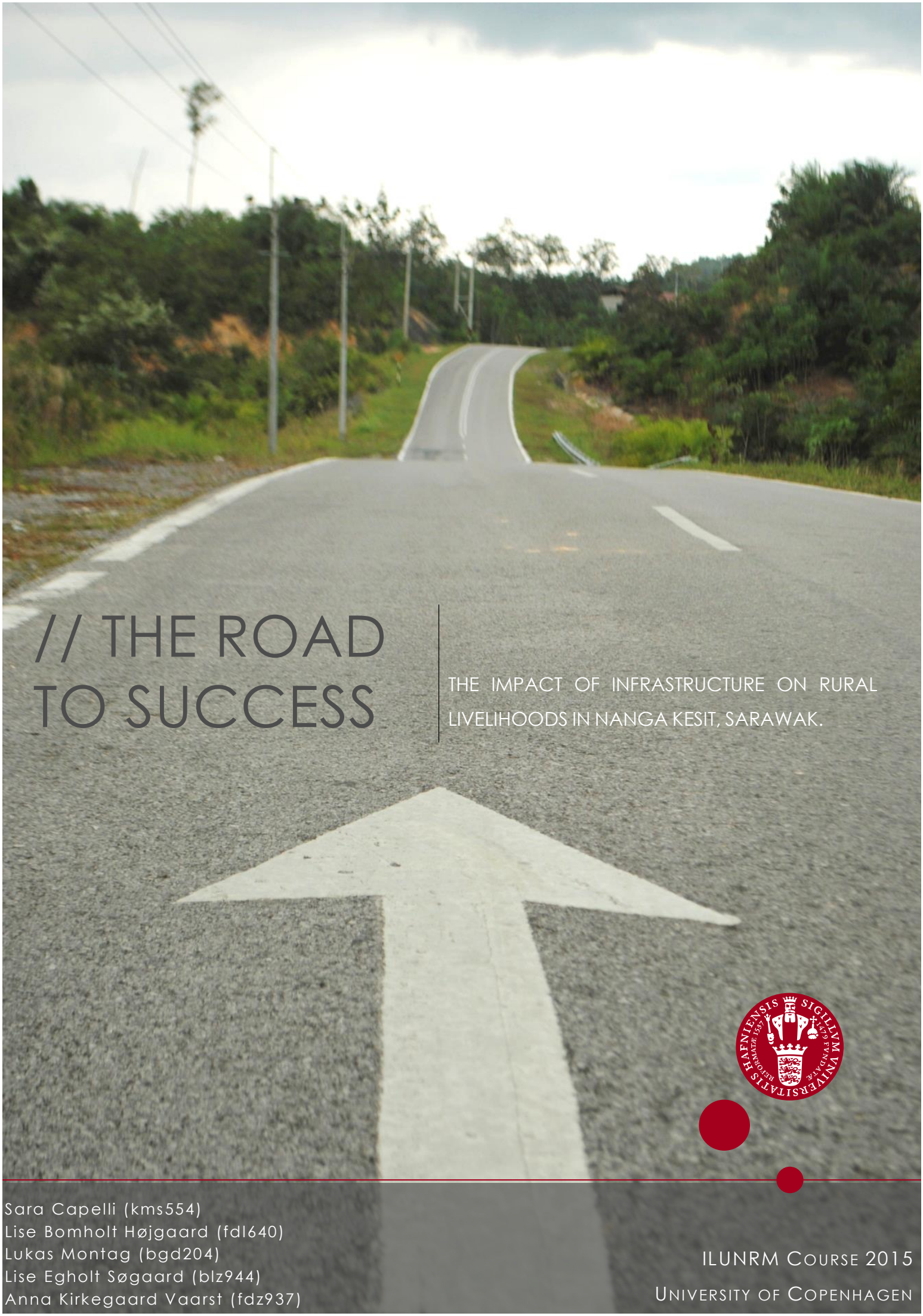

// THE ROAD TO SUCCESS

THE IMPACT OF INFRASTRUCTURE ON RURAL LIVELIHOODS IN NANGA KESIT, SARAWAK.

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// ABSTRACT

Improvement of infrastructure in one of the least developed areas in Sarawak, Malaysia, has within the last decade caused the village of Nanga Kesit to be connected with the federal road network. This study examines the impact of the road construction on the livelihood strategies of the villagers in Nanga Kesit in the context of the Sustainable Livelihood Framework (SLF). The focus is mainly on land use changes, land use decision-making and diversification of livelihood strategies. Therefore, we conducted an interdisciplinary study integrating natural and social science approaches. The data has been collected through 10 days of fieldwork in Nanga Kesit by conduction participatory rural appraisal methods, questionnaires, soil and water sampling, interviews and participant observation.

Findings of this study show that the villagers are mainly engaged in farming and that their farming activities, hence the land use, have changed since the improvement in infrastructure. The implementation of oil palm cultivation within the last five years is seen as the main change. Furthermore, the study argues that the land use has intensified in areas close to the road. Additionally, the road construction has influenced possible non-farming activities, since the villagers lost tourism as a source of income due to the road construction.

It is concluded, that the road construction has an overall positive impact on the livelihood strategies of the villagers, enabling more income-generating activities and providing easier access to markets, fields, families, health and education centres for the villagers. The changes are also perceived as positive by the villagers.

// PREFACE

This work is the final report for the "Interdisciplinary course Interdisciplinary Land Use and Natural Resource Management" (ILUNRM), which is organised and carried out by the University and Copenhagen and the Roskilde University. The course consisted of three weeks of lectures and group work at the University of Copenhagen, followed by two weeks of fieldwork and finally of writing the final report. The fieldwork took place in Sarawak, Malaysia, in collaboration with students from the University Malaysia Sarawak (UNIMAS). This report is the result of equally contribution by all students that are enrolled at the Danish universities, however partly supported by the students enrolled at the Malaysian university.

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// ABBREVIATIONS

BOD	Biochemical Oxygen Demand
C	Carbon
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
FGD	Focus Group Discussion
FCC	Faecal Coliform Count
HH	Household
INWQS	Interim National Water Quality Standard
IR-MS	Isotope-Ratio Mass Spectrometry
JVC	Joint Venture Company
N	Nitrogen
NH_3-N	Ammonia Nitrogen
NO_2	Nitrite
NO_3	Nitrate
NTFP	Non-timber Forest Products
P	Phosphorous
PoxC	Permanganate Oxidizable Carbon
PRA	Participatory Rural Appraisal
SOC	Soil Organic Carbon
SSI	Semi-structured Interview
SLF	Sustainable Livelihood Framework
TCC	Total Coliform Count
TSS	Total Suspended Solid
WQI	Water Quality Index

1.0 // INTRODUCTION

Malaysia is renowned for its rapid, and relatively successful, development into an industrialized economy (Drabble, 2004; Loke & Tham, 2014; EPU, 2010). Within only 50 years, Malaysia has moved away from the status of developing country, to become a middle-income country. Furthermore, the Malaysian Vision 2020 states that the country aims at transforming into a high-income country by 2020 (EPU, 2010).

In order to achieve this goal, the 10th Malaysian plan declares that: "*an advanced high-income economy requires world-class infrastructure to support its economic activities.*" (EPU, 2010:108). Additionally, it states that: "*the government is also committed to uplift the livelihoods of the 40% bottom of households*" (EPU, 2010:iv). One assumption by the government is that economic diversification is promoted by a good quality of infrastructure (OECD, 2013; EPU, 2010), thus the Malaysian government is making an effort in improving the infrastructure in these less developed parts of the country including Sarawak (Naidu, 2008). Thus, one of the initiatives to achieve these goals is the improvement in connections between rural and urban clusters, by investing in infrastructure (EPU, 2010). In terms of infrastructure quality, Malaysia is already ranked as number 29 out of 144 countries (OECD, 2013). However, the infrastructure is far from being equally developed in all parts of Malaysia. In 2005, the road network in Peninsular Malaysia accounted for 68% of the total road network in Malaysia, whereas the road network Sarawak with the least developed infrastructure in Malaysia only accounted for 12% (Naidu, 2008).

The correlation between poverty and infrastructure is supported in the literature (Naidu, 2008), and it is furthermore argued that infrastructure influences land use and agricultural activities, and thereby has an impact on natural resources (van de Walle, 2009). The impacts can be direct changes due to construction and development of infrastructure, though also indirect impacts, such as deforestation due to increased agricultural activity (Miyamoto, 2004). According to Schmitt and Kramer (2009), it is closely related to behavioural changes of individuals due to road access. Thus, infrastructure is interlinked with many important aspects of rural development, including agricultural activities, everyday practices of people, poverty eradication, natural resources and rural-urban connections.

Within rural development, the *sustainable livelihood approach* has been dominant for the last decades (Scoones, 2009). Central in the Sustainable Livelihood Framework (SLF) is the interest in the livelihood strategies, and how these are continuously adjusted to fit the context. Since "*rural livelihood strategies are often heavily reliant on the natural resource base*" (Scoones, 1998:11), land use decisions and practices are vital, when looking into rural livelihood strategies. Furthermore, it is generally acknowledged within this approach, that the level of diversification in rural people's livelihood strategies adds to the flexibility, thus sustainability of their livelihoods (DFID, 1999; Scoones, 1998). In relation to research in sustainable livelihoods, it is vital to look into the ability of people to adapt to changes or cope with stresses and shocks (Scoones, 1998).

As stated above, infrastructure has major impacts on many aspects in rural development. Especially in Sarawak, where the infrastructure is less developed, changes due to improvements in infrastructure are likely to have major effects on the livelihoods of people living in rural areas. But are these changes positive? How do they affect natural resources? Do they really contribute to the improvement of livelihood, as intended by the government? And how do people cope with or adapt to these changes - is everybody benefitting?

1.1 Description of the study site

This study looks into some of the above mentioned aspects in a village in Sarawak, which within Malaysia is the most rural and least developed in terms of infrastructure. Before stating the objective and research questions of this study, a brief introduction to the study site is given in order to get an understanding of the local context.

Nanga Kesit is an Iban village consisting of 40 households located in the Lubok Antu district of Sarawak, Malaysian Borneo. Close to the equator, the area is characterized by an annual rainfall of over 3000mm and an average temperature of 26°C (FAO CLIMPAG, 2007). Hill rice is widely cultivated as staple crop, but cash crops as pepper, oil palm and rubber also play a key role. In the last 20 years, the road network in the area has improved significantly, linking the village to Lubok Antu and other neighbouring villages. The road to Lubok Subong (orange in **Figure 1**) dates back to 2003, whereas the connection with the main road towards Jalan Lubok Antu (in green) was completed in 2003. The construction of the road Jalan Ulu Lemanak / Ulu Engkari (in red) then continued towards Sukunyit, and the last section was inaugurated in 2009.

Figure 1 Map of the Nanga Kesit area. The boundaries are marked by the Leput River and Tapang River

1.2 OBJECTIVE AND RESEARCH QUESTIONS

Having the national and local context in mind, the main objective of this research is:

To investigate how the development of infrastructure has affected the livelihood strategies of the people in Nanga Kesit and their natural resources.

Our focus in relation to the sustainable livelihood framework is primarily on the distribution of farming and non-farming activities within the village, decisions related to land use as well as livelihood diversification on a household level. Thus, we have developed two research questions:

1) How have the villagers of Nanga Kesit adjusted their livelihood strategies after the construction of the road linking the village to the federal network?
    a. How has the land use in Nanga Kesit changed in relation to this road construction?
        i. What are the major land use changes since 2009 expressed by the villagers?
        ii. What are the most important aspects for the villagers related to land use decision-making?
        iii. How have these changes impacted the quality and use of water sources around Nanga Kesit?
    b. How do villagers diversify their livelihoods, and how has this road construction affected this?
2) How do the villagers perceive the impacts of the newly expanded road network on their livelihoods?

For each research question, we have listed data required and methods, which can be found in the Data matrix (Appendix I). In the following chapter, the most relevant applied methods will be described more in detail. The full list of all methods applied can be found in Appendix II.

2.0 // METHODOLOGY

2.1 A HOLISTIC APPROACH TO OUR STUDY

In order to investigate the research questions, a number of methods have been applied. It has been difficult to separate the natural and social science methods, since both approaches provide possibilities of understanding the different and interlinked perspectives and the dynamics in relation to the impacts of the road on the villagers' livelihoods.

Thus, our approach has been holistic and inspired by the philosophy of hermeneutics, meaning that we have let our theoretical and increasing empirical knowledge interact continuously with the production of empirical data during our field trip (Juul, 2012). Since we are aiming at understanding the specific context of the people in Nanga Kesit, it is important to emphasize that the empirical data we have gathered during our stay is the locus of attention in our study (Kvale & Brinkmann, 2009). The overall understanding of the complexity of the peoples' livelihoods will be pursued through the SLF (DFID, 1999).

2.2 APPLIED METHODS IN THREE PHASES

The selected methods described below follow three chronological phases, which correspond to our different approaches during the fieldwork period. During the *exploratory* phase, in which the focus of the study was not yet clearly defined, general information about the village were collected from a broad and open perspective. Once the focus had been identified, a second *in depth* phase was initiated. The focus had then changed in order to gather data that was directly linked to our chosen research themes. However, challenges in the execution of the scheduled methods led to a shift to a third *participatory* phase. The approach in this last phase was towards less structured interviews and participant observation. The challenges relating these methods are reflected on in Chapter 4.

2.2.1 THE EXPLORATORY PHASE

EXPLORATORY SEMI-STRUCTURED INTERVIEW WITH THE HEADMAN

A Semi-Structured Interview (SSI) was conducted with the headman in the beginning of our stay to obtain knowledge about Nanga Kesit and the inhabitants. The headman was chosen as a key informant because of his position in Nanga Kesit (Casley & Kumar,

1988). This introduced us to the dynamics in the village and enabled us to identify participants for the following activities.

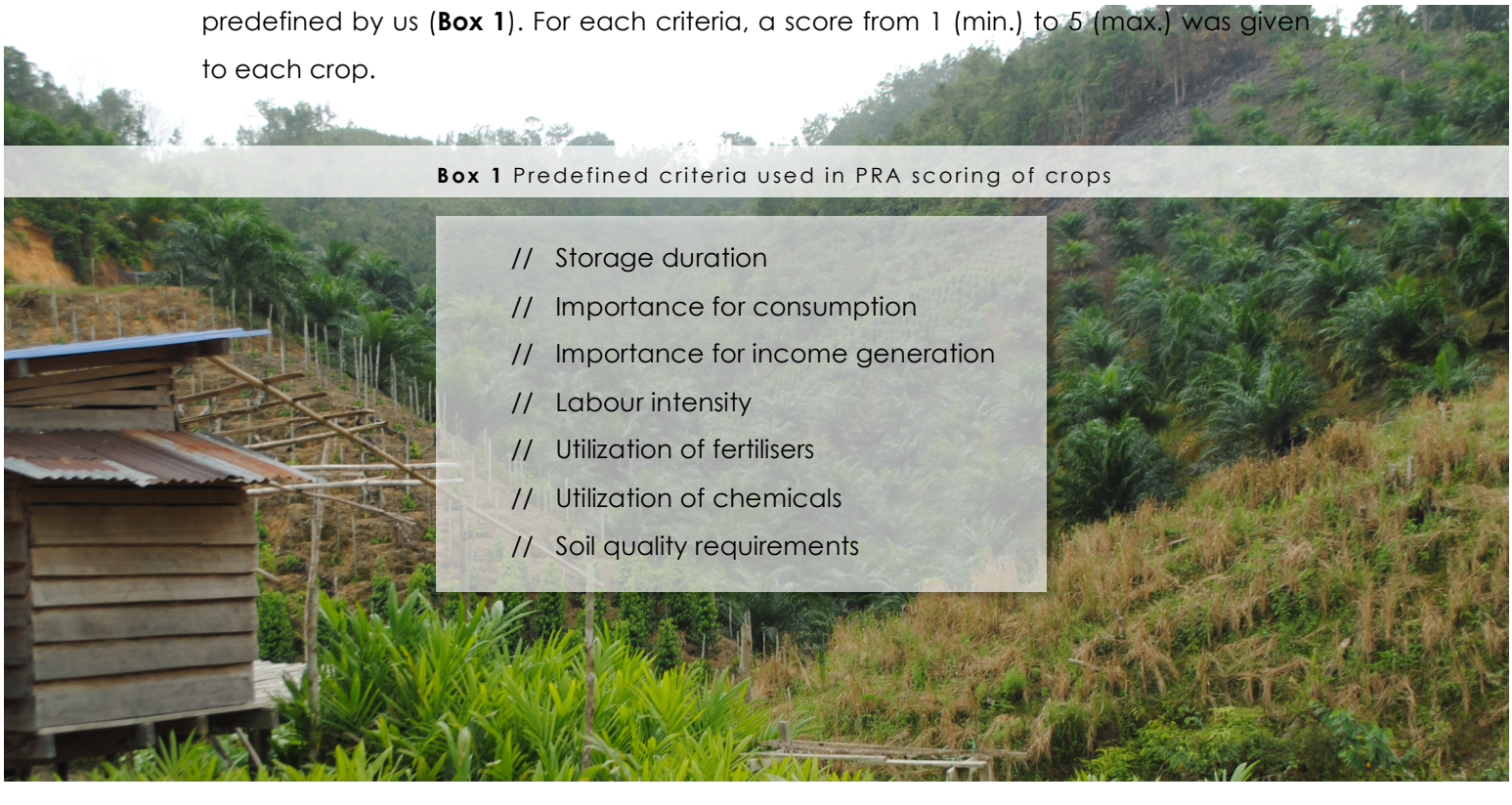
The interview guide was developed based on themes of particular interest, including *village characteristics, history of the village, values within the village, natural resource management* and *decision-making* (Appendix III). Additional themes or issues that were brought up during the interview were followed up on with further questions, which caused the interview to last for 3 hours.

FIELD WALKS AND VILLAGE WALK

One village walk and two field walks were conducted with local guides and farmers. The village walk was carried out to explore the village and service facilities in the area, including schools, clinics and other governmental facilities. On the other hand, the aim of the field walks was to explore the fields of Nanga Kesit, and to get an overview of the farming activities and land use changes. GPS tracks were recorded during the 3 walks in order to locate points of interest. These data were combined with Google Earth for generating descriptive maps of the area around Nanga Kesit (Strang, 2010; Mikkelsen, 2005).

PARTICIPATORY SCORING OF CROPS

In order to identify criteria and priorities in terms of the villagers' decision-making on land use, a participatory rural appraisal (PRA) scoring was conducted with four male farmers. Following the approach of Mikkelsen (2005), the participants were asked to list the most important crops, followed by evaluating each of these according to criteria predefined by us (**Box 1**). For each criteria, a score from 1 (min.) to 5 (max.) was given to each crop.



Box 1 Predefined criteria used in PRA scoring of crops

// Storage duration
// Importance for consumption
// Importance for income generation
// Labour intensity
// Utilization of fertilisers
// Utilization of chemicals
// Soil quality requirements

PARTICIPATORY TIMELINE OF VILLAGE HISTORY

To get an overview of the significant events that has occurred in the past, a participatory timeline was conducted. Following the principles of Selener (1999), the intention was to gather a group consisting of both men and women, though along the exercise the participants were only men in the age range of 35-75. A plain sheet of paper was given to the participants, and the facilitator started by drawing a line. At first, the participants were asked questions about major events. In order to facilitate a discussion about livelihood strategies and potential changes in these, questions regarding farming and non-farming activities were raised.

Once the research objective was developed, we wished to get more detailed information about the key events of the past 20 years. For this purpose, the previously conducted timeline was brought into a focus group discussion (FGD). Based on the experience from the previous timeline, where the participatory exercise was dominated by men, this timeline was conducted in a group of only women. The women were invited into our room in the longhouse in order to avoid interruptions from the men.

Once more, the concepts of conducting a timeline from Selener (1999) were applied. The facilitator asked the women to draw the road construction in order to start a discussion on the impacts of the road. The guideline for the FGD was based on three themes: *major changes, perceptions* and *benefits/constraints*.

The data obtained from the two discussions enables triangulation and insight in potential differences between men and women in their perceptions of significant events.

PARTICIPATORY MAPPING OF LAND USE IN NANGA KESIT

To get an idea of the land use in the area, a PRA mapping was held with four male farmers. Following Selener's (1999) approach, the informants were given a plain sheet of paper and asked to draw a map of the surroundings of Nanga Kesit, highlighting *cultivated areas, forest, fallow land, boundaries, drinking water sources* and *logging*. Discussion over recent land use changes, hunting and collection of forest products was facilitated during the exercise.

Once the focus of the study had been identified, the map was developed in four additional sessions, in which informants of different backgrounds (both men, women, farmers and elders) were asked to add information such as *field names, accessibility*

and distances, present crops cultivated, forest and *fallow land* before and after the road construction. This triangulation enriching the information obtained.

QUESTIONNAIRES

To obtain demographic data of the villagers, a structured survey based on questionnaires was conducted with 19 households (Casley & Kumar, 1988). Additionally, the guide focused on three themes of interest in order to obtain the basic information within these: *land use*, *income generating activities* and *food security* (Appendix IV). Since the sample was quite small in a statistical matter, the purpose of the questionnaire survey was not to produce general information on a larger population (Agresti & Finlay, 2014), but rather to increase our understanding of the villagers in Nanga Kesit. This enables us to situate them within a context as well as to identify possible key individuals for future interviews and activities, and to select the sites for soil sampling (Babbie, 2002).

The survey was conducted in three phases. At first, a pilot questionnaire was conducted with one household. This led to some adjustments (Babbie, 2002; Casley & Kumar, 1988). Subsequently, the questionnaire survey was conducted with five households. However, the group realized the need for a more clear focus before continuing, hence the rest of the survey was conducted in a third phase, after the objective and research questions had been fully developed.

In this third phase, the survey was carried out with the remaining available households. The six households, with whom we had already conducted the survey, were followed up on in order to get the same data for all households (Babbie, 2002). In order to allow flexibility and possibility of dialogue, the questionnaires were conducted as *face-to-face interviews* rather than *self-administered interviews* (Babbie, 2002).

2.2.2 IN DEPTH PHASE

TOPIC FOCUSED INTERVIEWS

With the determined research focus on the road construction, several *topic focused interviews* were conducted with *key informants* selected based on their unique insight in relevant matters (**Table 1**) (Casley & Kumar, 1988). For each key informant, an interview guide was developed, which was more or less structured dependent on our

existing knowledge of the particular topics of interest (Appendix V). The only common topic for all key informants was the *construction of the road.*

Table 2 Overview of the selected key informants

KEY INFORMANT	REASON FOR SELECTION	COMMENTS
THE COUNSELLOR, WHO IS THE LINK BETWEEN 14 VILLAGES, INCLUDING NG. KESIT, AND THE GOVERNMENT.	His knowledge about potential development plans in the area. Knowledge about the road construction and the different phases.	One was conducted and several follow-ups and informal talks.
AGRICULTURAL OFFICER	Knowledge about schemes and land use changes in the area.	It turned out that he was not an officer, but a driver for the officers.
SHOPKEEPER IN THE CLOSEST NEIGHBOURING VILLAGE	Insight in the development of the shopping habits of people in Nanga Kesit in relation to food products.	The shopkeeper left after 10 minutes and the rest of the interview was with a villager from Nanga Pulok.

The knowledge obtained from the topic focused interviews was used to develop our understanding of the context of the villagers in Nanga Kesit. Further, it was used to provide background knowledge on agricultural schemes and the process of the road construction. This knowledge was useful for the later SSIs with the villagers, which will be described later.

SEASONAL CALENDARS ON ACTIVITIES

The aim of conducting seasonal calendars was to investigate the activities of the villagers throughout the year (Mikkelsen, 2005). The seasonal calendar was conducted with both women and men in two separate groups to visualize potential differences in labour distribution, type of work and seasonality of activities. Even though both farming and non-farming activities were discussed, the emphasis was on farming activities. Both sessions followed the same guideline and took place at the same time in order to keep men and women separate (Appendix VI).

SOIL SAMPLING

Soil quality is a major concern when land use decisions are made, especially for smallholder farmers (Pauli et al., 2012; Erkossa *et al*., 2004). In order to investigate the

farmers' perception of soil quality, quantitative and qualitative data have been compared. From a quantitative perspective, soil samples have been collected to carry physical and chemical analysis.

Based on information from the questionnaires and interviews with farmers, two pepper fields were chosen as sample sites. Both sites were characterized by similar land use history, management practices, and topography. However, the farmers perceived the soil quality of the two fields as different. At each field, sample collection proceeded as follows:

VOLUME SPECIFIC SAMPLING with a 100cm3 ring - three profiles of 50cm x 40cm x 30cm (length x depth x width) were dug at the top, middle and bottom of the slope, making sure not to damage the pepper plants. In each profile, one vertical sample was taken from the topsoil (0-5cm, A horizon), and one horizontal taken from a depth of 30cm (27 - 33cm, B horizon).

SOIL PHYSICAL AND CHEMICAL ANALYSIS

Soil colour for both A and B horizon has been described in situ through the Munsell colour system. The samples have been air dried, weighed for the calculation of bulk density, and crushed to fine powder for chemical analysis in the laboratory at the Department of Plant and Environmental Science. The parameters analysed were pH, permanganate oxidizable carbon (PoxC), total carbon (C) and total nitrogen (N). The pH have been measured in a 1:2.5 soil:water solution using a pH meter. PoxC, a sensitive indicator of alterations of soil quality due to management practices, was determined in a solution of 0.02 M $KMnO_4$ in 0.1 M $CaCl_2$ at pH 7.2 (Culman *et al.*, 2012; Weil *et al.*, 2003; Blair *et al.*, 1995). Total C and N have been assessed by Isotope-Ratio Mass Spectrometry (IR-MS).

TRANSECT WALKS

As a participatory method, two transect walks were conducted on the soil sampling sites. The aim was to get a thoroughly understanding of *land use history* and *management*, and to identify which criteria influence the *farmers' perception of soil quality* (Mikkelsen, 2005).

Taking point of departure in the principles of giving by Selener (1999), the transect walks were conducted with two farmers. In both transect walks, the farmers neither did prepare nor fill out the transect diagram, and the categories in the diagramme was

predetermined according to the research interests. In both transect walks, the farmers were asked to point out the best and the worst soil in the field.

WATER SAMPLING

The water quality analyses were conducted to investigate if - and to what extent - the upstream activities of logging and intensified agricultural practices affect the quality of the water resources in Nanga Kesit.

The samples were taken from Kesit River and Lemanak River, which are important sources of water for daily household purposes of the villagers. Additionally, a sample from the gravity feed water source was taken to investigate the quality of the drinking water (**Figure 2** and **Table 2**) (Appendix VII).

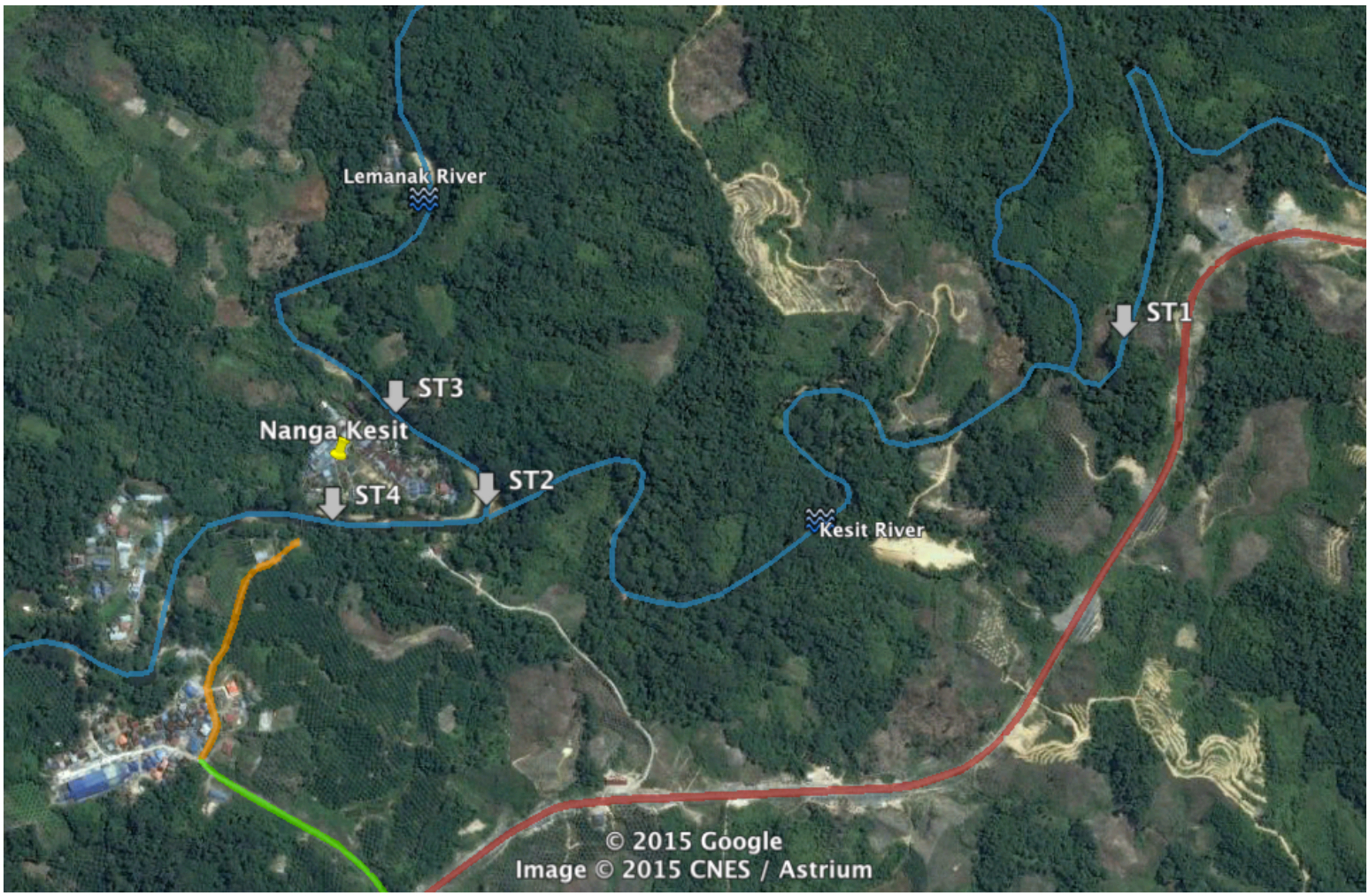


Figure 2 The locations of the sampling stations along the Kesit River and Lemanak River.

