Land-use Changes in Sarawak, Malaysian Borneo

A case study in Tanjung Udol

Interdisciplinary Land Use and Natural Resource Management (ILUNRM)
2019

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Submission date: 05.04.2019
Word Count: 9931

Abstract

Sarawak has seen a significant agricultural transformation over the last decades. This study touches upon that transformation in the context of Tanjung Udol; an Iban village in Sarawak. An interdisciplinary field study was conducted to assess how land is used in terms of land cultivation and livelihood strategies and how it has changed over the last decades. It investigates the proximate and underlying drivers and consequences of land-use change in Udol, through a number of PRA methods, focus groups, semi-structured interviews and natural science tests for environmental consequences. Both the LUCC programme's systematic approach to the identification of drivers behind land-use change and the sustainable livelihood framework have guided the analysis and discussion of the collected data. The findings indicate that the construction of the road, the different agricultural strategies, migration patterns, and agricultural support schemes are among the proximate drivers of land-use change in Udol. Underlying forces such as land policies, the state's perception of 'waste land', national development plans, and cash crop are feeding into those direct actions at the ground as underlying driving forces. Consequences of these changes are manifested as an increase in the community level wealth disparity along with a labour migration towards the cities. This paper aims to explain how this community has benefitted from land use change with respect to four major cash crops - OP, rubber, pepper, and rambutan, as well as what environmental consequences the shift might have.

Keywords: Iban, Land-use changes, Rural livelihoods, LUCC, Migration, Insect Ecology, Borneo, Sarawak, Malaysia, Oil Palm, Pepper.

Acknowledgements

The field-based part of the course was a collaboration between the University of Malaysia Sarawak (UNIMAS), Roskilde University and University of Copenhagen. The inputs and efforts of lecturers from the UNIMAS, University of Copenhagen and Roskilde University are highly appreciated, especially the support from Kelvin Egay John (UNIMAS), and from our supervisors Torben Birch-Thomsen (KU) and Kristine Juul (RUC).

Secondly, and most importantly, we would like to thank all the community members of Tanjung Udol for their kindness and hospitality, and for sharing their knowledge and spending time with us. They freely contributed to the information in this report, and their contribution and support is acknowledged and much appreciated. Especially, we would like to thank Aunty Ulas and Justin for hosting us in their homes, and Richard for serving endless amounts of Milo, tea and delicious snacks.

Furthermore, we highly appreciate the work done by our two interpreters, Grace and Katherine. We enjoyed working with the two of them and collaborating with our Malaysian counterparts from UNIMAS.

Thank you.

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List of Abbreviations

EOI: Export Oriented Industrialization

ISI: Import Substitution Industrialization

FFB: Fresh Fruit Bunch

MPOB : Malaysian Palm Oil Board

YB: "Yang Berhormat" (members of parliament and state legislative assembly men)

LUCC: Land use and land cover change

NTFP's: Non-timber forest products

OP: Oil palm

SLF: Sustainable Livelihoods Framework

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1. Introduction

Sarawak has seen a significant agricultural transformation over the last decades with the emergence of logging, cash crops, large OP plantations and other land development plans, which has influenced the land-use choices available to smallholders and consequently their land-use (Mertz *et al.* 2008). This report presents and discusses the findings from our field study conducted in Tanjung Udol, a longhouse community in the Julau District of Sarawak in March 2019. It will first introduce the relevant background and previous studies necessary for understanding the context of the study. That is followed by a brief introduction to the study site and the guiding research questions. Chapter 2 introduces the theoretical framework and concepts which we rely on for the analysis and discussion of the findings. Following this, the methods used and the challenges and ethical considerations will be discussed leading to a thematic presentation and analysis of the findings. Lastly, these will be discussed to assess the proximate and underlying driving forces behind the land-use changes, and the consequences here-off.

1.1 Economic development in Sarawak

Since its independence in 1963, the Malaysian government has operated through a system of centralized economic development consolidated in 5-year economic development plans (Abdullah & Hezri 2008; Akhir *et al.* 2013). The plans have since the first one in 1966 emphasized rapid, inclusive growth through various stages of Import Substitution Industrialization and Export Oriented Industrial (EOI) strategies. EOI strategies were first centered around exporting raw materials, such as rubber and palm oil. Later on, focus changed to promoting the export of manufactured goods to increase export revenue. While raw materials still make up a significant part of Malaysia's total exports, it has been overshadowed by manufactured goods, such as electronics, electrical equipment and machinery. Nonetheless, almost a third are still employed in the agricultural sector (Abdullah & Hezri 2008; Koen 2017; Department of Statistics 2019).

While both the strategies of ISI and EOI have had noteworthy effects on the landscape of Malaysia, the first stage of EOI (1968-1980) has been the most significant. As mentioned, this period was centered around increasing the exportation of raw materials, which was done by turning forests into agricultural land (Abdullah & Hezri 2008). The New Economic Policy (NEP) of 1971 accelerated this process significantly. The NEP was designed specifically to increase national unity after the 1969 racial riots. It emphasized eradicating poverty through rural development, where most of the

impoverished ethnicities resided, with massive effects on the landscape of the remoter regions, such as Sarawak (Abdullah & Hezri 2008; Koen 2017).

Sarawak's agricultural sector is today dominated by private plantations rather than smallholders (Cramb & Sujang 2013). This is seen primarily with oil palm as it is the cash crop of choice for large scale cultivation. The introduction of the Land Code Amendment Bill of 2000 exacerbated the problem as it allowed the government to repurpose large areas of fallow farmland into private plantations (Fox *et al.* 2009).

Indigenous peoples' land in Sarawak is referred to as *Native Customary Rights Land* (NCR) and is held under customary rights, which was obtained by clearing forest. New NCR land can only be acquired if the government issues permits. Much of this land, however, is targeted by the government for development purposes, and can be taken over if the the specific land is deemed "unproductive" (Hew 2011). Nonetheless, in spite of having operated in a political environment generally not in their favor, smallholder ownership and production of OP has increased from 9000 ha in 2001 to 36,000 in 2009 (Cramb & Sujang 2013). The district of Julau is a prime example of this, which can be explained through a juxtaposition of terrain, lack of infrastructure, and anxiety from stakeholders regarding land loss (Cramb & Sujang 2011; Cooke 2012). Additionally, the Sarawakian government seems to increasingly support smallholders as actors of development. This is primarily seen by the offering of agricultural support schemes that focus on cash crops, such as OP, rubber, pepper and fruit trees. The commodification and introduction of the smallholders into the supply chain has been widely advocated as a poverty reduction strategy by the World Bank (2007). It is also a key point in the previous Malaysian Development Plan, which, among other things, emphasizes *"encouraging good agricultural practices, agronomic management and mechanization especially among smallholders*" (Gov.ma 2010, p. 124). Smallholders are therefore set to play an increasingly bigger part in the agricultural development of Sarawak.

1.2 Study Site

The field work was carried out in the longhouse community of Udol (figure 1.1), which is located approximately 50 kilometres south of Sibu within the province of Sarawak in Malaysia. This community consists of 27 households, where the majority of the inhabitants are cultivating pepper, rubber, and OP. The agricultural activities are complemented by the collection of non-timber forest products (NTFPs) and fishing/hunting activities within the surrounding environment as both income and food sources. Udol is located in a river valley and has sloping hills, which the community has historically used for hill rice but now utilises for a plethora of crops.

Figure 1.1: Drone picture showing the longhouse and surroundings

1.3 Significance

Land-use changes are a central issue in debates related to sustainable development and the challenge of how to best combine socio-economic development goals and environmentally sustainable land management (Lambin & Meyfroidt 2011). It is important in the context of anthropogenically driven environmental degradation, however the various drivers behind it is not yet fully understood (e.g. Ostwald *et al.* 2009; Soda *et al*. 2016). Therefore, it is important to gain a better understanding of the many interrelated drivers behind land-use change and how they interact, as it can add to the scientific basis for how to design actions that enhance the contribution of terrestrial ecosystems to human well-being without undermining these vital ecosystems' long-term productivity (MEA 2005, p. 26). Understanding such factors is important to the design of interventions that lead to positive impacts on the environment and minimize negative impacts (MEA 2005, p. 85).

1.4 Research Questions & Objectives

The overall objective of this study is *to assess what drivers are behind the land-use changes in Tanjung Udol, and what environmental and socio-economic consequences it might have*. This has resulted in the following two research questions and sub-questions:

1. What are the drivers behind land-use change in Tanjung Udol?

a. What are the proximate causes of the land-use changes in Udol?

b. What are the underlying driving forces behind land-use changes in Udol?b

2. What are the consequences of the land-use changes in Tanjung Udol?

a. What are the environmental consequences of the land-use changes?

b. What are the socio-economic consequences of the land-use changes?

2. Theoretical & Conceptual Frameworks

For this study, we follow a general understanding of *land-use* as being characterised by "*the arrangements, activities and inputs by people to produce, change, or maintain a certain land cover type"* (Di Gregorio & Jansen 2005, p. 3). This refers to the use of land by humans for the various functions and services it provides, which establishes a direct link between land cover and people's use of their environment.To discuss the drivers behind the land-use changes, we rely on the land use and land cover change (LUCC) programme's systematic approach to the classification of drivers behind land-use changes. This framework, and our use of it, will be explained below. Furthermore, the Sustainable Livelihoods Analysis Framework will be explained, as it informs our general understandings of households, livelihoods and decision-making at household-level in relation to land-use.

2.1 Proximate Causes & Underlying Driving Forces of Land-use Change

It is increasingly recognised that land-use change is driven by a multitude of interrelated factors and forces at different scales, and that single factor explanations at household-level are inadequate for discussing land-use change (Ostwald *et al.* 2009). To overcome the challenge and complexity of drivers at different scales, this study follows the LUCC programme's systematic approach to the classification of drivers behind land-use changes. The LUCC programme suggests to distinguish between proximate causes and underlying driving forces, and the interactions between the drivers at different scales (Mertz *et al.* 2008).

The approach of the LUCC programme has previously been employed for analysing drivers behind land-use change for desertification (Geist & Lambin 2004), tropical agriculture (Keys & McConnell 2005), small-holder farming (Ostwald *et al.* 2009), and for deforestation (Geist & Lambin 2002). Their understanding of proximate causes and underlying driving forces will be used in our analysis to assess and analyse the two different classes of drivers behind land-use changes in Udol.

Proximate Causes are immediate actions at the local level with direct impact on land cover and land-use. In order to explain these factors, it is essential to assess and understand the *underlying driving forces*, which are broader societal trends and processes, such as demographic factors, cultural factors, policy/institutional factors, economic factors and technological factors, which feed into the

proximate causes (Geist & Lambin 2002; Ostwald *et al*. 2009). These factors and decisions at the proximate and the underlying level interact and are mutually responsive (Geist & Lambin 2002). As in the study of Ostwald *et al.* (2009), the word 'causes' will from here on be used to describe direct explanations for land-use change, while 'underlying forces' will be used to describe the more indirect societal reasons. The two words 'factors' and 'drivers' will be used interchangeably as general terms for describing anything leading to land-use change.

2.2 Sustainable Livelihoods Framework

In addition to the LUCC programmes' approach to analysing drivers of land-use changes, our study also rely on concepts and ideas presented in the Sustainable Livelihoods Framework (SLF) (Ellis 2000). It follows Chambers & Conway (1992)'s understanding of 'livelihoods' as being comprised of the capabilities, assets, and options that people possess and put into use to pursue income generating and/or life-supporting activities (Ellis 2000). SLF encourages an analysis of how the five livelihood capitals (financial, human, social, natural and physical capital) are used by individuals/households to follow certain strategies leading to particular outcomes. This all occurs in the context of trends and shocks, modified by institutions and social structures in society. Figure 2.1 depicts the different components of the framework and how they relate to each other.

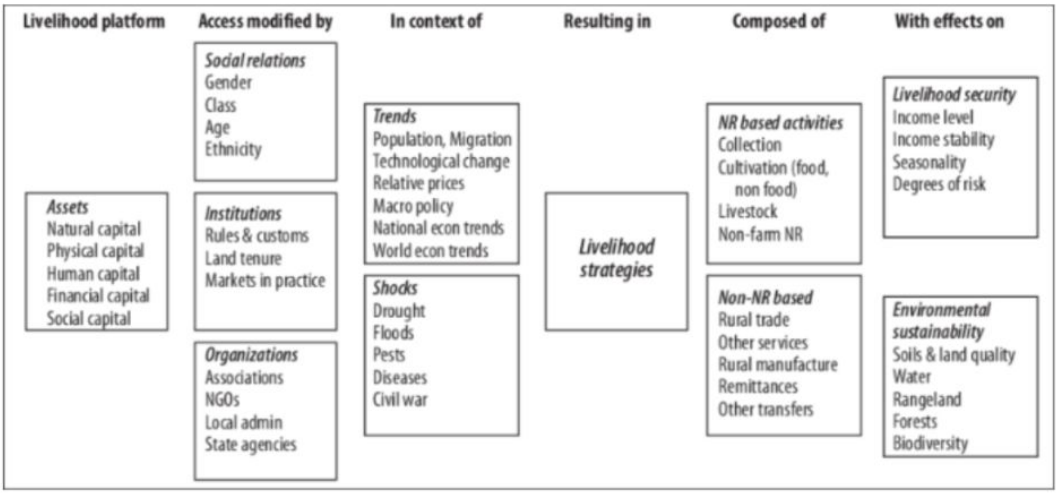


Figure 2.1: Sustainable Livelihoods Framework (Ellis 2000)

Although SLF was not specifically designed for understanding land-use decisions, it has been widely used in studies of rural communities to understand household level decision-making and livelihood outcomes (Mertz *et al.* 2008). It provides a useful conceptual and analytical lense for understanding how the households' broader livelihood strategies in Udol relate to their land-use over the last

decades. In that way, our analysis is not strictly following the SLF, but the framework provides a general understanding of rural livelihoods which has informed our understanding of household level factors that have influenced the land-use changes.

