodiversity amounts to a Shannon index

of 2.66, while the orchard reaches only a fourth of that value. The smallholder palm oil plantation has no biodiversity in trees as it is a monoculture (Fig. 8).

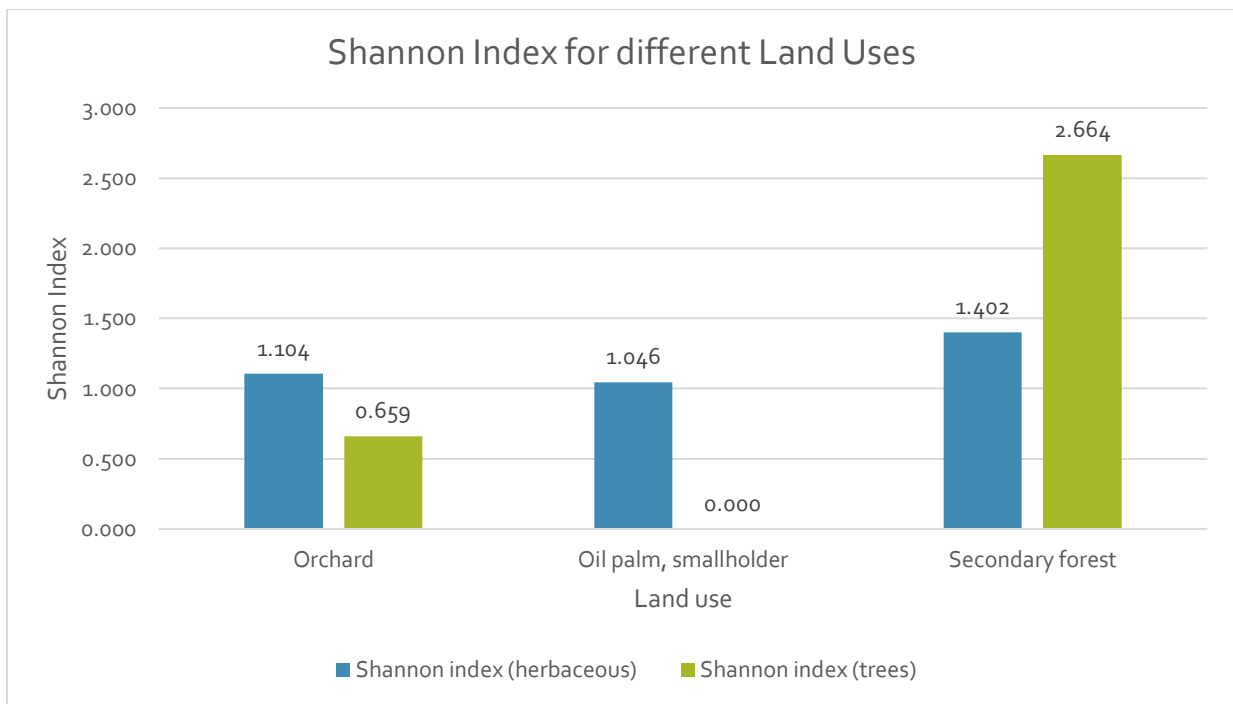


Figure 8: Shannon index for different land uses.

5.3.2. Impact of Land Use on Soil Quality

Bulk density is defined as the mass of solids per unit volume of the soil. The bulk density is a result of the soil composition and of soil management such as compaction by machinery, tillage and cropping (Dexter, 2004; Dexter et al., 2008). Figure 9 shows that the bulk density is highest in the orchard and the lowest in the forest. However, a statistical test showed a p-value of 0.159, which indicates there is no significant difference between the two.

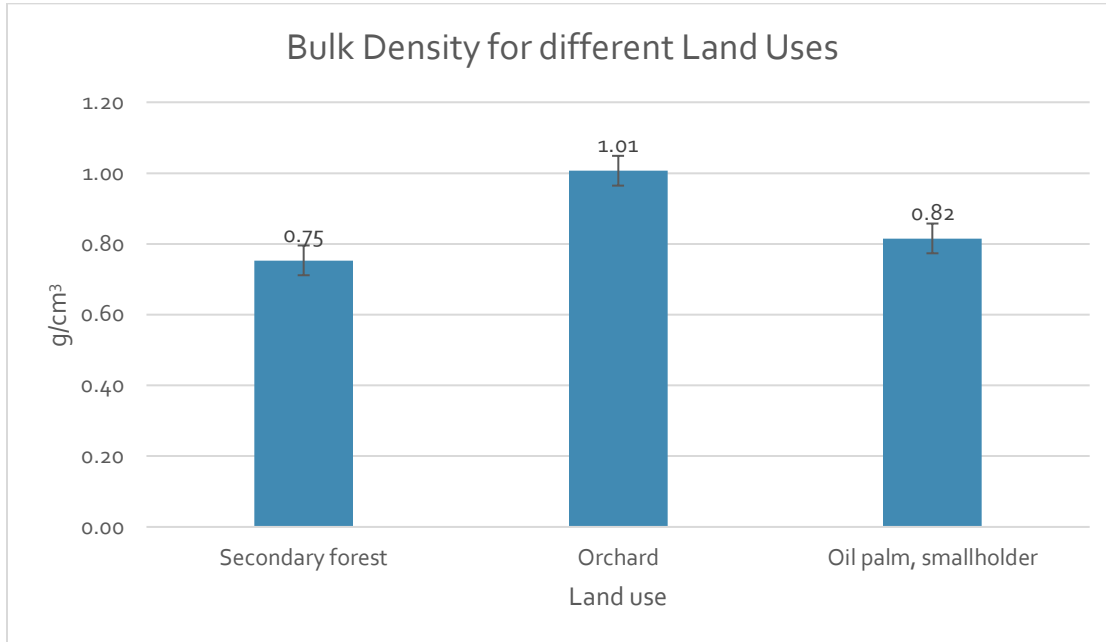


Figure 9: Bulk density of soil for different land uses.

Kara Atas is located on peat soil and close to a peatland (Fig. 10), so this parameter needs to be known to estimate the amount of carbon accumulated in the different areas (See section 5.3.3.).

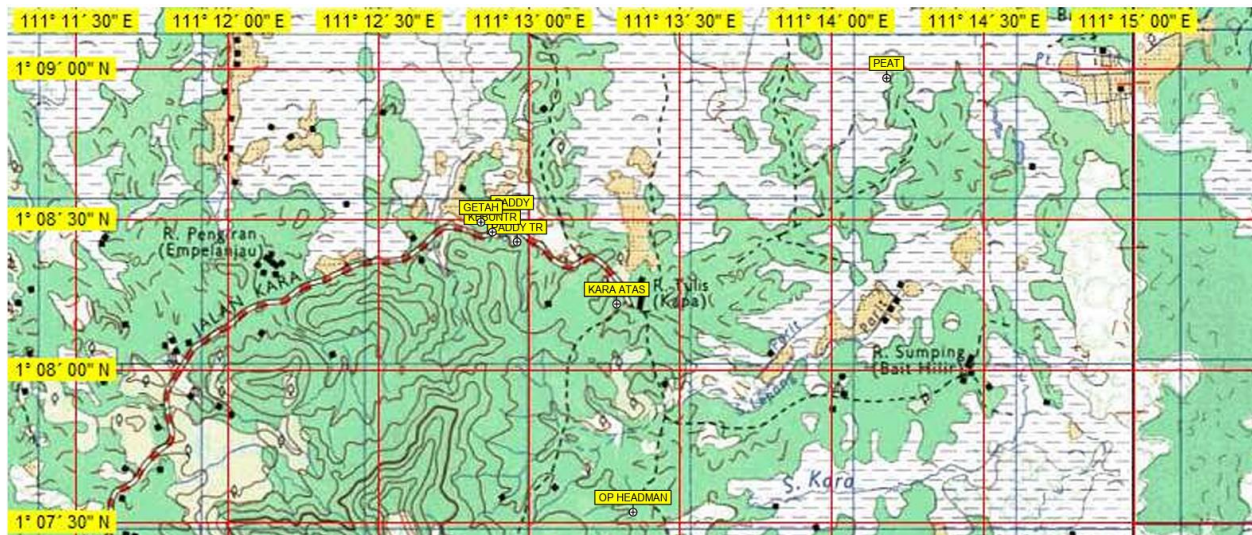


Figure 10: Map of mineral and peat soil in the area. White = peat soil; green = mineral soil. Source: Ajmal Asraff Ibrahim UNIMAS student.

Nitrate nitrogen ($\text{NO}_3\text{-N}$) is commonly measured in standard soil tests because it is the primary form of nitrogen there is plant available and, therefore, an indicator of soil fertility. However, soil concentrations of $\text{NO}_3\text{-N}$ depend upon the biological activity and may fluctuate with changes in

soil temperature, soil moisture, and other conditions (Veloo et al., 2015). Soil nitrogen was measured by testing the ammonium and nitrate content in the soil. The analysis showed significant differences in ammonium content between the areas ($p=0.009$) and at different depths ($p= 0.028$) accumulating mostly in the upper layer (Fig. 11). The Tukey test showed that the differences are larger between the forest and the two plantations, which might be due to fertilization. According to the interviews, we know that the Tuai Rumah and the Penghulu use fertilizer on their land.

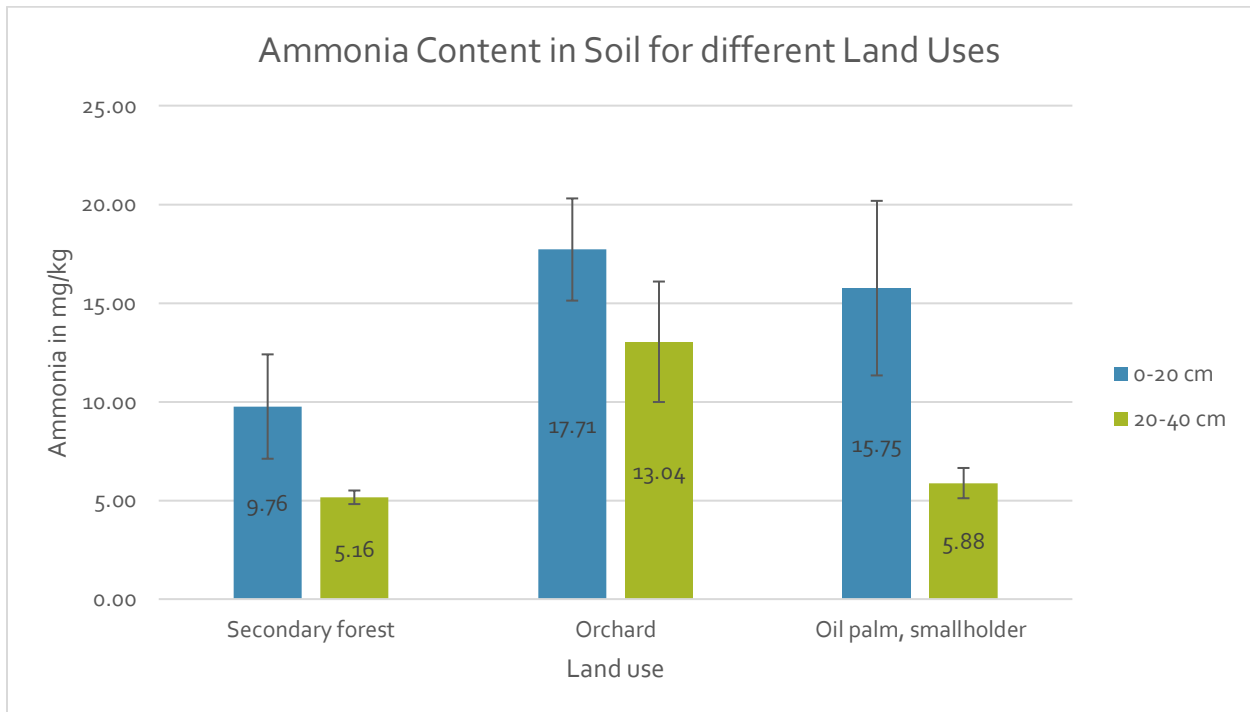


Figure 11: Ammonia content in soil for different land uses.