Table 3 Locations and GPS coordinates of the 4 sample stations

STATION	LOCATION	GPS COORDINATES
ST1	Upstream of Kesit River	N 01°14'09.0 E 111°47'52.2
ST2	Downstream of Kesit River	N 01°13'58.9 E 111°47'17.2
ST3	Ulu Lemanak River	N 01°14'01.56 E 111°47'15.85
ST4	Lemanak River	N 01°13'59.0 E 111°47'10.3

As described in Standard Methods for Examination of Water and Wastewater (USEPA, 2012), the water quality was assessed by measuring in-situ physical parameters, including pH, temperature, turbidity, conductivity and total suspended solid. In order to get the most accurate measurements (USEPA, 2012), a Water Quality Meter (HACH multimeter probe) was used for these analyses (SLUSE, 2014). Further measurements necessary for analysing chemical parameters, including ammonia nitrogen, nitrate, nitrite and phosphor, and biological parameters, including FCC and TCC, were executed in the laboratory.

The measured in-situ parameters of surface water and measurements processed in the laboratory were compared to the Interim National Water Quality Standard for Malaysia (INWQS) to evaluate the water quality (NREB, 2015). The physico-chemical parameters were used as individual water quality indicators, and later on combined to classify the sample stations according to water quality index (WQI). WQI is a way of simplifying extensive amount of data into a single value that indicates the level of contamination in the rivers. The contamination captured from both natural sources and anthropogenic activities, at a particular location in a specific time, making it possible to compare sample sites (Hossain, 2013).

2.2.3 THE PARTICIPATORY PHASE

SEMI-STRUCTURED INTERVIEWS WITH VILLAGERS

To obtain in depth knowledge about changes in land use decisions and income generating activities, as well as benefits and constraints related to the road

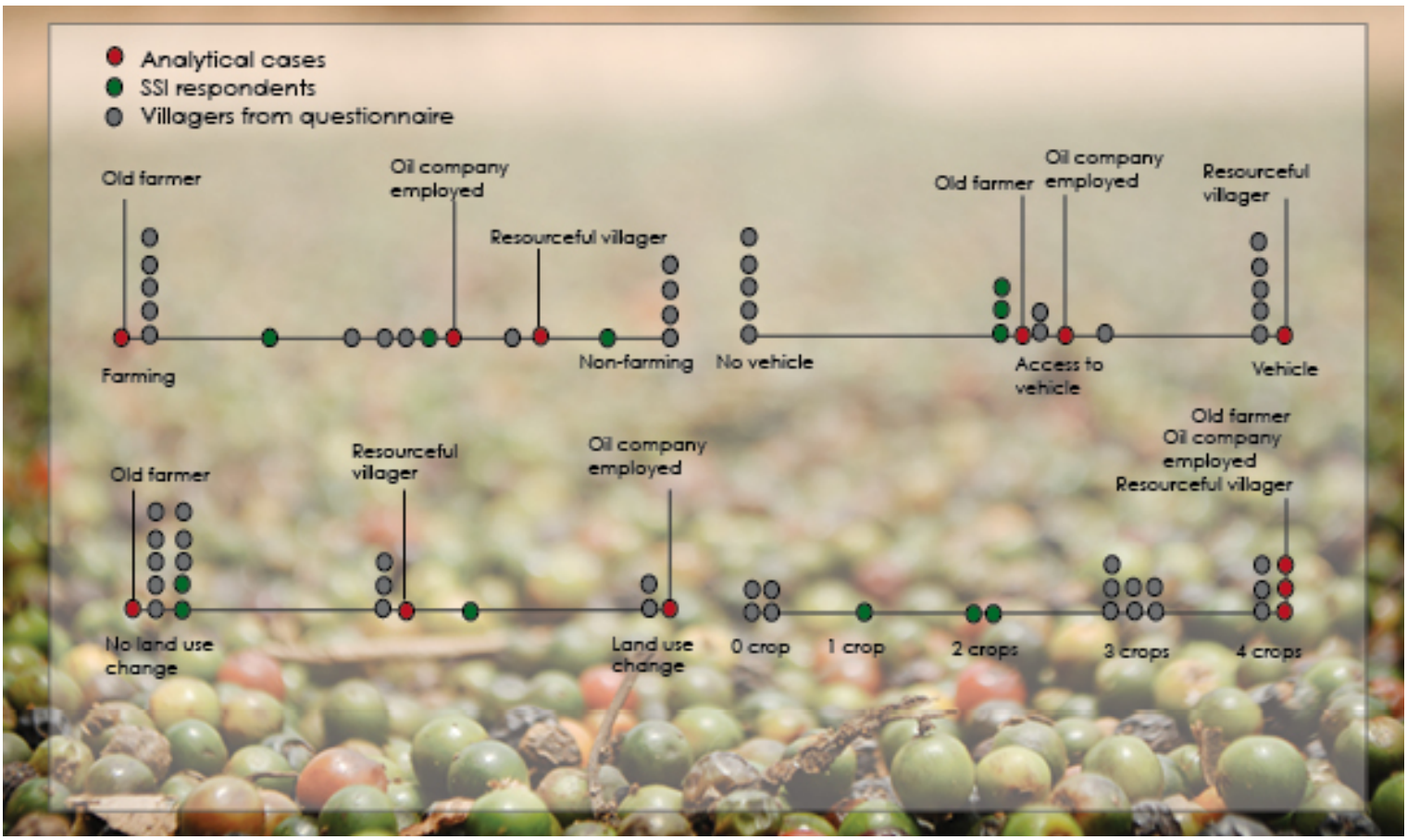
construction, SSIs were conducted with four villagers (Kvale & Brinkmann, 2009; Mikkelsen, 2005). An interview guide was developed based on the following themes: *land use decisions, utilization of forest area, income diversification* and the *road* (Appendix VIII). Due to the need of changing the approach of the study (see Chapter 5), the interview guide was not followed fully in the interviews. However, the topics remained as the foci.

From the knowledge obtained in the questionnaires, informal talks and observations, eight key informants were selected based on the following criteria:

- Ownership or no ownership of at least one mean of transport
- More or less diversification between farming or non-farming activities
- Diversification within farming activities
- More or less land use change within the last 10 years

Box 2 shows how the key informants were distributed within the four categories and who we ended up conducting the interviews with. The red dots represent the key informants selected for the analysis. They were chosen based on their different combinations of livelihood strategies and outcomes, and represented bigger groups of the village.

Box 2 Overview of respondents and criteria for sampling



INFORMAL, CONVERSATIONAL INTERVIEWS

Informal, conversational interviews were taking place whenever it was possible. Most of these conversations emerged from the casual conversation held with the villagers, when they were relaxing outside their *bilik* in the evenings. Often no predefined questions were made, since it was often not planned. Well aware of several limitations connected to this method, the talks were used to get a deeper understanding of certain themes related to the research objective (Casley & Kumar, 1988). Before going to bed, field notes were typed in from the information gathered (Mikkelsen, 2005).

PARTICIPANT OBSERVATIONS

As an overarching method for getting a deeper understanding of the everyday practices carried out by the villagers, *participant observations* were conducted throughout the study period (Emmerson *et al.*, 2011). Through more or less participatory observations, we took part in daily life activities and events, including a trip to the market as well as rice and pepper harvesting. Since this method implies collection of data in a relatively informal and unstructured way, efforts were made in writing field notes continuously during the stay (Dewalt & Dewalt, 1998).

FOREST WALK

The aim of the forest walk was to gather first hand observations and triangulate with informal interviews with our local guides to obtain knowledge of the villager's collection of non-timber forest products (NTFP). Furthermore, the aim was to assess how these NTFP are used both in the sense of self-consumption and income generation activities now and before the road was constructed. Therefore, two villagers with knowledge about the forest were guiding the walk and explained the utilization of different plants from the forest (Strang, 2010).

2.3 ANALYSIS STRATEGY

The framework for the analysis will be the SLF with point of departure in the work of Ellis (2000a), Scoones (1998; 2009) and DFID (1999).

The locus of attention in the analysis will be on *livelihood strategies*, which will be related to the *livelihood outcomes* and *access to assets*. Thus, due to limited study period, the study does not aim at applying the complete framework on the empirical data, even

though this would have enabled a deeper understanding of the villagers' lives, context and livelihood strategies (Scoones, 1998). Figure XX illustrates the focus of the analysis, which is based on the SLF (Appendix IX)

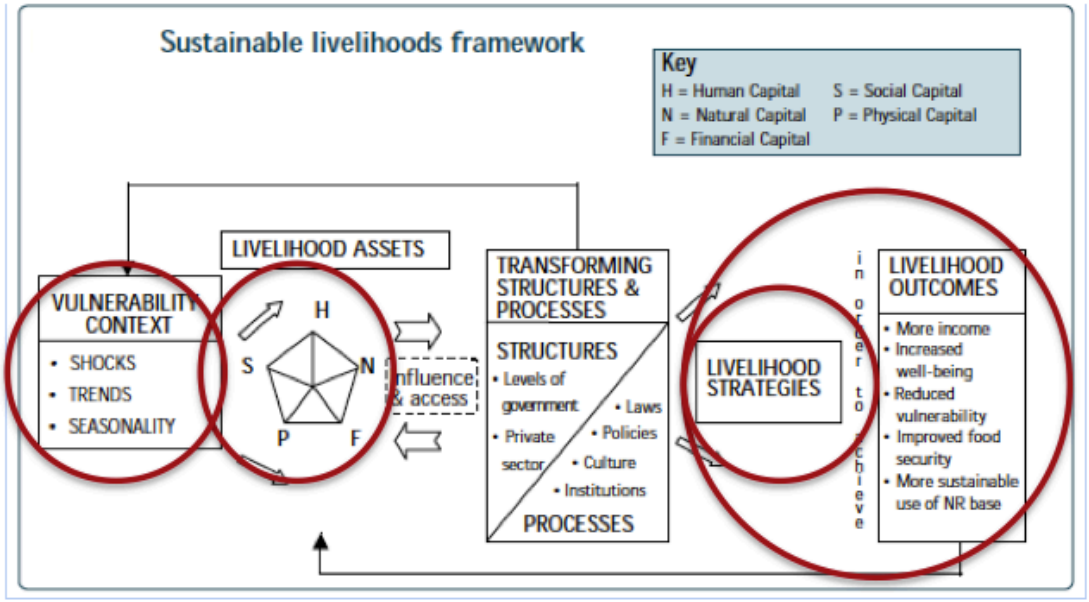


Figure 3 Sustainable Livelihoods Framework (SLF)(DFID, 1999).

Each individual section of the analysis relates to a research question, thus different ways of coding (driven by either theory, research interest and data) has been applied (Kristiansen, 2010).

3.0 // RESULTS AND ANALYSIS

This chapter will present and discuss the results and analysis derived from the data. Following a short section on context knowledge of the study site, the structure of the analysis will follow the structure of the research questions.

3.1 CONTEXT OF THE STUDY SITE: NANGA KESIT

Nanga Kesit comprises two separate longhouses under the jurisdiction of a headman and a headwoman, respectively (Box 2). Based on preliminary investigations, this study focused only on the community governed by the headman, which comprises a total of 27[1] households and 108 permanent residents[2] (Figure 3).

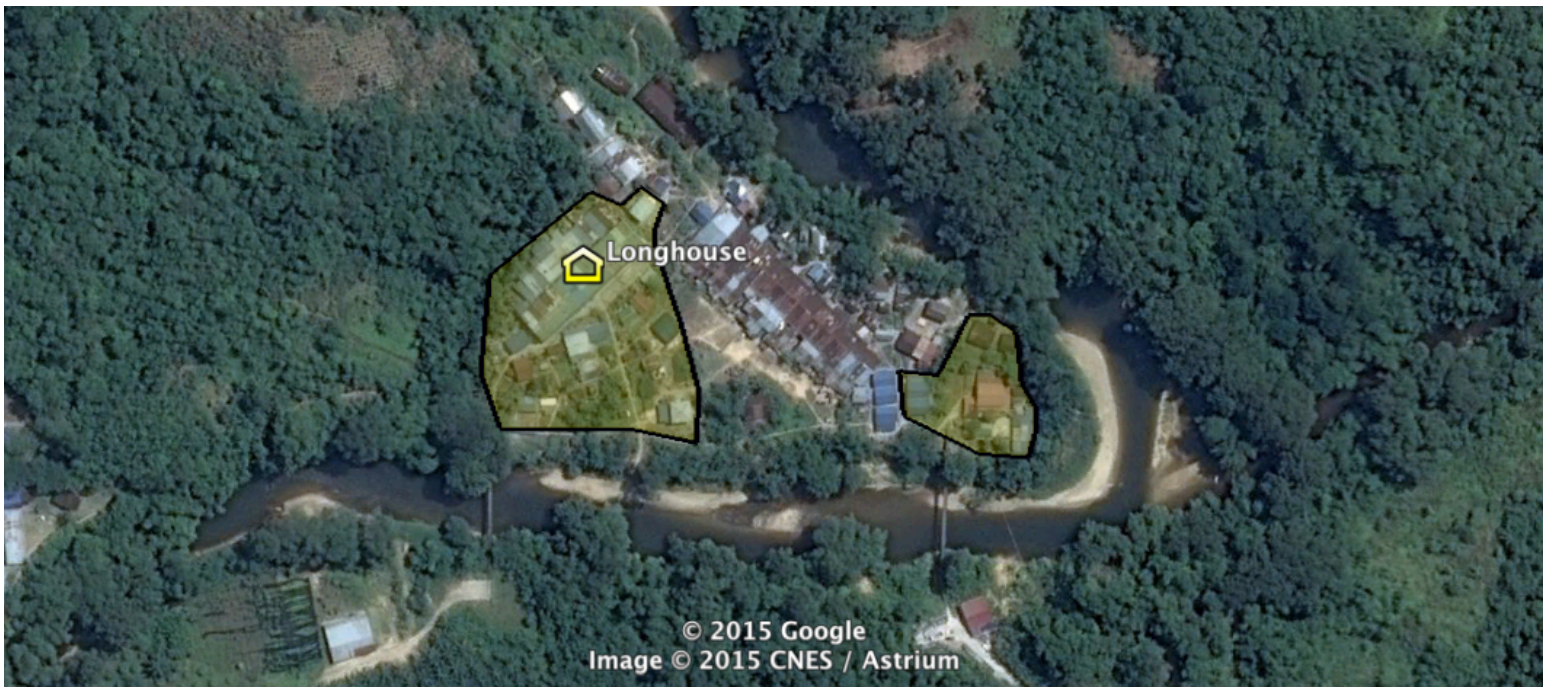
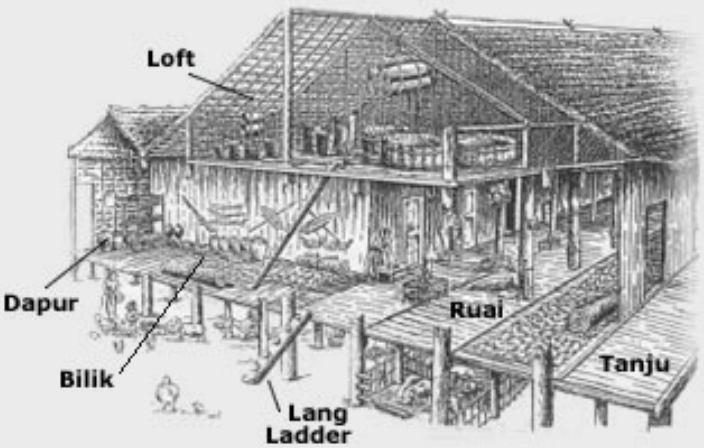


Figure 4 Nanga Kesit Village. Marked in yellow the area under the headman's jurisdiction (i.e. the focus of this study).

[1] This number has been provided by the headman. We counted 15 HH in the longhouse (of which 12 were inhabited) and 15 individual houses (of which 3 were found empty and 2 were included
[2] The remaining report will from this point refer to the longhouse under jurisdiction of the headman, when noting "villagers of Nanga Kesit" or "village".

Box 3 The Longhouse

A longhouse is the traditional Iban residential structure. It comprises different houses, called *bilik,* built one next to each other and sharing an inner and an outer veranda. Either a headman or a headwoman governs the longhouse, usually with the assistance of a secretary, treasurer, and both a men and a women council.



Source: Capslock, 2011

Taking point of departure in SLF (DFID, 1999), a brief overview of the *vulnerability context*[3] of the people of Nanga Kesit has been made (**Figure 5**). The figure will not be elaborated on here, but will be referred to in the later analysis sections.

TRENDS	SHOCKS	SEASONALITY
Population trends Relatively old population Youth move away for school or job opportunities **Resource trends** No vacant land Cultivation of oil palm, rice, pepper, rubber. **National/International economic trends** Fluctuating prices on crops **Technological trends** Electricity installed No telephone reception	**Economic shock** Dramatic decrease in rubber prices	**Prices** Decreasing prices on oil palm Unstable pepper prices **Production** Different labour intensity with different crops **Employment opportunities** Construction work on a project basis

Figure 5 Overview of the different aspects of the vulnerability context with information derived from the field work. Modified from/The figure is based on selected relevant categories from the SLF (DFID, 1999).

[3] It should be stressed that not all trends and factors influencing the vulnerability context are negative (DFID 1999)

The majority of the households in Nanga Kesit are engaged in both *farming* and *non-farming activities* (**Figure 6**).

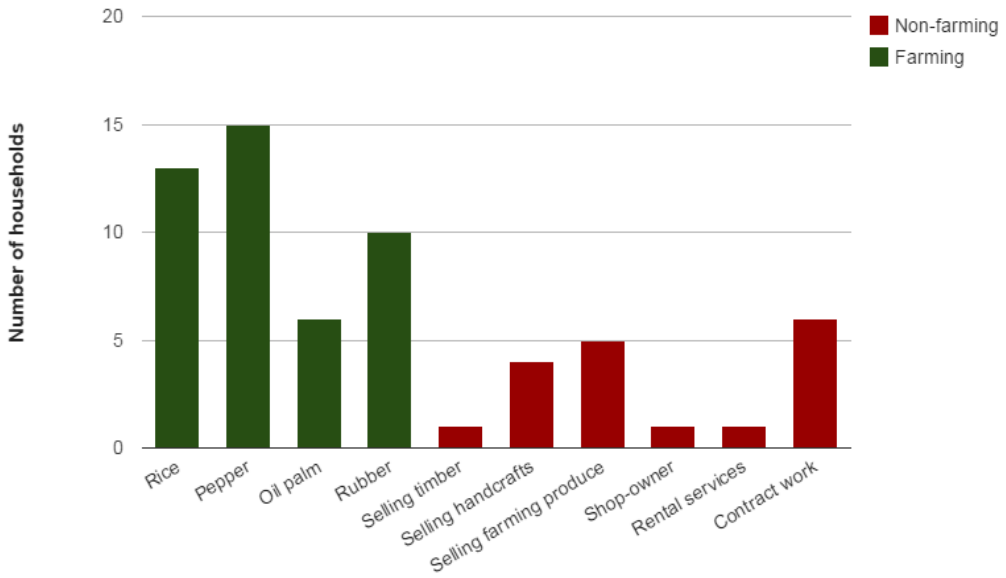


Figure 6 Number of households engaged in farming and non-farming activities present in Nanga Kesit based on the 19 questionnaires. A household can be engaged in more than one of the above activities. Remittances have also been included since they constitute an additional asset, when considering the household livelihood.

The majority of the households have diversified *livelihood portfolios* consisting of several of the above activities, and the diversification takes place both *within farming activities*, *within non-farming activities* and *between farming and non-farming activities*.

In order to analyse whether the recent improvements in the road network have had an impact on the livelihood strategies seen in Nanga Kesit, the types of diversification will be investigated further in the following analysis sections. Taking point of departure in the *farming activities*, the following section 3.2 will look further into three aspects; At first, the focus will be on *land use changes* in Nanga Kesit, followed by an investigation of how *land use decisions* are made by the farmers. This includes a comparison of the local perceptions of soil and a soil analysis, since soil quality is one of the criteria influencing land use decisions. Subsequently, the *impact of land use changes on water resources*, an important natural resource for the village, will be discussed. At last, section 3.3 will focus on *livelihood diversification* on a household level including both *farming* and *non-farming activities*.

3.2 LAND USE CHANGES

In terms of the current land use in Nanga Kesit, rice appears to be the main staple crop, though cash crops also occupy a significant share of their land. Pepper seems to be the most common, due to high market prices, whereas oil palm is still relatively new and rubber is largely left untapped, only with few exceptions.

3.2.1 LAND USE CHANGES IN NANGA KESIT

In relation to the *land use changes*, the data collected through the questionnaires, PRA mapping and SSIs give an overview on the land use before and after the road from Lubok Subong to Sekunyit was completed in 2009.

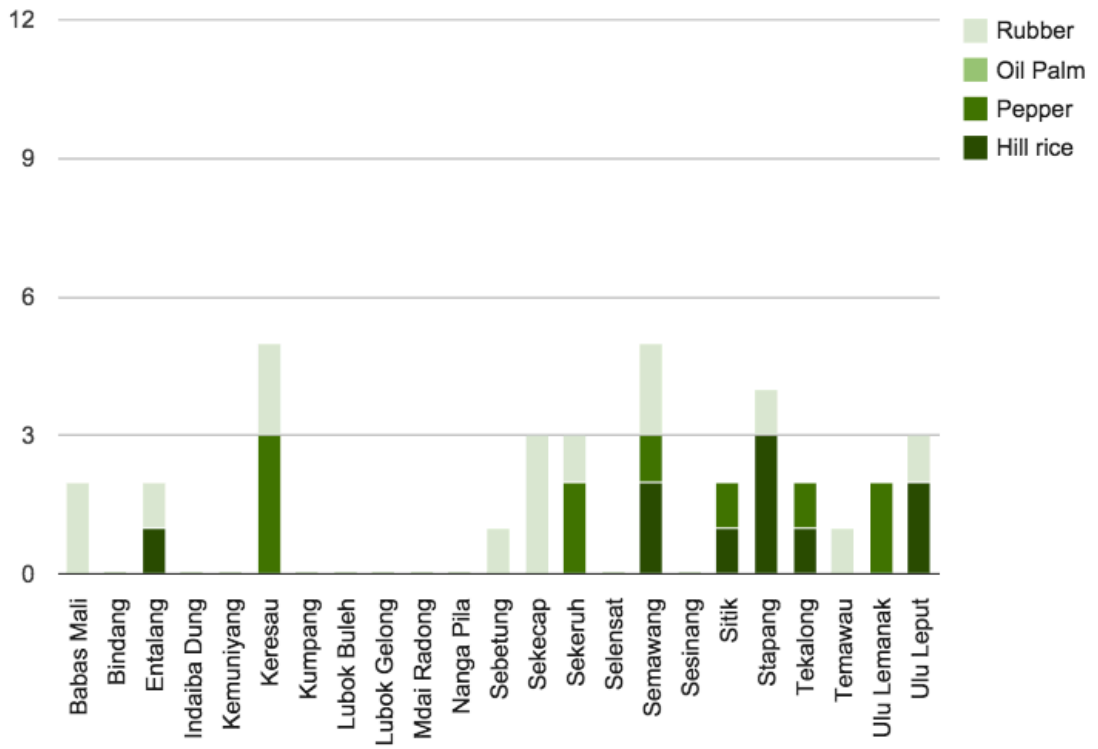


Figure 7 Characteristics crop distribution on different field use before the construction of the road[4]

[4] The fields are also being cultivated by other farmers, thus the crops seen in the figure, may not be the only crops in the fields.

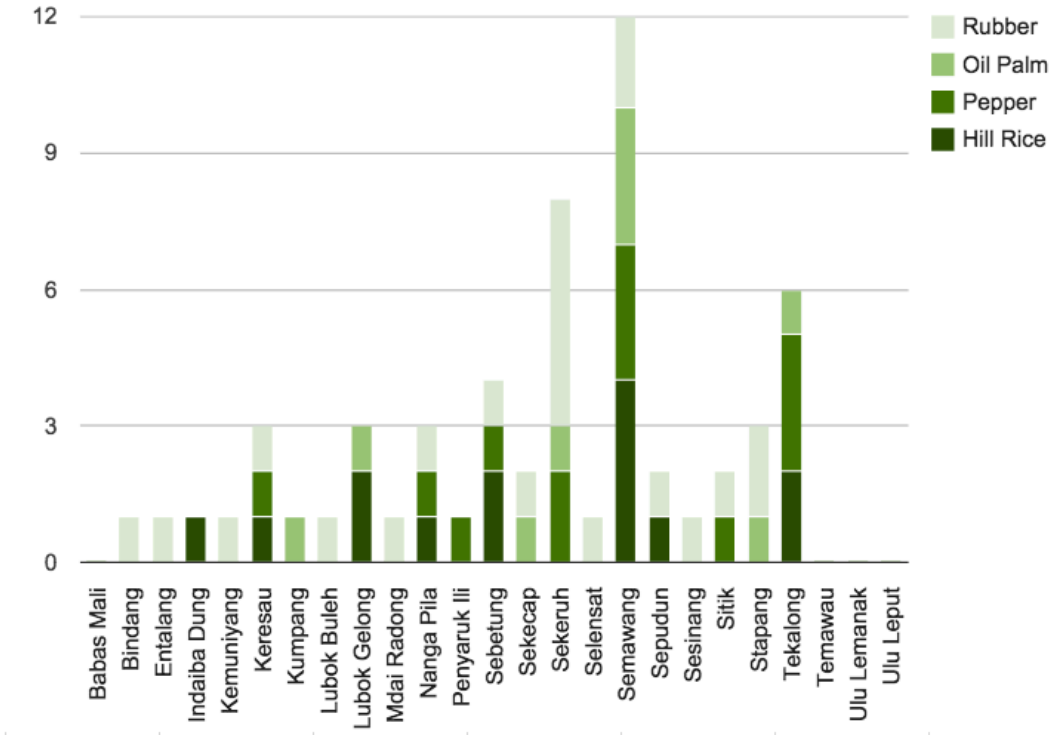
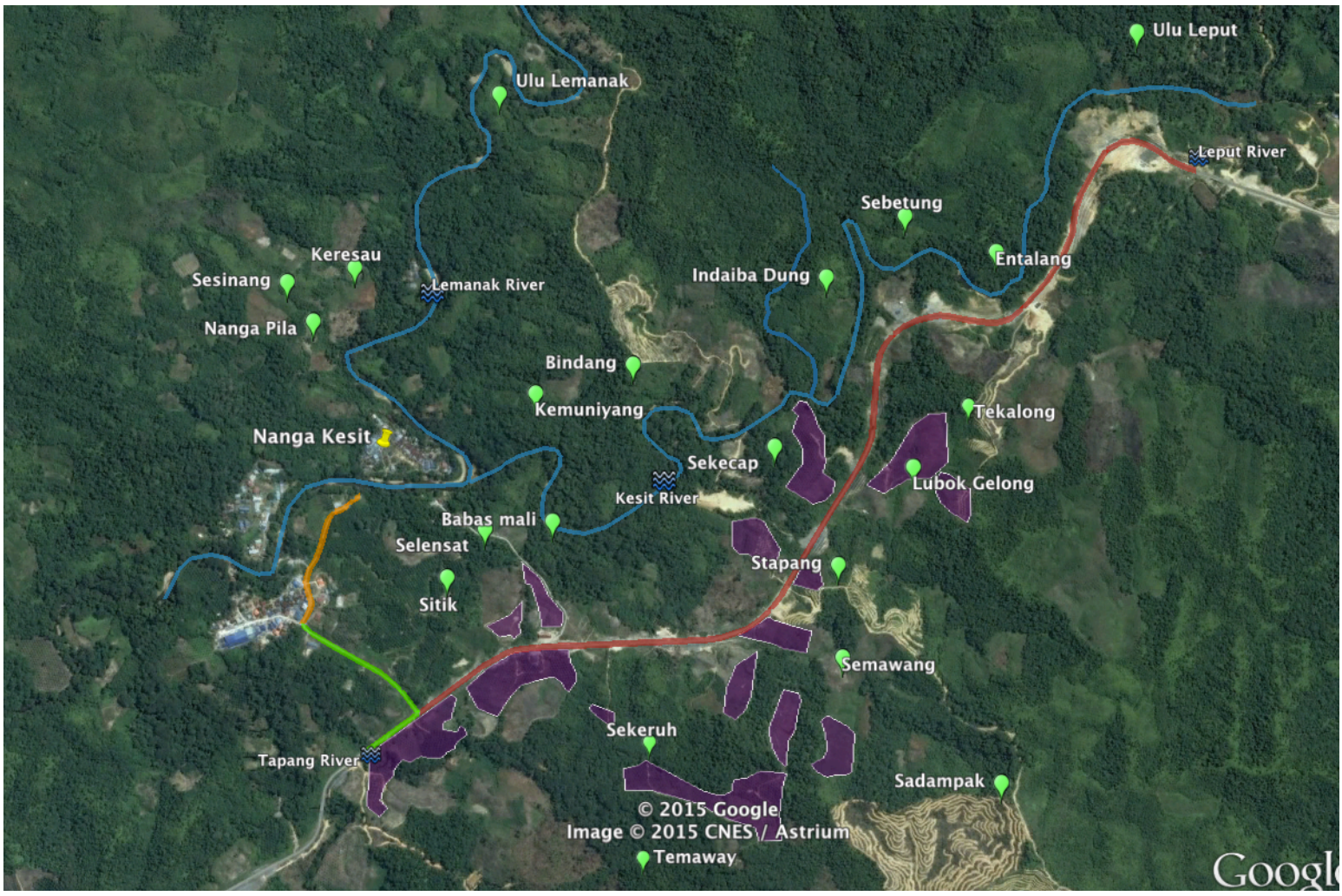


Figure 9 Characteristics crop distribution on different field use after the construction of the road.