3. Methodology

The study is an interdisciplinary case study. This chapter will explain the methods used and limitations faced when carrying out the respective methods.

3.1 PRA: timeline, ranking, mapping, seasonal calendar

Participatory Rural Appraisal (PRA) is a set of qualitative, participatory methods. The approach is to have a number of villagers share their opinions and insights through activities. As most people were away during the day, the methods were done in the evening.

3.1.1 Timeline

Three elders were asked to note down key events through their lifetime. These events were then used as a point of departure for a discussion on what significance each event had for their daily lives. The method was conducted early during the fieldwork to provide an overview of key topics for future discussions. However, placing it this early also had its disadvantages, as we were not accustomed to the translators and how the villagers perceive time.

3.1.2 Resource Mapping

The participants were asked to note down what they cultivate and to draw a map depicting where natural resources are within their community. This was an effective way in illustrating how they have structured their land and where the various resources are gathered and harvested. Through the method we identified OP, pepper, rubber and rambutan as the four major cash crops, which was used for various activities.

Figure 3.1: Resource Mapping

3.1.3 Crop Ranking

Four people were asked to rank the relative importance of the main cash crops for income generation, labour requirement, required inputs, road transport, soil suitability, and land size. This provided an overview of how the farmers value each crop. The ranking gave insights into the benefits and setbacks of each of the various crops and how they complement each other. It also helped us understand the farmers' decision-making processes.

Figure 3.2: Crop Ranking

3.1.4 Seasonal Calendar

This activity was carried out with the intention of understanding how the major crops complement each other throughout the year with respect to time of harvest, labour requirements, frequency of fertilization, and expenditures. We focused on the four major cash crops. However, a problem occurred: the participants chosen for the activity did not cultivate all four crops, but rather one crop each. We therefore got information for each crop separately, but not a comparison of the four crops. Nevertheless, it provided information about the associated seasonal tasks and improved our understanding of how the different crops complement each other.

3.1.5 Income Ranking

This exercise was conducted to investigate how income sources vary between households. Four community members listed all their income sources and then ranked them according to significance. The exercise and the included discussion showed us the significance of off-farm work, which led us to investigate this matter further in an interview.

3.2 Questionnaire

A questionnaire was created to acquire information about various topics at household level. The intention was to target one representative from each household, however only 22 out of 27 households were available. A trial questionnaire with one villager was conducted where both translators were present, as it was essential that they understood the questions. The trial was extremely valuable: for example, we found out that the villagers were not able to say how much land they have in acres or hectares. However, they all know the exact amounts of OP and pepper. Furthermore, the question of how many people there are in their household, was hard to answer, as there are different understandings of ‘household’. We edited our questionnaire according to these challenges.

After the edit, we had a team meeting where everyone was briefed on the potential pitfalls, the purpose of the questions, and how certain questions should be phrased. For example, we decided that the definition of a household will entail people having the household as their main residence, which includes those working abroad seasonally and any juveniles without their own apartment or house. It would not include people working and living abroad nor those only returning to the longhouse for traditional festivals.

Generally, surveys were conducted by one interviewer and a translator. After conducting the surveys we identified two major definitional issues:

Although we thought we had accounted for the issues related to ***the definition of a household,*** we realized that there had been some confusion around this based on the survey-answers. For example, some adults considered their children living in Bintulu and had their own family as a part of their household, or their children who had moved to a neighboring longhouse to still be part of the household.

Additionally, ***the difference between off-farm work and remittances*** was an issue. For example, some of the participants were under the impression that if the husband was working seasonally, the money he returned with was to be considered as remittances, while others did not.

3.3 Focus Group Discussions (FGD)

We conducted two focus group discussions: one with two elders and two adults (FGD1), and one with two younger men, who live and work outside the village (FGD2).

3.3.1 FGD1 - Adults & Elders

This FGD was conducted in order to learn how the older generations perceive migration and urbanization, and which consequences it will have for land-use, management practices and the longhouse in general. Key interests of ours were labour availability and whether increasingly relying on Indonesian guestworkers could be a potential solution.

A big issue in conducting the FGD was an inadequate inclusion of our Malaysian counterparts, which led to the Malaysian co-facilitator feeling left out. It sparked a strange dynamic, which took attention away from the conversation, leading to important comments not being followed up on. We managed to fix it halfway by better inclusion of their questions. The issue was remedied afterwards with the Malaysian co-facilitator.

3.3.2 FGD2 - Young Men

Originally, we sought to conduct a FGD with a mix of young people from the longhouse to compare the perceptions of migration, urbanization and farm work we got from the other FGD, because we wanted to represent both generations' perceptions of the transitions. However, since the young people left the longhouse after the first day, we conducted a small FGD with two young men working and living outside the village.

3.4 Transect Walks

Two transect walks were done with community members to determine plot sizes, choice of crops and the agricultural history of the area. It was beneficial for depicting where things were located through the marking of waypoints. The data was later imported into Google Earth to get an overview of the area, which is used in analysing the upcoming findings.

3.5 Participatory Observation

To better understand how villagers manage and farm their land, we participated in a variety of daily activities. OP has now become the main agricultural activity for most of the villagers, therefore we deemed it important to observe the management in practice. We went out with an older farmer, Empang, to help him fertilize OPs. Helping with the daily activities was a good opportunity to ask questions concerning land-use, agricultural management and the history of the area.

3.6 Semi-Structured Interviews (SSI)

We conducted three different semi-structured interviews. Informants were chosen based on their specific knowledge in a variety of fields which we needed further information about (table 3.1).

Table 3.1: Key informants for SSI

Informant	Reason for selection	Will be referred to as
Informant 1: Luyoh (Household #19)	Former headman. Was instrumental in developing relations with the political representative (YB) to Julau, which led the longhouse to getting the various schemes. His HH is also heavily invested in agriculture (has the most OP's) and has noone working outside the longhouse.	SSI1
Informant 2: Sarabi (Household #24)	Headman's wife. One of the biggest landowners in the longhouse.	SSI2
Informant 3: Ugan (Household #5)	The headman's uncle. Has been working offshore for decades.	SSI3

The biggest issue concerning our SSIs was that they were conducted in Iban and Malay, resulting in a loss of nuances, as it was often only the main points that were translated.

3.7 Soil Sampling

Five sites were identified based on land-use (OP, rubber, pepper, fruit, and forest) and four samples were taken from each site, which were then aggregated to create a single sample. The samples were taken back to UNIMAS for analysis.

3.8 Water Sampling

The water was tested for indicators of stream health at three sites. A test for ammoniacal nitrogen (NH4) was carried out to assess whether NO_3^- was present into the water as NO_3^- exhibits high levels of toxicity (WHO 2008). The chosen test sites were not in line with what we were aiming to test; however what was sampled is as follows. Site 1 was located within the reservoir the community currently uses. Site 2 was located after the OP fields, representing impact from OP activities. Site 3 was selected further downstream and was impacted by all agricultural activities. Because the first test was taken in the reservoir, it is difficult to compare it with sites 2 and 3 as a stagnant system is significantly different from one that is flowing.

3.9 MiniSASS (Stream Assessment Scoring System)

MiniSASS is based on the more comprehensive biomonitoring SASS system that was developed in South Africa to monitor river health. Both systems use the presence of macro-invertebrates to indicate the “river health”, however, where SASS contains over 90 different taxa, MiniSASS uses only 13 taxa, thus allowing for a simpler test. Each taxa has been assigned a sensitivity score, where the average score places the river in a certain ecological category (table 3.2 and table 3.3).

Table 3.2: The sensitivity scoring system used in MiniSASS (MiniSASS 2015)

GROUPS	SENSITIVITY SCORE
Flat worms	3
Worms	2
Leeches	2
Crabs or shrimps	6
Stoneflies	17
Minnow mayflies	5
Other mayflies	11
Damselflies	4
Dragonflies	6
Bugs or beetles	5
Caddisflies (cased & uncased)	9
True flies	2
Snails	4
TOTAL SCORE	
NUMBER OF GROUPS	
AVERAGE SCORE (miniSASS Score)	
Average Score = Total Score ÷ Number of groups	

Table 3.3: MiniSASS ecological categories based on the average sensitivity score (MiniSASS 2015)

Ecological category (Condition)		River Category	
		Sandy Type	Rocky Type
	NATURAL CONDITION (Unchanged/untouched – Blue)	> 6.9	> 7.2
	GOOD CONDITION (Few modifications – Green)	5.9 to 6.8	6.2 to 7.2
	FAIR CONDITION (Some modifications – Orange)	5.4 to 5.8	5.7 to 6.1
	POOR CONDITION (Lots of modifications – Red)	4.8 to 5.3	5.3 to 5.6
	VERY POOR CONDITION (Critically modified – Purple)	< 4.8	< 5.3

The point of using macroinvertebrates as an indicator is that the different taxa have different sensitivity to water quality conditions, thus the groups with the highest scores have the highest sensitivity to changes in the water quality (e.g. stoneflies). This means that a higher average score means better water quality. It is important to note that this test does not allow us to test for contamination by viruses and bacteria, which makes the test unfit for determining whether the water is potable. We used a homemade net, which consisted of a mosquito net attached to a basket.


Figure 3.3 & 3.4: The homemade net used for MiniSASS and Astrid examining the results carefully

It would have been more desirable to use a deeper and more compact net, as some of the macroinvertebrates might have escaped the net. Three sites were identified based on the surrounding land-use and practicalities. Each site was visited on two seperate days and we made approximately 15 sweeps at each site on each visit.

3.10 Insect Traps

Sites for the insect traps were identical to those of the soil samples. Each sample was collected after 72 hours. The insects caught were classified by order to demonstrate general diversity of the different sites. The insect traps were utilised as a proxy for ecosystem resilience within cash crop fields. Figure 3.5 shows the setup of the traps.

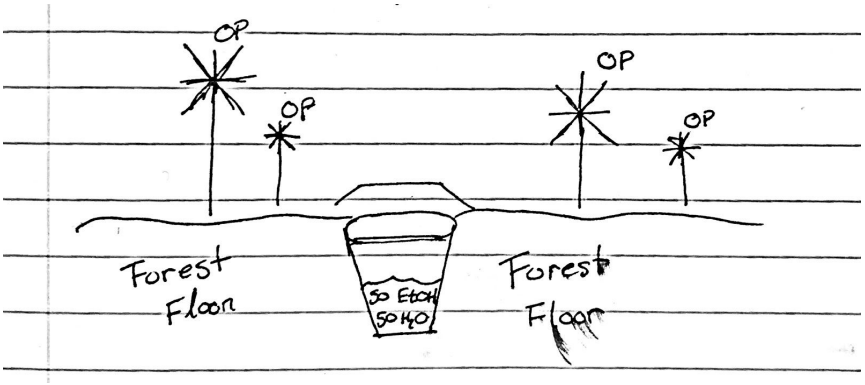


Figure 3.5: The insect trap design

The largest downfall to this method was the placement of a plate on top of the cup to prevent debris from falling into the cup. While this was very effective at preventing debris from entering the cup, it also could have hindered the entry of some insects into the trap, as the opening between the plate and the earth was perhaps too narrow. This could be explained by the fact that Bornean insect are significantly larger than those in temperate regions.

4. Challenges & Ethical Considerations

We faced several challenges and biases during the field work. While we have been trying to mitigate these to the best of our ability, they might have impacted our results.

4.1 Challenges

A major challenge was the language barrier that arose. To minimise linguistic misunderstandings, we discussed the aim and objective with the translators prior to the activities. Despite this, it was still challenging to communicate effectively with the community. Points might have been lost, as also mentioned in the methods section.

Furthermore, when working with a translator in an intercultural setting, it is important to consider that there are different mindsets embedded in language and as a result misunderstandings can easily occur. Each of the stakeholders involved might assign different meanings and understandings to particular words, such as ‘household’, ‘work’ and ‘environment’, as mentioned in the methods section as well. We tried to avoid this issue by having the interpreters explain us how the community members use the words. We became aware of these issues after several household surveys were conducted, which should be considered when dealing with the household data.

As we were only in the community for 12 days we have to consider whether the everyday life that we observed in the longhouse was a realistic depiction of the actual everyday life, or if it was adjusted due to our presence. This challenge relates what Chambers (2008) refers to as *diplomatic bias*, where urban and foreign visitors are not made privy to the intra-community conflicts or inequalities in wealth, as these can be hidden during the short stay (Chambers 2008, p. 38). We witnessed almost no conflicts within the community during our stay, which leads us to consider this bias, as there will almost always be some form of intra-community conflicts or differences. This was kept in mind while analysing our data in order to avoid misrepresenting the community as being a homogeneous group with equal opportunities. Furthermore, as Scheyvens (2014) discusses, being guests of the headman may have influenced the information we got from other community members and our interpretation of the community as a whole.

Udol is a small community, which means that some of the community members participated in several of the activities, which led to two separate issues. Firstly, since some participated more, their voices were heard more than others and are therefore overrepresented in our data. Secondly, the small size of the community meant that after those willing to participate had been involved in several activities, they naturally started to be less inclined to participate. For this reason, we had a considerably smaller pool of participants to choose from during the last days. Furthermore, we have to consider that since the community members are close, both spatially and personally, they might be hesitant to share their opinions when getting interviewed in the common space. We tried to mitigate this challenge by conducting some of the interviews in privacy.