Phosphorus is known to be strongly bound to the soil and therefore has a low plant availability. It is an essential macronutrient that plays an important role in all biochemical processes in crops, such as photosynthesis, respiration, energy storage, transfer, cell division, cell enlargement and nitrogen fixation (Esther Mwende Muindi, 2019). The concentrations differ depending on the land use and the depth of the soil. The highest concentration is found in the orchard and the lowest on the forest (Fig. 12), which might be due to the fertilization.

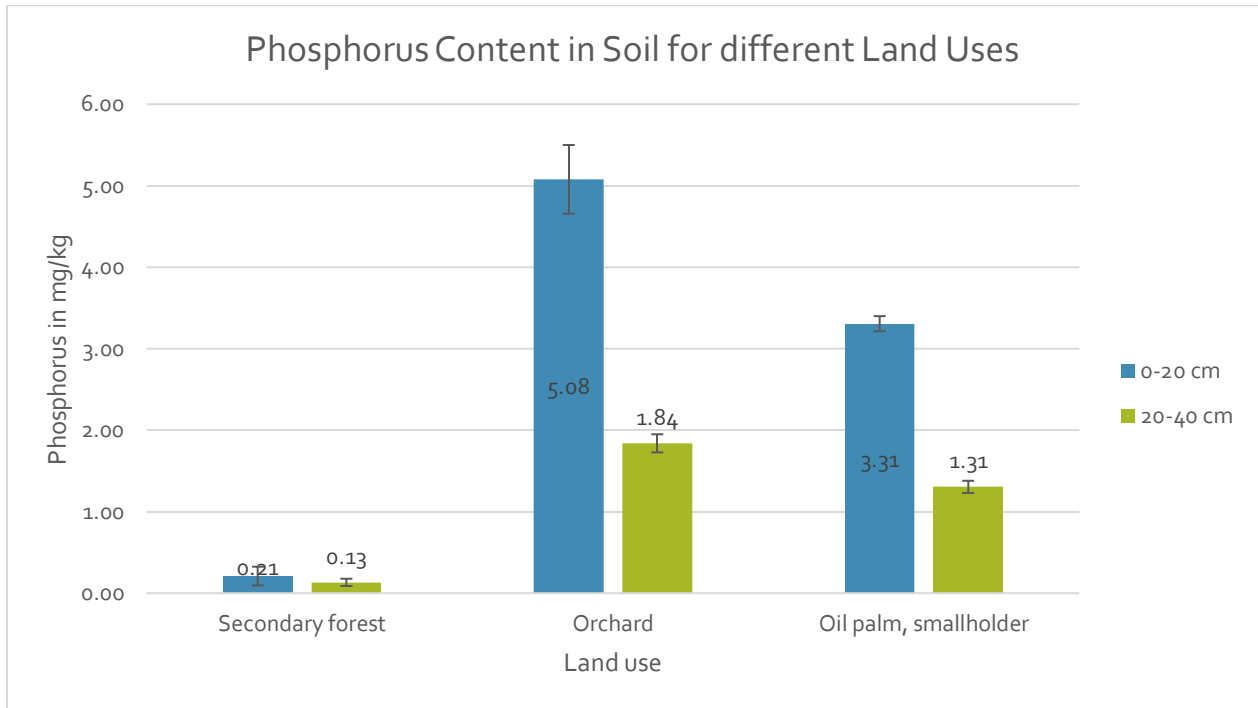


Figure 12: Phosphorus content in soil for different land uses.

Soil pH has a large influence on the availability of nutrients to plants. The nutrients that are essential for plant growth, such as nitrogen, phosphorus, and potassium, are most available to plants at a soil pH between 6.0 and 7.0. If the soil pH is too low or too high, the availability of these nutrients decreases, and plants may suffer from nutrient deficiencies (Dewangan et al., 2023).

The soil pH came out very similar in all areas and it is slightly acidic (Fig. 13), which is common in tropical soils (P. P. Motovalli et al., n.d.). It was below five in all land use types and the areas did not show significant differences between them ($p=0.796$) or in depth ($p=0.134$). In conclusion, the land use types do not seem to affect the pH of the soil.

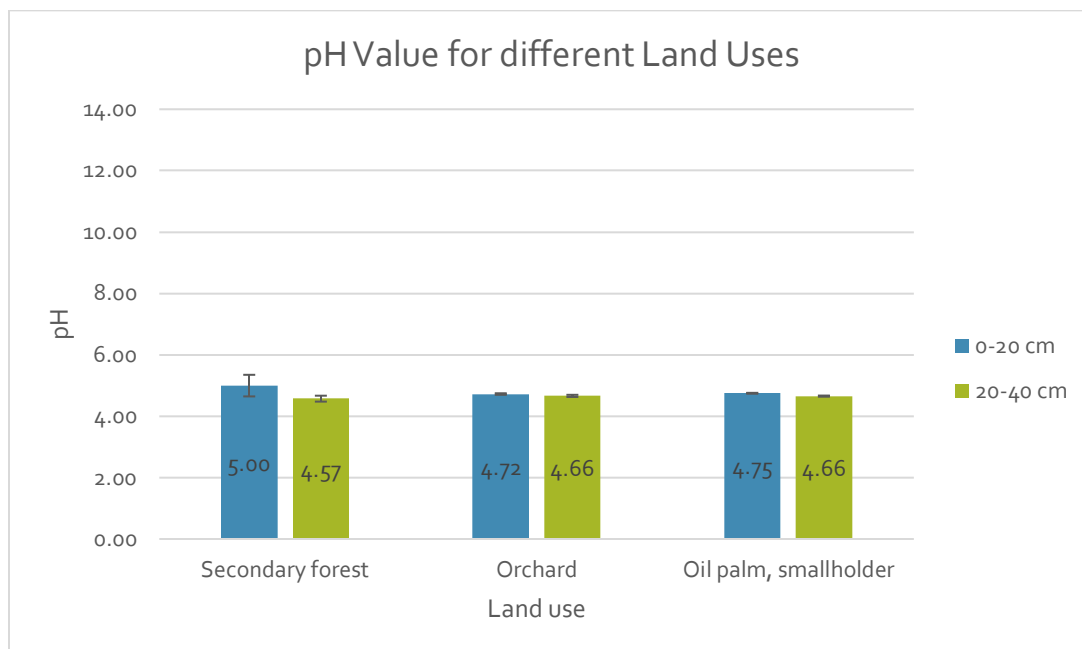


Figure 13: pH values for different land uses.

5.3.3 Carbon storage

We assessed the carbon storage both in soil and in above ground biomass in all three areas. Based on the abundance and size of trees, we calculated the amount of carbon stored in above ground biomass per hectare. Figure 14 shows that the orchard stores less carbon compared to the secondary forest in aboveground biomass, while the oil palm plantation stores about two thirds of the amount the forest stores per hectare. A possible reason for this could be the lower density of tree vegetation in the orchard and palm oil plantation. Furthermore, the trees in the orchard are younger and have a lower diameter than the trees in the forest.

The orchard has the highest carbon content percentage in the soil, storing almost 30 tons per hectare. The oil palm plantation and the forest store around one third of that amount (Fig. 14 & 15). The reason for this difference could be the low turnover rate in the orchard, which allows a larger accumulation of carbon in the soil. In contrast, the turnover rate in secondary forest is high, resulting in a low soil carbon stock. Although the palm oil plantation has a low turnover rate due to little under storage, the carbon stock might be low because of the previous deforestation and the accompanied erosion, which led to carbon loss.

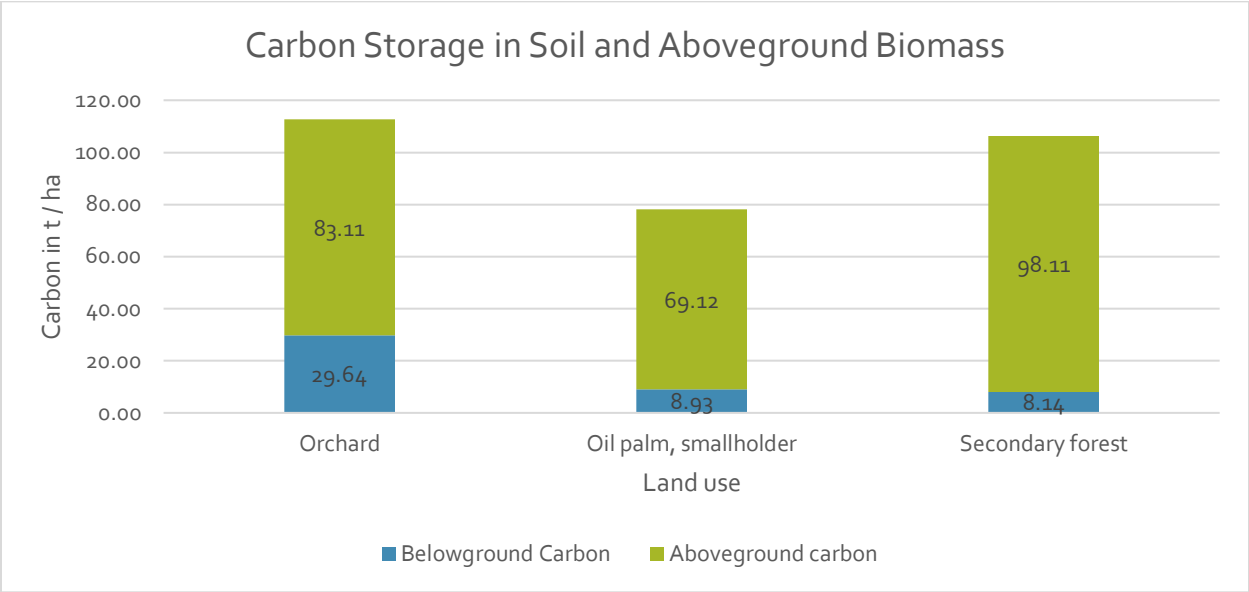


Figure 144: Carbon storage in soil and aboveground biomass for different land uses.

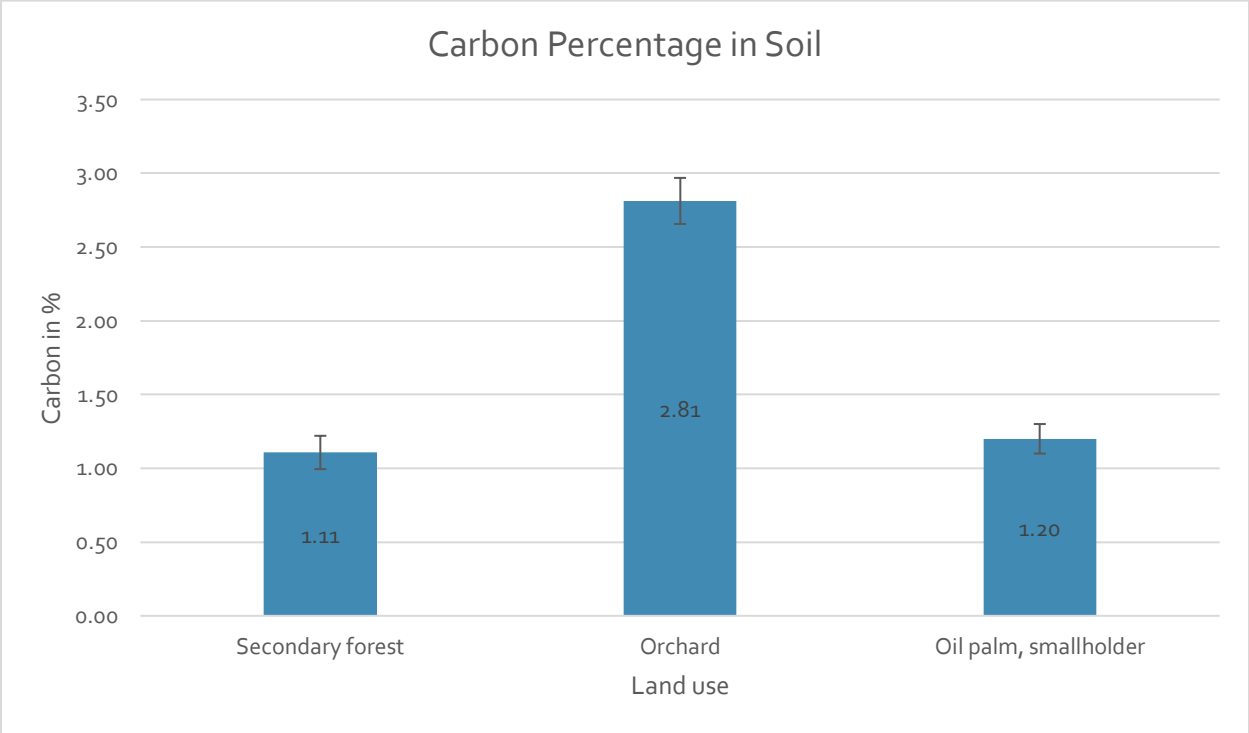


Figure 15: Carbon percentage in soil for different land uses.