Figure 8 Nanga Kesit area, with roads, rivers and fields (in green). Highlighted in purple the new oil palm plantations.



Overall, 23 fields in the figures[5] were mentioned by the villagers and the mapping exercise revealed some changes in land use since 2009 (**Figure 7** and **8**). A number of cultivated fields seem to have increased since 2009, though some fields also appear to be abandoned, including Babas Mali, Temawau, Ulu Lemanak and Ulu Leput (Figure 2). At present, Babas Mali is a cemetery, and the three latter are relatively far away from the village; actually only Ulu Leput is accessible by car.

Additionally, the cultivation in Sebetung, Sekeruh, Semawang and Tekalong seems to have intensified[6] since 2009, though the higher number of plots in the same area could be explained by the introduction of new crops on the same field. Oil palm was not cultivated before 2009, and pepper cultivation has increased from 10 to 13 plots. As shown in Figure 8, oil palm is now cultivated on 9 different plots, and based on the questionnaires, we know, that all those fields are younger than 5 years and accessible by the road.

CHANGES OF FIELD LOCATIONS

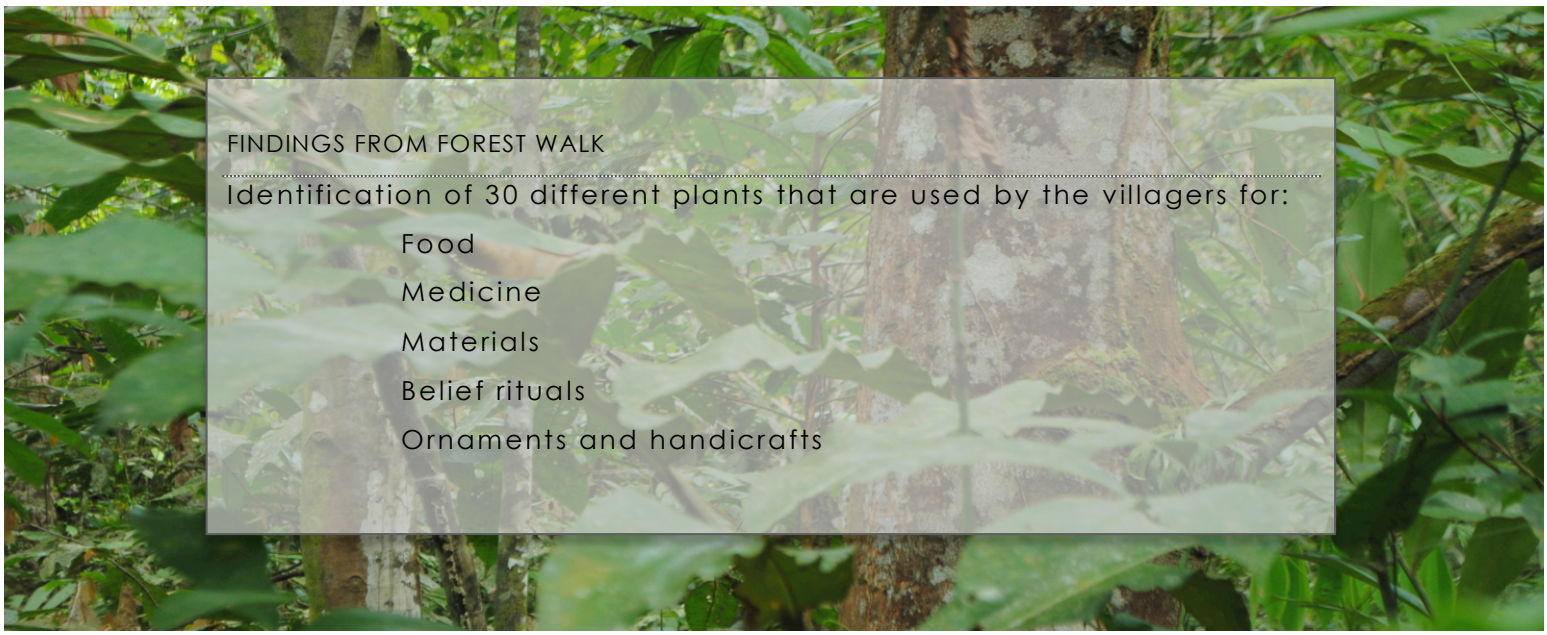
A possible explanation *why* the land use had changed is derived from the participatory mapping. The villagers explained that because of the construction of the road, they had after 2009 obtained easier access to other field than before. The majority of fields cultivated before 2009 were relatively close to the river, which corresponds to the fact, that the mean of transport at that time was by boat. After the road construction, the access to other fields had become possible or easier. Even though, not all the villagers owned a vehicle, we discovered based on the SSIs and questionnaires, that some villagers would borrow one in exchange of labour. Furthermore, since the transport time to the field reduced after the road construction compared to the previous boat transport, the road construction may have led to increased time available in the fields. This may be one of the explanations behind the intensification in some of the fields or behind the cultivation of new areas. At the same time, it could also justify the more extensive cultivation seen in the same area.

[5] The data used for drawing the map originated from the combination of PRA mapping and questionnaires. Since the main purpose of PRA mapping was not accuracy, some fields are missing because not enough information was gathered to place them on the map, while others might be placed wrong. Moreover, the oil palm fields have been identified by looking at the aerial images, taking into account the boundaries of the village. However it was not possible to distinguish between the fields owned by the two different longhouses.

[6] Intensification in this context is meant in terms of number of farmers cultivating in the same area.

CHANGES IN USE OF NON-TIMBER-FOREST-PRODUCTS

Land use changes outside the scope of farming activities also seemed to occur due to the road construction. The guides from the forest walk reported that the collection of NTFP from the forest has decreased since the markets for buying food were accessible by car. Through other informal talks we were told that when the tourism stopped the demand for handicraft materials decreased. Though, it is difficult to state a direct correlation between the road and the decrease usage of the forest, because the discontinued tourism most likely also have had an impact on the collection of NTFP.



3.2.2 LAND USE DECISION-MAKING

Land use changes and rural livelihood strategies are both closely interlinked with land use decision-making, which will be investigated in the following section. When investigating this, it is vital to the *livelihood outcomes* that may influence the decision-making.

Four outcomes related to land use decisions were identified; *food security, income, land tenure security* and *cultural value*, which can be interpreted as core drivers of land use decisions. Especially, the *food security* and *cultural values* seemed to be strong determinants behind the cultivation of rice, which justifies its definition as staple crop instead of simple food crop. On the other hand, *income* seemed to be an

important factor when choosing to plant pepper, oil palm and rubber. The case of *land tenure security* will be elaborated on in relation to schemes in box XX.

Having identified the outcomes of the farmers, the *access to assets* are also important to take into consideration. This can both be done on household or village level. In the following, the general picture for the villagers of Nanga Kesit will be the unit of analysis.

The available assets in the household can be influenced both by the *vulnerability context* (box xx2), and the *governmental schemes and subsidies programmes* related to transforming structures and processes from the SLF (see Appendix IX). **Figure 10** visualizes the different aspects and findings in the analysis related to land use decision-making and will be elaborated below.

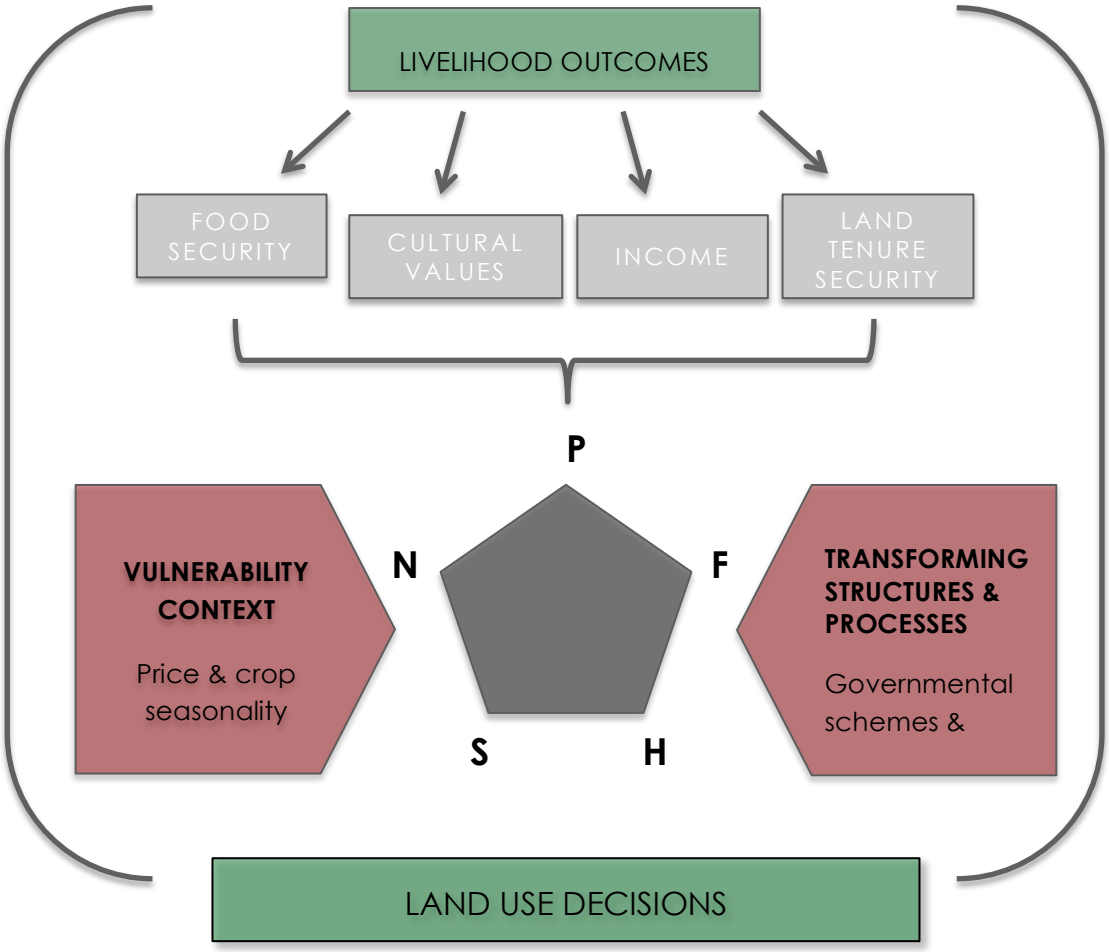


Figure 10 Outcomes, assets and seasonality regulate the process of land use decision-making.

SEASONALITY OF MARKET PRICES AND CROPS

For the case of this study, the *seasonality* within the vulnerability context showed to be particular important. Market prices appeared to be an important determinant for the choice of planting (and harvesting) cash crops. At the moment pepper is the most convenient cash crop sold for 28 RM/kg, whereas the prices for oil palm and rubber have been decreasing since 2010 (GEM, 2015). This reliance on market fluctuations, exposes the farmers to a certain degree of vulnerability (box xx). This is especially evident when considering cultivation of pepper, rubber and oil palm. All of these can be planted all year around in response to favourable market prices, though the harvest cannot start before 3, 5 and 3 years of age, respectively. However, once the rubber tree is mature, it can be left untapped if there is no demand for income. This practice was seen in the village. These practices allow more flexibility in response to market

fluctuations. It is therefore impossible to separate seasonality of *market prices* and of *crop productio*n.

GOVERNMENTAL SCHEMES AND SUBSIDIES

Another aspect influencing the available *assets* showed to be *governmental schemes and subsidies*, as they created incentives to cultivation of certain crops. In Nanga Kesit, governmental support to rubber production is quite evident. Fields in Stapang and Sadampak are being cleared by the authorities under the Joint Venture Company (JVC) scheme Skim Ladang Getah, asked by the villagers 3 years ago. The Malaysian Rubber Board launched the Rubber Mini Estate 5 year scheme in 2011, distributing 1800 samplings, fertilisers and chemicals to each of the 34 households participating. The villagers reported of a process of selection of the participants to governmental schemes, to which it is necessary to apply by filling in forms. None of the six farmers in Nanga Kesit cultivating oil palm in Nanga Kesit appeared to be involved. A JVC scheme proposed to the villagers three years ago had been rejected. The main concern according to the informants was related to land tenure; the farmers are indeed quite skeptical when it comes to lease their land for 60 years.

A brief overview of the present schemes and possible subsidies available to farmers in Nanga Kesit is summarized in **Box 4**.

Box 4 Schemes and subsidies for rice, rubber and oil palm.

Rice is a well protected crop due to governmental regulations through import restriction and fertilizer subsidies that help the farmers to keep the yield high and costs, thus sustain rice as a staple food (Ramli, 2012). As profitable cash crop production increases, it makes the labour intensive rice production less attractive. Therefore, subsidies become essential for sustaining the farmer's self-sufficiency in rice, which is an important part of their life and culture.

Malaysia positions as one of the world's largest exporter of natural **rubber** and producer of 60% of the world's supply of latex gloves, makes rubber production of political, strategic and economic importance for the country (BBC, 2014). Rubber schemes and subsidies on fertilizer and saplings make it favourable to plant rubber even though the there is no demand for it (Borneo Post, 2013).

Oil palm schemes are widespread all around Malaysia at the moment (Cramb & Sujang, 2013).

ACCESS TO ASSETS IN RELATION TO LAND USE DECISION-MAKING

With the identified livelihood outcomes and possible influences from seasonality and schemes in mind, the access to the different types of assets will be presented in the following section.

As already discussed in the previous section, the changes in the **physical capital** due to the road construction brought some significant changes to the land use. Better infrastructure, including the possibility to use vehicles to reach certain fields has most likely created incentives to more intense use of land in some areas.

The above changes also created new possibilities for improvements in the **financial capital**, which also appeared to be an influential in land use decision-making. Compensations for the road construction provided some villagers with more financial capital for, which in some cases were used for buying rubber or oil palm saplings. On the other hand, some villagers informed that they collected rubber seeds on the fields when they lacked enough money to buy their own saplings.

Furthermore, **human capital** had impact on the farmers' land use decision-making, since labour availability influenced the possible utilisation of land and the intensity of agricultural activity. The migration of the younger generation of Nanga Kesit reduces the availability of labour dedicated to farming activities. According to the villagers, gender and age also influence the labour availability. In seasonal calendar exercise, the women expressed that they lack the physical strength to carry the harvested oil palm fruit. Further, one of the older villagers also expressed the wish of reducing the size of his rice field, since it was too hard work. For the more resourceful households, hired labour was also an option. Previous experiences of hiring Indonesian migrant workers to tap rubber were not uncommon among the villagers. Concerning less resourceful households, **social capital** allows farmers to join *beduruk* (the Iban word referring to labour exchange practices), where the villagers organize in groups and help each other out during the harvest period, especially on rice fields. Both in the case of *beduruk* and hired labour, trust showed to be an important criteria of success, as some farmers reported discomfort when relying on others. This was mainly because of negative and unsatisfying past experiences. The farmers' participation in *beduruk* has at times been unreliable, whereas Indonesian workers was in general being accused of applying stimulants to increase rubber production, causing damage t the plants in the longer perspective. .

The latter illustrates that concerns about **natural capital** was also seen as an important aspect in the land use decision-making. Even though no vacant land was left around the village, land pressure did not seem to be an issue in the village. The villagers counted a number of fallow fields, abandoned mostly because of their distance. Land access seemed to be an issue only for foreigners moving to the village. Furthermore, land suitability is also and determining factor in land use decision-making, since it allows cultivation of certain crops irrespectively of one's livelihood outcomes. Therefore, the next section focus on this.

SOIL QUALITY PERCEPTIONS BEHIND LAND USE DECISIONS

In relation to land suitability, which is one of the criteria behind the farmers' land use decision-making, the farmers' perception of the soil quality of their fields seemed to be very important. This section compares the results of a laboratory analysis of soil quality in two different fields, and compares it with the farmers' perception of the soil quality.

Table 3 describes the characteristics of the two selected fields (**Figure 11**), focusing on land use history and management practices, important baseline data for the interpretation of the following results of chemical and physical analysis (**Table 4**).

Figure 11 Soil sampling sites. Semawang is 2.5km away from Nanga Kesit, but most of the track is accessible by car. Sitik is only 0.54km from the village and only accessible by walk.

Table 4 Description of the two fields selected for soil sampling

FIELD NO. AND OVERALL PERCEPTION	FIELD 1 - "BAD SOIL"	FIELD 2 - "GOOD SOIL"
LOCATION	Sitik	Semawang
SIZE	809m²	950m² / 300 plants
SLOPE	29% E	25% NNW
LAND USE HISTORY	- Rubber 2009 slash and burn for planting hill rice 2010 pepper	- Rubber 2013 slash and burn for planting hill rice 2014 pepper
MANAGEMENT	n.a.	Mulching with rice straw and weeds
FERTILISER APPLICATION	12-12-17+2+TE localized: in pits around the plants	12-12-17+2+TE localized: in pits around the plants
LAST APPLICATION	6 weeks before sampling	one week before sampling
AMOUNT	25kg	50kg
FARMERS´ STATEMENTS ON SOIL QUALITY	"bad soil, especially at the bottom of the slope" "worsened over time" "no worm dung" "too much fertiliser in the past"	"good soil, especially at the bottom of the slope, because of the water from the stream" "new soil" "organic soil" "black is good"

Table 5 Results of physical and chemical soil analysis

		Colour		Depth (cm)		Bulk density (g/cm3)		pH	
		"bad soil"	"good soil"	"bad soil"	"good soil"	"bad soil"	"good soil"	"bad soil"	"good soil"
P1	**A**	2.2 very dark brown	3.3 dark brown	10	5*	1,0265	1,1014	3,14	3,70
	B	6.6 - brownish yellow	6.6 - brownish yellow	-	-	1,5437	1,2864	4,46	4,71
P2	**A**	3.1 very dark gray	2.5/3 very dark brown	7	7	1,1646	0,9503	4,69	3,30
	B	6.8 reddish yellow	6.6 - brownish yellow	-	-	1,5115	1,4633	4,08	3,74
P3	**A**	3.1 very dark gray	2.2 very dark brown	7	6**	1,2978	0,9618	4,31	4
	B	6,6 reddish yellow	6.6 - brownish yellow	-	-	1,5330	1,3558	4,68	3,70

* Plus 4 cm of organic matter
** Plus 2 cm of organic matter

		Soil active C – PoxC (mg/kg)		%N		%C		C/N	
		"bad soil"	"good soil"	"bad soil"	"good soil"	"bad soil"	"good soil"	"bad soil"	"good soil"
P1	**A**	456	552	0,21	0,17	3,94	2,77	18,76	16,29
	B	24	48	0,07	0,11	0,34	0,73	4,86	6,64
P2	**A**	576	1176	0,09	0,26	0,53	5,32	5,89	20,46
	B	0	24	0,19	0,08	2,72	0,48	14,32	6,00
P3	**A**	192	528	0,14	0,2	1,76	3,16	12,57	15,80
	B	0	72	0,08	0,1	0,48	0,67	6,00	6,70

Legenda P1: upslope profile, P2: middle slope profile, P3: bottom slope profile, A: A horizon, B: B horizon.

PHYSICAL ANALYSIS

Based on observations, the soil on the selected sites can be ascribed to **Ultisols**, deep well-drained red-yellow podzolic soils on sedimentary, acid igneous and metamorphic rocks - as described in the literature and local soil maps (Bruun *et al.,* 2013; Chapin III *et al.,* 2011; Paramananthan, 2000; Coulter, 1998; Sarawak Department of Agriculture, 1968). The two fields do not present major differences in terms of **colour**. At both sites, the reddish- yellow colour of the B horizon reflects the presence of aluminium (Al) and iron (Fe), whereas the organic matter gradient can be deducted from the dark colour of the topsoil (Olaitan & Lombin, 1984).

Even though the two fields can be classified as "moderately steep" (FAO, 2006), the **slope effect** claimed by the farmers cannot be deducted from the data; differences in values between the three profiles (P1, P2, P3) can be interpreted as variations within the same plot, which could be explained by the non-uniform terrain. **Bulk density** is generally lower in field 2 (the "good" soil), which can be interpreted as soil porosity and organic matter contributing to the formation of a better soil structure (Chapin III *et al.*, 2011).

CHEMICAL ANALYSIS

The **pH** values show quite acidic soils, as it is characteristic for tropical areas (Coulter, 1998). Two general patterns can be identified: in both fields, the topsoil is more acidic than the B horizon, and the "good soil" showed lower pH. Parent material, high rainfall and consequent leaching, fertiliser use, and cultivation, common causes for acidification (Harter, 2002), can explain both trends occurring in our case. More specifically, the recent use of P rich fertiliser, together with the large amount of organic matter deposited on the surface, might have lowered the pH of the "good soil".

SOIL ORGANIC CARBON The analysis of the labile fraction of Soil Organic Carbon (SOC) - **PoxC** - shows two other general patterns: the "good soil" contains more active carbon than the "bad soil". At the same time, it can be observed how in both fields the topsoil contains more active carbon than the B Horizon, matching the findings of Bruun *et al*. (2013). When comparing the PoxC values to the total concentration of carbon (**%C** as labile plus stable) and nitrogen (**%N**), it can be stated that higher PoxC values correspond to higher concentration of carbon (%C) - as found by Culman *et al*. (2012) - as well as higher concentrations of Nitrogen (%N).

Variations in SOC can be interpreted as consequences of management practices. With both mulch and fertilisers applied on the surface, we expect a more visible impact on the topsoil rather than on the B Horizon (Tanaka *et al.*, 2009). In addition, the application of a greater quantity of fertiliser to the "good soil" may be the explanation behind the higher concentration of Nitrogen, whereas mulching for the higher concentration of Carbon.

It is important to notice that the values for the concentration of Carbon (%C) and Nitrogen (%N) are in line with values from a study by Tanaka *et al.* (2009) that analyzed, amongst others, soil parameters for pepper farms in Sarawak. It is to be considered that

the pepper garden cultivated on "bad soil" is older (5 years compared to 1 year), therefore affecting the quality of the soil on a different scale.

"GOOD MANAGEMENT" OR "GOOD QUALITY OF SOIL"?

Observations and information from talks with the farmers about the management of their pepper fields help to complement the results from the laboratory analysis of the soil quality, and to analyse the results with regards to socio-economic characteristics of the farmers.

The field described as having "good soil" is cultivated by an experienced farmer who for several decades. Moreover, all his plots are concentrated in the same area and, since the construction of the road, he has easier access to them. As a result, land suitability with the "good" soil quality might reflect a higher level of care and attention given to the fields.

On the other hand, the field characterized as "bad soil" is owned by a family, whose members are engaged in different non-farming activities, with one of them living outside Nanga Kesit for most of the year. Thus, farming might only play a secondary role, and remittances could disincentive committed work in the farm. In addition, the plots owned by the family are distributed on different fields, increasing the time and labour resources needed.

This knowledge in the farmers and their practices help to understand possible reasons behind the difference in soil quality and show how land suitability and soil quality is interlinked with farm-management and land use decision-making. In order to triangulate the above analysis, further considerations on land suitability for pepper cultivation can be found in Appendix XIII.

COMPARISON BETWEEN LOCAL PERCEPTION OF SOIL QUALITY AND THE RESULTS OF THE ANALYSES

When the results of laboratory analysis are compared to the farmers' perceptions, it can be stated that these reflect reality (**Box 5**).

Box 5 Comparison between the farmers' perceptions of soil quality with the result of physical and chemical analysis

"Bad soil, especially at the bottom of the slope"
"Good soil, especially at the bottom of the slope, because of the water from the stream"

No slope effect could be confirmed by the data analysis. Differences between profiles can be explained as intra plot variations instead. This does not necessarily contradict the farmers' statements, which were based on observations of different degrees of plant growth and health along the slope. The lack of significant data could be blamed on the small number of replicates instead.

"Worsened over time"
"Too much fertilizer in the past"

When the younger pepper field is taken as a reference, the parameters for the 5yr old pepper field could be interpreted as a sign of soil quality worsening over time. Management practices (excessive fertilizer application) and soil topography (steeper slope) might have an influence too. However, further considerations about management practices are found in the next section.

"New, organic soil
"Black is good"
"No worm dung"

Colours do not variate much between the two fields. However the farmers recognize the beneficial presence of organic matter in the darker topsoil, which is confirmed by the results for SOC and PoxC.

3.2.3 THE IMPACT ON WATER RESOURCES

As seen in the analyses in 3.2.1 and 3.2.2, land use decision-making translates into changes in the landscape, which is affecting the general livelihoods of the people. During the conduction of the seasonal calendar and timeline it was stated, that the rivers around Nanga Kesit have a key role in their lives, but that the quality and use has decreased over time. Therefore, we chose to investigate whether or not the land use changes already presented have an effect on the water quality of the Lemanak and Kesit Rivers, main source of water for the villagers.

Table 6 Result from in-situ measurements and samples treated in the laboratory. The various measured parameters are described by following abbreviations: Total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen (NH3-N), phosphorus (P), nitrate (NO3), nitrite (NO2), faecal coliform count - E.coli bacteria (FCC) and total coliform count (TCC). Description of the INWQS classes can be found in appendix XI.