4.2 Ethical Considerations

The first ethical consideration relates to to the duration of a stay, as we only spent 12 days in the village, which is too short to undertake research on which we can make recommendations and suggest solutions for issues raised by the farmers. Furthermore, it was important for us to clarify that we were there to learn from them and that we are not experts. These factors made it problematic for us to provide any recommendations as they would not be grounded in sufficient data nor an adequate understanding of the local context. However, among some community members there seemed to be a misunderstanding of the purpose of our stay, our role, and whether we would be able to 'help' with any of the problems they faced. It is difficult to know exactly what led to that misunderstanding, however, it is regrettable if anyone in Udol was under the impression that we were there to identify solutions to their problems. That feeds into the issue of informed consent, since if some were under the impression that we were there to 'help', it could have influenced the terms of their agreement to participate. Some might consider it necessary or more interesting to participate in research that their community could potentially benefit from (Sanjari *et al. 2014*). We tried to make it clear that participation was entirely voluntary, however, it is hard to fully know if their participation was truly voluntary and whether our presence was desired by the entire community. This could have influenced our data in terms of what information they chose to share, but more importantly, it can affect their experience of our presence.

5. Findings

This chapter will present our general findings in relation to land-use changes in Udol. The findings will be presented thematically based on the following themes: (1) the past decades in Udol, (2) land-use and farming, (3) migration patterns, (4) socio-economic consequences, and (5) environmental consequences.

5.1 The Past Decades

The timeline (figure 5.1) is based on the PRA activity *Timeline,* and is presented in order to get a brief overview of the past thirty years in Udol. It is a good starting point for understanding what the community perceives as important events during the last decades.

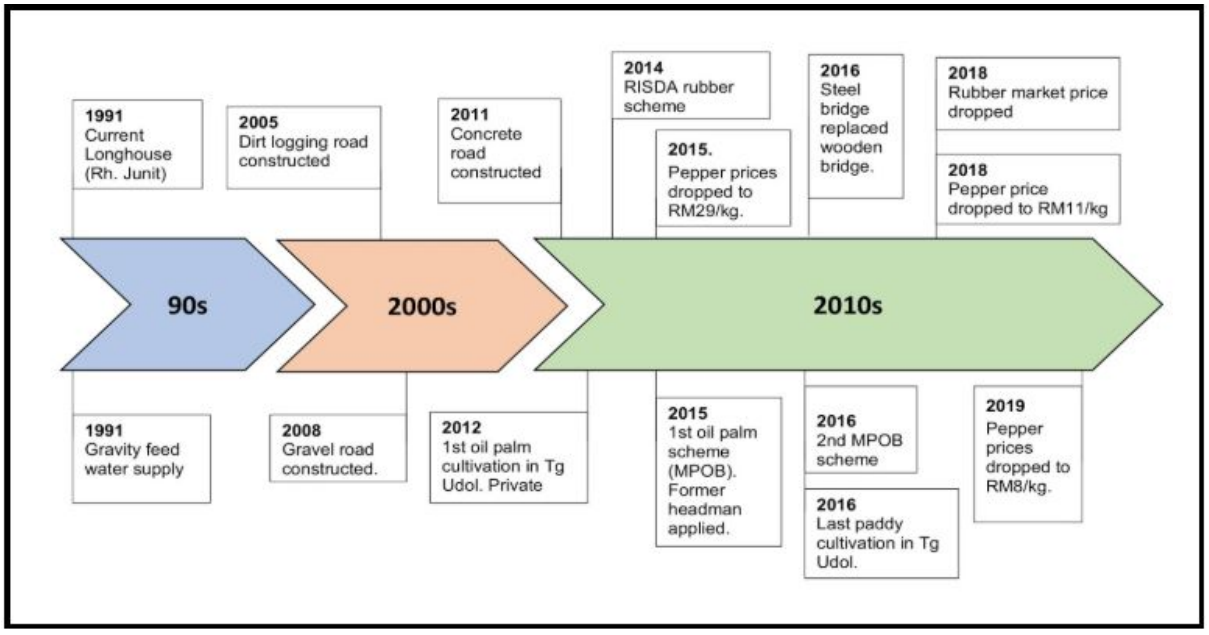


Figure 5.1. Timeline showing important events in Udol.

The information in the timeline is triangulated through informal conversations, the focus groups, and individual interviews. It portrays various events starting from 1991 when the community moved to the current location. The participants were encouraged to think further back, however, this proved difficult: *Timeline* was one of the first exercises during the field work, and in the following days we learned that their idea of time and history is less stringent than ours, which complicated questions about time. We tried to change how we formulated the questions, and we experienced that time-related questions worked better if we first made the participants identify an event, and then used

that as a point of departure for the further discussion. Knowing this already during the *Timeline* could potentially have led to a more fulfilling timeline with information dating further back.

One of the events emphasised in the timeline is the drop in market prices of rubber and pepper. The participants explained that it influenced the potential economic gains from these crops and thus their cultivation strategy related to those crops the following years. It also encouraged interest in the OP scheme. The drop in market prices was a returning topic throughout many of the PRA activities and interviews which indicates the importance of these prices for their livelihoods after they started cultivating pepper and rubber.

The timeline shows that receiving several agricultural schemes and the improvement of the road were important events for them. During the activity the participants explained the agricultural schemes and how each of them works (summarized in table 5.1).

Table 5.1: Agricultural Support Schemes

The Schemes	From	explanation	Times received
Rubber Scheme	RISDA *Rubber Industry Smallholder Development Authority*	Farmers "rent" out land for 5 years - trees are planted and managed. land returned to farmer after 5 years	1 time
Oil palm scheme	MPOB *Malaysian Palm Oil Board*	contractor clears and prepares land seedlings provided by MPOB farmers receives free fertilizer three times.	2 times, and have now applied for third scheme.

The community members explained that in practice it is the individual farmer, that applies and receives the different schemes. However, in Udol, the community normally collect the individual application letters and apply collectively through the *YB*, the local politician elected for the area to represent them.

5.2 Land-use & Cultivation

To be able to describe and understand the land-use, we investigated both what kind of crops they farm, the reasons behind their choices of crops, and the spatial placement of the different crops.

5.2.1 Crops Grown

We found that the aforementioned agricultural schemes have been an influential factor in their land-use. Rubber and OP are among the dominant crops in the local landscape, alongside pepper and patches of fruit trees. We realised this during our early field walks and through the exercise *Resource Mapping*. Before leaving Denmark, we anticipated OP to dominate the landscape due to the MPOB schemes and the drop in market prices for rubber and pepper. However, upon arrival, we learned that while there has indeed been a shift towards small-scale OP cultivation, they also cultivate a variety of other crops and fruit trees in the community. Figure 5.2 is based on the survey-data and it shows that out of the 22 responding households, almost everyone currently cultivate the following:

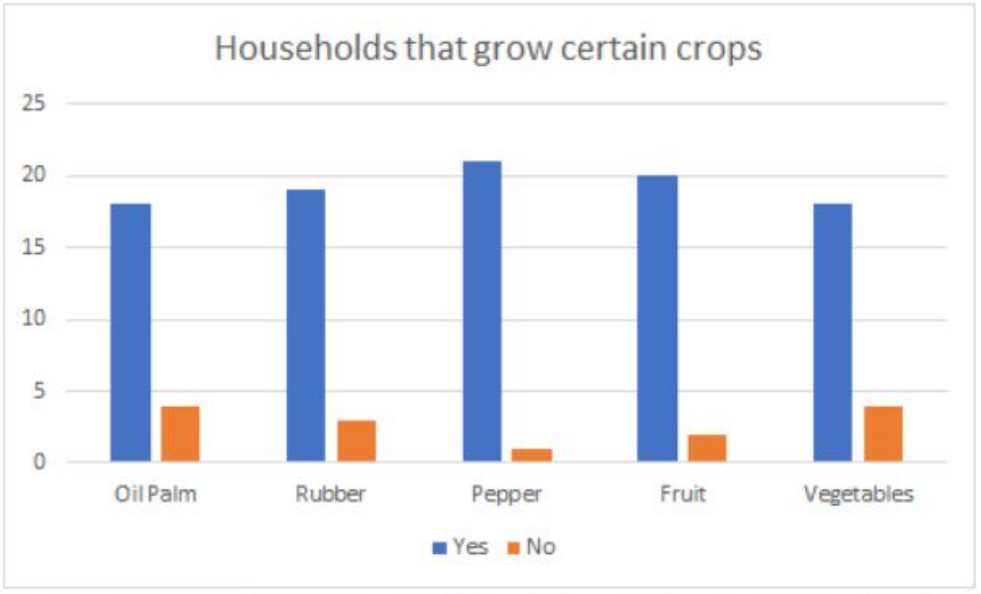


Figure 5.2: Graph showing how many households cultivate OP, rubber, pepper, fruit and vegetables. The information was obtained through the questionnaire. N = 22

With respect to the use of the major crops, figure 5.3 shows how vegetables are grown primarily for home consumption, fruit trees are grown for seasonal income (and to some extent for own consumption), and that OP, rubber and pepper are all cultivated primarily for income.

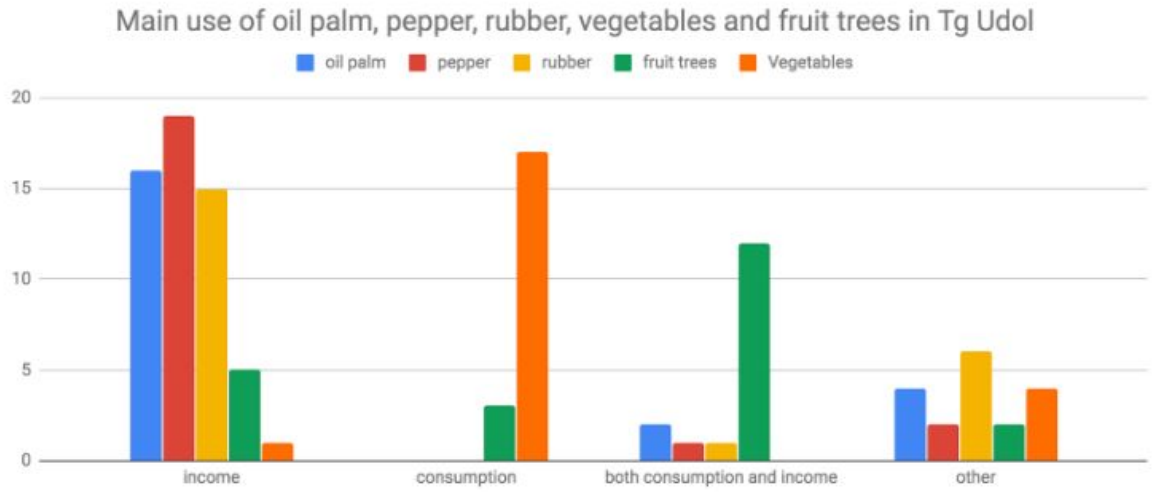


Figure 5.3: Main use of OP, pepper, rubber, vegetables and fruit trees among the households in Udol. N = 22, The information is obtained from the survey.

A few of the respondents have answered 'other' as their reason for cultivating rubber. Through follow up questions during informal conversations, we learned that it is because they do not tap rubber regularly these days due to the low market prices. Therefore, while the purpose of cultivating rubber generally is income, it is not perceived as an income source at the moment. In the *Crop Ranking*, the participants explained that rubber is kept and can be tapped if extra cash-income is needed, but otherwise they save it in case of better market prices in the future.

We further investigated the land-use through the exercise *Resource Mapping.* First, the participants made a list of all the crops and trees currently grown (figure 5.4), which amounted to a total of 54 crops, vegetables and fruit tree varieties. That gives a different picture than the survey, since the survey had the broad categories 'fruit trees' and 'vegetables'.