Our research indicates that the cultivation of land causes biodiversity loss and the reduction of carbon storage capacity in above ground biomass. When considering both biomass and soil carbon

storage, the orchard ecosystem emerges as a more effective carbon sink than the forest and the oil palm plantation. However, the carbon stock in biomass in the orchard is in fact lower than in the forest while the soil carbon stock is higher. The palm oil plantation shows the lowest carbon stock in biomass and soil. Both land use types lead to biodiversity loss albeit the palm oil plantation causes higher biodiversity loss than the orchards.

Soil analysis revealed a higher content of macronutrients such as nitrogen and phosphorus in soils for crops compared to the forest. This could indicate the use of fertilizers in these two plantations for higher yields due to the nutritional poverty of uncultivated soils. However, our analysis could not show the impact of cultivation on the environment, the quality of the soil, or if it is suitable for palm oil cultivation, since we were unable to find a baseline for this in literature. In addition, it was not possible to compare it with the ROPA due to lack of analysis of the area.

5.4. Future Expectations for Land Use and Livelihoods

As mentioned in section 3.1 palm oil is brought up by the community as one of the possible crops to cultivate. During the research project other land use strategies have been mentioned. This section will answer the two final sub-research questions regarding the expectations for future land use in Kara Atas: *What are people's expectations for future land use in Kara Atas?* and *What are the future possible land use strategies for the rejected oil palm area?*

Although the community was not able to establish a large-scale oil palm plantation, 58.8 % of the survey respondents are in favour of an oil palm plantation and only 11.7 % oppose it. Furthermore, we wanted to understand whether gender or age play a role in people's desire to have a palm oil plantation in Kara Atas. To test if gender relates to wanting a palm oil plantation a Chi-square test was conducted. The result showed that gender is not statically significant (p-value = 0.793). Therefore, we can reject the hypothesis that there are gender differences when it comes to wanting palm oil in our sample. For age, we divided the respondents into two age groups – below 59 and above 60 years of age. The result of this chi-square test showed that there was no statistical significance (p-value = 0.067).

Some responded that they were unsure if they want a palm oil plantation or that they would follow the opinion of the majority. When asked about how they think the land can be used in the future, palm oil was mentioned most frequently, but some stated this would only be possible with the help of a company. In interviews, the focus group and conversations, many pointed to the need for financial capital because of the high costs associated with developing land for a plantation.

Because the area sits on swampy peat soil, development for a large-scale plantation would require the area to be drained.

Other options that were mentioned were fruit crops like banana or pineapple, however some community members are concerned that monkeys in the nearby forests may destroy the crops, which would decrease the yield and therefore profit. Another option is coconut but compared to other cash crops the profit is lower.

In general, people view the impacts of a commercial plantation in a positive light. Job opportunities are most frequently mentioned but income through bonuses, dividends, compensations for renting out land and the building of infrastructure and utilities are also highlighted. However, a few respondents also express concerns about the environmental impacts of a large-scale plantation like habitat loss for animals, deforestation of trees and water pollution. According to a key informant, some people were initially opposed to the idea of a palm oil plantation when the company first approached them. People's concerns centred on the risks of exploitation, lack of proper monetary compensation for the land and the company stealing their land. The informant explained that after discussing the monetary benefits of a plantation and how it could otherwise benefit the community, everybody agreed to the idea of a large-scale plantation (Tuai Rumah, personal communication, 2024)

In the end, the company decided to discontinue the project and compensate those from Kara who have a share of the land. While it still is unclear what the exact reason for the rejection was, most people explained that it was due to it being a swamp area. The Pengulu further explained that it was due to peat soil and MSPO (Malaysian Sustainable Palm Oil) and RSPO (Roundtable for Sustainable Palm Oil) standards preventing palm oil development on peat soil. According to him, the nearby village of Emplanjau already has a plantation, established by PELITA (Land Development and Development Authority), which sits on the same type of land and soil as the area in Kara. However, their plantation was established before the implementation of the new RSPO regulations in 2018.

Options for large-scale development are also limited by the way land is distributed in Kara Atas. According to some community members, companies are more interested in bigger areas of land while land in Kara Atas is divided into smaller plots of land, scattered around a large area.

The government had considered providing the community with a scheme for growing vegetables in an area that is currently a swamp paddy field that people from Kara share amongst each other and cultivate. However, the community is reluctant to hand over this area because they think it

would be possible to receive a larger amount of compensation if land prices were to increase in the near future.

Another option recently brought up by a local politician was a coffee plantation funded by a government scheme. However, it is still a topic discussed within the community, and its location has not been decided on. One suggestion was to use a piece of fallow land near the long house but some participants from the focus group argued that it could not be used because they want to respect the ancestors that planted fruit trees there. According to them, a swamp paddy field was suggested as a possible site. The cultivation of coffee beans would then be associated with high development costs because the soil needs to be drained. The government scheme suggests that a company will work the land for two years, teach people of Kara Atas how to take care of the coffee and process it. Afterwards the villagers must take care of the coffee beans themselves which they can sell and use for their own consumption. According to the women of the focus group, the coffee scheme could be combined with other crops for providing more job opportunities and make it more attractive for family members who are currently working in the cities to return to Kara Atas. The return of family members and the creation of new jobs in the area was also seen as a way for the older community members to take up jobs with a lower workload or abandon physically demanding cultivation practices, such as paddy.

This sentiment is shared among others in Kara Atas regarding the plans for large-scale development on the ROPA. In the questionnaire and during interviews, some stated that a palm oil plantation would be a good opportunity for creating jobs. However, whether this would be enough to stop the younger generations from moving away from Kara Atas was not clear. Some were certain that jobs would make people come back, while one informant explained that people may continue to come back occasionally or after retirement. Another informant was more sceptical towards the younger generation and stated that they had grown too fond of life in the cities.

Nevertheless, there seems to be an agreement among most community members that a commercial plantation in Kara Atas could attract family members that have left to live in bigger cities to return home.

While a commercial palm oil plantation was rejected in Kara Atas, most people still prefer to have a plantation. Due to land being scattered, other areas were not considered by the company because they want to develop a bigger piece of land. In general, a large-scale commercial plantation is seen as something that would bring job opportunities to the community and a reason for family members to return to Kara Atas. Coffee has emerged as a new and feasible option currently being considered by the community.

6. Discussion

6.1. Environmental and Livelihood Impact of Land Use

Our research showed that the cultivation of land in Kara Atas impacts the environment. The land use seems to increase the Nitrogen and Phosphorus content of the soil and compromises both the biodiversity and the carbon stock in the area. The carbon storage capacity in trees depends on the amount and age of the trees in the area while the carbon stock in the soil is dependent on the turnover rate and the degree of human intervention. E.g. carbon is released if an area is deforested for the creation of a plantation. Consequently, the carbon storage and biodiversity are lowest in palm oil plantations (see chapter 5.3.3). Severe intrusion into the natural environment was required to create the palm oil plantation, leading to the release of carbon stored in biomass and in soil. The extent of herbaceous vegetation decreased and the biodiversity in trees was reduced to 0. For setting up the orchard, less human intervention was needed. However, the biodiversity was still reduced compared to the secondary forest. So was the carbon storage in biomass, since the trees are younger and therefore smaller. However, the soil carbon stock is larger than in the forest and the palm oil plantation, which could be due to the lower turnover rate, leading to carbon accumulation (see chapter 5.3.3). According to our questionnaires and conversations with people in Kara Atas, the community is considering expanding the cultivation of cash crops. They seemed especially interested in coffee or palm oil plantations.

The loss of biodiversity has been accelerating worldwide in the past decades, mainly due to human activities such as land use change (Shaikh Shamim et al., 2020; Steffen et al., 2007). However, biodiversity is vital for maintaining a healthy ecosystem that provides us with various ecosystem functions, such as clean air and fresh water. The release of carbon contributes to the acceleration of global warming, which leads to increasing climate extremes such as changes in precipitation patterns, increased risk of floods, draught, wildfires, and heatwaves (Abubakar et al., 2021). Some of these developments in turn accelerate climate change, e.g. with rising temperatures and less rainfall wetlands dry out and can turn into a carbon source (Sa'adi et al., 2023).

These developments will occur globally and therefore also impact Kara Atas. Besides being concerned by the constriction of supporting ecosystem services the community will be affected by the weakening of provisioning, regulating, and cultural services. The changes in precipitation patterns might decrease water resource availability, since Kara Atas depends on surface water. Additionally, the water demand will increase with warmer temperatures, which can lead to water scarcity (Payus et al., 2020). The weather extremes will be especially challenging for agriculture.

Droughts, floods, and wildfires can destroy a whole year's yield and lead to food scarcity (Firdaus et al., 2020). Both genders in Kara Atas reported a shift of the harvest season during the seasonal calendar. They explained that this development makes it difficult for them to know when to fertilise the land. Furthermore, insect outbreaks and the spread of diseases could become problematic in tropical areas such as Sarawak.

Although land use can have severe effects on the environment, it has many positive implications on the livelihood of the Kara Atas community at a local scale. Agriculture is vital for the community's livelihood as it not only generates income but also covers their personal needs for food and makes them partly independent from the market. People in Kara Atas cultivate crops only on a small scale, which makes their environmental impact less severe compared to large scale farmers. Most of the orchard yield and parts of the rice yield are used for their own consumption. The decision to transition from rubber to palm oil cultivation, which has the most severe environmental impact, is to an extent driven by changing market prices and the global demand for palm oil is exacerbating the environmental damage accompanying palm oil production. This could be minimised with a change in demand or with incentives for forest conservation, giving people a chance to receive funds for maintaining or even restore the forest ecosystem in the area.

6.2 Navigating the Changing Landscape of Kara Atas

As it seems, people in Kara Atas are currently navigating changes happening on multiple levels. While they are adjusting to drops in market prices on cash crops and the increasing costs associated with certain types of cultivation, they are considering their options in the light of larger, but slower demographic changes such as an aging population and outmigration.

Most notable are the transition from rubber to pepper, which many households in Kara Atas have experienced and which are due to the drops in market prices. Market prices for rubber lowered significantly in the 90s and early 2000s with the introduction of synthetic rubber and while the government continued to support the planting of new trees, rubber tapping started to diminish in many areas (Mertz et al., 2013). Although people in Kara Atas refer to rubber as a past land use because they stopped tapping them, the trees remain part of the landscape in some areas, most frequently among the fruit trees in orchards. One woman explained that she would keep the trees as a 'security' in case prices would go up again, and others left the trees because they were not able to cut them down themselves or left them out of respect for family members who planted them.

With the lowering prices of rubber, pepper became the new favourable cash crop in Sarawak, which was subsidized by government schemes in some areas (Mertz et al., 2013). Kara Atas has followed similar patterns as many households abandoned rubber for pepper cultivation. Today, pepper cultivation has almost disappeared in Kara Atas since to the costs of fertilizers and pesticides making it less profitable.

As mentioned in section 3.1, paddy cultivation has been abandoned by many households very recently but has remained a part of the land use practices in Kara Atas for a long time. For some households, paddy cultivation has been accompanied by a shifting cultivation pattern, where some plots of land would be left fallow or overgrown with crops like fruit trees for a certain period after harvest and paddy cultivation was then moved to a different plot of land.