		Results				National Water Quality Standards For Malaysia					
		Stations				Class					
Parameter	**Unit**	**ST1**	**ST2**	**ST3**	**ST4**	**I**	**IIA**	**IIB**	**III**	**IV**	**V**
Physical parameters											
Temperature	°C	25.4	25.8	25.7	25.8	-	Normal +2	-	Normal +2	-	-
pH	-	7.37	7.14	7.11	7.02	6.5-8.5	6.5 - 8.5	6 - 9	6 - 9	< 5	>5
Turbidity	NTU	293	21	17	20	<5	<50	<50	-	-	-
TSS	mg/l	0.15	0.03	0.02	0.01	25	50	50	150	300	300
Chemical parameters											
DO	mg/l	6.84	6.23	6.85	6.86	<7	5 - 7	5 - 7	3 - 5	1-3	< 1
Salinity	%	0.01	0.01	0.01	0.01	0.5	1	-	-	2	-
BOD	mg/l	2.25	1.64	2.18	2.1	<1	1-3	1-3	3-6	6-12	> 12
COD	mg/l	575	60	75	60	<10	10-25	10-25	25-50	50-100	> 100
NH3-N	mg/l	0.6	0.6	0.6	0.22	<0.1	0.1-0.3	0.3	0.3-0.9	0.9-2.7	> 2.7
P	mg/l	1.62	0,00	0.595	0,76	<0,1**	0,1-0,2	0,2	0,1	-	#
NO3	mg/l	ND	0,06	0,07	0,07	**	7	7	-	5	#
NO2	mg/l	0,17	0,01	0,00	0,07	**	0,4	0,4	0.4 (0.3)	1	#
Biological parameters											
FCC	00 ml	1463	625	625	1763	<10	<100	<400	<5000	<5000	-
TCC	00 ml	2650	1325	1325	1475	<100	<5000	5000	50000	50000	50000

** natural level or absent

above level IV

ND - Not detectable

DISCUSSION OF FINDINGS

The results show a tendency of upstream ST1 being more polluted than the downstream sample stations (**Table 5**). This was also indicated in the colour of the river, as the water was observed to be brownish near ST1 due to leaching of humic substances from the

soil. The high turbidity and phosphorus values in this station may be due to soil erosion caused by land clearance occurring upstream and wash-off of the soil during the rainy season, dragging high level of sediment into the river. The lower contamination level of ST2, ST3 and ST4 might be to due a small stream, perceived as very clean by the villagers, which run into the Kesit River downstream of ST1.

From the questionnaires and informal, conversational interviews knowledge about management practices related to fertiliser was obtained, which might have had an impact on the above results. Many of the villagers were given fertiliser subsidies for certain crops (see box), but in many cases they applied this fertiliser on other crops than it is made for. Thereby, extensive use of mineral fertilisers rich in N, P and K used on others crops than the crops the fertilisers are designed for, might contribute to the high level of phosphor. Insoluble phosphorus may stay in the topsoil and are thereby easily transferred to the river during soil erosion as it moves with sediment to the river (Stewart, 1994). This is also supported by the high reading of COD level obtained, which indicates high chemical reaction occurs at upstream station as compare to other stations. The low level of N might be due to mineralize of N to plant available forms easily uptaking by the plants or with leaching down the horizontal layers of the soil (Owens, 1994).

From the biological data, high microbial activities was found upstream. This could be the result of bacteria from soil erosion. Additionally, other sources of organic matter as animal wastes and wastewater may contribute to the high concentrations of nutrients and chemicals in the river.

Summarizing the results, the four sample stations seem to be class I at that specific station at that specific time based on the WQI analysis (**Table 6**). Based on the water analysis, it can be concluded that the water is safe for the purpose of public water supply and safe for washing and bathing as the villager mainly use the rivers for at all stations. Though, it is important to state, that these analysis are a snapshot, and that the results might look very different in another month. The overall good water quality could be due to the strong stream flow in the river keeping the DO high, temperature low and prevent the accumulation of chemicals. Also the season might be a factor as the water quality change due to seasonal difference in agricultural management and heavy rainfall.

Table 7 *WQI for the four sampling sites. Calculations and equations can be found in appendix XI.*

	Sampling Station			
	ST1	ST2	ST3	ST4
WQI	136.15	138.51	144.71	150.26
Class	I	I	I	I

Box 6 Drinking Water Quality Standards

A water sample was taken from the longhouse drinking water source coming from a gravity feed. Levels of nitrate, nitrite and ammonia nitrogen seem to respond well to normal values of drinking water, though the levels of phosphorus and COD are way higher than the recommended INWQS values for drinking water. This might be due to the stagnant condition of the water source. Comparing the results from the different sample sites, including the drinking water source, ST3 seems to be the cleanest. Thus, ST3 would be suitable as drinking water, and based on this snapshot analysis, it would not need to be treated with chemicals.

Parameters	GP
Turbidity	21
COD	275
AN	0.03
P	2.75
NO3	0.07
NO2	0

THE USE OF THE RIVER BEFORE AND AFTER THE CONSTRUCTION OF THE ROAD.

Moving from the *quality of the water* to the *use of the river*, the villagers expressed some changes within the recent years, out of which some of them are related to the road construction.

As the villagers explained in the seasonal calendar, the Kesit river was up to 1980s rich in fish and had very clear water until the water started to become unclear as logging companies started using the rivers for transporting timber. Fish became scarce due to overfishing and fishing nowadays only happens to a limited extent by the Lemanak River and in the Semawang river area, during the dry season where the water levels are low. In general, the water quality is seasonally and changes over the year; from clear condition during the non-rainy season of April to august to milky during the rainy season from December to February.

As the villagers do not use the rivers for transportation anymore, it has become less essential for their daily life. At present, they mainly use the rivers as a spare source of water when there is a water shortage from the gravity feed water source. This was observed by participatory observation as the women came down to the river to shower and wash clothes during the water shortage. From the participatory mapping it was stated that the drinking water source is coming from a gravity feet at the hilly area called "Penyaru" 40 minutes walk from the village. During informal talks with the villagers, they further added, that the water from Lemanak River is relatively clean, and that they would rather drink this, than from the Kesit river. This corresponds well to the results from the water analysis, for which the Lemanak River seemed to have the cleanest water.

3.3 LIVELIHOOD STRATEGIES ON HOUSEHOLD LEVEL

With the discussion of findings related to *farming activities* of the people in Nanga Kesit, aspects influencing their *land use decision-making*, the *changing land use* and possible *impacts on the water* in the previous section, the analysis and discussion of *diversification of livelihood strategies* will now be initiated. In this section, we find it useful to change the unit of analysis from the village level to the household level (DFID, 1999). The analysis will use some of the concepts of the SLF in order to give new perspectives on the data derived from the fieldwork (Appendix IX).

The current *livelihood portfolio* for each household, who participated in the questionnaires is shown in **Figure 12**.

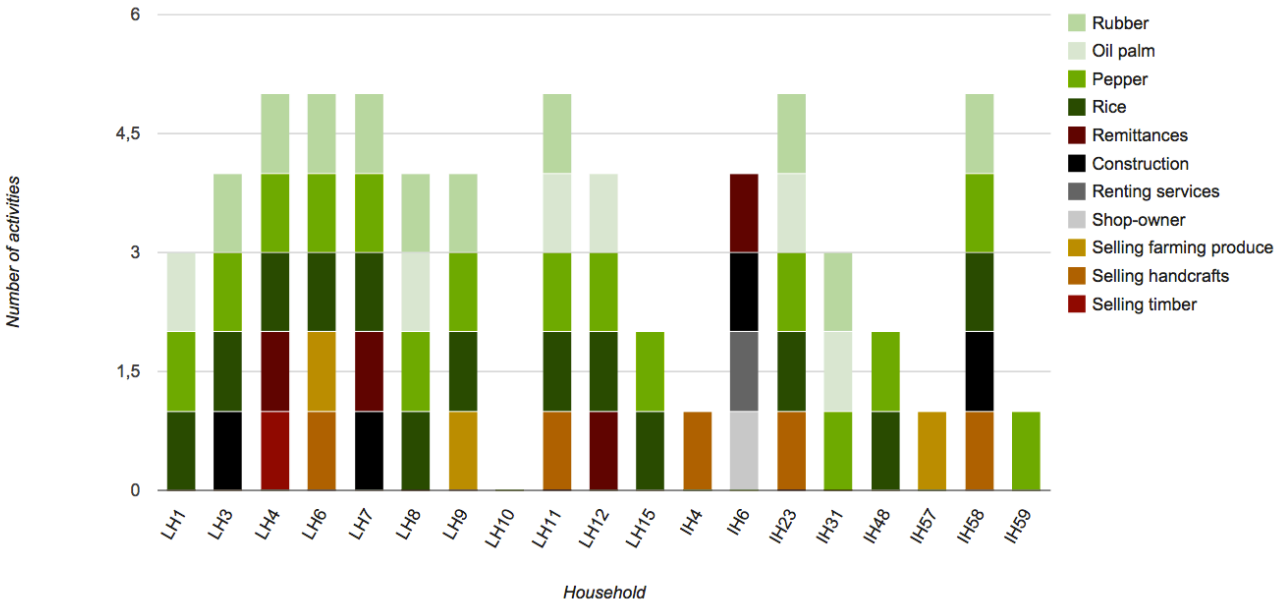
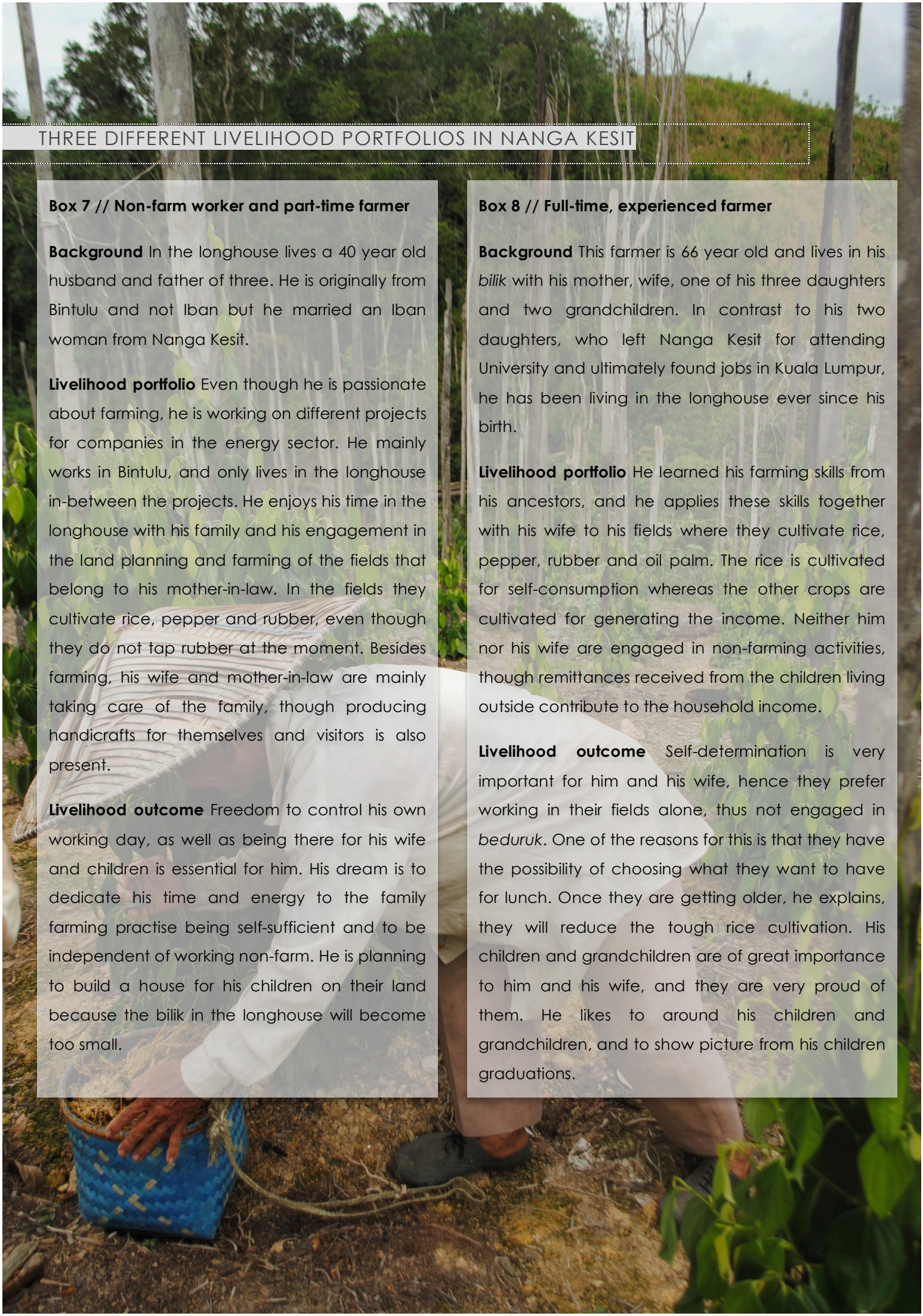


Figure 12 Diversification of household activities.

As previously stated, the majority of the households are engage in several activities, including both farming and non-farming. Only four out of nineteen households engage in nothing else but non-farming activities, though it is important to stress, that this figure does not show different non-farming activities, so it does not necessarily mean that they do not diversify their income. The overall picture of the livelihood portfolio of the villagers in Nanga Kesit thus shows to be relatively flexible, which is one of the criteria for sustainable livelihoods according to the SLF (DFID, 1999).

Nevertheless, the following part will look at three different households as analytical cases in order to get a deeper understanding some of the dynamics behind choices and possibilities of livelihood strategies.



THREE DIFFERENT LIVELIHOOD PORTFOLIOS IN NANGA KESIT

Box 7 // Non-farm worker and part-time farmer

Background In the longhouse lives a 40 year old husband and father of three. He is originally from Bintulu and not Iban but he married an Iban woman from Nanga Kesit.

Livelihood portfolio Even though he is passionate about farming, he is working on different projects for companies in the energy sector. He mainly works in Bintulu, and only lives in the longhouse in-between the projects. He enjoys his time in the longhouse with his family and his engagement in the land planning and farming of the fields that belong to his mother-in-law. In the fields they cultivate rice, pepper and rubber, even though they do not tap rubber at the moment. Besides farming, his wife and mother-in-law are mainly taking care of the family, though producing handicrafts for themselves and visitors is also present.

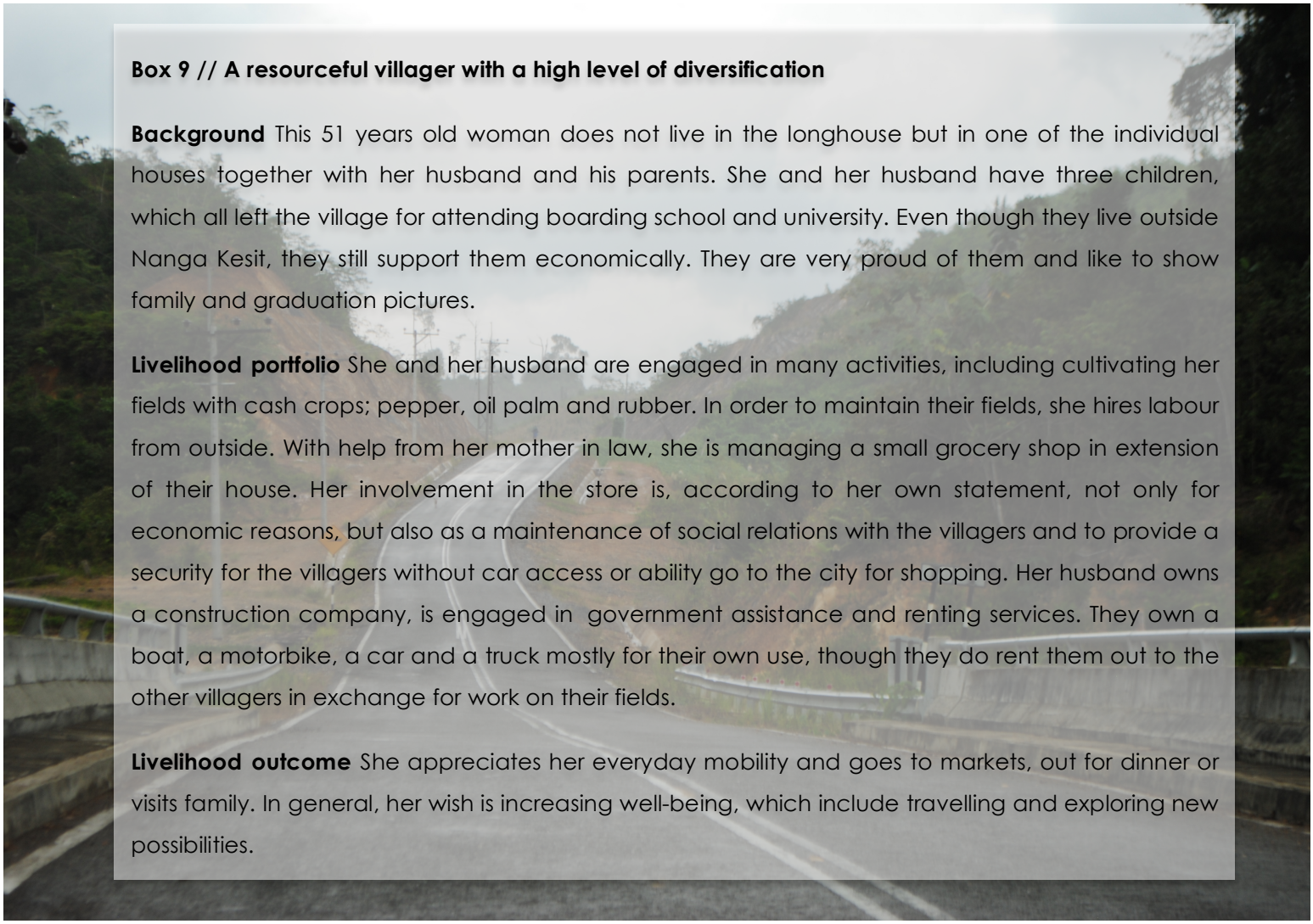
Livelihood outcome Freedom to control his own working day, as well as being there for his wife and children is essential for him. His dream is to dedicate his time and energy to the family farming practise being self-sufficient and to be independent of working non-farm. He is planning to build a house for his children on their land because the bilik in the longhouse will become too small.

Box 8 // Full-time, experienced farmer

Background This farmer is 66 year old and lives in his *bilik* with his mother, wife, one of his three daughters and two grandchildren. In contrast to his two daughters, who left Nanga Kesit for attending University and ultimately found jobs in Kuala Lumpur, he has been living in the longhouse ever since his birth.

Livelihood portfolio He learned his farming skills from his ancestors, and he applies these skills together with his wife to his fields where they cultivate rice, pepper, rubber and oil palm. The rice is cultivated for self-consumption whereas the other crops are cultivated for generating the income. Neither him nor his wife are engaged in non-farming activities, though remittances received from the children living outside contribute to the household income.

Livelihood outcome Self-determination is very important for him and his wife, hence they prefer working in their fields alone, thus not engaged in *beduruk*. One of the reasons for this is that they have the possibility of choosing what they want to have for lunch. Once they are getting older, he explains, they will reduce the tough rice cultivation. His children and grandchildren are of great importance to him and his wife, and they are very proud of them. He likes to around his children and grandchildren, and to show picture from his children graduations.



Box 9 // A resourceful villager with a high level of diversification

Background This 51 years old woman does not live in the longhouse but in one of the individual houses together with her husband and his parents. She and her husband have three children, which all left the village for attending boarding school and university. Even though they live outside Nanga Kesit, they still support them economically. They are very proud of them and like to show family and graduation pictures.

Livelihood portfolio She and her husband are engaged in many activities, including cultivating her fields with cash crops; pepper, oil palm and rubber. In order to maintain their fields, she hires labour from outside. With help from her mother in law, she is managing a small grocery shop in extension of their house. Her involvement in the store is, according to her own statement, not only for economic reasons, but also as a maintenance of social relations with the villagers and to provide a security for the villagers without car access or ability go to the city for shopping. Her husband owns a construction company, is engaged in government assistance and renting services. They own a boat, a motorbike, a car and a truck mostly for their own use, though they do rent them out to the other villagers in exchange for work on their fields.

Livelihood outcome She appreciates her everyday mobility and goes to markets, out for dinner or visits family. In general, her wish is increasing well-being, which include travelling and exploring new possibilities.

ACCESS TO ASSETS, LIVELIHOOD TRAJECTORIES AND THE HOUSEHOLDS' OUTLOOK

From the short narratives, it is clear that the households have different livelihood outcomes, therefore apply different livelihood strategies. Furthermore, these three households differ a lot in their *access to assets*, which enables what strategies they can adopt. The resourceful household has both a relatively high income level and income stability from their non-farming activities resulting in a strong *financial capital*, which can be used for investing in new activities. This is underlined by their recent investment in a new field, where they have cultivated pepper. This is also the only household in the village that is not cultivating rice, which can be interpreted as a sign of high income stability. Due to this, they are able to spend the time on other activities with a potential higher output, like cultivation of pepper. It enables them to maximize their achievements even more and increase their *human capital* as well. For the case of this

household, the road construction improved their possibilities to change their *livelihood trajectory* by open up new possibilities of engaging in more income-generating activities.

In contrast to the resourceful person, the non-farming worker would like to change his livelihood portfolio to farming activities. However, he does not have any authority over *natural capital*, since he is married into the family. This prevents him from developing the land the way he would like to, and it makes him dependent on the non-farm project-based employments. Nevertheless, he is engaged in the farming activities in their household and is very concerned about with land suitability, when taking part in the land use decisions.

The full time farmer on the other hand does have access to *natural capital*, but since it is only him and his wife working on the land, their *human capital* in relation to labour available is decreasing due to their age. Rather than joining the *beduruk*, this household however prefers to work on their own farm by themselves and then balance between rice and pepper cultivation, since rice according to them is less hard work but more labour intensive and pepper is labour-intensive in certain periods but also more income-generating. The fact that this household receives remittances from their children however removes some of the pressure on generating income from the farming activities and increase their income level and stability.

The *outlook* of the three households differ as well. The resourceful household has a lot of political influence on the development of the entire village allowing a broad outlook of development on a village level. Contradictory, the ambition of the non-farm worker is more related to his own household. Since he most likely will have the authority over the land with time, he already has plans for the land. in which food security and sustainability of natural resources play a role. The ambition of the full-time farmer is to have a daily life as convenient as possible without, thus no ambition of changing their current livelihood portfolio dramatically. Relating the outlook with the outcomes on a household level, the most achievable seems to be the case of the resourceful household, and the least achievable the non-farm worker, since he has more ambitions of changing livelihood trajectory than the full-time farmer has, thus the non-farm worker seems further away from achieving the desired outcome.

LIVELIHOOD STRATEGIES BASED ON CHOICE OR NECESSITY?

The above analysis gives an insight to the complexity and dynamics of the different factors influencing people's choices and livelihood strategies. Even though the analysis focus on three specific cases, the analysis of access to assets gives a clear impression from the fieldwork that all households in each their own way adapted to the surroundings and in different ways tried to reach their individual livelihood outcomes with the assets available.

However, some villagers had more possibilities to maximize their assets, as the case was for the resourceful household described above. Others had to struggle just to get by, as the case was for a young woman who was left by her husband without much natural or financial capital. Ellis (2000b) differentiate between peoples' ability to base their livelihood decisions on *choice* or *necessity*. Supported by the literature, a general trend in the village was that the more assets a household had access to, the more possibilities they had for making positive livelihood choices (leading to maximizing their achievements) (DFID, 1999). Another trend was that often the strategies of the households were entangled in one another. Households often had the ability to benefit from each other, with for instance through beduruk or by car rental for labour. In these ways among others, the villagers combined and swapped between different activities in order to adjust to the surroundings, which is a characteristic of sustainable livelihood strategies according to the SLF (DFID, 1999).

CHANGING LIVELIHOOD STRATEGIES DUE TO THE ROAD CONSTRUCTION?

For the case of most villagers in Nanga Kesit, the road construction led to smaller or bigger adjustments of livelihood strategies, since some possibilities disappeared and others came into existence. For instance the villagers' possibility of engaging in tourism stopped with the road construction, thereby a non-farming activity disappeared. However, cultivation of oil palm became more accessible as well as other existing activities became easier to carry out. In this way the type and accessibility of activities for the people in Nanga Kesit might have changed, but the possibility of diversifying livelihood strategies did not change. In order to investigate whether these changes in livelihood portfolios were perceived as good or bad by the villagers, the next section investigates the people's perceptions of the changes caused by the road.

3.4 PERCEPTIONS OF THE ROAD

In general, the villagers perceive the changes, they associate with the road, positive. It was stated that the road has made life easier and one villager even claimed, that the improved infrastructure was "*one of the best developments in the last ten years*".

However, the construction of the road was met by suspicion of some villagers. During the timeline conducted with the women, this suspicion was also mentioned. The women explained, that some villagers feared that they would lose their land, that more people would leave Nanga Kesit or that the village would get more exposed to theft and robbery. Yet, it seemed that after the completion of the construction, people in general were positive towards the road construction, and even the people who lost land were satisfied in retrospective by compensation payments. All the villagers we interacted with expressed the positive changes due to the road.

When choosing the research objective during our fieldwork, we had expected that the sudden stop of tourism would be perceived as negative, since it was a loss of income for the villagers, though this was not the case. One of the reason for that was that the villagers had felt constricted in their everyday lives by the tourism, since they had to hide their mobile phones and park their cars different places in order to give the tourists the most "authentic" experience.

INCREASED ACCESS AND MOBILITY DUE TO THE ROAD

The main benefit of the road was by the villagers perceived to be the increased access and mobility in relation to different assets of the villagers' livelihoods. Four different types of access can be identified from the generated data.

First, the **access to markets**, which is perceived as positive in two ways since it makes it easier for villagers to purchase food on the markets, and easier for them to sell their products. Secondly, the **access to the fields** is perceived as positive because of reduced travel time to the fields as well as easier transportation of inputs, e.g. fertiliser and the harvest. The third is **access to relatives,** and refers to improved options to visit family members that live outside of Nanga kesit, or to get visited by them. The last type of access is the **access to health and education services**, which enables the villagers to benefit from a wider choice of schools as well as clinics and hospitals. A benefit which was expressed in relation to all the above mentioned types of access was the reduction of travel time and costs.

These findings are conforming benefits of infrastructure development found in Banerjee *et al.* (2012), saying that development of infrastructure can be beneficial for economic development since it "*promotes market integration*", "*it promotes factor mobility*" and "*it is easier to take advantage of opportunities for investment in human capital*" (Banerjee *et al.*, 2012: 10).

To sum up, the connection to the federal road network is perceived as a successful project which improved the lives of people in Nanga Kesit. The success of the project related to all the research questions will be discussed in the following chapter.

3.5 CROSSCUTTING RESEARCH QUESTIONS: DOES THE ROAD HAVE AN IMPACT?

The results presented, analysed and discussed above indicate that the development of the infrastructure has had an impact on the villagers in Nanga Kesit in many aspects. But has the developed infrastructure improved the possibilities for economic diversification and uplifted the households as intended by the government?

Many of the villagers did adjust their livelihoods strategies to the changed context and some engaged in new income-generating activities, but at the same time other activities are not possible for them to engage in anymore. The diversified their activities before and they are still diversifying – just with different activities.

Some villagers have started farming activities more intensely on some fields, but at the same time abandoned others, that were previously cultivated. With the introduction of oil palm as cash crop, it also seems that there is also an impact on the land use decisions by the improvements in the road network, which corresponds well to the findings of Miyamoto (2006). And in terms of access, the developed infrastructure has clearly decreased transportation time and costs and opened new opportunities of access for the villagers.

So after all, a lot of changes have occurred since the village was connected to the federal network. Some might be directly related to the road, but it is important to include within this discussion that not all of the above mentioned changes are necessarily caused exclusively by the improvements of the road network.

The higher number of plots devoted to pepper cultivation over the last 5 years, for example, is most likely due to the increase of market prices, rather than the road construction. The engagement of a certain number of people in non-farming activities is also likely to be influenced by a set of factors that fall out the scope of this study, such

as the development of job opportunities in the region around Nanga Kesit during the last decade. These implications are characteristic for the evaluation of infrastructure projects (van de Walle, 2009).

4.0 // CHALLENGES DURING FIELDWORK

A number of challenges appeared during the study period, and even though adjustments and improvements were implied continuously, the data obtained from the different methods do have some limitations affecting the quality of the data. The following presents some of the general challenges in the execution of methods and subsequently reflections on our approach.

REFLECTIONS ON EXECUTED METHODS

Due to the limited amount of households in the longhouse, we had some difficulties with the *selection of informants*, since we often ended up talking with the same persons in several activities.

Another aspect related to the questionnaires was the *lack of reflection* on whether we really needed to conduct questionnaires or not, and we ended up only talking only about how to do it and not why, because we were in a hurry to conduct the questionnaires with as many as possible. This feeling of *time pressure* was a general challenge, which several times caused us to forget reflecting on the purpose of the methods applied and just focused on how to do it.

Related the latter, many of the PRA methods were conducted in a way, where the *possibility for participation* could be questioned. In many cases, we had already predefined the criteria given to the participants. Due to that, we might have missed out on a lot of important information, which could not be collected even though open questions concerning the topic were asked in the end of each session.