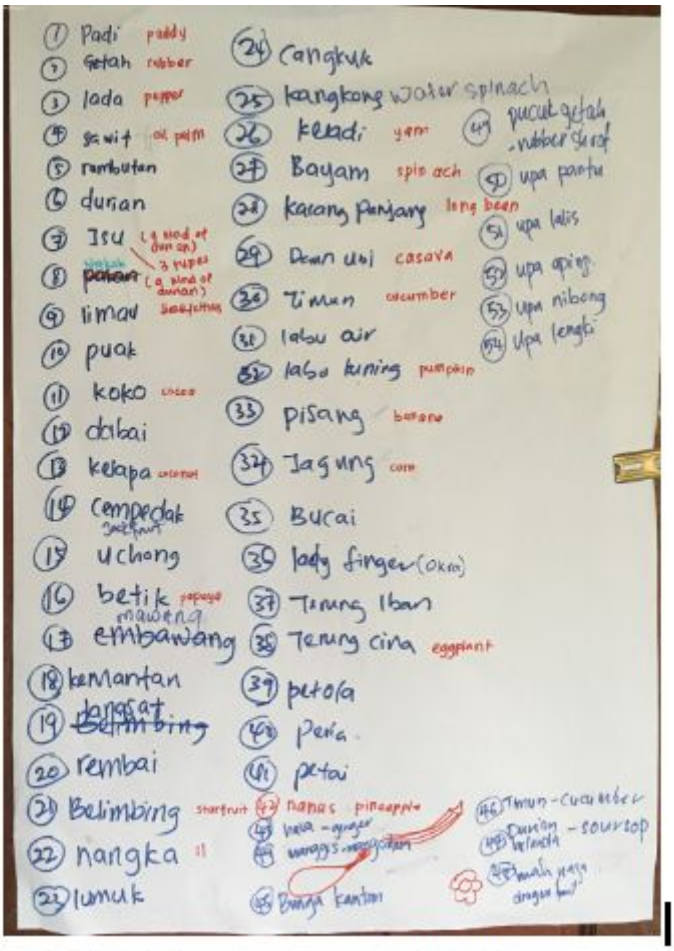


Figure 5.4: List of crops as a result of PRA Resource mapping

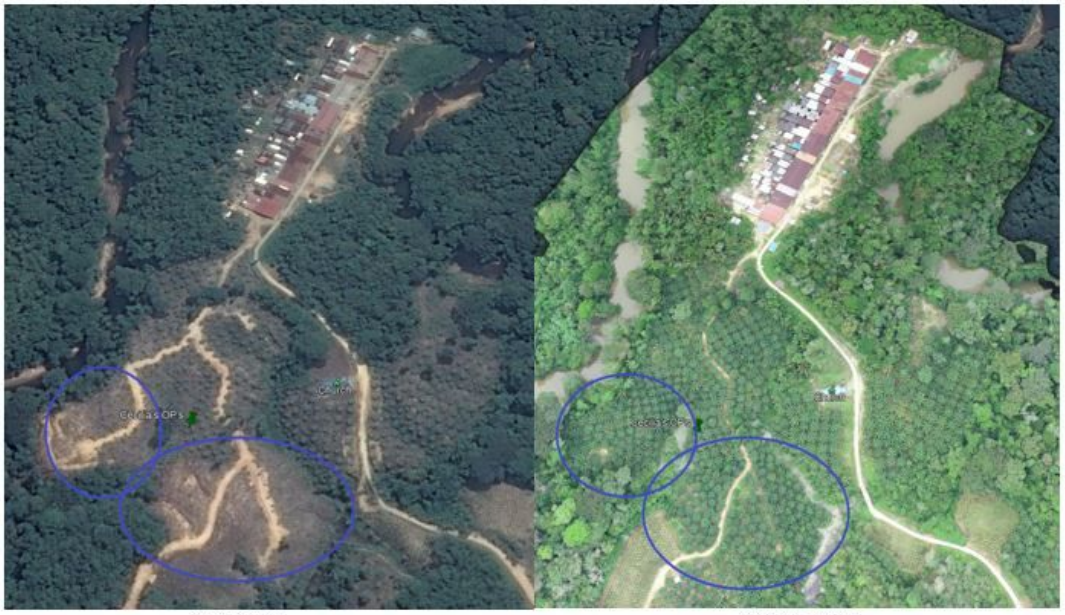
When comparing the survey-answers and the list of crops, we noticed that rice (*padi*) and cocoa (*koko*) are included in the list, in spite of them not cultivating them. This could be due to a misunderstanding about whether they were supposed to list what is currently being cultivated or also what has previously been cultivated. We must therefore consider whether all of the other vegetables and fruits mentioned in the list are actually still cultivated. Furthermore, it is unclear whether some of them are NTFPs, which are not cultivated but foraged. It would have been interesting to investigate this further, but we did not notice the issue while being in the field. However, during field walks we noticed several of the fruit trees and vegetables mentioned in the list, including cassava, banana, pumpkin, and papaya.

Although the land-use in Udol is currently cash crop dominated, subsistence agriculture is still happening. It would have been interesting to look into this, as one could expect that different income levels among households would be associated with different levels of reliance on subsistence agriculture and foraging as safety nets in their livelihood activities. Unfortunately, we do not have the necessary income data and household activity data to look further into it. However, during our field

walks we got familiar with some of the farmers and got an insight into their respective agricultural strategies. Spotlight#1 is an example of one of these households, which indicates that at household-level, their land-use decisions relate to many factors, including their income-portfolio, whether they have off-farm income, their assets and general situation.

Spotlight #1 *Celia – maintaining OP from a distance*

Cecilia was one of the first to cultivate with oil palm. She has an oil palm field adjacent to the longhouse (see pictures). The field is flat, which makes it ideal for both rubber and OP. This field used to be planted with rubber trees - Cecilia is thus one of the only villagers to replant her rubber field with oil palms. Interestingly, more than half of the OPs seem to have been planted before the first MPOB scheme in 2014, as evident by the Google Earth satellite photo from 2014. Although the picture is grainy, one can see that the trees above the circles are more mature than the seedlings planted by MPOB in that year (within the circles). In the picture from 2019 we see how the 300 seedlings from the MPOB have matured to similar size of her previously existing oil palms above the circles.



July 2014 *March 2019*

During the field walk we were told that the decision to replace the rubber field with oil palm was manifold. Secondly, prices - she early realized how much money OP generates despite relatively lower labor requirements than e.g. pepper. Secondly, the plot's proximity to the road eases transportation of the fresh fruit bunches, making it ideal for OP cultivation.

Cecilia herself lives and works in Kuala Lumpur, however, she keeps these fields which are harvested by Indonesian workers. She is relatively well of financially, and with her contacts and income she constitutes one of community members from Udol, who are benefitting from off-farm job opportunities. Despite living away from the long-house, she is part of a *bilek* so in that sense she is still considered a part of longhouse. This multi-locality reality of many of the households is what complicates the idea of a 'household", and something that affects how land is kept and managed - and by whom.

Land Rights and Agriculture

As mentioned in the background section, there are different categories of land in Malaysia. The land in Udol is all characterized as *Native Customary Land*. If the farmers do not cultivate the land, the government can claim it, and although they have in fact never experienced this in Udol, several of the community members expressed concerns about this, as in the quote below from our interview with Ugang - a community member working offshore but owns farming land in Udol as well.

"I plant something in my land just so the land belong to
me if I plant nothing there maybe the government take it (...)if there
is nothing in the land the government maybe take it so I plant some fruits
or something else to show that the land is mine "
(SSI3)

Spotlight#2, when compared to spotlight#1, is another example of how livelihood strategies and land-management within the longhouse differ depending on their capitals and composition of activities, and how both fear of losing land, off-farm work and migration is a part of these strategies and directly affect the land-use and land-management.

Spotlight #2 *Junit & his son Jack – OP turning into secondary forest*

Like Cecilia, Junit is also a pioneer in oil palm cultivation. Junit is the "headman of the region", the *Penghulu*, which is a level above the headman of the long house. Junit has four sons, who all work and live outside the longhouse but also own land in Tg Udol. However, contrary to Cecilia, they do not maintain their oil palm fields to the same degree. Below is a picture taken of two oil palm fields. One belongs to the former headman Luyoh and the other belongs to Junit's son Jack.

As we can see, while Luyoh's field is weeded and managed, Jack's is almost completely overgrown. While we saw that this was a common phenomenon for the rubber fields, it was the only oil palm field which looked like this. One might ask why he does not sell the land.

For Junit's son Jack, simply having OPs on the land means it is still cultivated and thus active, meaning it is not in jeopardy of being taken by the state. His income from off farm work allows him to not be dependent on working the land. Furthermore, him being the *Penghulu's* son might mean that he is expected to have land in the area.

5.2.2. The Road & Agriculture

After listing crops grown, the participants in *Resource Mapping* drew the actual resource map, depicting their fields and land-use (figure 5.5). They first drew the long-house and the road, and then the fields along the road. The participants informed us that the whole area was used for rice cultivation before, however, as the map shows, OP, pepper, and rubber are now the most cultivated plants along the road with fields and patches of fruit trees, and some secondary forest in between. They explained that the road is important because it facilitates access to these cash crops with respect to harvest and day to day management.

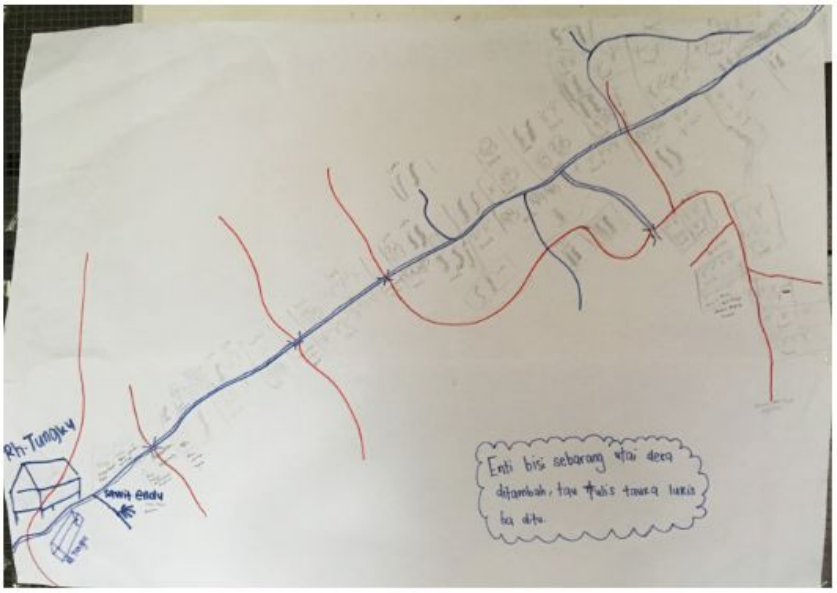


Figure 5.5: Resource Map. The blue line is the road, the red lines are the rivers and the pencil lines are the outlining fields of OP, rubber, pepper, fruit trees, and fallow land along the road.

Based on the resource map, we identified different areas for transect walks to gain a better understanding of the land-use. Figure 5.6 is a satellite map showing the fields we went to during the field walks. The two brown land areas marked with "OP" markers used to be secondary forest which was cleared and planted with oil palms by the MPOB. One might wonder why the area adjacent to the OP fields is planted with pepper and not OP. This is due to the elevation of these fields. We were told during the transect walk that in order to minimize erosion, OP should not be planted on slopes steeper than 25°. This suggests that land topography is a determining factor for whether a village is suitable for agricultural schemes. Interestingly, the white mark at the top of map shows an unused field. It is owned by the headman's wife's sister, who lives in Kuala Lumpur. She has not cultivated the land for years, but still keeps it.

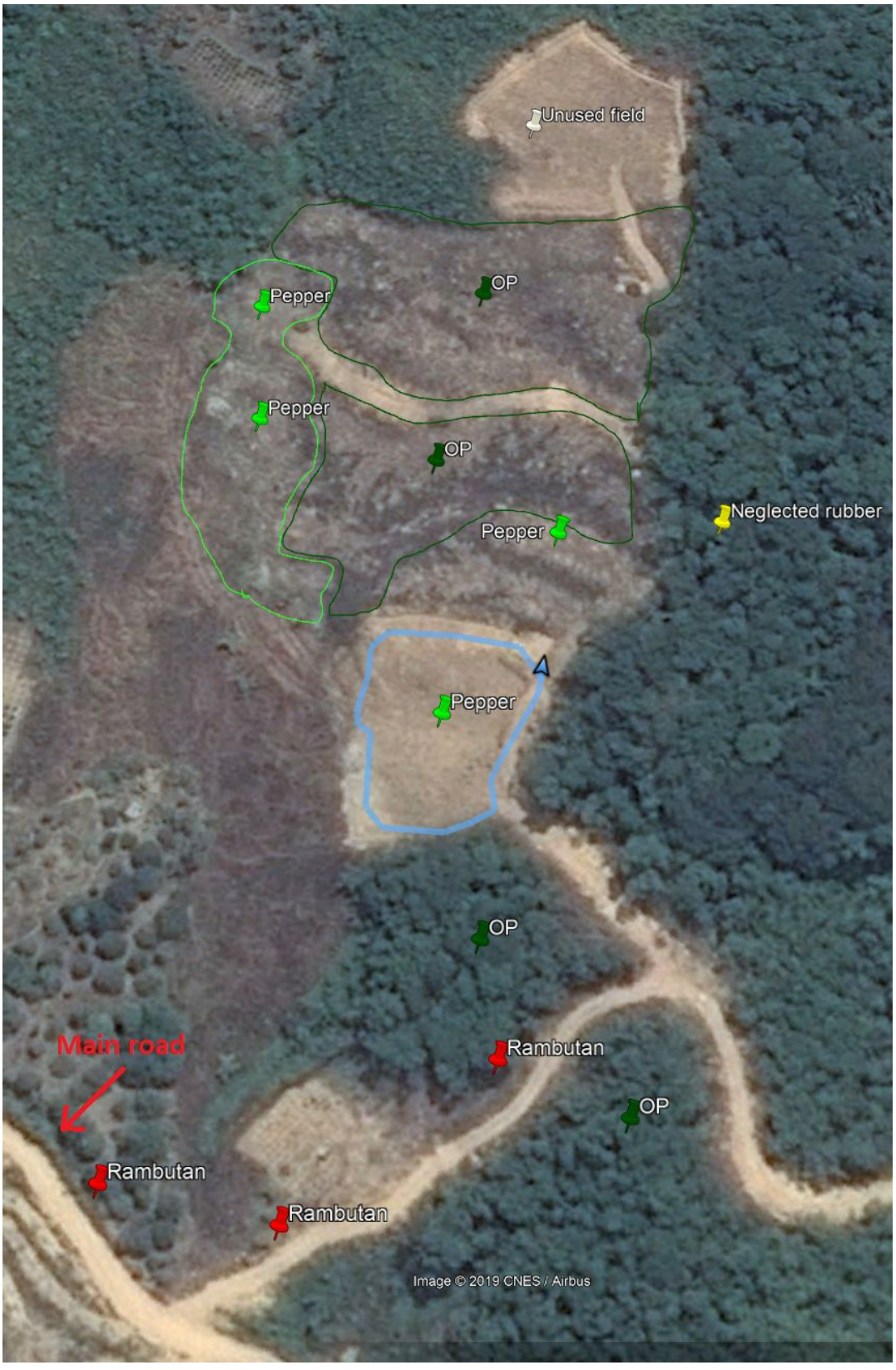


Figure 5.6: Satellite picture depicting area of transect walks and GPS walks.

Spotlight#3 focuses on Empang, a community member with an OP field located further away from the road. Empang's case exemplifies how distance to the road is an important factor for in their agricultural strategies. This was a point raised by several of the community members during our stay.