When joint venture companies (JVC) were introduced in 1990s it was in principle a way to reduce shifting cultivation and free up land (in many cases NCR land) for large scale plantation agriculture (Hansen & Mertz, 2006; Cramb, 2011). The JVCs have been criticized for appropriating NCR lands and leaving communities with little to no gains from the deal, however, others argue that the changing economic conditions in agriculture in Sarawak make customary landowners regard oil palm development as beneficial to their communities and a good way to generate income (Andersen et al., 2016). This corresponds with the positive attitude of people in Kara Atas towards large-scale land development. In Kara Atas, most people view the ROPA as ‘empty’ or of little to no value in its current state, because there are no valuable resources left from the time it was a *pulau galau*. They feel no one has the financial or physical capacity to work the land and without any inputs from an external actor, like the government, a company or a private investor, many view the area as invaluable. However, in other cases, land is valued much higher and seen as an important asset with which people are considering and negotiating ways to create other means of livelihoods.

These considerations about establishing a commercial plantation should also be seen against the backdrop of the powerful ‘development narratives’ promoted by the government since the 1980s (Andersen et al., 2016; Cramb 2011). The government of Sarawak has long supported large-scale plantation agriculture and promoted narratives of the need to develop ‘unproductive’ and ‘idle’ lands which were often falsely directed at the Iban and Bidayuh communities in these areas (Andersen et al., 2016; Cramb, 2011). Under the disguise of ‘bringing development to rural areas’, these narratives justified the reterritorialization of NCR land for commercial purposes.

6.3 Possible Future Land Use of the rejected oil palm area

Despite the legislative measures, mentioned in the previous section, the conversion of NCR land into palm oil plantations was quite slow and the Sarawak State Government sought other ways of freeing up land (Varkkey, 2020). The government argued that given the scarcity of agricultural land on mineral soils, it was necessary to develop on peatlands to improve the livelihoods of local communities. The valuable timber growing in peatlands, made it profitable for concessionaires to log the areas during clearing, which allowed for the profit from the sale of timber to fund the start-up of a plantation (Varkkey, 2020).

Given this perspective, it is interesting that the previous *pulau galau*, although logged over in the 90s, was rejected for palm oil development just last year. In this section we will explore some of the reason behind the rejection and other possible land uses of this area.

6.3.1 Development on Peat Soil

Tropical peat soil naturally has a high water-level which makes it unsuitable for most crop production and drainage is needed to make it suitable for agriculture (Ritzema, 2007). Several key informants informed us that this is costly, and people do not have the capital to develop the land themselves. They are currently hoping that an investor or company will develop the land and cultivate cash crops.

When peat soils are drained, GHG (like carbon dioxide, methane and nitrous oxide) are released, due to changes in the natural anaerobe environment in the soil. Land development can change the amount of GHG tropical peat soils emit to the atmosphere, but water levels affect this change more than land use (Prananto et al., 2020). The amount of GHG emitted when tropical peat soils is converted to palm oil plantations depends on several factors, however Hashim et al. (2018) suggests the yearly emission goes from 12.4 t CO₂ eq ha⁻¹ to 76.6 t CO₂ eq ha⁻¹ (see table 1 and table 2).

Table 1: Yearly GHG emissions per hectare for different scenarios. (Hashim et al., 2018)

Scenarios/sources	The Best-case, t CO ₂ eq ha ⁻¹ year ⁻¹	The Base-case, t CO ₂ eq ha ⁻¹ year ⁻¹	The Worst-case, t CO ₂ eq ha ⁻¹ year ⁻¹
GHG emission from land use change	-3.22 (gain C)	8.07	21.3
Peat emission/drainage	13.0	33.0	53.0
GHG emission for production of CPO	2.63	3.96	5.29
Total GHG emission for oil palm planted on peat	12.4	45	79.6

Table 2: Explanation of the different scenarios (Hashim et al., 2018).

	BEST CASE	BASE CASE	WORST CASE
LAND USE CHANGE (LUC)	Degraded (grassland) peatland	Heavily logged-over peat swamp forest (loss of 50% in biomass)	Lightly logged-over peat swamp forest
PEAT EMISSION/DRAINAGE	Best case soil emission	Average soil emission	Worst case soil emission
PRODUCTION OF (CPO)	With methane capture facilities at all mills	Average amount of GHG emission for CPO production if 50% of mills have methane capture facilities	No methane capture facilities at the mill

Because of these GHG emission as well as increased risk of fires on these soils, the RSPO released Principle and Criteria 2018 stating that members should no longer clear peat land (RSPO, 2020). In 2019, MSPO developed guidelines for “best practice” on peat soils, (CSPO Watch, 2019), however, as these are only guiding principles, it is still possible to develop on peat soil according to state law (Varkkey, 2020).

These changes could make it difficult for Kara Atas to find a company willing to develop the area. We already know the company who approached them, rejected the site due to it being on peat soil. However, it is also relevant to put the GHG emissions from developing peat soil into a more global perspective, and it can be difficult to know the size of these emissions. An average peat soil emits 33 t CO₂ eq ha⁻¹ year⁻¹, and a lightly logged-over peat swamp forest developed will emit 21.3 t CO₂ eq ha⁻¹ year⁻¹, giving a total on 54.3 t CO₂ eq ha⁻¹ year⁻¹. This number might be representative for Kara Atas, because the ROPA was heavily logged in the 90s, and therefore had time to regrow, however as of today there are still no large, hardwood trees and the area only consists of faster growing trees, smaller hardwood trees and bushes. A plantation might increase the livelihood for the people of Kara Atas. However, there are cases where palm oil plantations have created conflict among community members. Research from Indonesia, Kalimantan suggests that whether a palm oil plantation has social impacts on the community depends on their existing livelihoods (Santika et al., 2019). If the community has a moderate to low forest cover and rely on market-oriented (agriculture and non-agriculture sectors) livelihoods, the socioeconomic well-being will improve from having a palm oil plantation, compared to communities with no plantation (Santika et al., 2019). On the opposite, if the community is remote and has a high forest cover and relies on subsistence-based (swidden farming and supplemented by market exchange) livelihoods, it will only improve in the short run (Santika et al., 2019). In Kara Atas, there are both elements that suggest that the community livelihoods are both market-oriented and subsistence-based. They still practice shifting cultivation, forage and sell handcrafts on the local market, however they rely on wage labour. It is therefore difficult to determine the future impacts of a commercial plantation in Kara Atas.

Even if the ROPA could be drained and cultivated, it will be expensive due to the amount of fertilizer that would be needed. Peatland floors are heavily washed (Mohamed et al., 2002) and might not have good nutrient retention properties especially in areas with higher rainfall. Whether the soil quality of peat soil is good enough to establish a plantation depends on factors such as the depth or the amount of wood stored in the soil (Veloo et al., 2015).

Oil palm cultivation also requires additional land preparation work, road maintenance and water management which will result in increasing operational costs (Galau Melayong & Sylvester Fong, 2016). The choice of fertiliser is mostly an economic issue, not only in terms of fertiliser prices but also the likely returns from their applications in the fields. Therefore, the properties of the fertilisers and the agronomic conditions in the plantations such as climate, soils and terrain should be considered (K. J. Goh et al., 1999). However, as some of the respondents pointed out, they

receive government funded fertilizers and in the case of wanting to establish a palm oil plantation, also seedlings.

Many people are against developing palm oil fields because of their environmental and social implications. Conflicts, housing conditions and land grabbing are direct negative impacts. Additionally, there are indirect impacts such as climate regulation, soil erosion, habitat loss and struggles in food provision (Lacour M. Ayompe et al., 2021). But as pointed out in interviews an oil palm plantation would be a source of income, employment, infrastructure and social services for Kara Atas.

Nevertheless, palm oil production is a driver of deforestation (Abood et al., 2015) with its attendant GHG emissions (Nancy L. Harris et al., 2012), as well as air pollution from the use of fire for land conversion (Carlson et al., 2013) and biodiversity loss (Vijay et al., 2016). However, the 15th international peat congress in 2016 conclude that “With better understanding of the peat characteristics, improved peat planting technologies and best agro management practices, oil palm planting on peat can be carried out sustainably on properly selected peat areas, but still more research is needed.” (Galau Melayong & Sylvester Fong, 2016)

An alternative to a large-scale plantation, could be small-holder palm oil farming which would give lower yields but have less impact on the environment and the revenue goes directly to the people. However, people in Kara Atas do not feel they have the necessary knowledge, labour force or capital to start a plantation. To help small holders in Kara Atas quality planting materials and training in agricultural practices could be key interventions. Such product and process upgrading can be made possible through private companies (Zoë Ogahara et al., 2022), NGOs, cooperatives, or government-run programmes. Nevertheless, many studies show that training initiatives fail to meet their objectives. This may be due to a lack of communication with the target smallholders, poor investment and design, as well as indifference from smallholder communities who may not be convinced of the benefits of a high-input high-output system (Zoë Ogahara et al., 2022).

6.3.2 Possible Uses without Drainage

As drainage of the area will be associated with high financial costs, have a negative impact on the environment, and increase the risk of peat fire, this section will investigate a few possibilities that do not involve drainage but still can create a financial opportunity for people of Kara Atas.

Back in 2019 the Premier of Sarawak informed that Forest Landscape Restoration in Sarawak has been made one of the state’s main agenda (Zarina et al., n.d.). The state government has four objectives for forest restoration in Sarawak and one of them is “to enrich logged-over areas with

high-value timber species” (Zarina et al., n.d.). Forest Department Sarawak (FDS) has taken some initiatives to create forest nurseries, create public awareness, and intensifying research. Another objective is to actively engage the local community in the project. This is through direct employment as nursery workers for the seedlings, maintenance of the area and more or alternative income. They also mention support to the community or help to develop a market for non-timber forest products (Zarina et al., n.d.). To support this restoration, FDS want to explore the possibility of payment for ecosystem services like carbon offset.

Through carbon offset, companies can buy carbon credits to lower their own GHG emissions. Carbon credits can be generated in several ways, some are nature-based solutions like reforestation and soil preservation (Dunn & Freeman, 2011; Herr et al., 2019). However, this method has received critique for allowing developed countries to bypass their responsibility of reducing GHG emissions by buying extra carbon credits. Carbon credits are meant as a socioeconomic incentive that increases the livelihood for the communities that create the carbon credits. These initiatives have varying effects on the communities with both positive and negative impacts (Herr et al., 2019).

7. Limitations

7.1. Limitations of Methodology

Kara Atas only consists of 22 households, which makes our sample size quite small. This must be taken into consideration when addressing the community’s expectations for future land use and the wish to have a palm oil plantation, as it only represents the opinion of the people present at Kara Atas and not the opinion of all Kara Atas or Kara. Furthermore, most of the people that were present during our field study, were women (65 %) with an average age of 55. The convenience sampling used for parts of the data collection, such as the focus group, creates an undercoverage bias as the voices of men and younger people are inadequately represented in the data.

Questionnaire

During the creation of the questionnaire, we were too focused on what questions would be interesting to ask. However, it would have been better to construct the questionnaire based on relevant statistical tests that could answer our research questions. The questionnaire also had several open-ended questions which made data analysis more cumbersome.

Due to our limited knowledge of Iban language, several questions led to misunderstandings due to formulation. An example of this can be that we asked for 'income' and did not specify it as 'cash income'. Therefore 'income' could include things for own consumption. The questionnaire also had a part about their land use in the previous year and while some interesting information was received from this, it was not possible to properly analyse the information because the units of the variables were inconsistent.