Furthermore, *the setting* of many of the PRA methods and interviews took place in the inner veranda of the longhouse, and people therefore often stopped by or left during the execution of interviews and methods. Concerning the women gathered for PRA sessions had a tendency to leave the sessions, because the men took over.

A last perspective on the challenges faced during execution of methods, was that we often did not manage to *give our interpreters a proper introduction* to the activities or

interview guides, which caused some confusion in some activities and might have caused misunderstandings between us, the interpreter and the participants.

REFLECTIONS ON APPROACH AND LEARNING EXPERIENCE 326

As mentioned in the Methodology chapter (2.0), the fieldwork has been conducted in three different phases; the *exploratory phase, in depth phase* and lastly the *participatory phase*.

Since we found out in the initial stage, that rubber production was not as active as expected from the preliminary research in Denmark, we decided to change our focus (appendix XXIII). The search for and shift to a completely new topic required a great amount of work and collaboration with the counterparts, therefore limiting the time that should have been spent to integrate with the villagers during the *exploratory phase*.

Once the *in depth phase* started, our enthusiastic and eager way of conducting research resulted in a to some extent in too direct and insistent approach, causing some of the villagers to feel uncomfortable. As a group, we had to reflect on our approach and adapt it to the setting. Therefore a new, more *participatory phase* was then initiated, giving priority to more active participation in the villagers' everyday life. Even though fewer notes were taken, (limiting data analysis and triangulation), this approach showed to fit better to the villagers and we gathered different kind data we would not have obtained with our original approach.

This shift to a less structured approach implied a reduction in the number of semi-structured interviews carried with the villagers. Out of the eight planned, only four were carried out, limiting data on changes in non-farming activities, which was a main theme in the SSI. This has restricted the analysis on diversification within non-farming activities afterwards.

In general, it can be said that the overall experience provided the whole group with a new perspective on how to conduct research within a field in a more sensitive way, which is a very valuable learning outcome for the group. If we had to conduct the field work again, we would have putted more emphasis on merging data collection and integration into the local context.

6.0 // CONCLUSION

With infrastructure as one of the biggest requisite for development in rural areas, a better understanding of its impacts on rural livelihoods is of paramount importance for an informed intervention by the authorities towards poverty eradication.

For the case of Nanga Kesit, the livelihood strategies are concluded to be relatively diversified both within farming activities, within non-farming activities and between the two. The development of the road network has led to changes in the livelihood activities, in which the discontinued tourism and implementation of oil palm seem to be the biggest changes. Some villagers are more able to benefit from the increased access depending on their existing assets. However, the villagers' perception of the improvements of the road network in general can be concluded to be positive.

As this study has shown, it can be concluded that the road construction has had a positive impact on the on the villagers' livelihood strategies. However, we are well aware of the fact that it is very difficult to conclude direct causality and thereby exclude other possible relevant factors leading to the dynamics and changes in the livelihoods of people observed in the area of study.

FUTURE PERSPECTIVES

Since Oil Palm is very new to the soils and livelihoods of the people in Nanga Kesit, it seemed not reasonable to analyse the impact of the cultivation of Oil Palm on the soil quality as well as the livelihoods of the people in Nanga Kesit. That is why the environmental as well as social impact of small scale Oil Palm cultivation could be of interest for further studies. The findings could contribute to the discussion about impacts of Oil Palm and could be compared to findings by Bruun *et al.*, (2013) as well as Mertz *et al,* (2013).

Furthermore, the relation between infrastructure development, economic diversification and poverty reduction could investigate in Nanga Kesit and thereby expand the knowledge about the benefits and disadvantages of infrastructure investments.

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// 9.0 APPENDICES

APPENDIX I – DATA MATRIX

Objective	Research questions	Sub-research	Data required	Methods
To investigate how the road construction has affected the livelihoods of people in Nanga Kesit and their natural resources	1. How has the land use changed since the construction of the road?	1a. What are the major land use changes since 2009?	Land use before 2009 Land use today Land names of different fields	Timeline Mapping Interview with Headman
		1b. How do the villagers plan to utilize their land?	Schemes in Nanga Kesit - when, what, how & why Subsidies Longhouse planning Household planning - food & cash crops use of the road	Ranking & Scoring Seasonal calendar Interview with counsellor Interview with Headman Interview with Agricultural officer SSI with households
	2. How has the land use changes influenced the natural resources in Nanga Kesit?	2a. Soil quality	Local perception of soil quality Characteristics of soil, pH, SOC, Nitrogen, texture, Pox-C, colour, horizon depth, bulk density, moisture content, total organic matter & total organic carbon, available phosphate	Soil sampling & analysis Transect walk Semi structured interview
		2b. Water quality	In situ parameters, nitrate, nitrite, nitrogen, phosphate, COD, turbidity, BOD,TSS	Water sampling & analysis
		2c. Forest (temuda)	Collection of Non-timber products - wildlife, vegetation & useful plants Age & stage of forest Wildlife listing	Walk in the forest (temuda), interview and wildlife listing Semi structured interview
	3. How has the income diversification of the villagers changed since the road construction?	3a. What were the main income generating activities before 2009?	On-farm/off-farm/non-farm Remmittances before 2009	Questionnaires Interview with the headman Semi-structured interview Seasonal calendar on activities
		3b. What are the main income generating activities now?	On-farm/off-farm/non-farm Remmittances	Questionnaires Interview with the headman Semi-structured interview Seasonal calendar on activities
	4. How do people in Nanga Kesit percieve these changes?	4.a What do people view as the benefits and constraints ofthe road construction	Different opinions about changes due to the road conctruction	Focus group Semi-structured interview

APPENDIX II – OVERVIEW OF APPLIED METHODS

Date + *am/pm*	Team Awesome	Participants	Activity	Keywords/ data obtained
1/3 *am*	Beatrice Emma Anna Gab	Headman	Key informant interview	Introduction to the village history and general knowledge about the longhouse and the surrounding area.
	Lukas Lise H Sara Lise S Arlene Leo	Village guide	Village walk and mapping	Explore the village and service facilities in the area + map the most important houses and fertilities.
pm	Lukas Elan Emma Lise H Sara Leo	Headman	Farm walk to the headmans field in Bukit Tekalong (HR+ PG) and Sekeroh (OP+ RP)	Overview of the farming activities, land use and management of natural resources.
	Anna Arlene Beatrice Lukas Lise S.	2 villagers	Farm walk to villagers fields	Overview of the farming activities, land use and management of natural resources.
	All	The other longhouse	Invitation from the other longhouse	The headwoman's longhouse is not interested in being a part of the study
2/3 *am*	All	All	Pilot questionnaire	Trying out questionnaires – leading to adjustments
	Arlene Elan Sara Leo	4 villagers	PRA Ranking and scoring	Identify criteria and priorities in the villagers' decision-making process on land use.
	Lukas Emma Beatrice Gab	7 villagers	PRA Timeline	Overview of important event in the village and longhouse
	Arlene Elan Sara Leo	3 villagers	PRA mapping	To get an idea of the land use in the area.
pm	All	Allll	Questionnaires round 1	To obtain demographic data and info of the villagers. Led to some adjustments
3/3 *am*	Arlene Sara	3 villagers	Development of the land map (land names)	To get an overview of where the villagers field are located

pm	All	None	Presentation	Presentation of research proposal
	Anna Arlene Gabriel Emma Lise S	4 villagers	Seasonal calendar (women)	investigate the activities of the women throughout the year
	Beatrice Elan Lise H	10 villagers	Seasonal calendar (men)	Investigate the activities of the men throughout the year.
4/3 *am*	All		Questionnaire round 2	To obtain demographic data and info of the villagers.
	Arlene Emma Elan	Agricultural driver	Key informant interview with agricultural driver	Knowledge about schemes and land use changes in the area.
pm	Anna Lise H Elan Gab	The counsellor	Key informant interview with the counsellor	Knowledge about the road construction and the different phases.
	Arlene	4 villagers	Wildlife assessment (birds)	Asses the amount of wild birds in the area.
5/3 *am* + *pm*	All	4 villagers	Soil sampling	Farmers' perception of soil quality + soil samples from 2 fields.
	Anna Lise S Beatrice	3 villagers	Mapping of field Transect walk Transect walk	Identified parameters influence the farmers' perception of soil quality
			Follow up on questionnaires	Follow up on in order to get the same data for all households
6/3 *am*	Emma Elan Lise S	2 villagers	Water sampling	Water samples from 4 different sample station + one sample from their drinking water. In situ measurements conducted.
	Lukas Sara Leo	1 villager	Land map development (allocation of field names)	Add information to our map of location of the villagers fields.
pm	Elan Emma Lise H	Dr. Tay	Water analysis	Executing laboratory test
	Lukas Gab	Shop keeper	Key inform interview with shopkeeper	Insight in the development of the shopping habits of people in Nanga Kesit in relation to food products.
	Beatrice Lise S Leo	7 villagers	Timeline development	Adding information to the overview of important event in the village and longhouse
	Lukas Anna	1 villager	SSI with resourceful villagers	In depth knowledge about changes in land use decisions and income generating activities
	Beatrice	3 villagers	Wildlife assessment (mammals)	Asses the amount of wild animals in the area

		2 woman's	Informal talks	Talks about handicraft
7/3 *am*	Sara Lise S Beatrice Arlene	1 women	3 SSI with woman	SSI with 3 women about their non-farm activity, marked excess and land use
	Lukas Gab	1 villagers	Follow up with the counsellor	Extra information about the more exact time for construction of the road.
pm	Anna Lukas	1 villager	Participant observation: harvesting rice	Rice harvest with villagers to better understand the daily life of the farmer and small talk about his life and farming.
8/03 *am*	Lise S Lise H Sara	2 villagers	Participant observation: Harvesting of pepper	Pepper harvest with villagers to better understand the daily life of the farmer and small talk about his life and farming.
	Lukas Anna	2 villagers	Participant observation: Trip to the market	To find out what was sold and bought on the market and to see, how people accessed the market.
pm	Arlene Beatrice	2 villagers	Forest walk – Ethnobotany survey & herbarium specimen	Knowledge of the villager's used of the forest – now and before the road improvements

APPENDIX III – INTERVIEW GUIDE: HEADMAN

Theme	Primary question	Secondary question	Notes	Preassumptions/hypothesis
Introduction of SLUSE Presentation of fieldwork and aim of the interview				
Personal information	Name, age, education, what is your responsibility/role in the village?			
Village characteristics	How would describe Nanga Kesit?	How big is Nanga Kesit? What do you consider as a part of your village? How many households/people are living here? Do you have a primary school? Is there a health center? Where is the nearest shop/market?	Bring the map. Maybe the village already have a map, so he can show how big the village is.	
	Can you describe the social structure of the longhouse?	Social groups, longhouse council		
	What are the main activities in the village?	What are the main income generating activities? What farming activities are taking place? Are villagers engaged in activities outside their own farm? Are the enganged in other activities than farming? Are there any other activities you would like to add?		
	Do you experience people moving from the village to live other places?	Who are moving away? Is it permanent or are the season workers? Where are they moving to?		
	Do people from outside move to Nanga Kesit?	Why are they moving here? Are they permanent or seasonal workers? How many? How many the past year?		
Historical information	When was the village established?	When did the village split into two?		
	What are the biggest changes the village has experienced the past 10 years?	- farm activities, population, land u		
	When was the individual houses constructed?	Who lives there (characteristics)?		
Village values	What is unique about this village?			
	What are the challenges for village?			
Natural ressource management	Is there any predefined plan for the land use in the village?	Is the government involved in the planning of land use in this village?		
	Do the village/farmers recieve help/subsidies from the government?	Money, Governement programmes running in the villageat the moment		
	What role does the river play for the village?			
	Has the land use changed the past 10 years?	- Substantial (cash crop)		
	Do you make use of shifting cultivation?			
Case	We have heard that the village rejected to participate in a joint-venture oil palm project? Is that true?			
	How did tha village make that decision?	On what background did you make the decision?		
	Why did the village choose to join a rubber scheme 3 years ago?			
	Are there any benefits or constraints for growing rubber?			
Decision making	Can you describe the decion making processes in the village?	Is it consensus? Is it only the males/females?		
Closing	Thank you for sharing your knowledge and information. Do you have anything to add?			
	Thank you for your time			

APPENDIX IV – QUESTIONNAIRE GUIDELINES

Name of the interviewee _____

Date	Map no	Household no	GPS Coordinates	Individual household (X)	Longhouse		Interpreter	Notetaker
					TR Tindit	TR Sambun		

DEMOGRAPHIC DATA ON HOUSEHOLD AND HOUSEHOLD MEMBERS

1.1 Total n of members _____	1.2 Number of children (< 18) ____	1.3 Does anybody from the household live other places? ____
Household members	A. Interviewee	B. Spouse
1.4.Name		
1.5 Male/Female		
1.6.Age		
1.7 Marital status/ Are you married?	Single	Single
	Married	Married
	Divorced	Divorced
	Widowed	Widowed
1.8 Ethnicity/ Are you Iban?	Malay	Malay
	Chinese	Chinese
	Indian	Indian
	Iban	Iban
	Others	Others

1.9 Religion/ Are you Christian?	Muslim		Muslim	
	Christian		Christian	
	Buddhist		Buddhist	
	Hindu		Hindu	
	Others		Others	
1.10 Level of education	No education		No education	
	Early childhood education		Early childhood education	
	Primary School		Primary School	
	Secondary school		Secondary school	
	Pre–university school		Pre–university school	
	University		University	
Additional				
1.11 Do you farm?	Own farm	Off–farm (where?)	Own farm	Off–farm (where?)
1.12 Non–farmer (Where?)				
1.13 Additional comments				

1.14 Does anybody from the household contribute to the household?	[YES / NO]
1.15 Does any HH members living other places contribute?	[YES / NO]

2. Land use / Farming activities

2.1 Cultivated land (besides homegarden)

	A.Crop 1	B.Crop 2	C.Crop 3	D.Crop 4	E. Rubber (tapping Y/N)	F. Fallow
2.1 Type of crop						
2.2.Size (no. Of trees/plants)						
2.4.Food	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]
2.5.Do you sell it?	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]
2.7 Do you recieve any subsiders from the government? (Which kind?)	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]
2.8.Fertilizer	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]
2.9 Pesticides/chemicals	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]	[YES/NO]

3. FOOD SECURITY

Do you buy food from the market? (inc. food which they can cultivate themselves)

3.1 Do you grow anything behind your bilik or within your fields?	[YES / NO]			
3.2.Food [YES/NO]	A. Fruits	B. Vegetables	C. Medicinal plants	D. Rice/ Others
3.3a Do you have pigs?	[YES/NO]			
3.3b Do you have chickens?	[YES/NO]			
3.3c Do you have any other animals?				
3.4 Are they for self consumption or for sale?	Self consumption		SALE	

3.5 Do you buy food from the market?
Rice __ Drinking water __ Meat __ Vegetables ___ Fruit ___
Others/Snacks ___

3.6 Where do you get your drinking water from?

4. FOREST

4.1. Do you collect products from the forest?
4.2. Is the forest on your land (community)?
[YES / NO]

1. ADDITIONAL COMMENTS

APPENDIX V – TOPIC FOCUSED INTERVIEW GUIDES FOR KEY INFORMANTS

THE COUNSELLOR

HIS ROLE + TASK

- What is your job?
- For how long have you had this job?
- How did you get it?
- For whom do you work for? (government / private company)
- What are your responsibilities?(What kind of task do your job as a council include?)
- How do you conduct your work?
- What have you achieved in your time as a council?

VISION OF XX / GOAL OF EMPLOYER

- Are there any development plans for Nanga Kesit? *(Or maybe Lubok Antu if no NK plans)*
    - Past projects
    - Current projects
    - Future perspective

CONSTRUCTION OF THE ROAD

- Was XX(governmental department) involved in the construction of the road?
- When was the road constructed?
- Why was the road constructed?
- Did the villagers ask for the road or was it the XX((governmental department) that suggested it?
- And was there any challenges in the construction of the road?
- Were the villagers involved in the plans?
- How long did it take to go through the whole process – from idea to the road was finished?
- Were there any oppositions towards the road when it was first mentioned?
- What kind of improvement did the road give Nanga Kesit?
- What are the disadvantage of the road for the villagers?

CHALLENGES HE FACE

- What kind of challenges do you face as a council?
- How do you handle/ response to these challenges?
- Why are the villagers reluctant to engage in oil palm plantation schemes?

AGRICULTURAL OFFICER

HIS ROLE + TASK

- What are your responsibility?
    - What kind of task do your job as an agricultural officer include?
- When have you been appointed?

VISION/ GOAL OF EMPLOYER

- Is there any defined plan for the land use in the area? Nanga Kesit? *Lubok Antu?*
- How is the village (Nanga Kesit) involved in the land use planning?
- And how is the single farmer involved?

LAND USE CHANGE IN NANGA KESIT

OIL PALM

- When did the villagers of Nanga Kesit started cultivating oil palm?
    - Have the villagers been in any schemes?
    - Do the farmers receive any support? (subsidies/ fertilizer)
    - Where is the mill located?
    - Do they sell to a middleman?
- That was the villagers response to the oil palm scheme?

RUBBER

- We heard that the villagers is involved in a rubber scheme. Can you verify that?
- When did the rubber scheme start – when do it end?
- How many household are involved in the scheme?
- In what way do the scheme holders (government) support the farmer?
    - *What exactly do the farmers get from the scheme*?
- How did the villagers feel about the rubber scheme? What is the general perception?

PEPPER

- **Is there any planning regarding pepper cultivating?**

INTENSIFICATION

Has the agricultural activities intensified over the last 10 years?

- Location – is it the same area which is cultivated?
- Fertilizer used – has it intensified?
    1. On which crops?

- Shifting cultivation – is it practised now?
    1. If yes – where?
    2. If no – when did it stop? And where was it practised before?
- Do you have anything to add?

CHALLENGES AND FUTURE PERSPECTIVES

- How do you see the village in 10 years?
- Do you have any data/ maps/ statistics or others you would like to share with us?

SHOP KEEPER IN THE CLOSETS NEIGHBOURING VILLAGE

- What part of the road is new since 2009?
- What has been there before?
- When did they get to know about the road to be constructed?
- What is the name of the road?
- How did the road construction change the area and your everyday life?
- When was the road to Lubok Subong has been built when?
- How did you get to Lubok Antu before the road was built?
- How did the tourism change in this area?
- When did the tourism stop in Nanga Kesit?

APPENDIX VI – GUIDELINE FOR SEASONAL CALENDAR

Rainy season
a. When do the rainy season starts?
b. When does the rainy season end?
c. When is it most intense?

Rice
a. When do you plant rice?
b. When do you harvest rice?
c. When is the most agricultural work connected with rice carried out by men? What are the activities? (Planting/harvesting/in between/weeding?
d. How much do you harvest?
e. How much do you keep for yourselves?
f. What do you use the rest for?

Pepper
a. When do you plant pepper?
b. When do you harvest pepper?
c. When is the most agricultural work connected with pepper carried out by men? What are the activities? (Planting/harvesting/in between/weeding?
d. How much do you harvest?
e. How much do you keep for yourselves?
f. What do you use the rest for?

Oil Palm
a. When do you plant oil palm?
b. When do you harvest oil palm?
c. When is the most agricultural work connected with oil palm carried out by men? What are the activities? (Planting/harvesting/in between/weeding?
d. How much do you harvest?
e. How much do you keep for yourselves?
f. What do you use the rest for?

Rubber
a. When do you plant rubber?
b. When do you harvest rubber?
c. When is the most agricultural work connected with pepper carried out by men? What are the activities? (Planting/harvesting/in between/weeding?
d. How much do you harvest?
e. How much do you keep for yourselves?
f. What do you use the rest for?

APPENDIX VII – WATER SAMPLING: METHODS & CLASSIFICATION

DESCRIPTIONS OF LAB METHODS

IN–SITU MEASUREMENTS

The surface water sample was collected about 10 cm below water using plastic bottles (500 mL) and BOD bottles. The water samples for physico–chemical analysis were kept in ice for further analyses in laboratory; this will help to minimize the bacteria activities and chemical changes.

The temperature of water sample measure can regulate various biochemical reaction rates that influence the water quality. Dissolved Oxygen (DO) is to measure the amount of Oxygen dissolved in water and indicates the organism condition in water system, this also can be specifically determine through Biological Oxygen Demand (BOD) analysis. DO data indicates the condition of the living organism in the water system. Oxygen presence in water system is produced by aquatic organisms through photosynthesis process.

BOD is measuring the amount of dissolved oxygen consumed by bacteria. High reading BOD indicates the bacteria activities are very active in water system. Thus, BOD analysis is very critical as it must be done immediately. The water sample collect in BOD bottle of 300ml, the sample must fully fill and cover with stopper. The bottles were wrapped with aluminium foil and incubate for 5 days at 25°C. The BOD result is obtain by measure the final DO incubated sample and calculate based on the total DO uptake during incubating time. (BOD_5 = Initial DO–Final DO)

COD is indicating the oxidation process in water systems by measure the amount of organic matter degraded chemically using chromic acid. Basically, the reading of COD is higher than BOD value by three times. The results were obtained by HACH method.

TSS is to measure the amount of particles contain in the water. TSS was measured by filtration method. The known value of water sample filtrate through a pre–weight 0.45 um pore size membrane filter. This filter will be dry in the oven for 2 hours at 103°C and reweigh. The increasing of weight will be taken as the amount of TSS and calculate in mg/L.

Ammoniacal Nitrogen, nitrate and nitrite was carried out by following the step provided in HACH laboratory manual using spectrophotometer. Phosphate was determined using total phosphorus test. The sample will be digesting through heating and acidifying process first in order to convert all forms of phosphorus to orthophosphate. Then the concentration of the orthophosphate was determine by ascorbic acid method using spectrophotometer. All of these parameters are the nutrients for the microorganisms and organisms in the aquatic system.

Total Coliform Count (TCC) and Fecal Coliform Count (FCC) analysis were analyzed using the Paqualab System. These tests are used to indicate the likely presence of disease causing agents present in the water. In each analysis, measured volume of water sample is passed through a filtering apparatus. The 0.45 um membrane filters then placed on a pad soaked in excess broth medium in an aluminium petri dish. It is then incubated at 44°C for 12 – 16 hours, whereas for the

faecal coliform analysis and at 37˚C for 12 – 16 hours for the total coliform analysis. After incubation, the numbers of bacterial colonies are counted. Each colony arose from a single coliform bacterium in the original water sample.

INTERIM NATIONAL WATER QUALITY STANDARDS

WQI consist of five classes according to their Water Quality Index (WQI). Six water quality parameters are evaluated and fit in–to ´Best–fit equations for the estimation of subindex values.

Table 1.1: Best-fit equations for the estimation of subindex values

Parameter	Subindex Formula	Condition
DO	$SIDO = 0$ $SIDO = 100$ $SIDO = -0.395 + 0.030x^2 - 0.00020x^3$	for $x \leq 8$ for $x \geq 92$ for $8 < x < 92$
BOD	$SIBOD = 100.4 - 4.23x$ $SIBOD = 108e^{-0.055x} - 0.1x$	for $x \leq 5$ for $x > 5$
COD	$SICOD = -1.33x + 99.1$ $SICOD = 103e^{-0.0157x} - 0.04x$	for $x \leq 20$ for $x > 20$
TSS	$SISS = 97.5e^{-0.00676x} + 0.05x$ $SISS = 71e^{-0.0016x} - 0.015x$ $SISS = 0$	for $x \leq 100$ for $100 < x < 1000$ for $x \geq 1000$
pH	$SIpH = 17.2 - 17.2x + 5.02x^2$ $SIpH = -242 + 95.5x - 6.67x^2$ $SIpH = -181 + 82.4x - 6.05x^2$ $SIpH = 536 - 77.0x + 2.76x^2$	for $x < 5.5$ for $5.5 \leq x < 7.0$ for $7 \leq x < 8.75$ for $x \geq 8.75$
NH_3-N	$SIAN = 100.5 - 105x$ $SIAN = 94e^{-0.573x} - 5 \lvert x-2 \rvert$ $SIAN = 0$	for $x \leq 0.3$ for $0.3 < x \leq 4$ for $x \geq 4$

Calculations were performed not only on the parameters themselves but also on their sub–index whose values were obtained from a series of equations shown in the table below.

		Sampling Station			
Parameter	**Subindex**	**ST1**	**ST2**	**ST3**	**ST4**
DO	% (at Msia temp.)	84.28	76.68	84.32	84.44
	SIDO	211.27	174.84	211.47	212.09
BOD	SIBOD	90.87	93.46	91.18	91.52
COD	SICOD	-22.99	37.75	28.73	37.75
TSS	SISS	97.41	97.48	97.49	97.49
pH	SIpH	459.65	460.90	461.04	461.30
NH3-N	SIAN	35.59	35.59	35.59	61.42
	WQI	136.15	138.51	144.71	150.26
	Class	I	I	I	I

WATER QUALITY INDEX CLASSES

Table 1 Interim National Water Quality Standards

CLASS I	Water treatment is not needed Suitable for any form of usage NTU : <5
CLASS IIA & IIB	Water treatment is needed for water supply Suitable for recreation NTU : 5-50
CLASS III	Intensive treatment is needed for water supply. Suitable for aquatic and livestock NTU : -
CLASS IV	Only suitable for irrigation NTU : -
CLASS V	Not suitable at all for any form of usage NTU : -

Source from our Malaysian Counterparts

APPENDIX VIII – SSI GUIDELINES

Introduction of us and research

Land use decisions

1. From the previous interview (questionnaire), we know that you cultivate xx and xx (etc). Why did you choose to plant:
    1. Hill rice?
    2. Pepper?
    3. Rubber?
    4. Oil palm?
    5. Something else?

- Who made this decision? (decision making in HH) (landowner, consensus between fx husband and wife, advise from other villagers)
- Why did you choose **field x?** Why did you plant this specific crop there? (Criteria: soil quality, distance to field from home etc.)
- How do you decide where to plant your crops? (soil quality and land planning)
- Did you receive any agricultural training? (When and in what?)
- Are any of your crops managed under a scheme?
    - If yes – for how long, why and how did you decide it?
    - If no – Why?
- Have/do you considered to get involved in a scheme?
- Do you have any plans for your land in the future?
- What would you like to do with your land (if you could choose anything)?

Utilization of the forest/fallow area

- When you **changed your field from xx to xx,** did you cut and burn the tress?
- **(If has fallow land)**Do you plan to do something on this land?
- **(If has NO fallow land)** Did you ever have fallow land? Until when?
- Do you hunt for animals in the forest or on the fallow land?
- If yes: how often?
- Do you collect anything from the forest or from your fallow land? (vegetables, medicinal plants, other materials etc)
- If yes – How often and what do you use it for? (consumption, selling, handicraft etc.)

Income diversification/main activities *(Ice breaking question according to the HH situation) You mentioned that…..Handicrafts, etc*

- What is the distribution of income generating activities (both labour intensity and types of activities)
- flow chart:
- Start with asking them to draw the household (the members of the household)
    1. Names, relations, age
    2. Who has the responsibility of what in your household?
    3. Who owns the land?
    4. What are they doing?

Ask to draw their fields

1. Where does the rice/pepper/oil palm/rubber/etc. goes? (consumption/market/relatives)

Do you grow vegetables/fruits for consumption/selling/relatives?

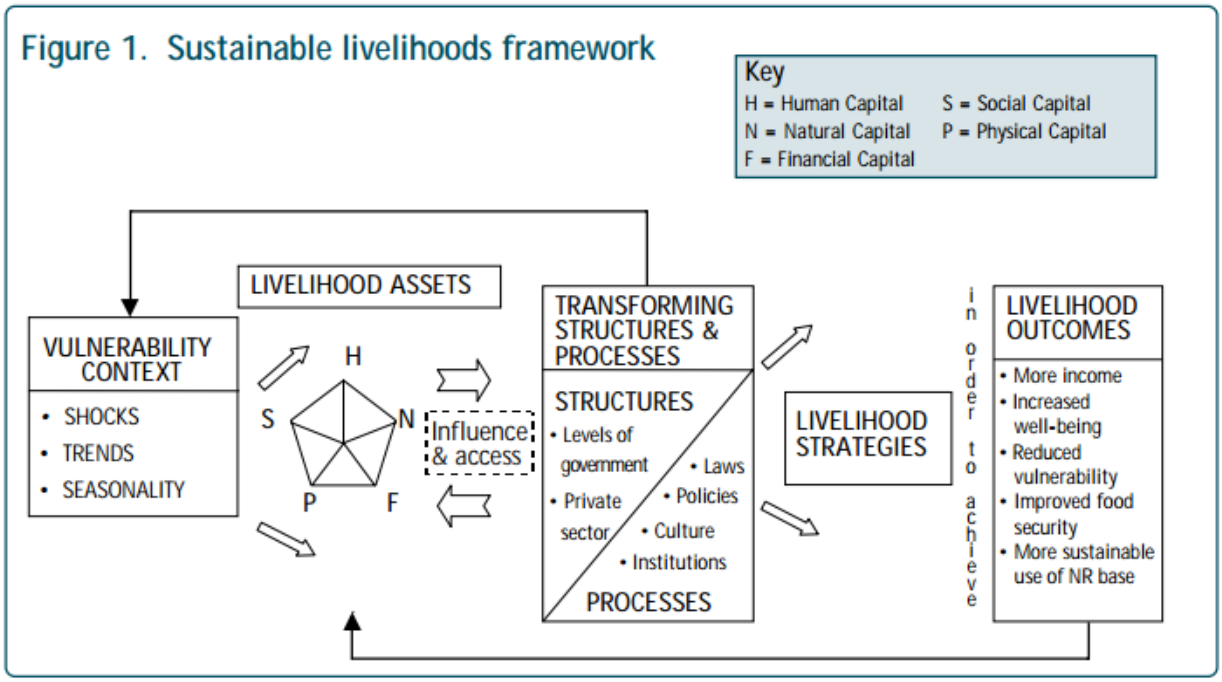
- Do you produce meat for consumption/selling/relatives?
- Do they buy anything from the shop? (what)
- Does anybody (we know their occupations) bring resources into the household? (money/food/help/labour/other stuff)
- What is most important for your income out of these factors that are note down?