Spotlight #3 *Empang - OP cultivation further from the road*

Empang is an older farmer from the longhouse. He is cultivating both oil palms and pepper on his own fields and is also working on the headman's pepper farm from time to time. One of his plots, planted with 100 OPs, is significantly different from those of Cecilia and Jack, as it is located far from the main road. This makes it much harder to access the field for fertilizing and harvesting it. We followed Empang and his son Richard to the farm one day to fertilize the 100 OPs. When harvesting, Empang, his wife, and Richard carry 2-3 FFBs at a time to the car, walking an average of 200 m. back and forth (red line in the bottom, following a bit of the blue). Considering the weight of FFBs, this considerably increases the workload.

When harvesting, he, his wife, and his son can get minimum 2 tons of FFB from 300 trees, which takes them 4 days. He can't afford to provide the oil palms with adequate amounts of fertilizer, which forces him to prioritize some over others. The field furthest away from the road is the one that is sacrificed in this decision – it is only fertilized once a year, whereas the other fields are fertilized three times a year. One might wonder why he doesn't leave this field fallow, as the payoff from working it is significantly lower, considering the decreased output from a lack of fertilizing and the extra work associated with working in rough terrain and managing the distance. When asked, he explained that it still pays better than working other people's farms. On top of that, he put pride in working his own field. However, as he is about to run out of fertilizer, he said he might have to leave this plot in favor of his others.

5.3 Migration patterns in Udol

Five types of migration were identified in Udol, with different effects on the available labour in the community and consequently the land-use (figure 5.7). Below, the five patterns will be introduced to create an understanding for the further discussion in section 6.

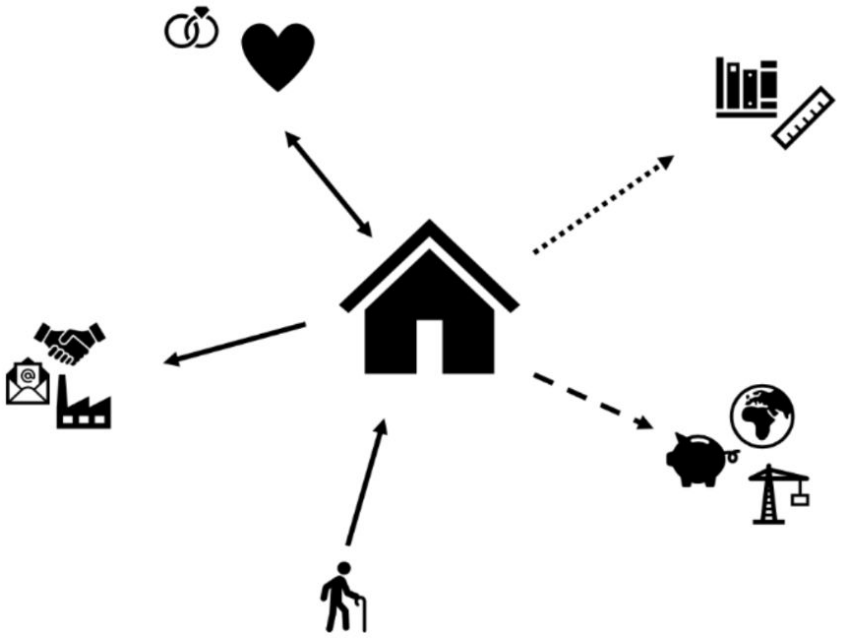


Figure 5.7: Migration patterns identified in Udol. The arrows show the direction of migration and the time perspective, as some types of migration are temporary and circular while others are not. The dotted line shows a type of migration that occurs on a weekly basis, while the dashed line is a monthly perspective. The full lines are of more permanent character.

Educational migration refers to young people, that attend school in the nearby city. Boarding schools have become increasingly popular in rural areas since Malaysia started focusing on the educational system and this was also seen in Udol. The FGD1 showed, that most parents want their kids to get educated, as it enhances the chance of getting a well-paid job, which is seen as a "better life" and makes it possible for the kids to send home remittances for the family.

"It is important that our kids go to school, because they can get good jobs (...) Those who are educated will work in the cities, those who are not will work on the land"
(FGD1)

The quote above show how education and off-farm jobs are prioritised over working the land, which in turn influence the labour available for farming in the household and thereby the land-use.

Nguay is an old *Iban* concept of following your wife or husband to their longhouse. This implies that you leave your own longhouse and now belong to a new community. It is thus a constant migration and does not affect land-use much.

Circular migration is a continuous form of labour migration between the longhouse and a workplace somewhere else. In Udol, this was especially seen with people working offshore, where they work three months abroad followed by one month of leave. For the households with someone working offshore, this had a tremendous impact on the household economy, which was confirmed in the PRA *Income Ranking*. Figure 5.8 shows that the households of Minah and Lydia rank "off-farm" as the most important income for their household. The interview with Ugang, who works offshore, showed that the main reason to work offshore is to support the family financially and to better their general situation (SSI3).

Name / Income Source	Minah	Sinda	Lydia	Gini
Oil Palm				
Pepper				
Rubber				
Rambutan				
Remittances				
Off-farm				
Farm work				
E-Kasih (government support)				
1 Azam (government support)				

Figure 5.8: Income Ranking

While only six households have members working offshore, it is the norm that the young people go to Johor to work after finishing their education. This is referred to as *labour migration*, which we characterize as a more permanent migration away from the longhouse, as they live permanently in e.g. Peninsular Malaysia and only return to the longhouse for festive seasons.

The concept of going somewhere else to work is known as *Bejalai*, however the original term implies that people return to the longhouse after a few years. As the quote below exemplifies, the focus group participants expressed uncertainty about the future and whether their kids will return (because of their education), but that maybe their grandkids will return to work the land.

"Although all my kids are educated, it doesn't necessary mean their kids will be as well - then they can work the farm"
(FGD1)

As it looks now in Udol, it is more common to only return to the longhouse once you have retired. The *Retirement migration* is a permanent movement into the longhouse, however it is also the type of migration with the lowest impact on land-use.

5.4 Socio-economic Consequences of the Land-use Changes

One problem associated with the cultivation of cash crops is rising inequality, both within and among communities. Although households have always differed in their capacities, the differences were, arguably, not as prevalent when everyone was cultivating rice for their own consumption. The increasing commercialization of livelihoods, however, accentuates these differences, and increasingly widens the gap between the more and less successful farmers (Cramb & Sujang 2013; Mertz *et al.* 2013).

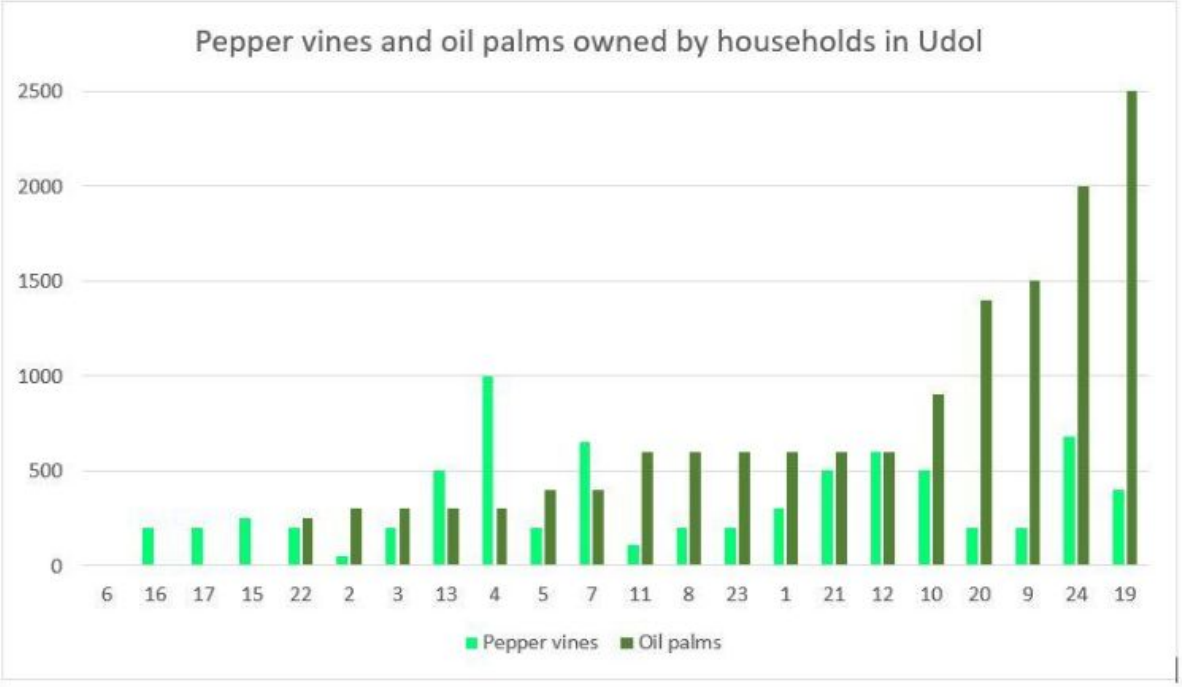


Figure 5.9: Number of OP and pepper owned by households in Udol

As seen in figure 5.9, all but one households cultivate pepper, with an average amount of 333.64 vines. Similarly, all households except four cultivate OP, with an average of 643.18 OPs. However, four households own significantly more OP than the rest, particularly the households of the former headman (#19) and the current headman (#24), who own 2000 and 2500 respectively. This suggests that some are more involved in the cultivation of OP than others, which impacts intra-longhouse differences and could increase socio-economic inequality. As Mertz *et al* notes: "*the households engaged in smallholder oil palm production have experienced considerable improvements in income and wealth whereas the other households have experienced more limited wealth increases or even a decline in income"* (Mertz *et al.* 2013, p. 109).

As not all villages or even members of a specific village's plots are suitable for OP cultivation, due to the necessity of adequate infrastructure, inputs and topography, some lose out. The literature also states that those villagers who planted OP at an early stage, often become significantly richer than their counterparts, who perhaps were more risk-averse or could not afford the initial costs, thus further widening the gap (Mertz *et al.* 2013). In Udol, this is evident by looking at the cases of Cecilia, household #19 and household #24.

The increasing *educational migration* will increase this tendency as well. While this migration will result in less available labour for the village as a whole, some households can better mitigate this, as

they have the financial capabilities to pay others, either guest workers or other longhouse members, to work their land for them - again adding to the economic divide (Mertz et al. 2013).

Another socio-economic consequence of the land-use changes relates to the selling and buying of land. Although land has always been traded in the community, the tendency has increased in recent years (FGD1). On our first field walk, the headman's wife, Sarabi, mentioned that she had recently bought a piece of land from an elderly widow. This was followed up on in an interview with her, where we learned that she often buys land from other households. Her husband, the headman, is working as an operations manager in Peru. His salary allows them to buy up land. The quotes below are from our interview with her, and exemplify why some people sell their land:

> *"People call her to see if she wants to buy land. Because these people need cash. So they just sell their land. [...] "They need the money to send their kids to school. And through university. So they sell their land."*
>
> *(SSI2)*

We therefore see division of people: some of buying land, whereas others need to sell for short term profit. This dynamic connects land-use and intra-community differences in Udol, and reinforces those differences in the long run.

Another way the differences are reinforced is through what type of land they buy. In the quote below from the same interview, the translator Grace explains Sarabi's requirements to the land she is interested in buying.

> *"Actually, these people just asked her to buy more land from this part, but she didn't want to buy that because it did not have the road access. So she only pick the ones with road."*
>
> *(SSI2)*

This way, through the selling and buying of land, the "good land" with road access increasingly gets in the ownership of those who are already in stronger financial position.

When asked why she buys land, where she responded that "*money can finish, but the land…[...] people want to sell me land so i just buy it"* (SSI2). This indicates that the land is a long term investment, but also that she buys land to help others in dire financial situations. However, the considerations about the placement of the fields indicates that it is not only an altruistic deed, but also involves some level of self-interest.

5.4.2 Four Approaches to Land-use and Management

With the cases of Cecilia, Jack, Luyoh, Empang, and Sarabi in mind, the villagers in Udol can be divided into the following four groups according to their financial capacity and approach to their land.

1. The traditional farmers (mixed financial capability)

This group represents the traditional farmers, whose main livelihoods consist of working their own and other peoples' fields. Members include Empang as well as the former headman Luyoh. Amount of crops owned differ highly within this group; while Empang and his wife 's household has 600 OPs, Luyoh's household owns the highest amount of OP, namely 2500. Although this group once constituted the majority, it is increasingly dwindling due to various forms of migration, urbanization and changing livelihood activities, as we learned through the interviews and focus groups.

2. Villagers, who sell their land (low financial capability)

As it is a sensitive topic, we did not ask for specific names or households in this group. Members in this group was described as being "desperate" and in need of money to put their kids through school and university. For them selling their land is a "short-term solution" to get extra income. However, it is a one-time payment and therefore that money might not decrease the intra-community differences on the long term. Another part of this group are those who sell their land because they moved away from the longhouse and have gotten other income sources. However, no such cases were identified during our stay.

3. Landowners, who do not cultivate their land (high financial capability)

We also identified people who keep their land although they do not cultivate it nor sell it. These include Jack and Sarabi's sister with the empty lot, who lives and works in Kuala Lumpur.

This could be explained by a cultural attachment to the land, as mentioned by the villagers on several occasions. Empang noted during the fertilization of OPs, that land is important to them and they do not want to sell it. Similarly, the participants in FGD1 all noted that "*the land will forever be our land"* (FGD1). Considering that it was originally cleared by them and their ancestors, one can understand the attachment. Another explanation could be keeping the land in hope of increasing land prices, or as something for their kids to inherit.