Biodiversity and Soil Assessment

The realisation of the biodiversity and the soil assessment was limited by several factors. We were not able to sample peat soil areas, which is why we did not obtain any data for swamp paddies which cover a large part of Kara Atas or the ROPA. Furthermore, the size and the number of sampling areas are rather small due to our time constraints, which limits the representativity of our results. So does our lack of experience in conducting soil and biodiversity assessments. For example, we were not able to identify most plant species, which is why we could not perform any more in-depth analysis. In addition, the sampled forest is not primary forest and therefore does not represent the natural state of the area accurately. Furthermore, it was not possible to store the soil cool to stop microbial activity or other processes in the soil, since we did not have the respective facilities at the longhouse and the journey back to Denmark was long. Upscaling of the carbon stock results is not possible because we do not know the exact size of the sites. Especially, the orchard and the forest cannot be delimited by using GIS or Google Earth.

Ethnobotany

The Ethnobotany assessment was conducted only with a professor from UNIMAS present. Therefore, it was possible to identify relevant species that could potentially be used for medicine, own consumption or other purposes. However, because no one of the local community was present we are unable to say with certainty if these plants are being used.

7.2. Language Barriers

A very defining challenge of this study has been language barriers and the dependency on interpreters as it restricted our data collection in many ways. Everything was either translated by the Iban-speaking translators or UNIMAS students and sometimes interviews were conducted in Malay by the Malaysian students. Being depended on someone to translate every conversation, made it difficult to engage freely with people, which meant informal conversations and participatory observation could never become truly unstructured.

During interviews, the need for translation limited the interviewer's ability to control how questions were posed as they were often modified to fit the Iban or Malay cultural context. Sometimes, it would also be unclear whether the participants' answers were translated directly or based on the interpreter's own knowledge.

Language was especially a barrier during the focus group discussion as much knowledge and many details were lost in translation. It also complicated the ability to pose follow-up questions or clarify misunderstandings in the questions posed. While it limited our observations and notes during the session, the choice of facilitating the discussion in Iban made for a more uninterrupted and engaged discussion.

7.3. Limitations in Interdisciplinarity

While our work has been driven by our different disciplinary backgrounds and interests, we experienced difficulties in truly merging the natural and social science approaches to the fieldwork (Krishnan, 2009). Despite wanting to link natural and social sciences, it was sometimes difficult to find the connection between them. The interdisciplinarity we were able to conduct were a multidisciplinary approach, where we were able to enlighten our research question with different disciplines and thereby widen our scope (Krishnan, 2009).

8. Conclusion

The land in Kara Atas has undergone constant changes from the past to the present, influenced largely by external factors such as fluctuations in rubber and pepper prices, as well as increasing fertilizer costs. These shifts have not only impacted livelihoods but have altered land use patterns. Outmigration due to seeking employment opportunities elsewhere has left some areas abandoned, with remaining residents engaging in small-scale activities like handcrafts or relying on pensions. While a few individuals have turned to palm oil cultivation, constraints in capital and labour make independent land development unfeasible for the majority. The logging of the ROPA further exacerbated resource scarcity, forcing residents to seek substitutes or spend income on previously freely available resources. Despite the abandonment of plans for large-scale oil palm plantations, many in the community still hope for a commercial plantation. Thus, transitions in land use not only affect livelihoods and the environment but are also influenced by livelihood decisions,

creating a complex interplay. This is underlined by the fact that some members of the community recognizing the potential impact on biodiversity and soil quality.

The comparisons with the forest baseline reveal loss in biodiversity with the establishment of orchards and palm oil plantations. When it comes to carbon storage, the orchard showed a larger carbon stock in soil and smaller carbon stock in biomass than the forest. In the palm oil plantation, the carbon storage was lower than in the forest and in the orchards in both soil and biomass. The two plantations also showed higher macronutrient levels, likely due to fertilizer usage, which can have environmental implications that might need future research.

One of the possible strategies for the ROPA is to drain it and use it for a large-scale palm oil plantation, but those requirements exacerbate environmental concerns. Proposed alternative crops face similar challenges, leaving forest restoration or carbon credits as feasible options in the absence of investors. To better understand the environmental impacts of fertilizer usage, further research, including soil sampling and biodiversity assessments of the ROPA, is recommended, especially if large-scale commercial plantations are to be realized.

In conclusion, the economic and environmental landscape of Kara Atas has witnessed significant transformations, that requires a balance between economic opportunities and environmental conservation. Initiatives like Forest Landscape Restoration and carbon offset offer potential pathways for sustainable development, although with potential drawbacks. Collaborative efforts and exploration of alternative approaches like a coffee plantation are essential to ensure a future that supports both livelihoods and ecosystem health in the region.

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Appendix

Appendix I: Synopsis

Excluding synopsis appendixes

Synopsis Kara Atas

Alternative Livelihood Strategies to Palm Oil Cultivation in Sarawak, Malaysia: Assessing the Environmental and Social Impact of Different Land Use Strategies in Kara Atas



Figure 1: Oil Palm Plantation in Sarawak (Bratanova-Doncheva et al., 2018).

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1. Introduction

This synopsis serves as a preliminary outline for the interdisciplinary field research trip in Kara Atas, Malaysia. The research will be carried out between the 4th and 15th of March in collaboration with students from UNIMAS.

Palm oil is the main source of income in most communities in Sarawak (Statista, 2022). However, in Kara Atas palm oil is only cultivated on a small-scale, as their recent attempt to engage in a joint venture scheme with a company was rejected due to poor soil conditions (SLUSE, 2024). Since many communities in the area produce palm oil, we are curious why Kara Atas was rejected.

The aim of this study is to understand the role of palm oil production in Kara Atas, which livelihood strategies the local people engage in, and how they envision the future of the community in the light of the rejected plans to establish a palm oil plantation. Furthermore, we would like to test the soil quality in the respective area to understand why the community was turned down by the oil company. Lastly, we will assess the biodiversity and estimate the carbon storage capacity of the land to conclude how different land use options will impact the carbon storage and biodiversity in the area while counterbalancing them with the expected livelihood benefits for the community.

Research questions:

What are alternative land use strategies to palm oil cultivation for the local community in Kara Atas and how do they impact their livelihoods and the environment?

- *How has the land been used in the past and how is it currently being used?*
- *What are the main livelihood strategies for people in Kara Atas?*
- *How does soil quality impact the possibilities of palm oil production on a largescale level and household level?*
- *What are the community's expectations for future land use and what is the role of palm oil in them?*
- *What is the impact of cultivation vs. conservation of the (fallow) land on biodiversity, carbon storage capacity, and livelihoods?*

2. Local Context

Sarawak is one of 13 states of Malaysia and occupies the northwestern part of Borneo. The state's economy is primarily agricultural, focusing on cash crops such as rubber, pepper, and sago, primarily cultivated in coastal areas, while subsistence and shifting agriculture, for crops such as rice, are practiced inland. Sarawak's main exports include petroleum products, timber, and rubber, with industries such as manufacturing, sawmilling and processing of sago, copra, and pepper contributing to its economy. The population of Sarawak consists mainly of Ibans (Sea Dayaks), and Malaysian Chinese, along with Malays, Bidayah (Land Dayaks), and Melanaus (Britannica, 2024).

Malaysia is the world's second-largest producer and exporter of palm oil and Sarawak's economy has been shifting towards oil palm in the past decade. Every year, the hectares of planned area for oil palm plantations are increasing, reaching 1.62 million hectares in 2022 (Fig. 2). Most of the palm oil plantations in Malaysia are found in Peninsular Malaysia, followed by Sarawak and Sabah (Statista, 2024).

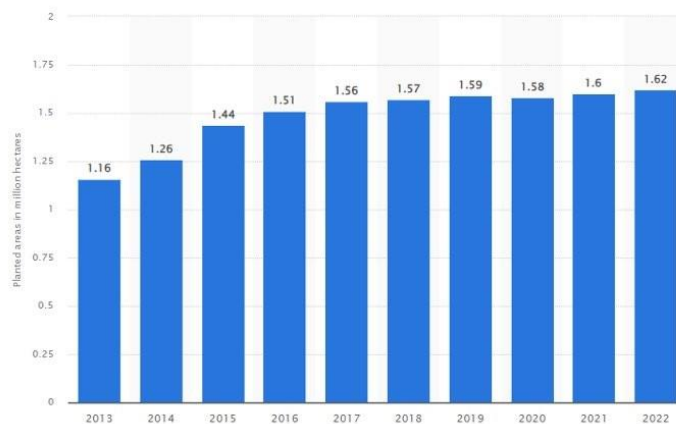


Figure 2: Total Area Planted with Oil Palms in Sarawak 2013-2022 (Statista, 2022).

While palm oil production has become associated with deforestation, biodiversity loss and land-conflicts (Cramb & McCarthy, 2016; Koh & Wilcove, 2008), it has also contributed to economic development in Southeast Asia and brought employment opportunities and investments in infrastructure and agriculture (Hasan & Hidayat, 2018). Key drivers of development include road construction to rural communities, enhanced accessibility, and stimulated agricultural activities.

Our field research is in Kara Atas, a village close to the Pan Borneo Road. This village has experienced a transformation away from traditional agricultural activities, focusing on rice cultivation, pepper, and rubber. These crops, once essential for household consumption and income generation, have declined over the past decade. Swamp rice cultivation has dwindled due

to labor shortages and increased costs of fertilizers, while hill rice cultivation has ceased as household members seek employment opportunities in urban areas. Similarly, maintenance costs have made pepper cultivation and rubber tapping economically unviable, leading to their abandonment. Those remaining engage in small-scale economic activities such as selling biscuits, fruits, handicrafts, and receiving government pensions. Limited land use activities persist in Kara Atas, leaving vast areas of fallow lands and forest around the longhouse. Some households are turning to oil palm cultivation but unlike other communities in the area, palm oil is not being cultivated on large-scale level in Kara Atas (SLUSE, 2024).

3. Methodology

Due to our research objective's interdisciplinary nature, we will employ a wide variety of qualitative and quantitative methods. Through social science methods, we want to understand the opinions of people regarding palm oil plantations, their land use and livelihood strategies. We will apply natural science methods to study soil quality and biodiversity to understand why Kara Atas was rejected for developing a palm oil plantation and to assess the carbon storage capacity of the land.

3.1. Social Science Methods

3.1.1. Participant observation and informal conversation

We expect participant observation to complement other methods throughout the fieldwork, as we will make sure to have observers for multiple methods to get a better sense of the dynamics between community members and their interaction with the surroundings. However, through participating in daily activities, sharing formal and informal spaces with people, we also hope to gain a better understanding of the less explicit elements of daily life in Kara Atas. While this approach would mainly be exploratory and complementary to other methods, it could also provide us with knowledge necessary to choose relevant themes for later coding and analysis of data or for further investigation in interviews. The level of participation will be affected by our position in the field and will require us to be transparent about our research objectives and mindful of using knowledge gained through informal conversations.

3.1.2. Semi Structured Interviews

Semi-structured interviews will be one of our main methods for gaining knowledge of livelihood strategies in Kara Atas, land use changes and the expectations of palm oil production. This interview form allows for in-depth exploration of the participants' experiences, perspectives and knowledge with more flexibility than a questionnaire (Brinkmann, 2020). Through these interviews, we are also able to pose follow-up questions on insights gained from other methods we apply. To get an overview of the history of Kara Atas and changes in land use, we will conduct a semi-structured interview with the headwoman at the beginning of the fieldwork, which will be followed by interviews with other community members (see Appendix III).

3.1.3. Focus Groups

Kara Atas is one of the few communities where palm oil production is not produced on a large scale. To get an understanding of the expectations of future land use and the role of palm oil we

want to conduct focus groups. The point of departure for the discussion is set by the moderator. Focus groups enable people to interact with each other and share their point of view. Furthermore, within the discussion participants elaborate on other ideas or bring arguments and counter arguments that potentially lead to insights that would not come up during an individual interview. Moreover, it is possible to look at the group dynamic and processes that help to understand how opinions or ideas are formed (Flick, 2022).

3.1.4 Participatory Rural Appraisal (PRA)

Participatory Rural Appraisal (PRA) is the term for multiple participatory approaches, aimed at facilitating the active involvement of community members in the research process (Selener, 1999). The purpose of using PRA in our research is both as a means of engaging creatively with data collection, but also to ensure our research is driven by the needs and perspectives of the community.