The road

- How was it 10 years ago (when the second bridge was made)?
  - Was your household involved in the same activities?
  - Refer to use of fallow land/ forest / hunting/ collection of plants / other income generating from questionnaire
- Has anything changed since the road was built?
- What do you think about the road?
  - What are the benefits for your household? Why?
  - What are the disadvantages for your household? Why?
- What do you use the road for?
  - Farming acitivities?
  - Market:
  - Work
  - School
  - Hospitals
  - Meetings (govn. officials)
- Is there anything that you cannot do anymore because of the road? (Toruism)
- Why was the road made?
  - Was it the government requesting for it or the people in Nanga Kesit?
  - Were you for or against it?
    - Was anybody from Nanga Kesit against the construction?

- **Finishing up**
  - Is there anything you would like to add?

APPENDIX IX ANALYSIS STRATEGY – SUSTAINABLE LIVELIHOOD FRAMEWORK



Source: DFID. 1999. Sustainable Livelihoods Guidance Sheet.

APPENDIX X – SOIL SUITABILITY AND PEPPER CULTIVATION IN SARAWAK

Table 1 Parameters for optimal growth of pepper (*Piper nigrum*) on tropical soils

Slope	< 25%
N%, P%, K%	0.26%, 0.2%, 0.41%
pH	7
Soil properties	From heavy clay to light sandy clays rich in humus with friable nature, well drained, high base saturation and ample water holding capacity.
> Pepper is a surface feeder, developing roots within the first 50-60cm of soil	

Adapted from Sivaraman *et al.* (1999) and International Pepper Community (2007)

Table 2 Results of soil analysis on 24 pepper farms of 1 to 22 years of age, established after or during rice cropping

Depth (cm)	0-10	30-40
pH	4.39 +/- 0.36ab	4.46 +/- 0.22
% clay	39.3 +/- 14.2	42.8 +/- 15.0
% silt	29.0 +/- 7.4	27.3 +/- 7.8
% sand	31.7 +/- 13.4	29.9 +/- 13.9
Total C (g/kg)	25.0 +/- 10.6	7.0 +/- 4.1
Total N (g/kg)	1.87 +/- 0.90	0.80 +/- 0.57
C/N	13.8 +/- 3.4	9.2 +/- 2.6
Bulk density (g/mL)	1.01 +/- 0.13	1.28 +/- 0.17

a ECEC, sum of exchangeable bases and Al.
b Exchangeable Al in percent of ECEC.

Adapted from Tanaka *et al.* (2009).

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Sivaraman, K., Kandiannan, K., Peter, K. V., & Thankamani, C. K. (1999). Agronomy of black pepper (Piper nigrum L.)-a review.

Tanaka, S., Tachibe, S., Wasli, M. E. B., Lat, J., Seman, L., Kendawang, J. J., ... & Sakurai, K. (2009). Soil characteristics under cash crop farming in upland areas of Sarawak, Malaysia. *Agriculture, ecosystems & environment*, *129*(1), 293-301.

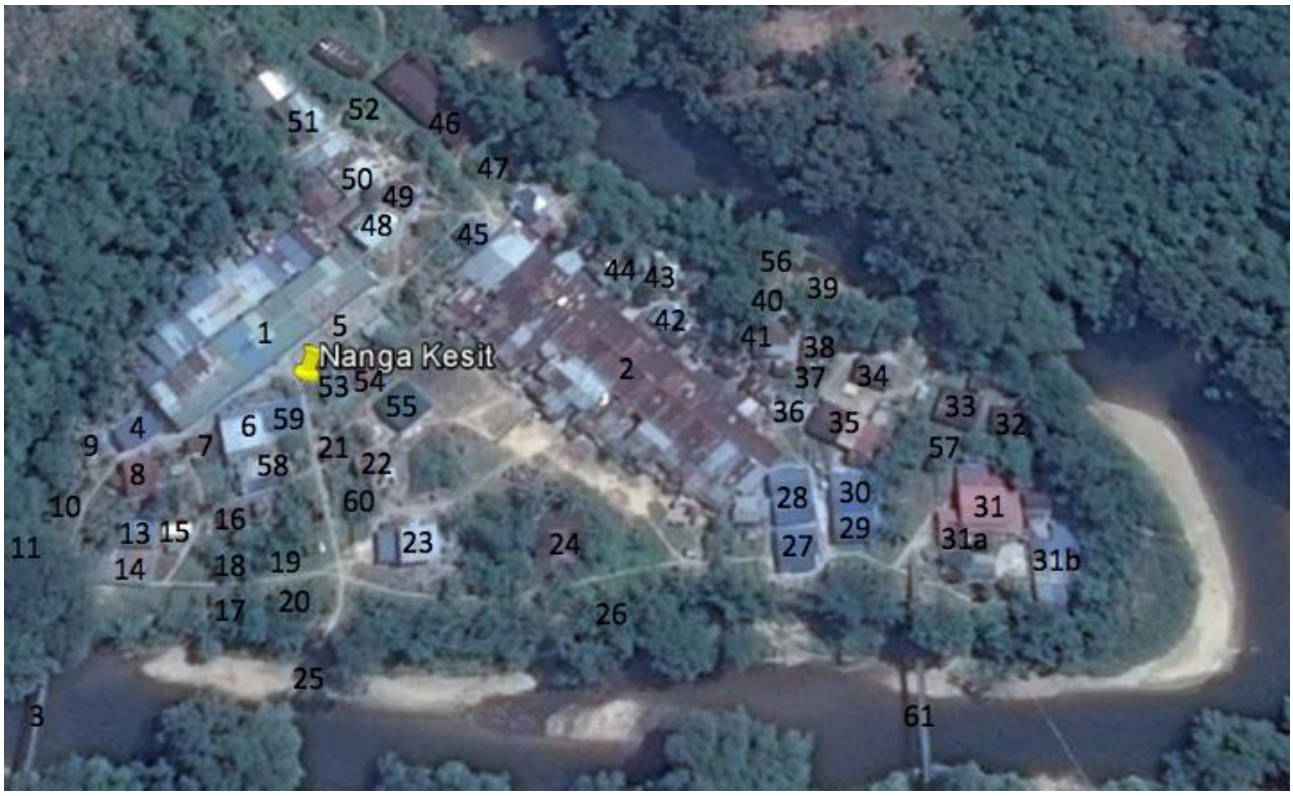
APPENDIX XI – EXPLORATORY SEMI–STRUCTURED INTERVIEW WITH HEADMAN

Nanga Kesit is located at Engkelili, which is the sub–district under the jurisdiction of Lubok Antu District Council and dominated by the Iban. According to the oldest man living in the longhouse, Nanga Kesit existed roughly two hundred (200) years ago. "Nanga" in the Iban language means estuary and since then, the village Nanga Kesit exists. Eventually, Nanga Kesit settled at the present place, near the river bank of Sungai Lemanak. The people in the longhouse majorly work as farmers. Nanga Kesit has two longhouses that administered by the headman. His education level is secondary school (Form 4). He has been headman for 3 years starting from year 2012 until year 2015. He is in–charge 27 "pintu/bilek" including the individual houses. His role is to look after the households under his jurisdiction. The headman is the chairman of the longhouse followed by his secretary, Treasurer, Assisstant Treasurer and other members. There are facilities in Nanga Kesit such as primary school (SK Nanga Kesit), clinic (Klinik Desa Nanga Kesit), and agricultural department (Jabatan Pertanian Nanga Kesit). The households buy their groceries from the canteen. They also buy their vegetables and meat from mobile vendor that usually come to Nanga Kesit on Wednesday and sometimes on Tuesday.

The women committee are responsible for activities such as doing preparation to welcoming visitors, "gotong–royong"(cleaning the longhouse). In the decision–making, all the households will get involves. HH in this longhouse are farmers. One of them is a contractor specialize in building construction. All of the households are cultivating hill rice, rubber, and pepper. Some of them cultivating oil palm. Cultivating hill rice for subsistence and cash crops to generate income. Rubber trees existed a long time ago but present day there are no one tapping rubber due to the declining price of the rubber. There are 34 households involving in the rubber scheme, which is called Skim Ladang Getah that just started 3 years ago. The headman ask for the rubber scheme because the rubber price was high and he afraid that government will take their land as there are no crops planted on their land located at Stapang. Under this scheme, The Agriculture Department supply 1800 rubber saplings to thirty–four (34) households. The rubber scheme is valid for 5 years where the Agricultural Development will be providing the 34 households with fertilizers. After 5 years, the households who involves in this rubber scheme can tapped the rubber trees and sell the latex to any traders that buy latex. This is a good thing in his opinion because it can improve the households living. The households can work on the land by planting the rubber which are given by the Agricultural Department and get paid. During this time, the Agricultural Department will be stopped in supplying the fertilizer.

The villagers define their land boundaries using fruit trees, hill, and river. The households do sell some handicrafts, carve the handle of 'dukuk', remittance from their children, hunting wild animals, sell wild animals if there is surplus to the villagers. Tourism activity had stopped since there was road access to Nanga Kesit. The tourism has been moved to Ngemah located at upperpart. The Ngemah area more traditional and tourists love it. No people from outside move to the longhouse. If move out not on permanent basis (marriage, working in the city, buy house at town). 13 households living permanently in the longhouse. The longhouse split into two because not enough land and there was dispute them.

APPENDIX XII – VILLAGE WALKS



Village map

LEGEND

1 LH Headman
2 HH
3 HH
4 HH
5 Pepper drying area
6 HH
7 Storage - LHT14
8 HH
9 Storage - LHT3
10 Chickens - LHT4
11 Bridge to school and
12 GL
13 Craft workhouse
14 Storage
15 Rubber rollers
16 Storage
17 Storage
18 Chicken and pigs
19 Storage + animals
20 Bananas
21 Rice mill
22 HH
23 HH
24 Old LH location
25 Washing area
26 Bananas
27 HH
28 HH
29 HH
30 HH
31 HH
a shop
b boat warehouse
32 Storage
33 HH
34 HH
35 HH
36 HG
37 Storage
38 Storage
39 Washing area
40 Rubber rollers
41 Events/Cooking area
42 Storage
43 Storage
44 HG
45 HH
46 Abandoned tourism LH
47 HG
48 HH
49 HH
50 Empty house
51 Old traditional prayer
52 PG
53 HH empty
54 HH empty
55 HH empty
56 Old Tourist entrance
57 HH
58 HH Rubin
59 HH Lucy
60 Animals
61 2nd bridge (2006)

APPENDIX XIII – FIELD WALKS

GENERAL INFORMATION – FIELD NOTES

- The price for **Pepper** 6 months ago was 30 ran/ kg, but now it is 26 ran/kg
- The market where they were selling it was:
    - 1: Sriamam (1 Hours)
    - 2: Kiyli (0,5 hour)
    - 3:(unknown) – ask Elan
- **Rubber:** 2–3 ran/ kg – dried
    - 3–4 years ago it used to be 10 ran
    - 1 cup for rubber seed = 1 RM
    - 1 small tree = 4 RM
    - 2000 RM = 300–500 tree
    - 5 years before you can tap it (the tree should be around the size of a human)
- **Hill rice** is harvest once a year and growing season is 9 months
- **Oil palm** 5 years
    - 4 RM/ day for the paid workers
    - Before was rubber

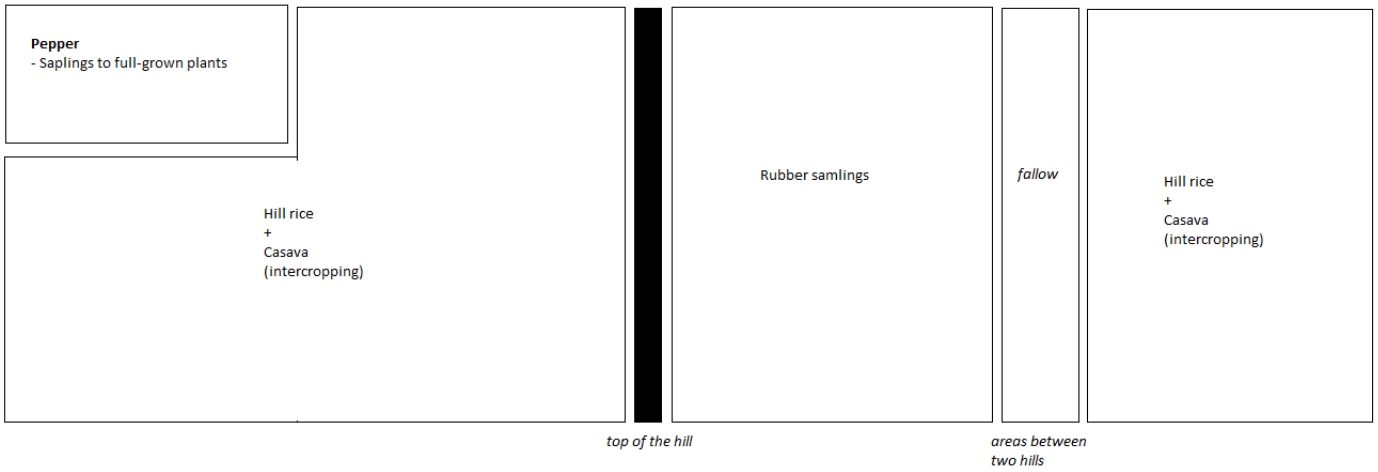
Before the construction of the paved road did they have field 1–2 hour away from the village, after the road/ doing the last 10 years have the moved their fields closer to the road so they now can access their field by car.

We know that logging and intensification of agriculture is occurring upstream of Nanga Kesit River. They use to practice slash and burn and leave the field fallow in between. Now it mostly depend on the individual farmer and how much land he has. They do not leave the land fallow anymore, but practice more cash crops using fertilizers and pesticides to increase crop production.

FIELD WALK WITH HEADMAN – NOTES

Land division: The land are divided by the village and are divided by loads and hills**.** When the parents past away due the land divided among the siblings, everyone can have some. But often the ones who stay in the village gets more land.

1. **Hill fields (first stop on the field walk d. 01-03-15)**



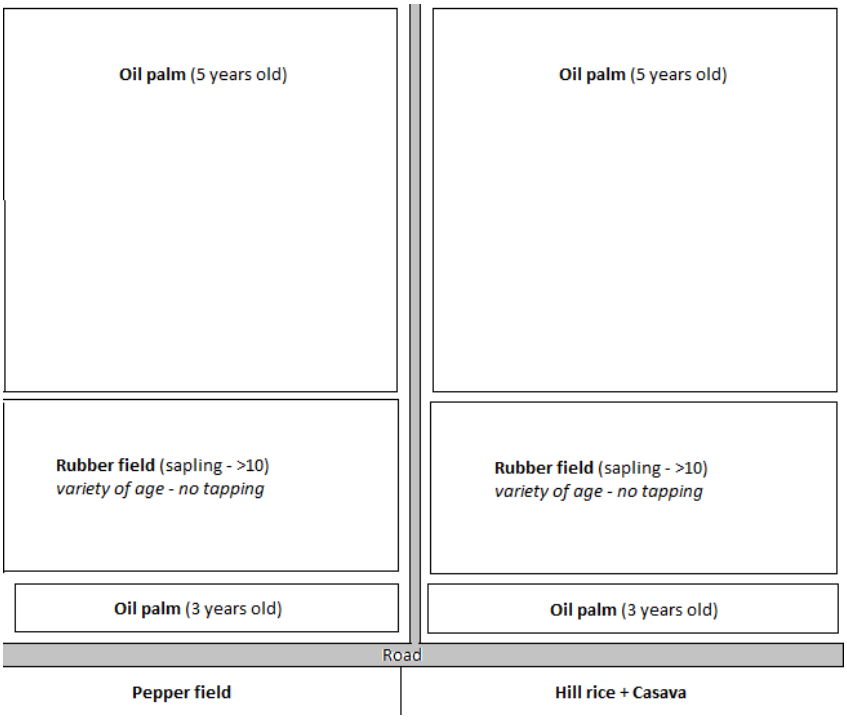
Hill rice

- Hill rice grow for 9 month before the harvest. Hill rice is harvested ones a years around this time.

Land use + owner

- The headman owns the hill rice + cassava field to the left; his cousin owns the pepper field. Rucie own the mixed vegetables.
- Before the field was old rubber trees, then they burned the rubber plantation and now they are starting planting pepper and hill rice (with cassava most times).
- The do not general have fallow land, but just start planting/ cultivating when the file is “ready”.
    - The area which look like fallow might be a kind of secondary forest/ tress occupying the land because the soil is not fertilize enough/ it is unpractical to cultivate that peace of land.
- They due slash and burn cultivation
- The land is surrounded by secondary forest.
    - Some of it belong to Nanga Kesit but they do to not cultivate it.
- In the horizon are the starting doing logging, but the logging is not under the control of Nanga Kesit
- All the land is owned by Nanga Kesit and they divide it among themselves

2. Oil palm, rubber + pepper (second stop on the field walk d. 01-03-15)



Rubber fields

- They are part of a government rubber scheme and three years every HH got 1.800 saplings

Oil palm

The oil fields use to be rubber fields

- They used to sell the fruit bunches to a chines mill but it burned down so now they are selling to a middleman. Each fruit bunches weight around 20 kg.

Land use + owners

- The headman owns the fields

- The soil at the hill rise field is better/ more fertile than soil for the oil palm. But it doesn't affect the oil palm too much because they get fertilizer.
- Every three gets fertilizer around the stem.

FIELD WALK – WITH FARMERS

Objective: Follow the flow and accept the invitation from a farmer from the village to get a better understanding of the surroundings. We did not plan to go on the field walk.

Setting: The farmer came into our apartment and invited us for going with them to their field. We went there in their car. Beatrice, Arlene and Anna were sitting inside and the rest in the back. On our way there the farmers explained different things along the way.

Design: When we got to the field, we went around and asked questions about what was visible on the field. Anna took notes and Arlene and Beatrice translated. All of us

Data obtained: The field was newly bought land covered with 1 year old pepper plants. They did intercropping in this field (close to the dirt road on the top of the hill) with their "home garden" with chili, banana eggplant and other vegetables.

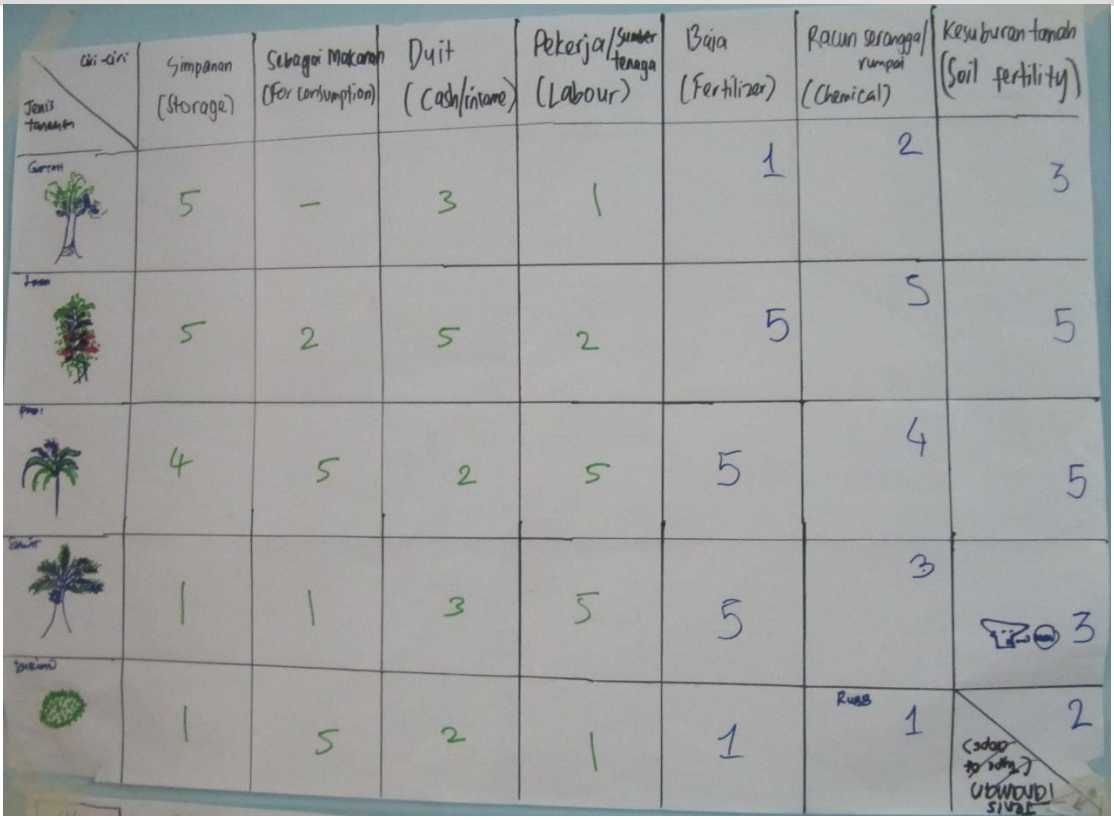
The pepper plants are around 1 meter tall. It takes 3–5 3 years from the sapling is planted till it is ready for harvesting. It is possible to harvest once a year. The yield of the plant depends on the size. When they plant pepper and during the harvest, they need more labour. They gives 40RM per day per worker. It took under 1 week to plant this field for 10 people. Now they leave it until it is ready to be harvested. The only job is to weed once in a while.

The main cause of pollution in the river is the logging. Nobody from Nanga Kesit is working in the logging industry. (It was possible to see a logging place from the top of their farm).

The main crops (of them or in general?) are pepper and oil palm. Oil palm started 2–3 years ago, when the road was constructed. It is possible to cultivate hill rice in between the oil palm for the first 3 years of planting oil palm. After that, it is not possible anymore.

The boundaries of the land is distributed according to the ancestors. When a family inherit land, all siblings will get some land – both men and women. The one, who stays in the house of the parents will get the most, but the others will also get some. The boundaries are either the top or bottom of a hill, a stream/river or other physical boundaries.

APPENDIX XIV – PARTICIPATORY SCORING OF CROPS



Ciri-ciri / Jenis tanaman	Simpanan (Storage)	Sebagai Makanan (For consumption)	Duit (Cash/income)	Pekerja/Sumber tenaga (Labour)	Baja (Fertilizer)	Racun serangga/rumpai (Chemical)	Kesuburan tanah (Soil fertility)
Getah	5	–	3	1	1	2	3
Buah	5	2	5	2	5	5	5
Kelapa sawit	4	5	2	5	5	4	5
Kelapa	1	1	3	5	5	3	3
Sayur	1	5	2	1	1	1	2

Notes taking doing the ranking:

Oil Palm

- 1 tonne = RM280 - The kernel is edible.
- Fertilizer and chemicals bought by themselves. Harvesting can be done after 3 years of planting, with proper fertilizer application. Cannot be stored more than 12 hours.

Pepper

- Current price per kg is RM25, but it was RM30. They use pepper for consumption but not much. Pepper will mature at the age of 3 years and when it start flowering, it will take around 9 months til harvesting.
- Pepper need both fertilizer and chemical application for maintenance and good production.
- They buy their own fertilizer (Brand: Cap Jambatan) which it cost RM 145 per 50 kg. Previously, it was RM 120 per 50 kg

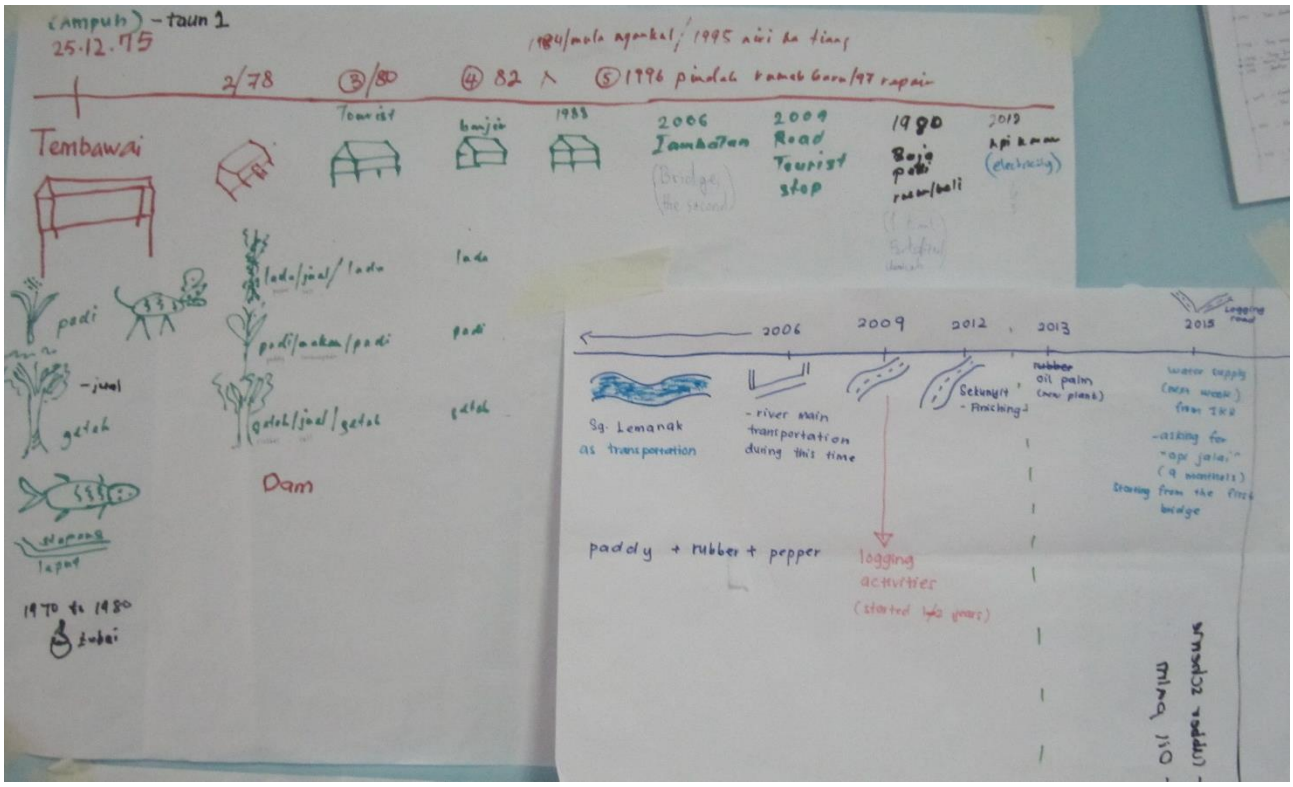
Rubber

- Rubber can be tapped in 300-500 trees in 2 hours per person. Tapping can be done after 5 years of planting.
- They get subsidies for the fertilizers from the government but they will not use it for their rubbers, but apply it in their rice and oil palm fields. Only need herbicide application to control weeds. If not, rubber will die.

Rice

- Both fertilizer and chemical applications are needed for maintenance. They get subsidies for the fertilizers from the government.They used to do activities together (*gotong royon*g) and they will share the produces. Harvesting can be done after 6 months of planting.