4. Landowners, who employ others to cultivate their land (high financial capability)

This group includes people living outside the longhouse (such as Cecilia) and people living in the longhouse (e.g. Sarabi) - both with the financial capacity to employ others to work for them. Both were reported as employing a variety of Indonesian guest workers, other longhouse members, and

family members outside the longhouse to maintain their land. Although some people in this group live in the longhouse and others not, they still constitute a common group, based on land management.

It should be noted that other subgroups might exist, which we did not uncover during our field work. However, based on our observations, it seems that the villagers, in spite of increasingly living outside the longhouse, prefer to keep their land. While some decide to sell, it seems to primarily be out of desperation. Part of this could be explained through cultural attachment to their ancestral land and their centuries long identification as farmers. However, as not all longhouses have the financial capacity to buy land, it will invariably lead to the upper echelons of the community owning an increasingly bigger share of the farmland surrounding Udol.

5.5 Environmental Consequences of the Land-use Changes

The environmental consequences of the current land-use practices were assessed with a handful of environmental tests. While most of the tests had some issues due to time constraints or methodology implementation, what was tested and found will be highlighted within this chapter.
We tested the physical properties of the soil to determine how erosion may or may not have been impacting the community's land. We agreed that the soil tests would be run at UNIMAS and the results would be sent to us. The values collected is found in table 5.2.

Table 5.2: Soil Physical Properties (Results)

		Properties				
Landuse	Depth (cm)	Texture	Root Size	Color	Bulk Density	Moisture Content
Oil Palm	0-15	Clay (Heavy)	Medium	Red	0.8	2.37
Rubber	0-15	Clay (Heavy)	Fine	Red	0.85	2.23
Pepper	0-15	Clay (Heavy)	Fine	Red	0.87	1.67
Rambutan	0-15	Clay (Heavy)	Fine	Red	0.76	2.53

The important values to look at here are the bulk density values. As this soil was a clay/heavy clay texture, the expected bulk density of the soil should be around 1.0 g/cm^3 based on the other information from the table (USDA 2008). As the bd values are low it is possible that there was a removal of the top layers of the soil that had a bulk density value closer to 1.0 g/cm^3. As the forest samples were not tested, it is difficult to provide commentary on the validity of the cropland values.
We also took water samples both in the form of a chemical analysis test and the MiniSASS for stream health. The water samples were taken after heavy rains which resulted in flooding of the streams our samples were dilute. Thus our results cannot adequately comment on the stream health. The results can be found below with a slight commentary.

Table 5.3: Water Test (Results)

Parameters	Station 1 (Reservoir)		$\bar{X}$	Station 2 (After Oil Palm Fields)		Ave	Station 3 (After All Crop Fields)		$\bar{X}$
BOD_5 (mg/L)	5.83	5.03	5.43	3.3	3.83	3.57	1.9	2.4	2.15
TSS (mg/L)	105	85	95	56	68	62	56.7	56.7	56.7
Phosphorus(mg/L)	0.48	0.33	0.405	0.00	0.11	0.055	0.09	0.16	0.125
COD(mg/L)	0.00	0.00	0.00	5.00	7.00	6.00	0.00	0.00	0.00
Turbidity (NTU)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
AN(mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.005

Figure 5.10: Nitrification

The water test above was done with a focus on many values however for this analysis we will only focus on Ammoniacal Nitrogen (NH4+). As the nitrogen cycle follow the above figure 5.10 we tested for NH4+ to see if there was any threat from the fertiliser. Only upon completion of the tests did we realise there was a possibility that we were testing for the wrong values, as NH4+ is not often found in high concentrations due to runoff (Carter 1997).

The first site for MiniSASS was a small stream adjacent to a pepper field. The stream is characterized as *sandy* in the MiniSASS system, which means that the average score at 6,25 points puts it in *good condition* (table 5.5). Site 2 was located at Segetah River, which is near an area dominated by OP fields. This river was classified as *sandy* and had an average score of 5 points. This means that it is in *poor condition*. These results can suggest that Udol fertilises the OP more than the pepper which eventually will affect the river health due to excessive amounts of fertilizer. We are unable to make any claims with certainty though. Site 3 was located just downstream from the reservoir. The river at

this site is considered *rocky*, which means that the average score of 5 points categorizes site 3 as in *very poor condition*. This category means that there has been critical modifications, which substantiates the fact that the test was done just below the retaining wall. Which can be considered a heavily man-made modification with implications on the macroinvertebrates.

Table 5.4: MiniSASS results from the three selected sites showing the macroinvertebrates found and their sensitivity scores, total scores and average scores.

Site 1		**Site 2**		**Site 3**	
4 x ”dragonfly”	6 points	2 x “Shrimps”	6 points	12 x ”Shrimps”	6 points
10 x ”bugs & Beetles”	5 points	2 x “Bugs & Beetles”	5 points	6 x ”Bugs & Beetles”	5 points
4 x ”Minnow Mayflies”	5 points	9 x “Mussels & Clams”	4 points	2 x “Mussel & Clams”	4 points
1 x “Uncased Caddisflies”	9 points				
Total score	25 points	**Total score**	15 points	**Total score**	15 points
Average score	6,25 points	**Average score**	5 points	**Average score**	5 points

Table 5.5: MiniSASS ecological categories based on the average sensitivity score (MiniSASS 2015)

Ecological category (Condition)		River Category	
		Sandy Type	Rocky Type
	NATURAL CONDITION (Unchanged/untouched – Blue)	> 6.9	> 7.2
	GOOD CONDITION (Few modifications – Green)	5.9 to 6.8	6.2 to 7.2
	FAIR CONDITION (Some modifications – Orange)	5.4 to 5.8	5.7 to 6.1
	POOR CONDITION (Lots of modifications – Red)	4.8 to 5.3	5.3 to 5.6
	VERY POOR CONDITION (Critically modified – Purple)	< 4.8	< 5.3

The last test carried out was insect trapping. This method provides some information about the insect diversity of various ecosystems and subsequently serves as an indicator for their resilience.

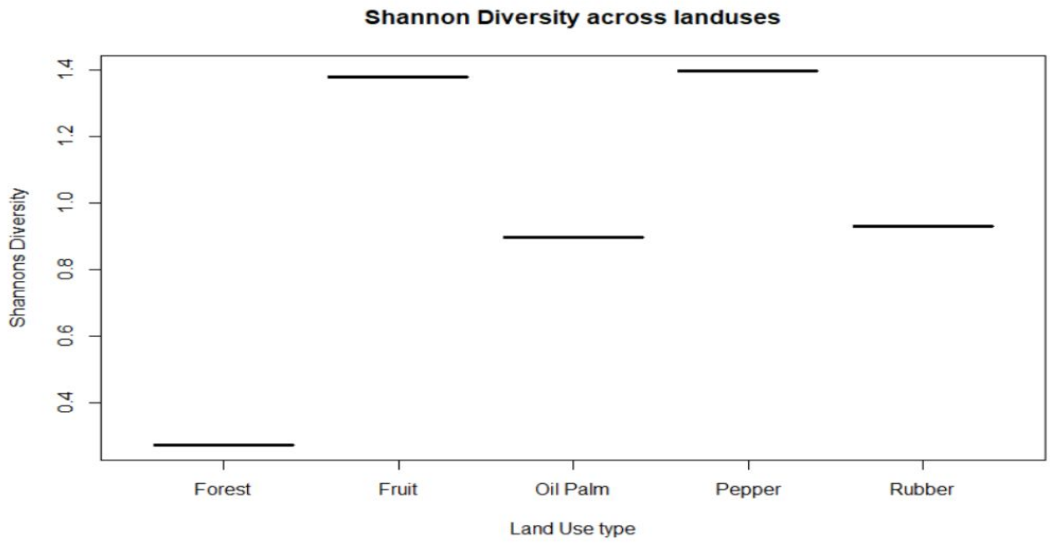


Figure 5.11: Shannon Diversity Index for insect traps

As seen in figure 5.11, the diversity of the fruit and pepper plantations are far higher than that of the forested ecosystem. This does appear as a discrepancy in what would be expected with respect to our understanding of diversity within ecosystems. Irwin (2004) demonstrates that insects often find themselves in ecological traps as in the short run there is enough food. Yet in the long run, there is not enough to sustain the population, which will result in a crash. With this in mind it is possible that the insects have been moving towards ecological traps and away from the forest. The lack of diversity in the forested ecosystem does not demonstrate a lack of resilience but rather a more stable ecosystem. If this ecosystem is an ecological trap it does not mean that the cropland systems are incredibly resilient, rather the forest system is the most resilient and the insects are being attracted to these ecological traps.

Unfortunately we cannot say much about the environmental consequences of the land-use changes with certainty as the time used and methodology had some major flaws. However, the following conclusions can be made based on the data that is present above:

1. The soil has possibly been eroded as the bulk density is lower than the expected value.
2. The water systems are likely in poor condition as seen by the MiniSASS results but given the flooding that occured at the time of the other water sampling methods this cannot be said for certain.
3. The insect diversity is higher in the cropland systems than the forest which is likely due to the creation of an ecological trap within which the insects are being drawn to. While this increases perceived resilience of the ecosystem, it cannot sustain itself in the long run.

6. Discussion

This chapter will first discuss our findings in relation to our first research question about drivers of land-use changes in Udol. Afterwards the consequences of the observed land-use changes will be discussed with a particular focus on the socio-economic intra-community differences in Udol.

6.1 Drivers of Land-use Change

As mentioned, we follow the LUCC programme's systematic approach to the classification of causes of land-use changes to assess the different drivers at each level and how they relate to each other. Figure 6.1 is based on the figure presented in Geist & Lambin (2002), which presents the proximate causes and underlying driving forces behind deforestation. We follow the general structure of their figure, however, it has been adjusted to the case of Udol. Most headlines remain the same, but two have been left out and one changed, to fit better some of the factors identified in Udol.

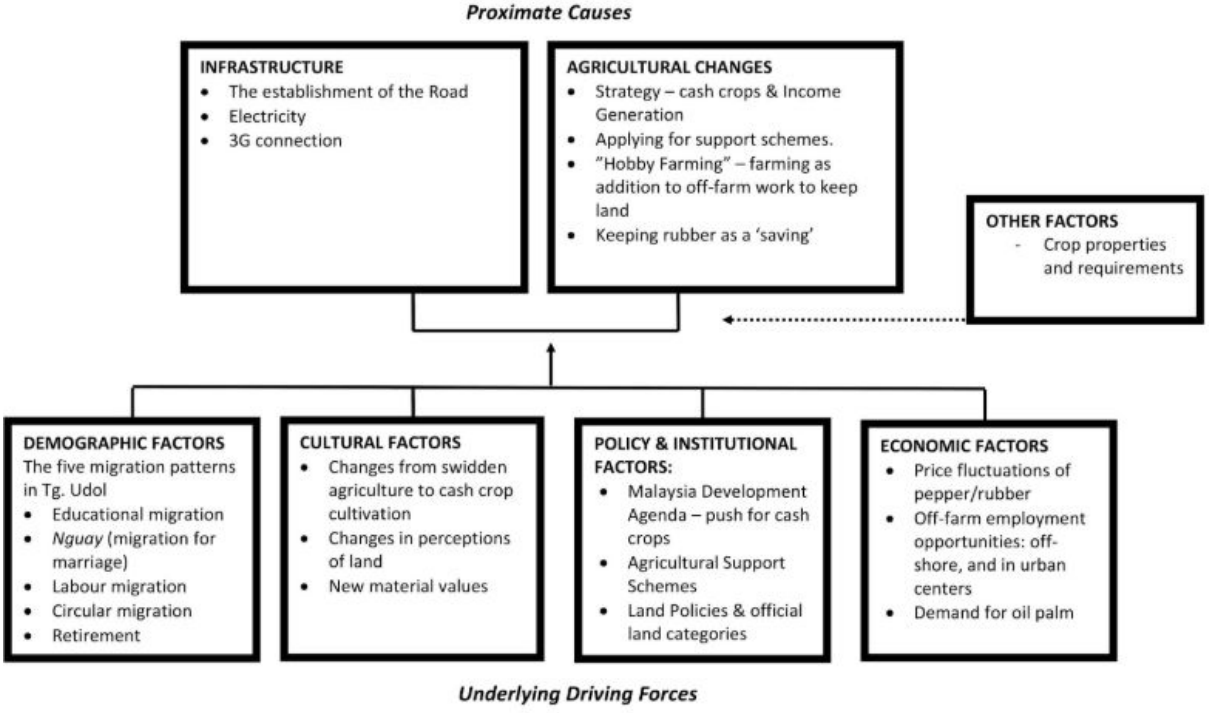


Figure 6.1 An overview of the proximate and underlying drivers of land-use change in Udol

Figure 6.1 gives an overview of the proximate causes and the underlying driving forces behind land-use changes in Udol which we have identified. These will be explained below, starting with the underlying forces behind the changes, which feed into the proximate causes.

Underlying Driving Forces

As outlined previously, fluctuations in the market prices of pepper and rubber have been an influential driver of the choice of crops and their management in Udol. We identify this economic factor as a central underlying force that has influenced the agricultural strategies on a local scale. The move towards cultivating cash-crops means that the farmers have become more vulnerable to such underlying economic factors, and that affect their livelihood strategies including their land-use.

In a similar way, the international demand for palm oil, and Malaysia's development plans for Sarawak are also underlying driving forces. The push to involve smallholders in this plan, for example seen in the offering of OP schemes, encourages them to cultivate OP and thus change their land-use. OP cultivation is now a major part of the land-use in Udol, so in that way, Malaysia's focus on cash crops, and particularly the OP boom, is an underlying driving force behind the last decades' changes in land-use in Udol. The availability of choices and the vulnerabilities and opportunities that affect their choices are influenced by the underlying forces including the development strategies of Malaysia during the last half a decade .