Transect Walk

To get a better understanding of the ways the land has been used in the past and how it is currently being used, we will do transect walks. This will help us identify relevant areas for further investigation. We are planning to do an initial transect walk with the headwoman to familiarise ourselves with Kara Atas and identify the area that was discussed for a possible plantation. Additionally, we want to do transect walks with another community member to further investigate how the land is being used. We will use GPS to mark relevant places that are being mentioned during the walk.

Participatory Mapping

We will also use participatory mapping where we ask members of the community to draw a map of the village and the surrounding land and how it is being used. We would then ask the same group to draw another map of how they would like the land to be used in the future. Doing this with multiple groups can help to understand how land is currently being used and what expectations they have for the land in the future. Furthermore, the maps that come out of this method can be used to complement the focus groups and facilitate a discussion regarding future land use of the community.

Financial livelihood ranking

Our aim with this method is to investigate how the community creates a financial livelihood, and how they value it based on different parameters. Through this method, rather than a simple questionnaire or interviews, we want to identify the categories and parameters for the ranking scheme in collaboration with the participants to ensure the relevance of scheme for the participants. This will also provide us with a general overview of the importance of different livelihood strategies, which can be useful points of departure for later interviews. For further information see Appendix VII: Financial livelihood ranking (PRA).

3.1.5. Questionnaire

Conducting questionnaires is an efficient way to gain a good overview of the population. A translator will help us conduct the questionnaire, and it will be supervised by another student to make sure there are no misunderstandings or bias during the survey (Rea & Parker, 2005). The survey will focus on aspects such as land use, agriculture, food consumption, livelihoods and

sources of income and the questions will mostly consist of closed-ended questions similar to those posed in the interview guide (see Appendix III & IV). The data collected with the questionnaire will be summarized and analyzed through descriptive statistics and triangulated with relevant data.

3.2. Natural Science Methods

3.2.1. Soil Assessment

A soil quality analysis is needed to assess why the palm oil company rejected planting palm oil in this area. We will try to obtain the company's standards for acquiring land for palm oil cultivation and compare those with our own soil analysis results to find out if the land is in fact not suitable. Furthermore, we will sample the soil in areas where the community is cultivating palm oil on a small scale and the areas where neighboring communities cultivate palm oil and assess the differences to the land that has been considered for large-scale palm oil production.

3.2.2. Forest/ Biodiversity Assessment

We are planning to conduct a forest/biodiversity assessment on the land that was considered for palm oil production to assess the amount of carbon stored in the area. If the soil is peat soil, the area would constitute an important carbon sink. The assessment would give us insight into how the cultivation or conservation of that land would impact the carbon storage capacity of the area.

3.2.3. Remote Sensing

Before going to Kara Atas, we will use remote sensing to gain knowledge on the land-use in the area around the community. We will use aerial photography for the landscape of Kara Atas and compare this with information from the transect walk when we arrive using in situ verification. This will also help us prepare some of the other methods to be more precise beforehand, including the questionnaire and interview guide.

3.2.4. Land Assessment

The last method to be used is a land assessment. This method helps us to gain knowledge of different areas related to the community and to investigate what has happened in the past, how the area is being managed in the present, and to get information on the vegetation/ land cover in the area.

3.3. Limitations

There are several factors that might limit the feasibility of our project and the accuracy of the results. In social science methods, small sample sizes due to our limited time in the community might be problematic. Additionally, we may have difficulties recruiting participants for our surveys. Interviewees might not be representative, which would create a bias. This could be due to our selection method or because not every demographic group can be reached, as young adults or middle-aged people may live in the city or commute there for work. Furthermore, power dynamics within the group may add a bias to the data if it leads to participants not wanting to voice their opinions.

When it comes to the natural science methods, we might not be able to get access to the oil company's soil analysis. In that case, we will need to find different values for soil quality we can use as a benchmark to compare our results to. Additionally, none of us have much experience with conducting biodiversity assessments which might make our experiments prone to errors. Furthermore, the results for soil quality and the biodiversity data might not be 100% reliable as they are an extrapolation from a small area.

3.4 Positionality and collaboration

When conducting field research, it is important to be mindful of how social identities, such as gender, class and race, influence, and potentially bias, the researcher's understanding of the field or limits the access to certain arenas within the field (Haraway, 1988). Going into this research, we will have limited knowledge of the social norms of Kara Atas and whether these and our own social norms, could have implications for our research design and use of methods. We will therefore remain flexible and transparent in our research approach, while accounting for or, if necessary, adjusting e.g. group compositions and dynamics in focus groups and sensitive or irrelevant questions in interview guides.

As the field study will be conducted in collaboration with students from UNIMAS, we also acknowledge that our research design should be flexible and, if possible, merged with the research design proposed by the UNIMAS students. Ideally, we want at least one of each 'student group' to be present during data collection as this could bring about interesting discussions and insights on research approaches or bias.

3.5 Time Schedule

Day 1 March 4th	Day 2 March 5th	Day 3 March 6th	Day 4 March 7th	Day 5 March 8th	Day 6 March 9th
Arrival	Revising field research	Revising field research	Proposal presentation	Focus group	Semi structured interview
	Transect walk	Semi-structured interview with headwoman	Participatory mapping	Soil sampling	Land assessment
	Informal interviews	Informal interviews		Transect walk	Soil sampling
Day 7 March 10th	Day 8 March 11th	Day 9 March 12th	Day 10 March 13th	Day 11 March 14th	Day 12 March 15th
Semi-structured interview	Questionnaire	Questionnaire	Buffer Day	Presentation	Departure
Biodiversity assessment	Biodiversity Assessment	Livelihood ranking			

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5. Appendix

Appendix I: Matrix

Overall Research Aim	Investigate alternative livelihood strategies to palm oil cultivation in Kara Atas and assess the environmental and social impact of different land use strategies.				
Research question	What are alternative land use strategies to palm oil cultivation for the local community in Kara Atas and how do they impact their livelihood and the environment?				
Objective 1	Assess past and current land use. Get an overview of how much fallow land there is and where. Gain background knowledge for the rest of the project.				
Sub Question 1	How has the land been used in the past and how is it currently being used?				
Hypothesis 1	There is a lot of fallow land and forest. The community cultivates mainly pepper, rubber, etc.				
Data required	Variables	Data Collection	Sampling Method	Data Analysis	Limitations
General information about the way the land has been used/managed in the past and how it is currently used/managed.	Information about land use changes in the area.	Literature review	Keywords: land use changes; Sarawak; agriculture; cultivation; swidden; deforestation; palm oil	See if the elements we have from the transect walk and the remote sensing for cultivation are the same and how this holds up with general trends for the area.	Lack of experience in conducting Biodiversity assessment Small sample size is not representative for the whole community

Appendix II: Matrix

Data on where fallow land is and how much.	Types of land cover in area: Smallholder palm oil, pepper, fallow land, rubber and rice If aerial photos align with reality	Remote Sensing with aerial photography	Mapping of land cover with google earth: Inspection of landscape within 1 km radius	Transcription and analysis with NVivo for semi-structured interviews. Compare the results with the land assessment to see if the information we gain for the semi structured interview is the same as for the transect walk and land assessment.	Bias in remote sensing due to limited knowledge of the area
	Land use	Transect walk	Convenience sampling: 1 Transect walk with the headwoman or person assigned by the headwoman. Every group member focuses on a different aspect of the walk when taking notes	Also provide with information how they use the land and their sources of income Remote sensing will be analyzed with in situ verification	Small sample size; not representative for the whole community
	Forest, fallow land and cultivated land	Land Assessment / interview	Purposive sampling based on identified areas of interest during transect walk		Sampling strategy is subject to bias and unreliability; statistical test is not possible
	Land use	Semi-structured Interviews	5 interviews based on mix of snowball and stratified sampling.		Small sample size; time-consuming; difficulties in recruiting participants

Objective 2	Investigate ways people sustain livelihoods and create an income and whether this is done through cultivating the land.				
Sub-question 2	What are the main livelihood strategies for people in Kara Aias?				
Hypothesis 2	People engage in diverse ways of generating income with an increasing amount engaging in wage-labor and trading of products (handcrafts and food).				
Data on the ways of creating livelihood, how labor-intense it is, how much they get out of it etc.	(Selecting proper income categories with participants – e.g. pension, palm oil (smallholder; plantation), handicrafts)	Financial livelihood ranking	A member of a minimum of 10 households	Analysis in NVivo through thematic coding	Small sample size; possibly time-consuming and complex if all ranking values are to be added.
Data related to how the migration, price change in crops, climate change, and possible other elements has changed the ways of creating livelihood	Ranking different values such as importance of livelihood (in terms of financial or cultural value); labor intensity; social value (individual or collective work), distance to community (remote or within community)			Triangulation with questionnaire and interviews	Bias in terms of sampling strategy and representation
	Sources of income; importance of livelihood (in terms of financial or cultural value); labor intensity; social value (individual or collective work), distance to community (remote or within community)	Questionnaire	At least one member of each household (22).	Descriptive statistics Triangulation with questionnaire and interviews	Bias in terms of sampling strategy, size and representation
	Perceptions on limitations and opportunities of different livelihood strategies	Semi structured interviews	5 interviews (some participants from PRA ranking; rest based on mix of snowball and stratified sampling)	Analysis in NVivo through thematic coding Triangulation with questionnaire and interviews	Small sample size; time-consuming; difficulties in recruiting participants

Objective 3	Assess the community's reasons for not producing palm oil and plans for future land use (of fallow land). Find out whether they are planning to cultivate palm oil in the future. Find out which one of their current sources of income has the most potential.				
Sub Question 3	What are the community's expectations for future land use and what is the role of palm oil in them?				
Hypothesis 3	There are some community members that are concerned about planting palm oil on a large scale and might want to use the land for other purposes, while some are in favor of it.				
Data on the perceptions and expectations of locals of palm oil production	Opinions on palm oil production; engagement in palm oil cultivation; perceived benefits of palm oil production	Questionnaire	At least one person of each of household (22)	Descriptive statistics Visualization of data	Bias in terms of sampling strategy, size and representation; reluctance to participate due to time
	How people in the community draw current land use and how do they think it will look in the future	Participatory mapping	2 groups of 3 - 4 people; random sampling or clustered by gender (if necessary for dynamics)	Maps will be triangulated with the data from remote sensing, transect walk and land assessment to look for similarities or areas of 'conflicts' in the use and expected use of the land	Availability of participants; bias in sampling strategy; power dynamics; unwillingness to participate due to format (drawing)
	Future land use: Expectations from planting palm oil	Focus group	2 groups of 4 - 8 people; random sampling or clustered by gender (if necessary for dynamics); different groups from participatory mapping	Analysis of fieldnotes in NVivo through thematic coding. The community's expectations of planting palm oil or alternative uses for the land in the future	Power dynamics in group leading to silencing of some voices; exacerbating existing conflicts; Representation and survivorship-bias (might only be elders and kids available due to migration)

Objective 4	Assess limitations and obstacles for palm oil production through Interviews, soil assessment, and literature (e.g. climate change, migration)					
Sub question 4	How does soil quality impact the possibilities of palm oil production on a largescale level and small-scale level?					
Hypothesis 4	The soil is not suitable for palm oil plantation because of peat land. Palm oil on peat land can't be certified and is therefore not of interest for company.					
	Perception on soil quality; information on palm oil company assessment	Transect walk	Convenience sampling: 1 Transect walk with the headwoman or person assigned by the headwoman. (same as q.1)	Compare the soil quality perception given by the people to the one given by the oil palm company and see the crops they have.	Small sample size: not representative for the whole community	
			Every group member focuses on a different aspect of the walk when taking notes			
Data on current soil quality, Data on soil quality that is necessary for palm oil cultivation (according to the palm oil company)	Nitrogen (nitrate, nitrite and ammonia), Phosphorus, organic matter, pH, water-holding capacity, structure, type of soil, conductivity, and water storage (bulk density)	Soil test	Random sampling from the area considered for palm oil plantation; 2 samples from plantations in other communities (e.g. Emplangau); 2 samples from small-scale palm oil plantation; (Perhaps also rice plantation, rubber plantation, fallow land, two random samples in the forest)	Statistical analysis with R computational tool to compare the soil samples to see if there are any significance differences between all of them	Need of a soil permit. Need to transport the samples to Copenhagen; possible cross-contamination of samples; improper sample collection; we can only sample the upper layer of the soil due to lack of time	
	Data from the oil palm company	Document analysis	Compare the previous analysis with the soil analysis made by the oil company which rejected the joint venture	Statistical analysis with R computational tool to see if there are any significance differences between them	Access to data	
Assess the peat land around Kara Atas	Data from other plantations.	Literature review, GIS	Assess the peatland area in Kara Atas and delimit it in GIS	Data visualization	Availability of data; access to data;	
Assess the possible income from oil palm production on small scale	Income from smallholder plantations; perceptions on joint venture schemes	Questionnaires	At least one person of each of household (22)	Statistical approach to see the mean income of people in Kara Atas and other places	Reluctance to talk about income from palm oil; few people engage in palm oil cultivation;	