APPENDIX XV – PARTICIPATORY TIMELINE OF VILLAGE HISTORY



FOCUS GROUP DISCUSSION + TIMELINE

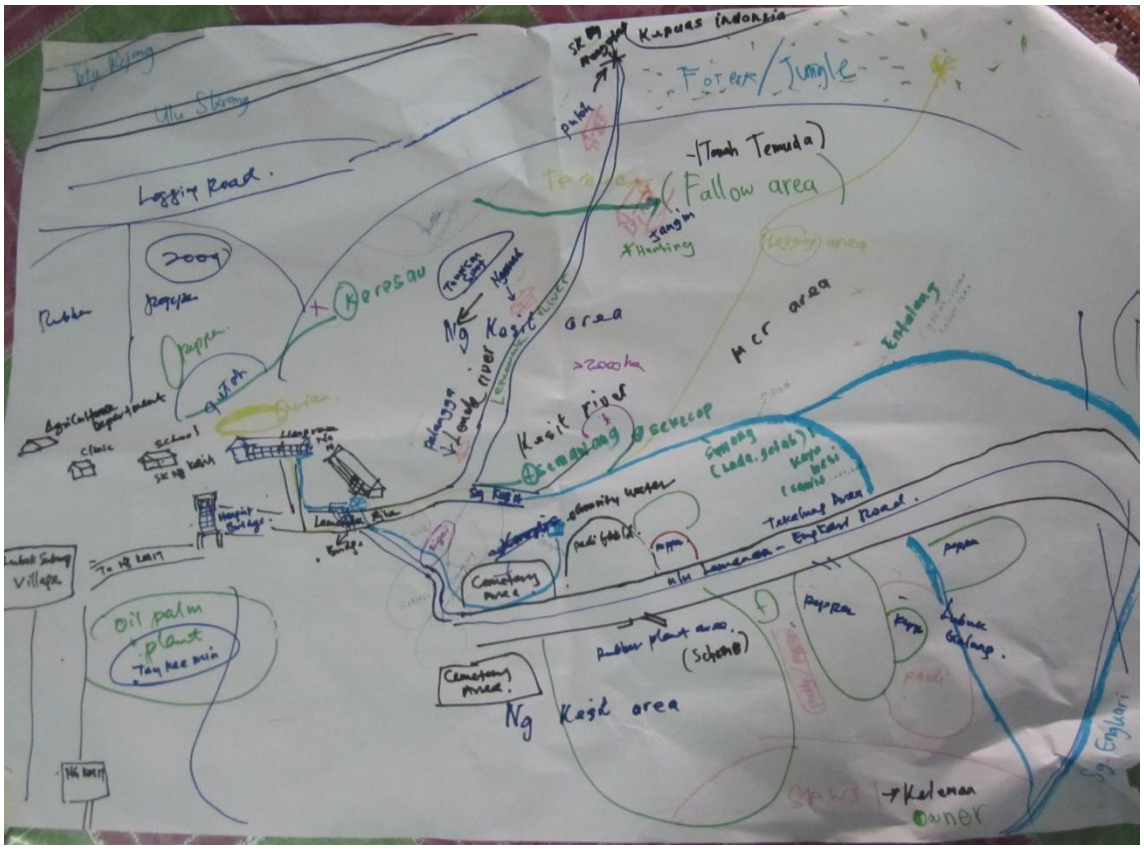
Interviewee: 3 women from the village

Before road construction, the people at Nanga Kesit use river as their main transportation. Their children had to stay at the boarding. The cost using boat was expensive because they have to buy fuel for the boat. They also had to stay at their farm last time because their house located far away. Road to NK constructed in year 2009 and there were also road constructed up to Sekunyit.

Perception of road

- Easy access to buy food, visit relatives, children can go forth and back
- Less transportation costs
- Tourism stopped due to the road
- New crops introduced which is oil palm
- Can plant crops at other land

APPENDIX XVI – PARTICIPATORY MAPPING OF LAND USE IN NANGA KESIT



Notes from participatory mapping:

Drinking water source: It is using gravity feet at the hilly area which they called "Penyaru". It takes 40 minutes walk to the area and it has water fall.

Fallow area: They used to plant paddy at Semengon area but now shift to other areas that are nearer to the road. Before the road construction, they used to walk to their farm fields for 2–3 hours. It was difficult for them to carry heavy fertilizers. Now, the farming activities are mostly in Semawang, Sekecap, Setapang, Sekeruh and Bukit Tekalong. Due to road construction– they moved to the fields that are nearer to the road.

Reasons: its nearer and it is possible to use cars or motorcycles– easy to carry fertilizers

Other matters: Village's cemetery located near Semawang area. There are logging activities near the upstream area of Nanga Kesit. Lemanak river are cleaner than the Kesit river. Villagers told that the Kesit river used to be very clean and clear before and fishing was used to be actively done by the villagers. Due to the logging activities, Kesit river now is polluted and cloudy. They will go to Semengon area for hunting activities.

APPENDIX XVII – TOPIC FOCUSED INTERVIEW WITH KEY INFORMANTS

INTERVIEW WITH COUNCILOR

Objective: To obtain knowledge about development plans for the area and to get insight in the goals and visions of the local government. To get more details about the road construction and the process – especially if people were against or for the road construction.

Setting: We had made an appointment with Koncil, and he came to the longhouse in the evening. We sat in a circle in the inner veranda. No one was sitting around us, but in the other end, people were sitting and drinking.

Design: We had an interview guide, which was followed but also allowed for following what Koncil was interested in talking about.

Data obtained: His job is to help the members of the parliament to get information from the office to the people. If someone is in trouble, he will also try his best to help them. For instance, if they can't built a house, they can assist this person in this. Koncil is responsible for the area from Serubah Ulu and to Nanga Kesit and he is responsible for the welfare in the area.

For how long have you had this job? This is his second year in his first term. Usually you can have up to three terms. *Per term is somehow used to be 2-3 years. More approximately 2 and half years. (18months)

How is the councillor chosen? The ruling local government picks the councillor. He is representative from PBBB. (Sarawak).

For whom do you work for? Political party & Government

What are your responsibilities?(What kind of task do your job as a council include?) He is a meditator between government & villagers. In the area he is responsible for, there are 14 villages.

How do you conduct your work? In each village, the head of the village will report to him what they would like and then he brings it to the government.

What have you achieved in your time as a council? Bus stand/bus line system, Gravity pipe water and Something with schemes, but he explains that not all of them have schemes.

Are there any development plans for Nanga Kesit?

Past projects: PPRT Houses (13 houses Ng Kesit) and 2nd bridge which cost RM 600 thousand including road access.

Current projects: Public toilet, Drainage system and Repair the bridge

Future perspective/project: Repair the first bridge and a road to Lubok Sambong.

When was the road constructed? There was a gravel road before, they have remade the road.

Why was the road constructed? The villagers requested it a long time ago. The requested it, so that they could sell the produce and to get easy access to town.

And was there any challenges in the construction of the road Some of the villagers didn't want a road.

How did he cope with this? Before him, but they had to be very patient in dealing with the villagers about this. People wanted compensation for the land.

Were the villagers involved in the plans? No, but the headman of the villages were. Something with 'Ketua masyarabou decides. (Maybe the council in every village – Do you know that, Arlene, Elan, Fredicia or Emma?)'Ketua Masyarakat' means Society Representative *Cauncil is only 1person but in charge for several long houses/area. So basically each council might be in charge for few headman's.

Were anybody else involved? No, the government paid the compensation for the road.

How long did it take to go through the whole process – from idea to the road was finished? We (the village) were asking for a road. The government was very slow in fulfilling the request. If parties are staple, it will be easier to achieve. It is ruled by different parties: government and opposition. If only one party is ruling, it is easier to ask things.

Were there any oppositions towards the road when it was first mentioned? No, not from Nanga Kesit

What kind of challenges do you face as a council? Too many challenges , it will be a long story to tell all of them. You have to be in charge of 14 villages and not everybody likes what you are doing. He focuses on them, who accepts his plans. He is short of funds to run projects. He has little money compared to other places, because people don't pay so much in taxes.

How do you handle/ response to these challenges? He works slowly with people and try to approach them. And he is trying to do the best for the people. This is the second councillor for this area. The previous one was there for 20 years.

Why are the villagers reluctant to engage in oil palm plantation schemes?*(They rejected an oil palm joint venture)* In Nanga Kesit, everybody plants their own oil palm. They are replaced every 60 years, then they are worn out.

What would you like to do as a councillor? His hope as a councillor is that he wants everybody to be developed in every aspect: yourself – family – village and surroundings.

INTERVIEW – SHOPS OWNER

Objective
Key informant interview with identified informant with:
1. A high degree of income diversification
2. Cultivates pepper, rubber and oil palm but no hill rice
3. Owns a truck
4. Has stopped cultivating hill rice and started cultivating oil palm since the road came

The main objective of this interview was to understand the influence of the road on the villagers household's livelihood changes and strategies.

Setting
We entered her house after having asked permission to talk with her for about half an hour. We entered the small shop first, which mostly had basic food products, piles of beers and a fridge with soda and beer. Inside the house, an older woman was sitting in the couch and the television was on. She asked us to sit down and we sat on the floor around a small table. Pictures were hanging on all walls just under the roof. Mostly they were formal pictures with graduation ceremonies and portraits.
Comments: They seemed like they have a high level of income because of the technical devices and the many pictures of the graduation ceremonies hanging around.

Design
We had the interview guide for villagers with us, but had decided that the interview should be very semi-structured and follow what she wanted to talk about. The main focus should be on the road and the changes in their everyday life because of the road.
Since none of the notetakers were able to transcribe the conversation (see introduction below), the following is based on memory, where Shirin and Anna sat together afterwards to put together what they could remember.

Data obtained
Q: Has the road changed anything for the people in Nanga Kesit?
R: Since the road, came, there is more easy access to some things: city for visiting (family), market (food), to get supplies for the shop. Before they had to transport the supplies by boat from Enkili.
Q: Is it easier for your husband with his business? Yes, he has started it 2 years ago after the road was made. We talked about that it was easier for them to go to Kuching now with the road. There they could visit family. Her children are living in Kuching.

She stood up and showed us her pictures hanging on the walls of her children. She had 3 kids and 2 of them already graduated from university. The last kid was in form 5 and she explained, that after the road, it was easier to visit him and for him to come home.

While we were standing and looking at the pictures, the headman came. When we sat down again, she changed behaviour: looked at him all the time, and sometimes he answered for her. (Own thoughts: Is he coming to control us, to accompany us or because we shouldn't go anywhere without asking him? Also - I don't know how much it influenced her answers.)

Q: Oil palm has been introduced after the road was established? Why?
R: It is easier to sell and to bring fertilizer.
Q: Were is it best place to shop?
R: Lubok Antu (more people, better for selling handicraft) – it is also good for buying things and eat. Enkili and Batang aii is best for food. The villager explains, that they had a car before the road. Before they parked it somewhere else and would go there by boat. Now it is more convenient.

Before the road, they used the boat for transport much more. They still have a boat.

Q: When did you open the shop? R: 6am
Q: When did you start having a shop? R: They had it for more than 20 years. Before that, when they still lived in the longhouse, they sold snacks.
Q: Where did you get the idea from to sell snacks in the longhouse? R: It is normal to have one or two households selling snacks in a longhouse.
Q: Were you engaged in tourism before the road came? R: No, the person at Lubok Subok shop was the person who was engaged in tourism. And the shopkeepers brother.
Q: Is it good or bad that the tourism stopped? R: She doesn't know.
The headman is answering intead of her: It is better now, they don't have to hide their information. Leo explains that before they had to hide their mobile phones and car for the tourists and that was annoying.
Q: What do you use these hats for? (We point at a small pile of rice hats in the corner of the living room) R: They don't sell it – they make them for themselves. It takes a month to make one.
Q: Do you have any questions for us? R: How is Denmark? us: Denmark is cold.
Q: Are you all from same country? us: No. (We explain where we are from).
Q: Have you been outside Malaysia? R: No, but she has been to the peninsular + Sabah. She has been on Mount Kinubalu in Sabah and to Kuala Lumpur in the peninsular.
Q: Where is better - Kuala Lumpur vs. here? R: Here is better, Kuala Lumpur is more expensive
Q: Do you think we are asking too many questions? R: No, it's okay
Q: Do you have any tips for us during our stay here about what to do? R: To be more outside the room and talk with people

A boy around 14-15 enters the room with some bags and the villager explains that this is the son from form 5 and he has come back from the boarding school to spend the weekend with them. We say hello to the boy and thanks for her time and leave the house.

INTERVIEW WITH THE OWNER THE SHOP IN LUBOK SUBONG

Situation/Bakground information:

The interview started with the shop–owner at a bigger table in front of the shop. After ten minutes, the villager came and started answering the questions as well. A few minutes after that the shop–owner left and the interview was continued with the villager. It is important to note that the longhouse of Nanga Pulok has no access to the road and is up–river on the Lemanak river. He came by boat to Lubok Subong to take his motorbike to go to Lubok Antu.

Q: What part of the road is new since 2009? The road to Lubok Subong (from the main road to Lubok Antu/where our bus stopped). Then bit by bit further in to the direction of the fields, finished in 2012

Q: What has been there before? Nothing but trees

Q: When did they get to know about the road to be constructed? In 2004 when the government surveyed the area for the construction [We don't know if NK people had the information at the same time]

Q: What is the name of the road? Lamanak Ankari

At this point the owner of the shop oined the interview

Q: How did the road construction change the area and your everyday life? In general positive changes, it is better than before the road was constructed. Especially transportation and mobility improved: easier, faster, more efficient before by boat to town. Now transportation is independent of high/low water. Buying and selling on market is easier, cheaper, more efficient. thereafter the products in his shop can are cheaper now. Merchants can come and pick up produces now. less self–sufficiency is seen.

At this point the villager took over the conversation and Kim In left: I had the impression that the villager wanted to express his dissatisfaction about the government thereafter some of the following information are likely to be exaggerated

A:

- villages with road access are better off than his village, road access is important in his eyes
- since they have easy market access and can sell their produces, whereas he only produces for self consumption
- the money from the government was mainly spent on the dam and the road for logging companies and not for the people in the villages
- the money for projects for the people is missing now
- he is living in Nanga Pulok which is 2h up–river from Nanga Kesit, they have no electricity
- the officials don't distribute the money equally to all villages and projects but privileges companies
- the federal government doesn't know about that because the state officials don't report this
- he mentioned that local officials were bribed by companies to build the road more beneficial for the companies
- the officials privilege Malays
- different areas have representatives and they are in Lubok Antu, the official for his longhouse is called Penghulu Chabik
- the officials at that level are all under Koncil (the counselor who lives in Nanga Kesit)

Tourism: How did the tourism change in this area?

- tourism is not in Nanga Kesit anymore
- the tourists move up–river, they want to see wood (originality)

The villager left with his wife to Lubok Antu, we went in the shop and asked if we could ask some more questions to the wife of the shop–owner, she didn't have time right now and asked us to come back at 5 p.m.

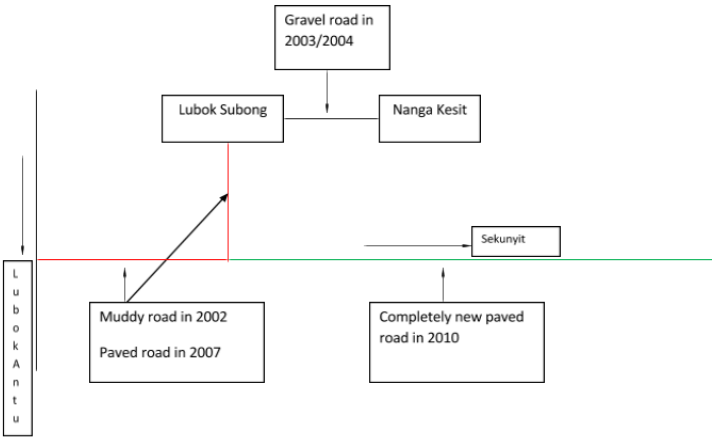
Interview with the owner the shop in Lubok Subong (5 p.m.)

We arrived at 5 p.m. but the wife was not around. So we were waiting at the table in front of the shop and talked to her son instead. He was around 30 years old. Across the table sat the father of the wife of the shop–owners' son.

Interviewee: Son of the shop–owners

Q: When was the road to Lubok Subong has been built when? A: He said that there was a muddy road since 2002 that could only be used with an off–road vehicle. It was a logging road that also passed the junction to Serubah Ulu.

I drawed a scatch of the roads and villages and asked him when each part was built and what has been there before.



Q: How did you get to Lubok Antu before the road was built? A: He took a boat to a bridge at the Sebeliau River and then took a bus.

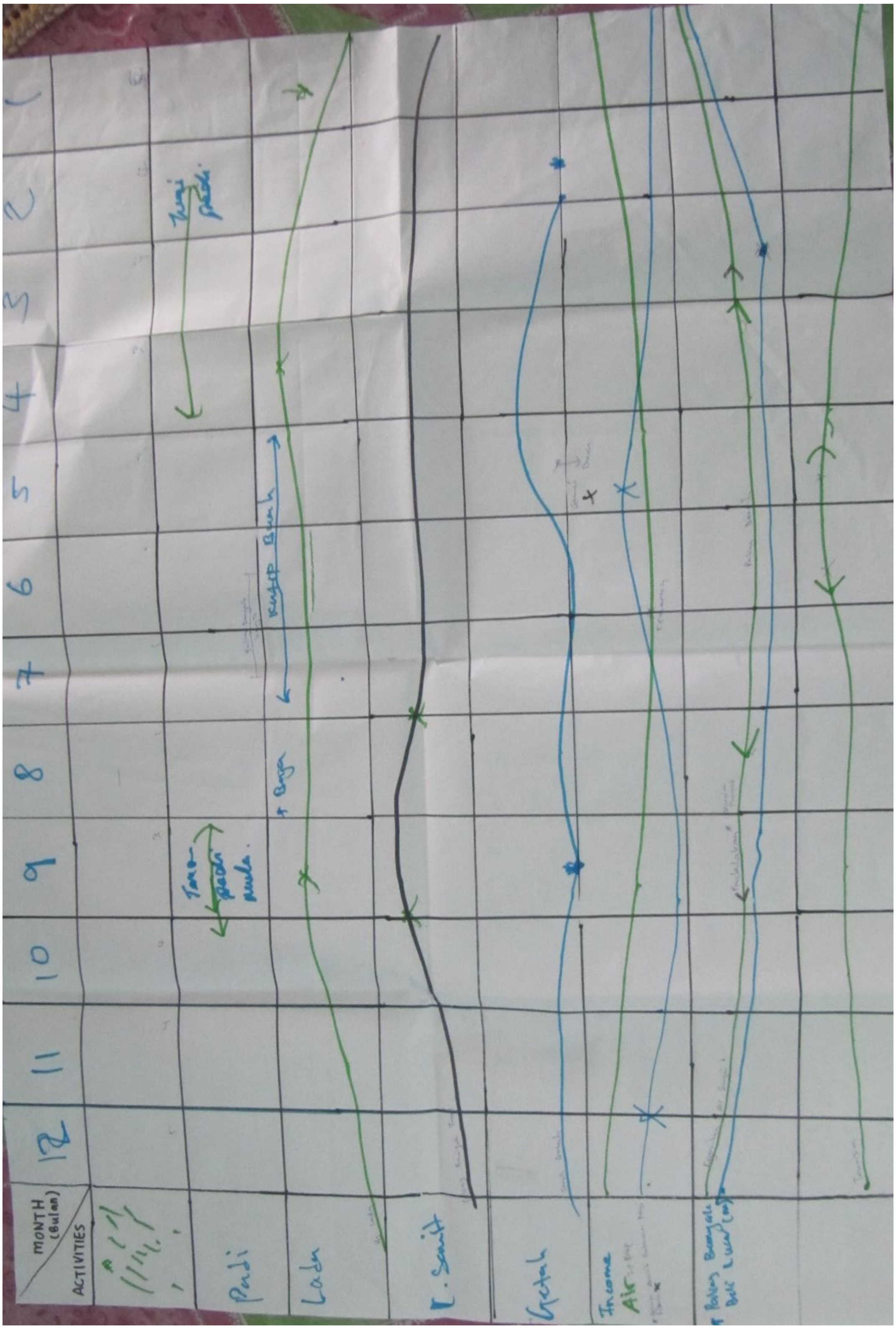
Q: When did the tourism stop in Nanga Kesit? A: 4–5 years, when the road was finished, he mentioned that it stopped because of the road. it was organized by a travel agency in Kuching (Cat City Tour) We started to talk to the father of the interviewee's wife, who spoke English and lives in Lawas (northern Sarawak): the talk was not about our topic in specific but he told things that can be related to our topic.

– it is easier to come to see his daughter in Lubok Subong, more often. He mentioned that Oil Palm, especially the field of the shop–owners, are getting more due to the road. After an hour of small talk the wife of the shop–owner came back and I asked her about her Oil Palm field and her shop. But after 10 minutes she got distracted by a friend who came by the shop is still benefiting of the tourism. The road improved their lives, made things easier, especially mobility.

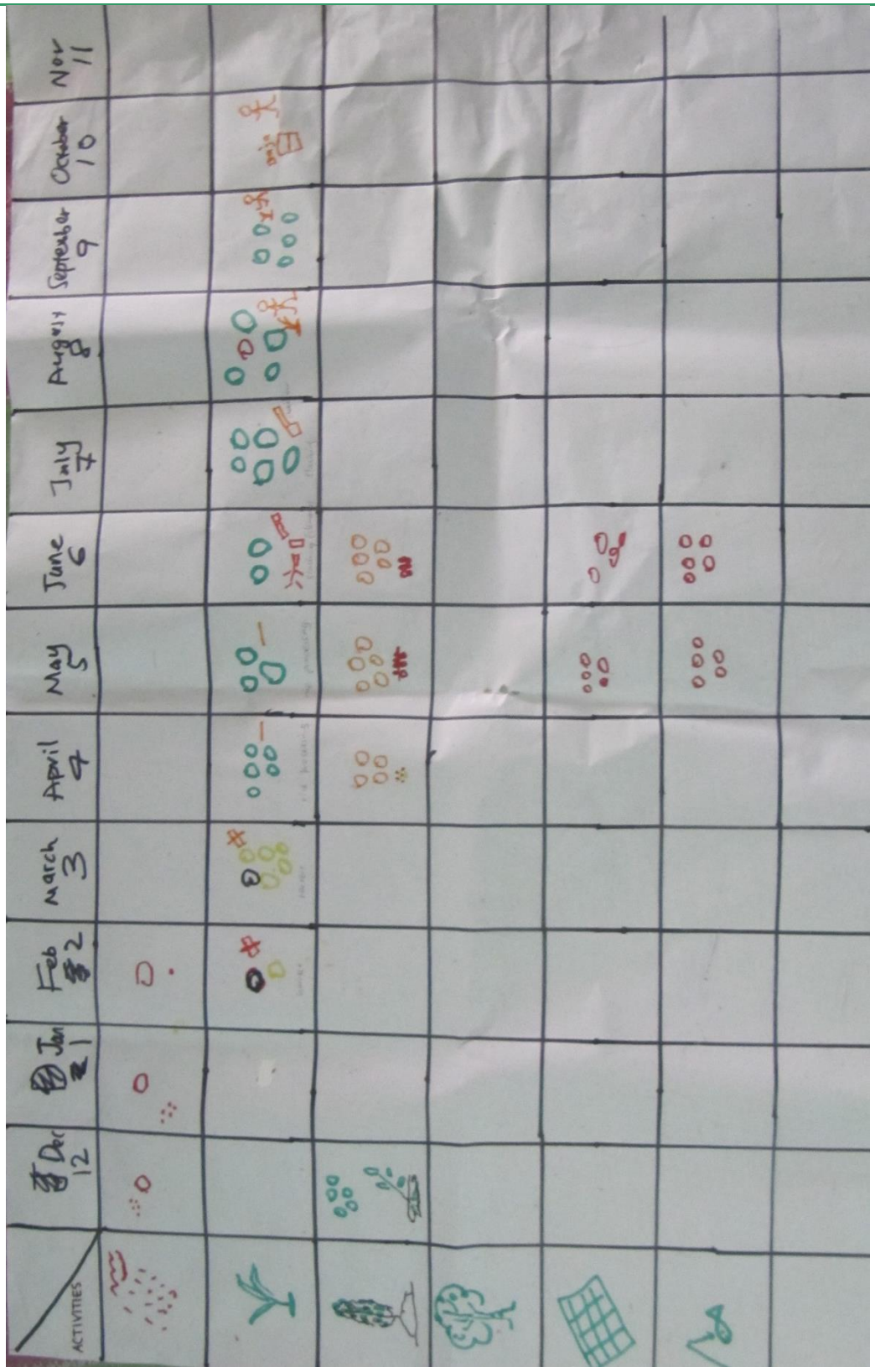
They started Oil Palm when the (muddy) road was constructed, (OP is 10 years old). Without the muddy road, no OP would have been possible, she mentioned that she prepared her field with a bulldozer. [they must have had some money to invest in off–road vehicles and prepare the plantation]. After she left with her friend we thanked and said good bye to the man and left