Another set of underlying driving forces are cultural changes. This includes how the community members have adopted the state's perception of idle land as 'wasteland'. This has been an influential factor driving the community members to not leave too much land fallow due to the fear of losing it. It thereby stand as a underlying driver that feed into their agricultural strategies on the ground - the direct causes of land-use.

As figure 6.1 shows, we have also identified the five patterns of migration observed in Udol as an underlying demographic force. People's movements away from the longhouse, whether for school or work, and permanent or circular, inevitably results in less available labour for farming during the movers' absence. The *Seasonal Calendar* showed that harvest times and yield are affected by the in- and out movements of the younger generations, as more can be harvested when they are home in the longhouse and contribute as extra labourforce. Furthermore, the youth's time spent outside of the longhouse influence their dreams for the future and their perceptions of how they want to live their lives. We see that influence from the outside and the generational changes as another important underlying force behind the changes towards more focus on income and material wealth and off-farm employment.

Proximate Causes

As can be seen in figure 6.1, we have identified the construction of the road as a important proximate cause of the land-use patterns in Udol. It has been a driver in the new agricultural direction in Udol, particularly with respect to their shift towards OP cultivation. As Soda *et al.* (2016) states, and as we learned in Udol, road infrastructure is crucial for the transportation of FFBs, fertilizer and other inputs (p. 357). In the case of Udol, the road was an essential factor in making Udol suitable for the MPOB schemes to begin with. In our interview with the former headman, he argued that without the road, he does not believe that they would have received the MPOB schemes, as a contractor has to be able to reach the village, prepare the land, and plant the OP seedlings. This is an example of how the proximate causes and underlying forces are interrelated and mutually responsive in how they influence the local land-use.

Another proximate cause of land-use changes is the community members' choice of crops and their farming strategies. It relates both to *what* they farm and *how* they farm. Almost everyone in Udol have both rubber and pepper, although these crops are not their main income sources at the moment. As mentioned the market prices feed into their strategies related to these crops. Rubber fields are left are not managed and weeded - a change in land cover which is directly affected by the land-owners' choice to not weed there and not tap the rubber driven by the underlying force of the market prices. Similarly, the choice to still keep the fields' somehow cultivated is for many driven by the underlying fear of losing land. These agricultural strategy factors are important direct causes of land-use change in Udol, but they are evidently affected by the underlying forces explained above.

7. Conclusion

The purpose of the study was to assess what the drivers of land-use changes in Tanjung Udol are, and what environmental and socio-economic consequences the changes have had on the community. The drivers identified were classified through the LUCC programme's systematic approach, which divides drivers into proximate causes and underlying forces. The predominant proximate causes identified were the construction and continuous development of the road, as well as the villager's agricultural strategies. However, it is vital to also look at the underlying driving forces which were identified as the fluctuations in cash crop prices, national development plans, global demand for palm oil and various forms of migration. These underlying drivers indirectly affect the proximate causes. Agricultural strategies, while being a proximate cause, is heavily based on underlying factors such as the presence of schemes and price fluctuations.

The environmental consequences of the land-use changes ranged from good to poor depending upon the test that was taken. Because there was such a large spread in the results generated it is hard to say with certainty that the consequences of the actions from this community are good or bad in relation to sustainable practices. This is due to the time constraints faced with this short visit to the community. In relation to the socio-economic consequences, we identified an increasing economic discrepancy among the households which is a direct result of some of the drivers identified. The focus on cash crops, labour-migration and increasing urbanization, will likely have significant effects on the longhouse community in the years to come as a secondary consequence of these socio-economic consequences.

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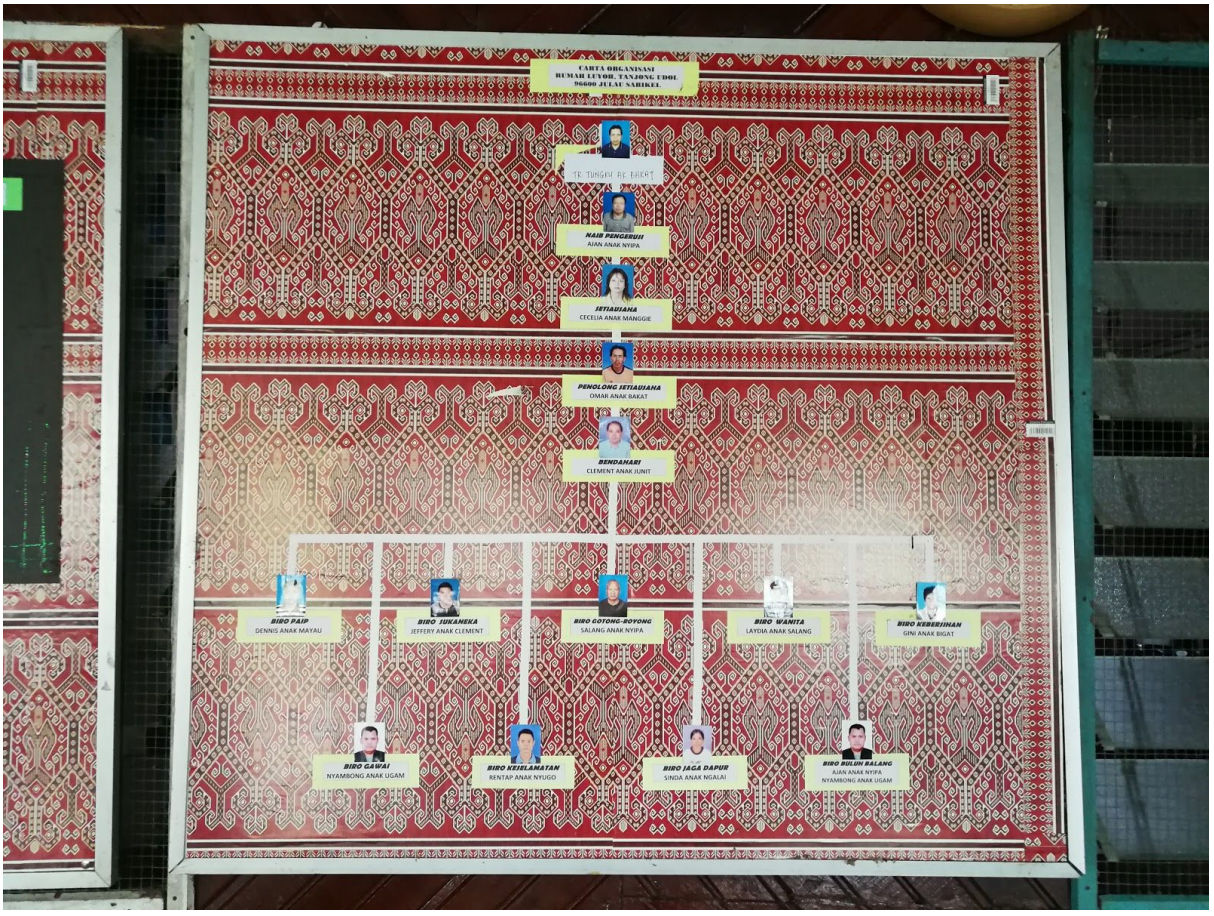
Appendix

Appendix A: Social Hierarchy of Tanjung Udol



Appendix B: Overview of methods all methods applied during the field trip

Type of method	**How many were carried out**
Timeline (PRA)	1
Survey/questionnaire	1
Focus Group discussion	2
Semi-structured interviews	4
Income ranking (PRA)	1
Crop ranking (PRA)	1
Resource mapping (PRA)	1
Seasonal calendar (PRA)	1
Venn diagram (PRA)	1
Informal conversations	
General observations	
Participant observation activities	
Transect walks	3
Soil sampling	5 sites
Water sampling	3 sites
MiniSASS	3 sites
Insect traps	5 sites

Appendix C: Synopsis

Research Project Synopsis

Smallholder oil palm cultivation in the Julau Province of Borneo

Tg Udol Village

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Submission date: 20/02/19

Word count: 2393

1. Introduction

This synopsis presents the preliminary outline of our field study of land-use changes towards smallholder oil palm cultivation in the Iban longhouse of Tg Udolin Sarawak, Malaysian Borneo. The data collection will be carried out from Feb 26th until March 11th, 2019, in collaboration with counterparts from UNIMAS.

1.1 Context

Sarawak is a resource-rich state in the Malaysian part of Borneo. The agricultural landscape in Sarawak used to be characterised by upland rice cultivation under swidden, practiced by the indigenous Iban, Bidayuh and Kayan people among others on their customary land (Cramb, 2016). The traditional upland cultivation of rice under swidden still persists, however national land and development policies have fuelled significant land-use changes in the region (Cramb, 1993). Since the 1970s people began to seek alternative livelihood activities from which they could better benefit from the local economic advances, while still keeping control over their land and resources.This initially involved the incorporation of cash crops, primarily rubber and pepper, into their traditional farming systems (Mertz *et al.*, 2013; Cramb, 2016). Recently, it is the widespread expansion of oil palm (OP) in the region, that has transformed and continues to transform the rural landscapes and farming systems in Sarawak.

Palm oil has become the most important vegetable oil globally - a market in which Malaysia and Indonesia are dominant players that for approximately 84% of the world's palm oil production. Sarawak is considered the last frontier for oil palm expansion in Malaysia, and the continuous global demand for palm oil, coupled with the the wet equatorial conditions in Sarawak, which are favourable for OP cultivation, has led to a significant expansion of oil palms in Sarawak (Cramb & McCarthy, 2016). The Sarawak Government has primarily pursued policies that favour the establishment of large-scale OP plantations under private estates or joint venture schemes. Smallholder cultivation of OP has, however, also increased dramatically,, which indicates that smallholders have managed to take part in the Malaysia OP venture despite unfavourable policies and governmental discouragement (Cramb & Sujang, 2013). The few studies carried out about smallholder OP cultivation in Sarawak suggest that while the smallholders obtain lower yields than the larger estates, the returns are good considering their inputs in terms of labour, resources and capital (Cramb & Sujang, 2013). However, few studies about smallholder oil palm cultivation exist, meaning that its role for the smallholders is still uncertain.

This study will focus on Tg Udul, which is an Iban longhouse community in the Julau district of Sarawak. Since receiving support through the Malaysian Palm Oil Board (MPOB) in 2014, the primary livelihood strategy in Tg Udolhas shifted towards smallholder oil palm cultivation. They used to rely on upland rice cultivation for subsistence use, and they have also cultivated both pepper and rubber, and still do to some degree (Hand out, Tanjung Udolstudy sites). As the transition is still very recent the study will focus on why the shift occurred, what the benefits and the challenges are, and what role it plays in the community as a livelihood strategy.

1.2 Significance

Land-use changes are central to debates on sustainable development and how to integrate socio-economic development and environmentally sustainable land-management (Lambin & Meyfroidt, 2011). The expansion of OP cultivation in Malaysia has received much attention in this debate, however attention has primarily been on large scale plantations and their encroachment on tropical forests, endangering wildlife and biodiversity and the vital ecosystem services the forests provide. Despite the increase in smallholder OP cultivation, only few studies have focused on how it influences the livelihoods of the the engaged farmers and their land-use decisions. While the environmental consequences of OP plantations have received much attention over the last decade or so, studies on the environmental consequences and potential opportunities of smallholder OP cultivation are limited (e.g. Yahya *et al.*, 2016). To contextualise and nuance the debate on the expansion of OP, more knowledge is needed about smallholder OP cultivation, and Tg Udolis a relevant case for investigating that.

1.3 Objectives & Research Questions

The overall objective of this study is *to assess what drivers that are behind the shift towards smallholder oil palm cultivation and what environmental and socio-economic consequences it might have for the households in Tg Udul*. This has resulted in the following two research questions:

- *What are the drivers behind the shift towards smallholder oil palm cultivation for the households in Tg Udul?*
- *What are the consequences of the shift towards smallholder oil palm cultivation for the households in Tg Udul?*

Appendix A includes a data matrix that shows the objective, the overall research questions and subquestions, what data is required to answer the questions, and what methods we intend to use for the different parts. This is a preliminary plan, which will be adapted as we arrive in the field and can get a better grasp of what is realistic and of particular relevance there.

2. Methodology

2.1 Research Design

The study is designed as an interdisciplinary case study. It will focus on both social and environmental aspects, and rely on both qualitative and quantitative methods. This is to achieve a broader understanding of the Tg Udolcommunity and their land-use decisions with respect to the shift towards small-scale OP cultivation. With an interdisciplinary design grounded in both social and natural sciences, we can approach our research questions in a holistic manner, as the difference in disciplines can be leveraged to triangulate findings, and create a broader understanding of whether the village is benefiting from the conversion to small scale OP cultivation. (Bryman, 2016).