		Literature review from other communities in Sarawak	Key words: joint venture; palm oil plantation (small-scale & large-scale); Sarawak	Compare the mean incomes from other communities to ours	Availability of data;
Objective 5	Assess the carbon storage of the fallow land and the impact the cultivation or conservation of that area would have on biodiversity, carbon storage capacity, and livelihoods.				
Sub question 5	What is the impact of (peat)land cultivation vs. conservation on biodiversity, carbon storage capacity, and livelihood?				
Hypothesis 5	Peatlands are biodiversity hotspots and the most important carbon sinks due to their soil properties. Even though the cultivation of the land (e.g. with oil palm) can help with the development of the area, this could lead to huge carbon emissions as well as loss of biodiversity.				
Carbon storage in peatlands and in different plantations, Effect of cultivation of land on carbon storage capacity, Impact of carbon release of soil on the climate	Peatland/plantation carbon storage; Carbon sink/source, Impact of carbon in the atmosphere on climate	Literature review	Review peer reviewed scientific papers	Assess impact of cultivation on carbon storage; Describe importance of peatlands for carbon storage and the impact of carbon release on the climate	
Ecosystem services of the fallow/peatland currently used by the community, Info on how the cultivation of the area would impact the livelihood of the community	Ecosystem services provided by uncultivated land; benefits of land cultivation	Questionnaire	At least one person of each household (22)	Coding and analysis in NVIVO: Assess advantages and disadvantages of cultivation vs. conservation of the land	

Biodiversity data	Vegetation types, Key species, Tree height & diameter	Biodiversity survey, Dendrometry survey	Stratified sampling within the area considered for the palm oil plantation. Sampling points evenly distributed along a random transect line within the research area. Searching for a list with key species for peatland in Sarawak.	Calculate Shannon index with Excel (How biodiverse is the area?) Analyse dendrometry data -> calculate (approximate) carbon storage in soil and vegetation Make a checklist of key peatland species in Sarawak and compare it to the biodiversity survey results.	lack of experience in conducting Biodiversity assessment, calculation of carbon storage is an estimation, Calculation is only possible for the upper soil layer.
Data on soil carbon content	Soil carbon content	Soil analysis	Take a representative amount of soil samples in the respective area.	Analyse soil samples for carbon content and extrapolate to the whole area.	Data might be not 100% reliable as it is upscaled from a small area, We can only sample the upper soil layer; lack of time and tools to sample deeper soil layers.

Appendix III: Applied Methods

Research methods	
Participatory Observation	12 days
Participatory mapping	2 maps
Transect Walks	3 walks
Biodiversity assessment	3 areas 6 plots
Soil sampling	3 areas 24 samples
Questionnaire	17 household
Semi-structured interview	4 people
Focus group	1 group
Livelihood rankings	2 groups (Women and men)

Appendix IV: Ethnobotany assessment

Local name	Scientific name	Family	Quantity	Uses					
				Food	Medicinal	Construction	Fibers and Crafts	Ornamental	Others
Topia momat	<i>Rourea mimosoides</i>	Connaraceae	49	1					
Tapak Kuda	<i>Bauhinia purpurea</i>	Fabaceae	2		1				1
Bokah Tibug	<i>Piper caninum</i>	Piperaceae	39		1				
Getah	<i>Hevea brasiliensis</i>	Euphorbiaceae	103	1		1			1
Cempedak	<i>Artocarpus integer</i>	Moraceae	144	1					
Halia Jerangau	<i>Acorus gramineus</i>	Acoraceae	158		1				
Nyatoh	<i>Palaquium gutta</i>	Sapotaceae	4			1			
Kandis	<i>Garcinia huspidata</i>	Clusiaceae	75	1			1		
Kumpang	<i>Horsfieldia sp</i>	Myristicaceae	7			1			
Bird nest fern	<i>Asplenium nidus</i>	Aspleniaceae	17	1	1			1	
Semudang	<i>Smilax sp.</i>	Smilacaceae	1	1	1				
Rotan	<i>Calamus sp.</i>	Arecaceae	5				1		
Potik	<i>Baccaurea hookeri</i>	Phyllanthaceae	1	1					
Buan	<i>Dillenia suffruticosa</i>	Dilleniaceae	3	1					
Midin	<i>Stenochlaena palustris</i>	Blechnaceae	21	1					
Boyuh	<i>Artocarpus elasticus</i>	Moraceae	1	1					
Buluh munti	<i>Gigantochloa cf. hasskariana</i>	Gigantochloa	30	1			1		1
Durian	<i>Durio zibethinus</i>	Malvaceae	1	1		1			
Nanas	<i>Ananas comosus</i>	Bromeliaceae	1	1			1		
Pijulud	<i>Anisophyllea disticha</i>	Anisophylleaceae	2	1					
Purang	<i>Macaranga sp.</i>	Euphorbiaceae	2			1			1
Marudang	<i>Smilax odoratissima</i>	Smilacaceae	16	1	1				
Opit	<i>Arenga undulata</i>	Arecaceae	2	1					
		TOTAL	684	16	6	6	3	1	4
		%		44,4	16,7	16,7	8,3	2,8	11,1

Appendix V: Questionnaire Livelihood, Land-use and palm oil

Appendix IV: Questionnaire: Livelihood, Land-use and palm oil

We are 11 students from University of Sarawak and University of Copenhagen, Denmark. We are conducting a field study as part of a course on land use and natural resource management. Our study is focusing on land-use and livelihood strategies, and we are particularly interested in how different ways of managing the land in Kara Atas impact your livelihood. Your answers for this questionnaire will be used for a part a report that will be conducted as a part of Sustainable Land Use and Natural Resource Management (SLUSE) at UNIMAS and Practicing Interdisciplinary Field Research on the Environment (PIF) at KU. The information provided in the questionnaire is only representative of the participant and is not the view of the whole household. This final report will be made public, and you will be anonymous in relation to this questionnaire. If you have questions, comments, or would like to withdraw your answer, please feel free to let us know.

We are interested in interviewing one person from each household. The information the person provides is only applicable for them and is therefore not the view for the whole household.

Demographics

1. Name: _____
2. Gender: Male _____ Female _____ Other _____
3. Age: _____ years
4. Job(s)
 - a. _____
 - b. _____
 - c. _____
 - d. _____
5. Head of household (name) _____
6. Household number: _____
7. Household status of respondent
 - a. Head of household,
 - b. Partner of head of household,
 - c. Adult in the household,
 - d. Child (under 18) in the household,

e. Other (please specify) _____

8. What is the highest level of education you have completed?

No formal education		
Preschool		
Primary school		How many years have you completed? 1 2 3 4 5 6
Secondary school		How many years have you completed? 1 2 3 4 5 6
Tertiary school		

9. Is the longhouse your primary residence?

- a. Yes, everyday
- b. Yes, sometimes
- c. No

10. If b or c for previous question?

- a. How many months did you spend in this household the last year
_____ month

11. Were you raised in this village?

- a. Yes
- b. No

12. If b for previous question:

- a. How long have you been living there?
_____ years _____ months

13. List of household members

Name	Relationship to respondent	Age	Primary residence (Kara Atas or other)	Job(s)	Education *

*No formal education=0, preschool=1, primary school =2, secondary school=3, STPM/ matriculation/ ASASI/ vocational/ diploma =4, higher education=5

Sources of income:

14. Do you find that your household income covers the most essential needs (by essential needs we mean food, electricity bill, petrol, gas etc.)?

- a. Very sufficient
- b. Sufficient
- c. Neutral
- d. Insufficient
- e. Very insufficient
- f. Don't know

15. What ways do you or someone in your household generate an income? (Please select all relevant answers)

- a. Hill paddy
- b. Swamp paddy
- c. Pepper
- d. Palm oil
- e. Wage labor
- f. Lease of land
- g. Pension
- h. Remittance
- i. Fruit
- j. Handcrafts
- k. Timber
- l. Hunting
- m. Fishing
- n. Other, please specify _____
- o. Don't know

16. Please rank the answers selected above with 1= most important

17. Have the ways of income changed during the last 10 years? (Y/N) _____

If yes, please specify: _____

Food Consumption

18. How many days a week so you consume food that you have cultivated yourself?

_____ days

19. Has the amount of food you cultivate for own consumption changed over the last 10 years? (Y/N)

20. If yes, please elaborate: _____

Land use :

21. How many acres of land do you have? _____ acres

22. What is your status of this land? (Please select all relevant answers)

- a. Customary land
- b. With title
- c. Community owned
- d. Don't know

23. Do you cultivate land? (Y/N)_____

If Y to previous question please specify below and continue with the following questions, otherwise skip to 33. (Please select all relevant answers)

- a. I do the labor myself
- b. I hire the labor
- c. I get help from the village/ family
- d. Don't know

24. What is the total size of the land (acres) _____

25. What were the previous (30-50 years) uses of this land?

26. What crops do you farm on the land that is most important for your own consumption or income (max 5) (note the answers for 2023)

Crop	Area size (acres)	Harvest (month)	Total yield (ha/kg)	Price/kg	Input subsidies *	Buyer/market	Investment	Hours of work (week, high season)	Hours of work (Week, low season)	Main use**

* 1= chemical fertilizers, 2= natural fertilizer 3= pesticides, 4= seed, 5= other (note which one)
 ** 1= own consumptions, 2= fainance income 3=no use/ damaged, 4= other, please specify

27. If applicable, what crops did you previously cultivate that you do not cultivate now (past 10 years)?

Please specify _____

28. Why has this changed?

Please specify _____

29. What support would be most beneficial to you in managing your cultivated land?

- a. Agricultural training
- b. Financial investment
- c. Legal advice on land rights
- d. Access to markets
- e. Equipment and supplies (e.g. Fertilizer)
- f. Others (please specify): _____

NCR land and land development?

The next section will be related to the NCR land with peat soil that has been considered for land development. We will ask you a few questions on soil and future use of this land.

30. How do you think the soil quality is in the land?

- a. Very fertile
- b. Fertile
- c. Neutral
- d. Unfertile
- e. Very unfertile
- f. Don't know

31. How do you see the land being used in the future?

- a. Palm oil plantation
- b. Pineapple plantation

- c. Banana plantation
- d. Restored for nature purposes
- e. No development
- f. Fruit orchard
- g. Don't know
- h. Other, please specify: _____

32. Why do you think the land has not already been developed? Please specify:

33. How much do you agree with the following: The soil in Kara Atas is suitable for a large-scale plantation?

- a. Strongly agree
- b. Agree
- c. Neutral
- d. Disagree
- e. Strongly disagree
- f. Don't know

34. In what ways do you think a commercial plantation will impact the community? Please mention the 3 most important impacts

- a. _____
- b. _____
- c. _____

35. From the above question, please note if the impact is positive or negative

- a. Positive or negative
- b. Positive or negative
- c. Positive or negative

36. Would you like an oil palm plantation in the community? (Y/N) _____

37. Do you think you will have a palm oil plantation in the future? (Y/N) _____

38. Why do you think so?

Natural resources

Now we want to know more about natural resource products, so we will be asking you a few questions on your use of these (if applicable). By natural resource products we refer to natural non-timber products which are not planted in a monocultural field.