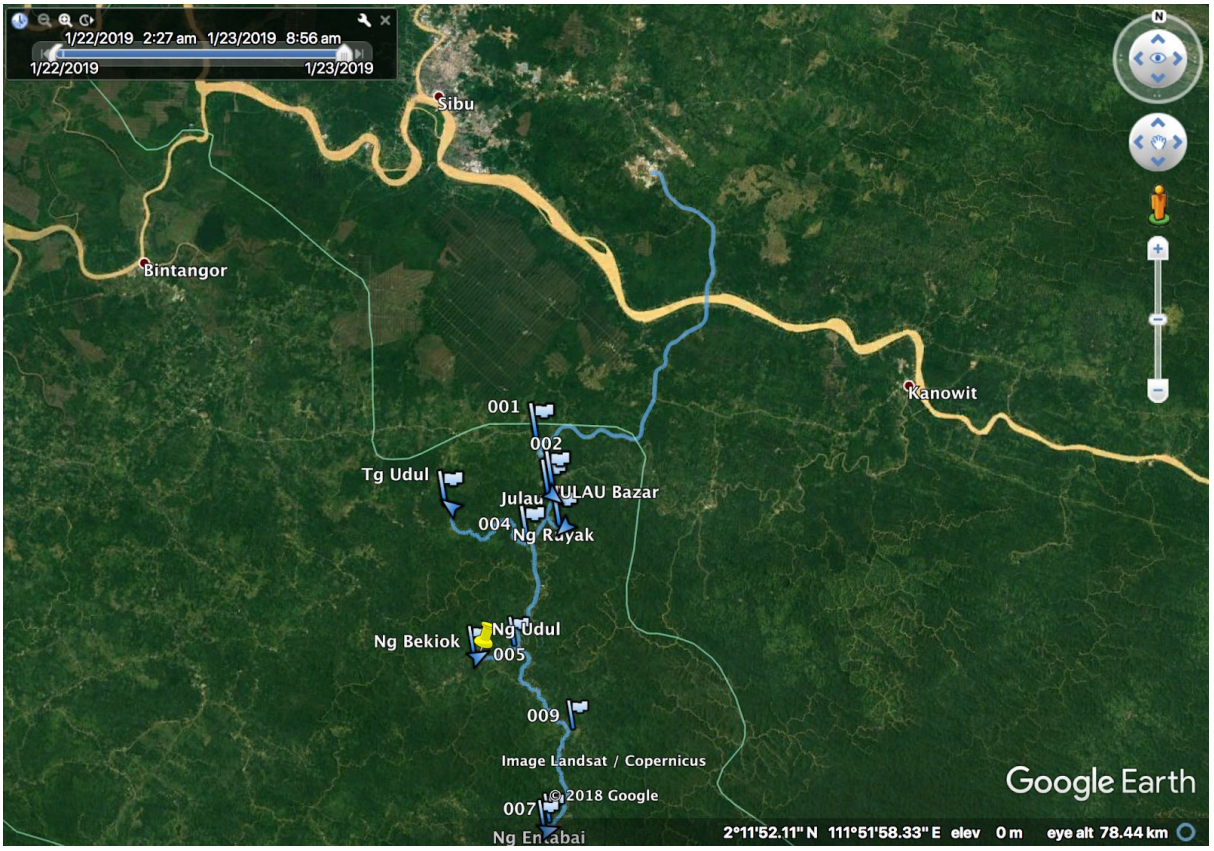
Semi-structured interviews utilise a template of open-ended questions that can tease out more information from the interviewee (Bryman, 2016). This is useful as it allows for interviewees to provide useful information that we likely not know to ask otherwise. Participatory focus groups provide an interactive space in which conversation between stakeholders takes place in a way that it may not traditionally occur. Participatory methods can be a good way to identify major stakeholders, triangulate other data collection, and better understand the priorities at the household level (Evans *et al.*, 2006). These methods will allow for an in-depth understanding of the views and perceptions held by the households in Tg Udolabout their shift towards small scale OP cultivation.

The data collection methods that stem from the natural sciences, will allow us to explore potential environmental consequences of the land use changes with respect to water contamination, soil degradation, and biodiversity impacts. The use of these methods will done in a way that can describe the environmental impacts of the shift to OP as far as nutrient flows, population diversity, and access to cultural goods are concerned. The use of these methods also helps to paint a bigger picture with respect to what is currently occuring within the Tg Udolcommunity (Bryman, 2016).

2.2 Study Site

The field study for data collection will take place in Tg Udul, which is located around 60 kilometers south of Sibu in Sarawak. A map depicting where this is located is found below.

Map:



2.3 Methods For Data Collection

Natural science methods

- Water Test
    - This serves to determine the ecological effects of OP cultivation. The water test will determine the amount of leaching that is seen from the OP land as far as erosion and nutrient loss in concerned. The greater the amount of sediment found in the river the greater the erosion rate. Furthermore, the water test can determine the amount of agrochemicals in the nearby streams, that may run off from the cultivated land. This can be assessed with NPK/pH tests and a test for TDS both up- and downstream of the OP field.
- Soil Test

    - This is to determine a baseline level of nutrients that can be expected within the natural forested area and that of the OP plantations. The baseline nutrient levels should give an idea of how the soil is being amended if at all. This method will be implemented with 20 replicates of a sample collected from the top 30 cm of soil with 10 coming from the OP plantation and 10 coming from the forested area. All these samples will be collected at random throughout the plots owned by the community of Tg Udul.
- Insect collection
    - Use of ethanol insect traps placed around the forest to determine insect diversity of both the OP plantation and the forested ecosystem. This will be done with a 50/50 mix of ethanol and water placed in cups that are flush with the forest floor to trap insects as they walk over the area. A total of 10 traps will be placed around the forest within which insects will fall into. A sketch of this trap system can be found in Appendix D. This can help to determine biodiversity of macro/megafauna such as birds or other insectivores that can be found in the forested ecosystem in Borneo as the presence of a thriving insect population is integral in the success of the ecological niche found here.

Social science methods

- Semi-structured Interviews
    - Stakeholders for OP cultivation will be interviewed to determine their perceptions of how OP adoption has impacted their livelihoods over the last decade.
    - Interviews of government officials in the agricultural department in Julau to understand the bigger picture of agricultural schemes in Sarawak and what the drivers are from the government to invest in these projects.
- Timeline creation in participatory focus groups
    - This will be done with the headman or community elders to determine how the LULC has changed over the last decade and how that has impacted factors such as food security, access to cultural goods, and access to NTFPs that are of importance in daily life.
- Field walks and Observations
    - Engaging in walkabouts with the community members to see how the LULC has changed and gather stories about the uses of different plants from the community members to determine how things have changed.

2.4 Methods for Data Analysis

- Natural Science Analysis
    - Utilise RStudio to make use of comparative statistics to demonstrate how the levels of NPK in both the water and soil vary spatially (and temporally) with respect to the introduction of OP in the region.
    - Create a count of the number of distinct insect species that were collected in the traps to determine tsoi
- Social Science Analysis
    - Thematic analysis of interview transcripts
    - Discussion of timeline and outcome of focus groups - comparison to interview themes.

3. Practicalities

A preliminary time plan for the field work is available in Appendix C.

4. Limitations and Challenges

We foresee different challenges for this projects, which we will try to mitigate in different ways.

- **Cultural differences**

  There will be an obvious challenge in working across cultures, due to the different learning methods, work ethics/routines and problem solving. To mitigate this, we will have a discussion with our Malaysian counterparts to explain how we see the project and for them to explain their view on this. Furthermore, it can be helpful to discuss the basic differences in personalities (for instance, how Danish people deal with disagreements).
- **Infrastructural challenges**

  We are aware that infrastructure is very different in Borneo, compared to Copenhagen, both in terms of accessibility and transport. Therefore, the preliminary time plan is also made with room for changes and everyone in the group is aware of the need of adapting quickly to the context specific possibilities.
- **Working in interdisciplinary groups**

Working across disciplines can also be a challenge, thus it is important to address differences in approaches. The project will include both social science and natural science methods, so that everyone in the group can contribute with their background knowledge.

- **Language barriers**

  With many languages involved the risk of misunderstandings is very high. Therefore, it is important to brief to interpreters very thoroughly before the interviews begin and also to state, that if anyone is unsure of what is meant, it is very important, that one asks for clarification. This is especially evident in the interview context, but also through discussions within the DK-group and with our Malaysian counterparts.

5. Reflections

It is difficult to balance the scope of the research. We have limited information about Udul, e.g. which support scheme they received OP seedlings from, who owns the mill, if rice paddies has been completely overtaken by oil palms etc. It is therefore necessary to be flexible and open-minded in regards to the research objectives and methods, as they need to be subject to change.

However, in order to have some form of direction, we are working with a number of hypotheses:

1. **Hypothesis 1:** *Improved road access led to less labour supply and therefore a support scheme*

   Although a number of proximate villages have unsuccessfully applied for OP support schemes, Tg Udolreceived one in 2014. We believe it may be because of a large emigration in the last 10 years due to improved road access, resulting in less available labour in the village. Since the most established cash crops, namely rubber and pepper, are very labour intensive, the village might have received oil palms to accommodate the decline in labour availability.

2. **Hypothesis 2**: *The geography of the village makes Tg Udolideal for cultivating oil palms.*

   The improvement of the road has made Tg Udolmuch better connected to the surrounding area, particularly the urban centres and the mill (although the location of the mill is at this

point unknown). Since the fresh fruit bunch (FFB) has to be transported to a mill within 24 hours, adequate infrastructure is essential to the production of palm oil. Furthermore, large parts of the village' agricultural land is located next to the roads, which makes it easy to transport the FFB to the mill.

3. **Hypothesis 3:** *Due to its relatively small size, Tg Udolis a test village for implementing oil palm support schemes.*

   The other surrounding villages, who also applied for oil palm support schemes, consist of multiple longhouses. Tg Udul, however, only consist of one longhouse and therefore constitutes a good test case for implementing a oil palm support scheme.

4. **Hypothesis 4:** *Cultivating OP can be a way of reassuring continuous access to the land.*

   If the land is left fallow, it might be deemed "inactive" by the government, which can result in the government claiming the land from the community/households. This can be avoided by cultivating it.

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7. Synopsis Appendices

Synopsis Appendix A - Data Matrix

Overall Objective: To research livelihood strategies and land-use changes in Tg Udolin order to assess what drivers that are behind the shift towards smallholder oil palm cultivation and what environmental and socio-economic consequences it might have.

Research questions/themes	Sub-questions	Data Required	Methods
Drivers of Land-use change *1. What are the drivers behind the shift towards smallholder oil palm cultivation in Tg Udul?*	What institutional drivers and barriers affected the land-use change?	Knowledge of the role/influence of different institutional factors, e.g. road and infrastructure changes, the OP support scheme, gender dynamics, wealth/wellbeing, OP demand & market prices, education level, national policies, inspiration from others, climate changes) Information about requirements to join the government's support scheme	Semi-structured interviews with: ● Community members ● Other major stakeholders ● Semi-structured interviews with Agriculture department Questionnaire
	What perceived advantages and disadvantages of OP cultivation were central to Tg Udul's decision to engage in smallholder OP cultivation	Knowledge about the community members expectations and motivations related to cultivating OP cultivation: Local perceptions of advantages and disadvantages of small-scale OP vs. large-scale plantations? A timeline depicting the important steps in the shift in land use over the last decade	Semi-structured interviews with ● Community members ● Other stakeholders? Informal conversation & field walks. Participatory Focus Groups (constructing timeline) with: ● Community members (mixed gender)

Consequences *2. What are the consequences of the shift towards smallholder oil palm cultivation in Tg Udul.*	How do the households perceive the consequences of the land use change with respect to quality of and access to natural resources?	Knowledge about households perceptions of change in quality of and their access to natural resources. from the community members	Focus groups with different groups in the community
	What are the environmental consequences of the land use change around the community of Tg Udul?	Water quality in terms of leaching and erosion Indicators for status of biodiversity A map presenting the land-use changes around the community	Water sample analysis Insect collection Soil testing Participatory mapping
	What are the socio-economic consequences of the land use change within the households?	Amount of OP owned - and by who? Knowledge about changes in gender roles in the workforce & voice in land-use decision making. Time-use in an ordinary day	Observations & informal talks Field walks Semi-structured interviews
	What role does oil palm play in the households' current livelihood strategy according to them?	Information about the the different households' current livelihood strategies - relative importance of different crops/activities. Knowledge of differences among households in Tg Udolin the importance of OP Knowledge about what purpose OP cultivation primarily have for the households.	Survey - Community members Semi-structured interviews - Community members

	How does the community perceive the future with oil palm?	knowledge about what role the community members' see oil palm having in the future for them? Dreams and expectations for the future. Perceived Environmental & Socio-economic sustainability of smallholder OP cultivation	Focus Groups & Semi-structured interviews w. Community members Informal conversation & Observations

Synopsis Appendix B - Google Earth image of Tg Udolland

Tg UdolVillage

Synopsis Appendix C - Preliminary Time Plan

4.2 Preliminary Time Plan

Date	Activity	With who
26/2	● Arrival at Sibu ● Dinner with the entire group	Everyone
27/2	● Getting familiar with our Malaysian counterparts ● Discuss project including time plan for field work and different methods ● Final shopping before the field work	Everyone
28/2	● Transport to Tg. Udolfrom Sibu ● Settle in	Everyone
1/3	● Get familiar with the community ● Go for a walk around to get familiar with the surroundings ● Very informal talks with different members of the community to get a feeling of culture, structure and groups ● Re-evaluate time plan	Everyone
2/3	● Supervisors will visit during the day ● Present time plan for supervisors in order to agree on water analysis and trip to Julau (agricultural department) ● Initiate questionnaire	Everyone for supervision Divided into 2 groups for questionnaire (with one interpreter each)
3/3 (Sunday)	● Water analysis (can be moved, if not possible	Groups

	with lab equipment) ● Biodiversity samples ● Questionnaire, if not done ● If possible, interviews ● Arrange field walk for tomorrow	
4/3	● Morning: Field walk (with GPS) ● Interviews ● Timeline with elders/headman ● Follow up on water analysis	Morning: 2 groups, doing 2 different walks (with one interpreter each) Afternoon: Groups
5/3	● Visit the agricultural department in Julau ● Follow up on tasks that are lacking ● Re-evaluate time plan for the remaining days	Depending on transport possibilities
6/3	● Interviews ● Soil samples	In groups
7/3	● Interviews ● Another field walk, if necessary	In groups
8/3	● Interviews	In groups
9/3	● Buffer day ● Collect insect traps	Groups
10/3 (Sunday)	● Follow up on last minute tasks ● Wrap up and farewell to community	Everyone
11/3	● Transport back to Sibu ● Dinner with the entire group	Everyone (unless someone has married and stay behind)

Synopsis Appendix D - Insect Trap Sketch