39. Do you collect natural resources products? (Y/N) _____

40. If yes, how many times per week do you collect natural resource products? _____

41. If yes, for which purpose(s)?

	Own consumption	To sell	Sell excess products
Edible plants			
Meat			
Medicine			
Ritual purpose			
Fuel wood			
Fodder (food for animals)			
Source of raw material to create products			
Other, please specify			

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42. Where do you primarily source natural resource products?

- a. Nearby land (less than 1 km from Kara Atas)
- b. Far away land (more than 1 km away)
- c. Water body
- d. Other, please specify _____

43. Do you face any issues when accessing these resources (Y/N)_____

44. If yes, please specify _____

45. How important is the land where you collect natural resources to you?

- a. Very important
- b. Important
- c. Neutral
- d. Unimportant
- e. Very unimportant

46. How else do you use this land?

- a. Ritual purposes
- b. Recreational purposes
- c. Other, please specify _____

Appendix VI: Interview guide for semi structured interviews

Interview guide revised

Objective: To get an understanding of land use changes in Kara Atas for the past 30-50 years and the current livelihood strategies of the community to investigate how these are interrelated and discuss possible or expected (land use or livelihood) strategies for the future.

Why semi-structured interview: With the semi-structured interview we hope to explore the same themes and questions as the questionnaire and focus group but going more into depth on areas where we need more clarification. Using the same questions as the focus group could also provide us with insight into how individuals come to think about topics such as fallow land and land use compared to a group setting.

Participant: Anyone who was not there for the focus group, Someone that might cultivate land or someone with knowledge on cultivation/land use in Kara Atas.

- Apa: Seem to have a lot of knowledge, maybe also of land around.
- Lunie (the teacher)
- Penghulu's niece (Doreen?)

Interview guide

Introduction by students

- We are conducting a field study as part of a course on land use and natural resource management. Our study is focusing on land-use and livelihood strategies, and we are particularly interested in how different ways of managing the land in Kara Atas impact your livelihood. This interview will be used in our final report, which will also be made public. You will be anonymous. If you have questions, comments, or would like to withdraw your answer, please feel free to let us know.
- We will be recording the interview. Will that be okay with you?

1. Introduction: Getting to know the respondent

- What is your name?
- Age?
- Where do you live?
- Have you lived in Kara Atas your whole life?
 - o If yes, what have you been doing here?
 - o If no, can you tell about the time you were living outside of Kara Atas?
 - What did you do?
 - How long?
 - When did you come back?
 - Why did you come back?
 - What have you been doing since you came back?
- What is your job? (Can also ask about past jobs)

2. Land use/historical changes

- Do you have land?

- If no, is there a reason why you don't have land? (explore this the way that seems appropriate)
- If yes, where is the land?
 - Do you cultivate it?
 - Can you tell us how you first cultivated the land?
- If possible, could you tell us bit about how people have been cultivating the land in Kara Atas - as far back as you can recall (maybe past 30-50 years)?
 - What major changes have occurred in land use during this period?
 - Have there been any events or policies that have influenced land use here?
 - How have these changes affected the community?
 - How have these changes affected the local environment/nature around Kara Atas?

3. Unused/fallow land

- Do you think you are fully utilizing the land you have?
- If yes go to this section → From our time being here, we have noticed that there are some areas that is not being used/cultivated (fallow) at the moment. If you know, could you tell us about this?
 - Previous use
 - Do you know of any plans to cultivate the lands?
 - How do you feel about fallow land?
- With the tradition of swidden agriculture it is common that the land is changing.
 - Can you tell us some more about this tradition?
- How would you hope the fallow land to be used in the future?
 - How do you think development of this land would change your use of forest products?
- If no go to this section → Even though this land is fallow land it seems like people still use the land. Can you describe how you use the fallow land?
- We have been seen the area that was previously pulau galau and we are curious about it.
 - Can you tell us about its history?
 - How do you hope it will look like in the future?
 - What possibilities do you see for the land to become Pulau Galau again?
 - If yes, how would you want to manage it?
 - How would it be established?
 - What (if any) impacts do you think developing the land would have?
 - On Kara Atas
 - On the environment

4. Future land use

- What do you see as potential future strategies for land use in Kara Atas?
- What are your hopes and concerns regarding the future of Kara Atas?
- How do you hope Kara Atas will look like in the future

Appendix VII: Guide for focus group

Materials: Existing map, extra paper and pens (perhaps to extend map)

General thing to think about: encourage discussion among participants. Be neutral as facilitator. End the meeting by giving a summary of what was said or implied. Use follow-up questions if further elaboration is needed, like 1) Could you tell us more about that? 2) Could you give us an example? 3) What do you mean by ...?

Participant: 6 participants

Facilitator: Anne

General notetaker: Winnie, Remy

Notes on bodylanguage/speaking time: Nethe, Freja

Introduction

- Name of facilitators and participants
- Agree on ground rules e.g. Speak one at time, speak for yourself nor what other believe, differing opinions are expected and its okay if do not agree on everything.

Questions for focus group

- 1) Can you tell us how you first cultivated the land here in Kara Atas?
- 2) What terms would use to describe different ages of fallow land?
- 3) We know that according to the state government, fallow land is considered to be unproductive (Some people consider fallow land to be unproductive). *What do think about that?*
- 4) How would you prefer the fallow land to be utilized?
 - o What do you think would be needed to utilize the land in that way?
- 5) What do you think causes people to change the way they use fallow land?
- 6) We know that in Emplanjau they have a support scheme by the government for rambutan. We have not heard about any schemes here. *What is your opinion about government support schemes? What do you think it would mean for Kara Atas?*
- 7) Land development might result to that there is less natural resources around for you to use. What do you think about that?
- 8) We have noticed that a lot of people are leaving Kara Atas for work and is not staying here full time. What is your opinion on this?
- 9) There is a large fallow land close to the powerlines. *Can you tell us about its history (How long has it been fallow? What has been the use of it?)*
- 10) We have heard that there has been talks to cultivate palm oil on the land. However, we also know that the MSPO want to stop the planting of palm oil on peatland. *What do you think about that?*
 - o The MSPO is the Malaysian Sustainable Palm Oil, which is a certification scheme for Malaysia for small-scale palm oil production. The government supports the work of MSPO and MSPO can sent out warnings of fines for uncertified palm oil producers.
- 11) From being here the past couple of days, we have noticed there is a large fallow area behind the longhouse. *Can you tell us about its history (How long has it been fallow? What has the use of it?)*
- 12) We have heard that the local MP have suggested to plant coffee in this area. Have you heard about it and what is your opinion on that?

13) What are your expectations for future land use in Kara Atas?

Appendix VIII: Livelihood ranking

Categories of the livelihood

- Rows
 - Income (cash) / Penatai pemisi
 - Expenditure (how costly) / Perbelanjaan
 - Own consumption / Uquesttai diguna. Kediri empu
 - Social value / Beduruk
 - Labour needs / Tenaga Kerja
 - Area needed / Pemesai Tanah
 - Household dependence / Kebergantungan ke penatai pengisi nya
- Columns
 - Palm oil (smallholder) / kelapa Sawit
 - Pepper / Lada
 - Swamp Paddy / Padi paya
 - Hill Paddy / padi Bukit
 - Rubber / Getah
 - Durian / Buah Rian
 - Other fruits / Buah lain – lain
 - Fishing / Nginti
 - Hunting / Ngasu
 - Forest products / Hasil hutan
 - Pension / pencen
 - Handcrafts / Kraftangan
 - Remittance / Duit diberi – bala anak – anak udah bekerja
 - Wage jobe / Gaji Ari

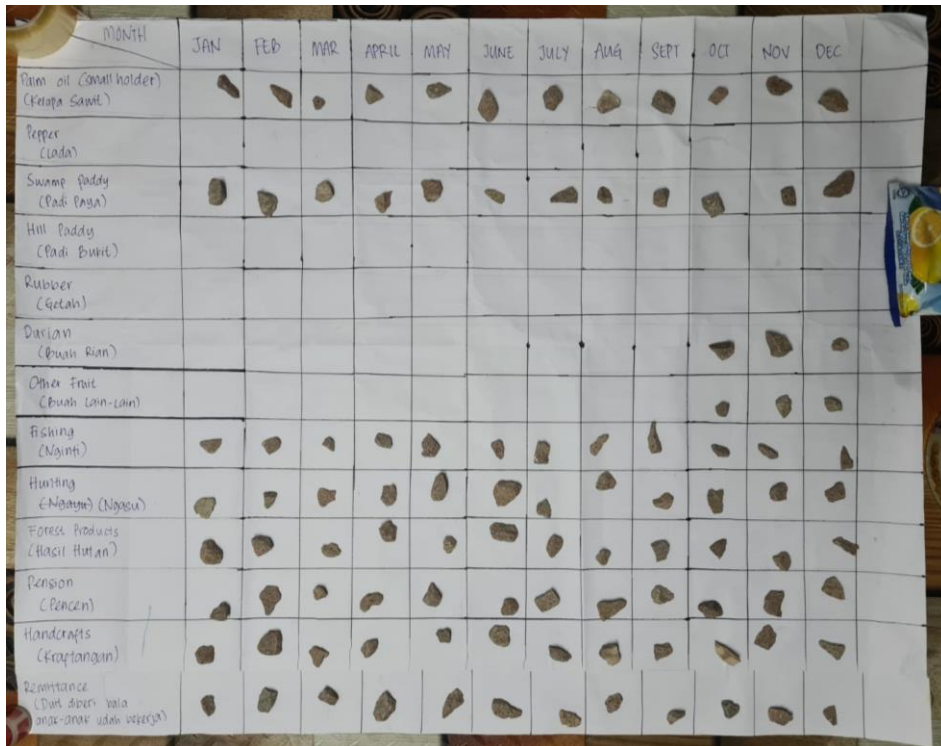
	Palm Oil / (Smallholder) Kelapa Sawit	Pepper / Lada	Swamp Paddy / Padi Paya	Hill Paddy / Padi Bukit	Rubber / Getah	Durian / Buah Rian	Other Fruits / Buah Lain-lain	Fishing / Ngenti	Hunting / Ngsar	Forest Products / Hasil Hutan	Banana / Pisang	Handicrafts / Kerajinan	Remittance / Duit diberi bala anak-anak udah bekerja	Wage job / Gaji An
Income (cash) / Penatai pomisi	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Expenditure (how costly) / Perbelanjaan	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Own consumption / Utai diguna kediri empu	0	0	2	0	0	1	1	0	0	2	2	2	1	2
Social value / Beduruk	0	0	3	0	0	1	1	0	0	2	2	2	1	2
Labour needs / Tenaga Kerja	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Area needed / Pemesai Tanah	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Household dependence / Kebergantungan ke penatai pengisi nya	2	0	3	0	0	1	1	0	0	2	2	2	1	2

Livelihood ranking for women.

	Palm Oil / (Smallholder) Kelapa Sawit	Pepper / Lada	Swamp Paddy / Padi Paya	Hill Paddy / Padi Bukit	Rubber / Getah	Durian / Buah Rian	Other Fruits / Buah Lain-lain	Fishing / Ngenti	Hunting / Ngsar	Forest Products / Hasil Hutan	Banana / Pisang	Handicrafts / Kerajinan	Remittance / Duit diberi bala anak-anak udah bekerja	Wage job / Gaji An
Income (cash) / Penatai pomisi	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Expenditure (how costly) / Perbelanjaan	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Own consumption / Utai diguna kediri empu	0	0	2	0	0	1	1	0	0	2	2	2	1	2
Social value / Beduruk	0	0	3	0	0	1	1	0	0	2	2	2	1	2
Labour needs / Tenaga Kerja	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Area needed / Pemesai Tanah	2	0	3	0	0	1	1	0	0	2	2	2	1	2
Household dependence / Kebergantungan ke penatai pengisi nya	2	0	3	0	0	1	1	0	0	2	2	2	1	2

Livelihood ranking for men.

Appendix IX: Seasonal calendar



Seasonal calendar for women.



Seasonal calendar for men.