Appendix XVIII – Seasonal calendars

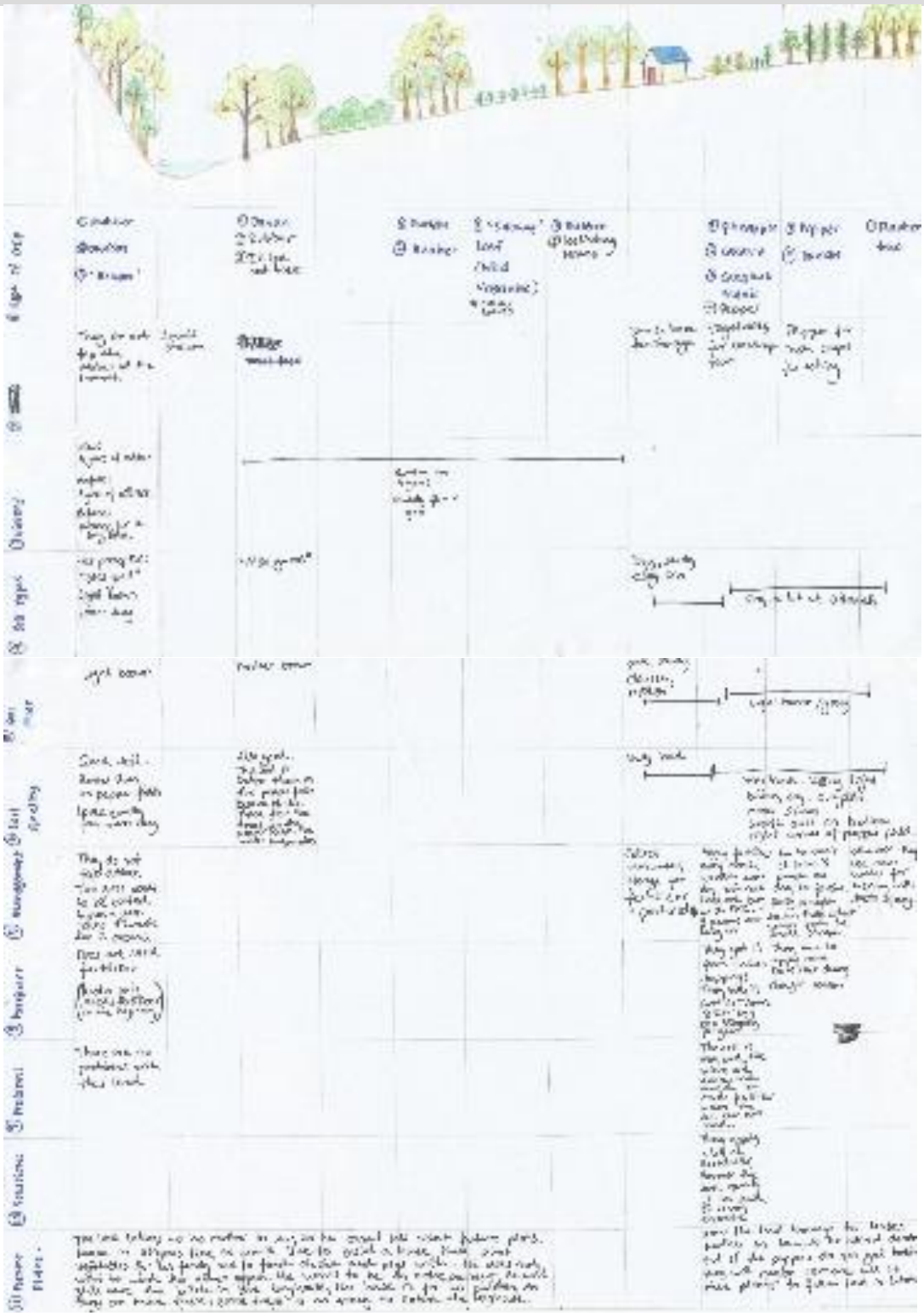
Seasonal calendar – Men

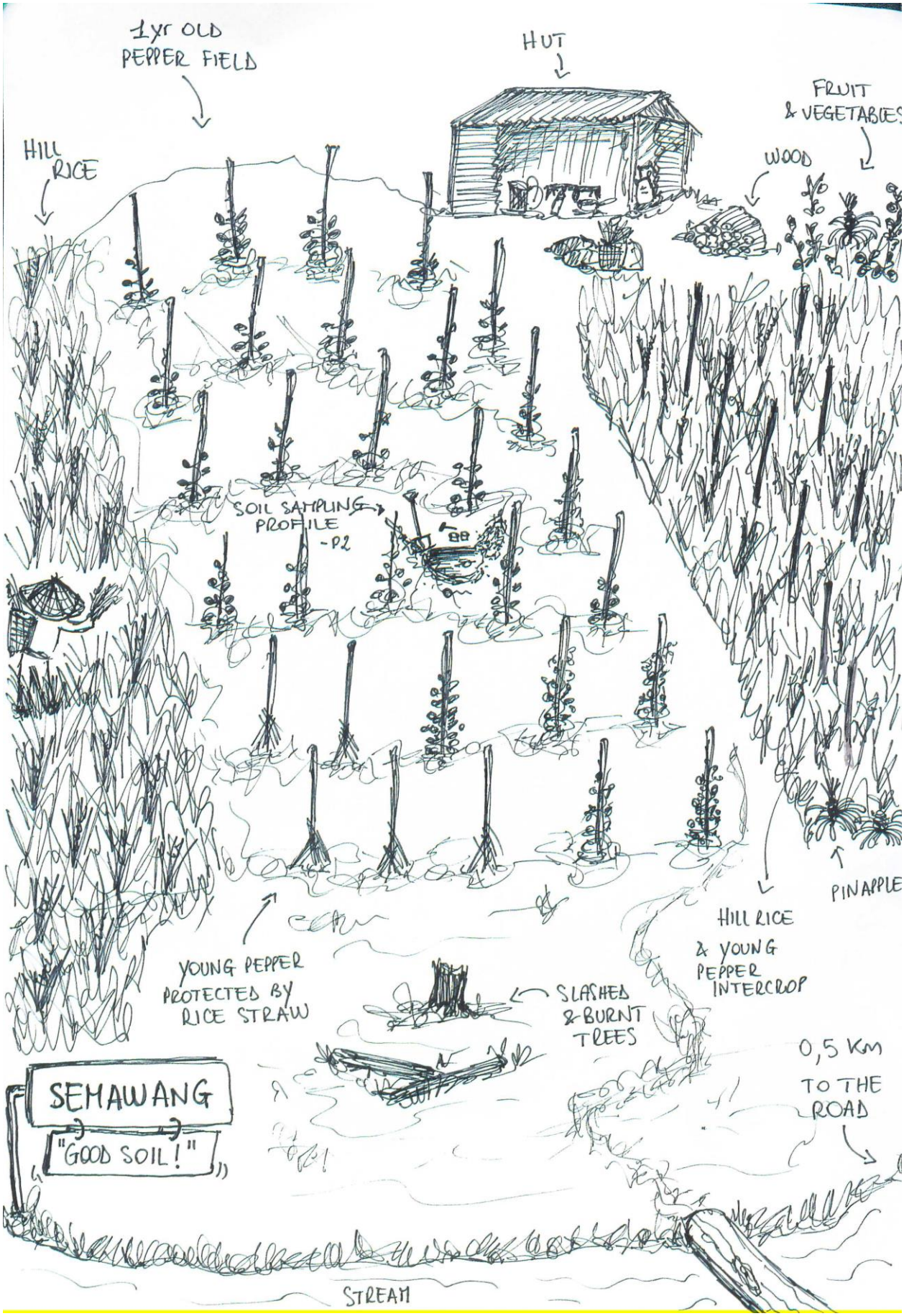


SEASONAL CALENDAR – WOMAN



APPENDIX XIX – TRANSECT WALK




1yr OLD
PEPPER FIELD
HUT
FRUIT
& VEGETABLES
HILL
RICE
WOOD
SOIL SAMPLING
PROFILE
-P2
PINAPPLE
HILL RICE
& YOUNG
PEPPER
INTERCROP
YOUNG PEPPER
PROTECTED BY
RICE STRAW
SLASHED
& BURNT
TREES
0,5 KM
TO THE
ROAD
SEMAWANG
"GOOD SOIL!"
STREAM

APPENDIX XX – SSI WITH VILLAGERS

SSI with women from the village about the road:

The road was established first and then electricity supplied to Nanga Kesit. The roads were applied by the villagers according to their agreement to have the road. After the electricity came to NK, the households applied for water supply. The households are happy with the road construction because they can access to the market, school, clinic, and their farm. Besides that, they can lessen the transportation cost because during old days they used long boat/boat to go to the town. Before they reach the town, they have to use boat to go to Sebeliau which took 2 hours. From Sebeliau, they use bus went to the Engkelili/Lubok Antu town. The transportation cost was high because they have to pay the petrol for the boat/long boat (if its own by themselves).

SSI with another women from the village about the road:

The second bridge was constructed in 2012 which was 3 years ago. In her perception, the road brings a lot of benefit. She has the access to the clinic, school, and farm, and school compared to the old days she have to travel by long boat/boat. The road was ask by the households many times.

APPENDIX XXI – DEFINITIONS

Household:
"A household compromises a person or group of persons generally bound by ties of kinship who live together under a single roof or within a single compound and who share a community of life in that they are answerable to the same head and share a common source of food." (Casley & Kumar, 1988: 60)

Land use decision-making:
The decisions made by farmers about "the arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it" (FAO/UNEP, 1999)

Livelihood:
"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living." (DFID, 1999: 1.1)

Livelihood outcome:

"Livelihood Outcomes are what people are seeking to achieve through their Livelihood Strategies" (DFID, 2000: 4.13)

Livelihood portfolio:
The combination of activities that are pursued" (Scoones, 1998: 10).

Livelihood strategies:
The different ways people choose to utilize their assets and decide which assets to invest in or which to divest of, in order to meet their goals (DFID, 2000).

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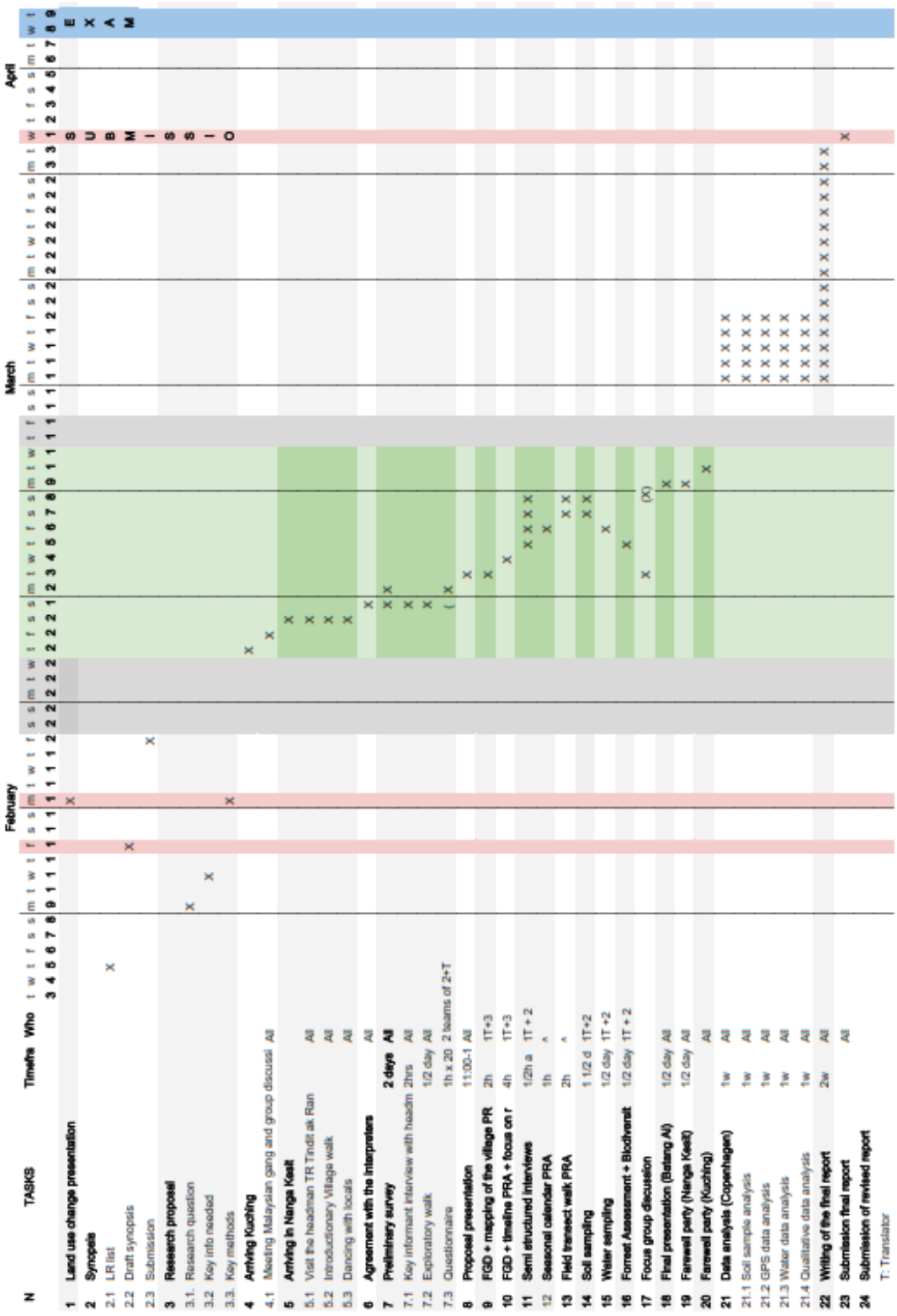
APPENDIX XXI – GANTT MATRIX



APPENDIX XXII – SYNOPSIS

FLEXIBLE AS RUBBER?

THE IMPACTS OF RUBBER AS THE MAIN CASH CROP IN THE VILLAGE OF NANGA KESIT, SARAWAK

SYNOPSIS

Word count: 2595

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ILUNRM COURSE 2015
UNIVERSITY OF COPENHAGEN

TABLE OF CONTENTS

1. INTRODUCTION

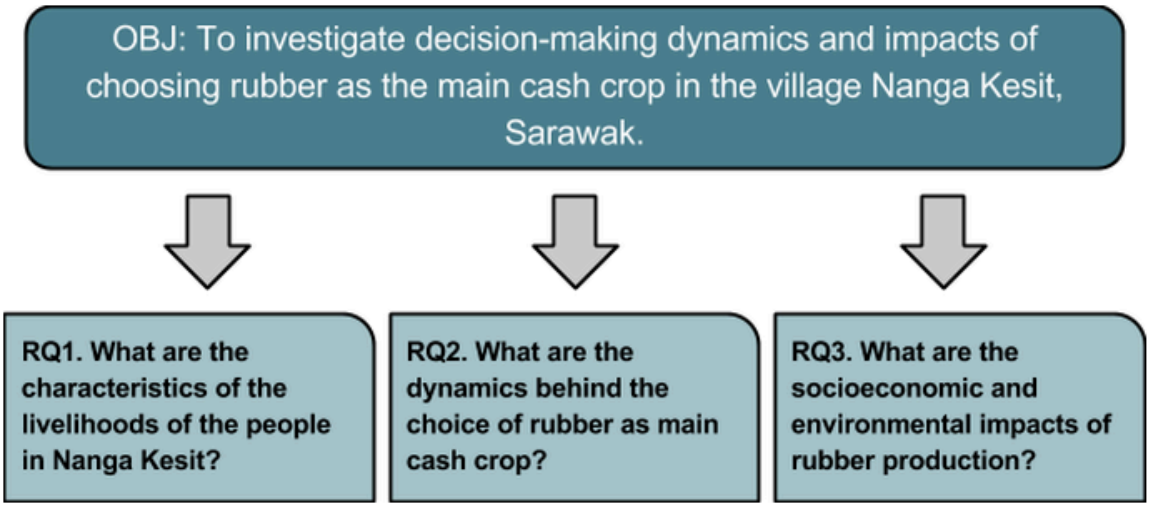
Malaysia is often highlighted as one of the success stories in relation to economic development, natural resources management, and rapid transformation from a commodity-based to an industrialized economy (Drabble, 2004; Loke & Tham, 2014; EPU, 2010). Within only 50 years, Malaysia has quickly moved away from the status of *developing* country, to become a *middle-income* country, with the Malaysian Vision 2020 stating that the nation aims at transforming into a *high-income* country by 2020 (EPU, 2010). In order to achieve this vision, one of the goals is to modernize the agricultural sector. For the purpose, the government is specifically focusing on the Malaysian part of Borneo, Sarawak and Sabah, because of the relatively vast land available in those two regions (Bendixen, 2013; Abdullah & Nakagoshi, 2008; MLDS, 2015).

Currently, the majority of the rural population of Sarawak is still dependent on agriculture for both subsistence farming and income generation. Cash crops, such as rubber, palm oil and pepper, are vital to the livelihoods of a large part of the population, hence leading to high vulnerability to world market price fluctuations (Bendixen, 2013). In the village of Nanga Kesit, in Sarawak, rubber seems to be the main cash crop; the currently decreasing rubber prices (GEM, 2015) are believed to be a potential challenge for the local population. By choosing this village as the case study for our research project, we will investigate the impact of rubber production on the livelihoods of the villagers.

Nanga Kesit is located 33 km from Lubok Antu, Sarawak, along the Kesit River and its tributaries. There are 40 households in total, distributed within 2 longhouses and additional individual households, which were built overtime in the surroundings. Hill rice is the main staple crop cultivated by each of the households, though also cash crops occupy their fields as mentioned earlier. Three years ago 33 households took part in a rubber plantation scheme while rejecting an oil palm Joint Venture scheme. Thus, today, only 5 households are engaged in oil palm cultivation. With increasing land and population pressure (Cramb & Sujang, 2013; Hansen & Mertz, 2006), the choice of food crop versus cash crop cultivation is vital. It is of high interest to the research team to investigate what drives land use choices in the village of Nanga Kesit, and what impacts such decisions have on the livelihoods of the local population.

OBJECTIVE AND RESEARCH QUESTIONS

With the above mentioned context as starting point, the main objective and research questions of this research are:



For each research question, we have developed sub-questions, which can be found in the Data matrix in Appendix I, together with a specification of data required and applied methods.

This research proposal - which might appear too ambitious – has been developed as guidance for an iterative process of research on the field. Different kind of depth might be achieved at the end of the project as a whole, leaving room for adjustments and therefore unexpected outcomes.

2. METHODOLOGY AND APPLIED METHODS

In order to investigate the research questions listed above, it is impossible to separate natural and social science methods. Both approaches provide unique possibilities of understanding the different and interlinked perspectives in relation to the dynamics and impacts of the choice of cash crop or crop production. Ours is thus a holistic approach, and we aim at combining different methods to gain as differentiated data as possible, as well as for the purpose of triangulation.

Our approach is inspired by the philosophy of hermeneutics and we will therefore let our theoretical and increasing empirical knowledge interact with the production of empirical data (Juul, 2012). It is important to stress that since we are aiming at understanding the specific context of the people in Nanga Kesit, the empirical data we will produce during our stay is the locus of attention in our study (Kvale & Brinkmann, 2009). The overall understanding of the complexity of the people's livelihood will be pursued through the Sustainable Livelihood Framework.

THE SUSTAINABLE LIVELIHOOD FRAMEWORK

The Sustainable Livelihood Framework (SLF) is a useful tool to better understand the livelihoods of people around the world. The framework is designed to capture the main factors affecting these livelihoods and show the linkages between livelihood outcomes, capitals, structures and processes from different institutions and vulnerabilities (DFID, 1999). Taking point of departure in the sustainable livelihood framework by DFID (Appendix II) specific factors within the framework will be assessed. Due to limited time for the fieldwork, we will focus on the financial, natural and social capital in order to assess the impact of rubber production. Though, the fieldwork is designed in a way that has room for unexpected outcomes.

2.1. SOCIAL SCIENCE METHODS

2.1.1.PARTICIPANT OBSERVATION

Throughout our stay in Nanga Kesit we will do participatory observations. We will be aware about when to be more and less participatory in our observations (Emmerson *et al.,* 2011). The fact that we will be staying with the locals allows more participant observation, since we have a chance of being a part of their everyday life.

2.1.2. EXPLORATORY WALK

The first days we will explore the village and the surrounding area together with a few villagers, so to get an overview of the land use and main farming activities. We will be observant to what the locals point out during the walk. Hopefully, this walk will help us understanding the land use mapping exercise that we will carry out later in the process.

2.1.3. QUESTIONNAIRE SURVEY

We plan to conduct questionnaires in all 23 households (HH) in Nanga Kesit to obtain demographic data on the households in the community. However, the main focus of the questionnaire will be the land use at HH level (cultivated crops, harvesting practices) as well as other income generating activities (off-farm/non-farm) of the people in Nanga Kesit. The data obtained from these questionnaires could help to develop and understand how the people structure their livelihoods.

A questionnaire is suitable to get comparable information from a large number of individuals with a relatively little time effort (Rea & Parker, 2012). Yet, the questionnaires will not provide in-depth information about the reasons behind the choices of specific farming or income generating activities. The data from the questionnaires shall be used for the sampling of following methods.

2.1.4. Focus Group Discussion

We plan to use Focus Group Discussion (FGD) as an explorative method in the early stage of our field work in order to gather general information about the villagers, which later will be used to plan the structure of SSIs. First, we would like to get an overview of the land use in Nanga Kesit, the villagers' perceptions of soil quality, and how the land use choices are affected by these perceptions. In order to do so, we will include a participatory mapping exercise of the land use within the FGD. Additionally, we aim at identifying relevant decision-making processes. Within another FGD we will include a participatory timeline exercise, which will mark important events and major changes that have affected the lives of the villagers. The focus of this exercise will be brought on rubber production, so to get an overview of its role in the village from a temporal perspective, but also of the farmers' opinion about its benefits and constraints.

According to Jakobsen (2012), each FGD is supposed to have eight to ten participants; however, we would prefer to have six to eight participants due to the difficulties that may arise because of language barriers. The FGD will be composed based on the information from the questionnaires, such that the group consists of farmers cultivating different crops.

2.1.5. Semi structured interviews

Semi-structured interviews (SSI) will provide data to answer many different questions. This form of interview is appropriate because the open-ended questions provide data richness, as the answers are not set (Mikkelsen, 2005; Asia Forest Network, 2002). SSI will be conducted with both key informants and farmers/villagers, which are either engaged or not engaged in the rubber production.

Key informant interviews

Interviewing key informants is especially relevant to obtain knowledge within a specific topic (Mikkelsen, 2005). Thus, the person interviewed is chosen on the basis of his or her knowledge and role within the community. In order to obtain knowledge about the characteristics of the livelihood strategies in Nanga Kesit, different data are required (Appendix I). An interview with the headman of the village, TR Tindit ak Ran, would enable us to assess the structure within the longhouse and individual households, the general health status of the village, and the social status hierarchy within the village. By interviewing the headman we will also get an idea of the land use, and of the decision-making processes, relevant for RQ2.

Villagers

SSIs will be conducted with household members of different age, which are engaged in different types of work, including rubber farmers and oil palm farmers. The knowledge obtained within the SSIs with the household members will be used for assessing the decision-making at household level, the health status, and land sizes. Additionally, it will enable us to get a picture of the general family structure, farming activities, level of rubber production, and the benefits and constraints of the cultivation. Also, we will ask an open question about how/if the rubber cultivation seem to affect other household/family activities (cleaning, education, non-farm, migration). This will be relevant in order to obtain knowledge on how the

cultivation is interacting with other household activities. We will sample in a way that the SSIs will be conducted with both male and female, and people with different occupations. In that way we will minimize bias when getting more aspects on the same issue(s).

2.1.6. Participatory Rural Appraisal Methods

The Participatory Rural Appraisal (PRA) has been developed in order to allow the local people to define their own problems, come up with possible solutions, and let them express what they find important (Mikkelsen 2005). Robert Chambers was the first to address and formulate the need of "putting the last first" with his work on rural development and poverty in 1997, which came to be the foundation for the PRA methods (Chambers, 1983). We will briefly introduce the PRA methods we have chosen in different contexts. All the applied PRA methods are based on Mikkelsen (2005).

Participatory mapping of land use

In order to get an overview of the land use in Nanga Kesit, a land use map will be drawn with 4-6 villagers gathered in one of the previously mentioned FGD. Emphasis will be put on the production of crops, ownership of the land and other things the group finds important. The exact area of the plots is not the most important aspect in this context. The participatory mapping will also be used for identifying possible informants for the following SSIs.

Participatory timeline

As earlier mentioned, we will conduct the timeline within a FGD with 4-6 elders in order to gain knowledge about the history of the village with specific attention to land use and rubber cultivation. The participants will be asked to identify important events that have affected the life in the village, including drastic changes, elections and land use schemes. After this, the focus will be brought on rubber, which we hope may contribute to our knowledge upon the role of rubber for the villagers and knowledge concerning benefits and constraints following rubber cultivation. Posing the focus on rubber, we will investigate how land use decision are made and to what extent can be influenced by e.g. market prices. The timeline will be conducted with both rubber farmers and elders from the village and both men and women. Additionally, we aim to include participants who cultivate rubber and some that do not.

Participatory Ranking

We will use participatory ranking in both the participatory timeline group, if possible, and in some of the SSIs. In both cases will we use the "problem, preference and opportunity ranking" in relation to the benefits and constraints of rubber production. We aim to use it first as exploratory to identify what benefits and constraints people links with this livelihood strategy and to gain knowledge about what matters the most for people in both aspect. We hope to be able to use this knowledge for the interviews with farmers, where we will use the ranking to get more in depth and understand the complexity of the interaction and importance of benefits and constraints in rubber production. In the ranking process the informants will be asked to come up with the benefits and constraints themselves and then they will be given an absolute amount of some kind of points, which they will be asked to distribute between the categories.

SEASONAL CALENDAR

To get an overview of the labour flow and intensity of the villagers, we will create a seasonal calendar. This will be conducted by visualizing the distribution of resources, production activities, seasonality, labour availability and migration throughout the year. This will hopefully help us to get a better understand of the seasonal patterns and when the villagers are especially vulnerable and exposed to risks.

TRANSECT WALKS

We will go on transect walks to some of the fields around the village with local farmers to gain knowledge about how they perceive quality of their soil and the different management practices of the various crops. We will combine these field walks with taking soil samples and using GPS mapping.

2.2. NATURAL SCIENCE METHODS

2.2.1. VOLUME SPECIFIC SOIL SAMPLING

Once the different land uses in the village, the current status of rubber production, and the local perception of soil quality will be assessed, we will attempt to determine the effects of rubber cultivation on soil quality/fertility. To do so, we will collect volume specific soil samples from rubber fields at different stand ages. The control samples will be collected from secondary forest fields. The rationale behind this procedure is found in the so called *space for time substitution* technique, where we assume that the soil in the plots allocated to secondary forest can be considered as proxy for the soil condition if rubber was not cultivated.

More details regarding procedures and parameters can be found in Appendix VI.

2.2.2. WATER SAMPLING

As part of the environmental impact assessment, we will investigate the quality of the water in the Kesit River in proximity of rubber plantation. We will rely on our counterparts' expertise for the discussion and definition of the sampling criteria.

More details regarding procedures and parameters can be found in Appendix VII.

2.2.3. FOREST RESOURCE ASSESSMENT

We will execute a Forest Resource Assessment (FRA) to be able to give a qualified description of the current forest resources base. The assessment will be conducted by first choosing a defined area as a sample plot. Then we will use a relascope to give an indication of the density of trees in the sample plot. A clinometer will be used to measure the height of threes and, together with calculation of basal area and diameter, determine the above ground biomass (AGB). The collected data of timber height and density will hopefully give us an indication of the forest resources available in Nanga Kesit.

The FRA will include a non-timber forest product (NTFP) resource assessment aimed to study the collection of NTFP and potential changes of forest management in the process of converting traditional forest management to timber production and plantation development of oil palm and rubber trees (Wong, 2000; Lorbach *et al*, 2000).

3. SCHEDULE OF FIELDWORK

The timeline of the planned activities can be found in Appendix VIII. Guidelines for other methods than Questionnaires and SSI can be found in Appendix IX.

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ADDITIONAL LITERATURE

The title of this research proposal is a quote from the book:

Strasser, B. (2009). We are as flexible as rubber!: livelihood strategies, diversity, and the local institutional setting of rubber small holders in Kerala, South India. Manohar Publishers.

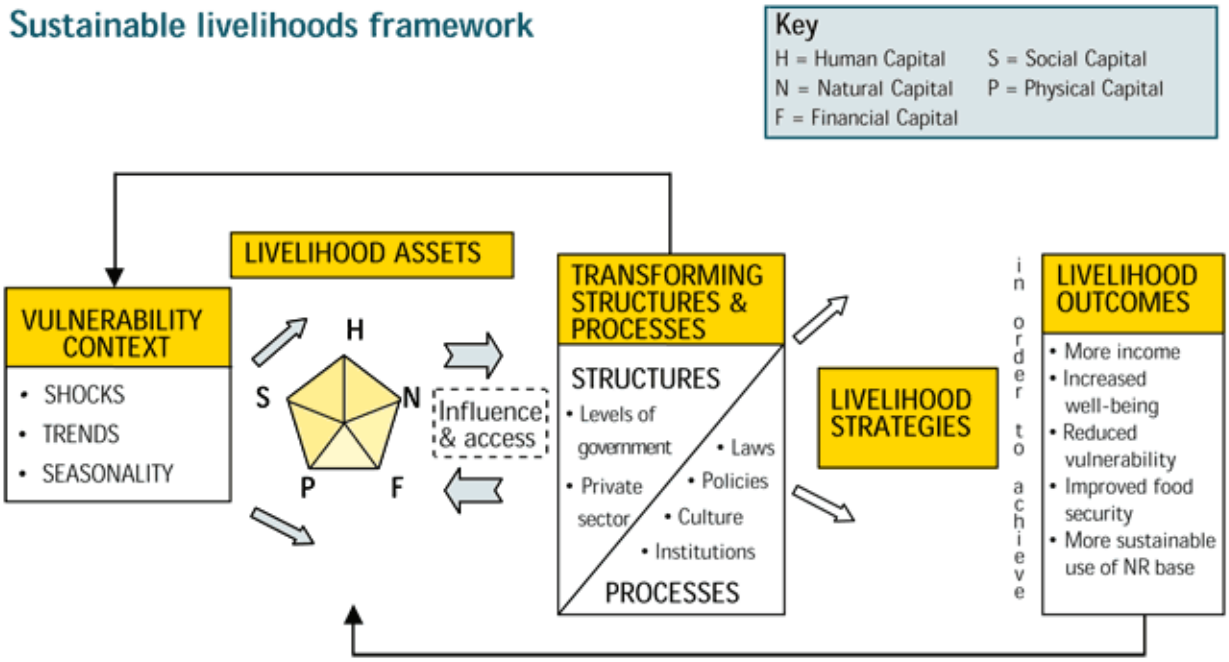
APPENDICES

APPENDIX I - DATA MATRIX

Objective	Research question	Subresearch question	Sub-sub question	Data required	Methods/Activities
To investigate decision-making dynamics and impacts of choosing rubber as the main cash crop in the village Nanga Kesit, Sarawak.	1. What are the characteristics of the livelihood of the people in Nanga Kesit?	1.1.What are the characteristics of households in Nanga Kesit?		- family members - land size - health status - longhouse/household characteristics - social status - Demographics	- Observation/ Land area walk - Key informant interview with headmen - Questionnaires + additional data throughout the field research (e.g. household surveys/interviews, etc)
		1.2.What is the LU in Nanga Kesit?		- primary and secondary forest - protected forest - what does the village grow and where - shifting/ fallow	- Land area walk - Key informant interview with headmen - Questionnaire - GPS mapping - Mapping of Land Use PRA (village level)
		1.3. What are the farm activities?		- what do HHs grow where - cash and staple crops - shifting/ fallow - use of fertilizers and pesticides - use of machines - labor intensity	- Field Transect Walk PRA - Key informant interview with headmen - Questionnaire - GPS mapping - Mapping of Land Use PRA (village level) - SSI (HH) - Seasonal calendar (HH)
		1.4. What are the non farm / off farm activities?		- off farm activities - non farm - remittances	- Key informant interview with headmen - Questionnaire - Observation - SSI (HH)
	2. What are the dynamics behind the choice of rubber as main cash crop?	2.1. What has been the decision-making process behind the choice of rubber as cash crop?	2.2.1.At village level?	- rubber decision-making processes -hierarchy in the community	- Key informant interview (headman)
			2.2.2.At household level?	- rubber decision-making processes - Family structures/hierarchy - Autonomy of families	- SSI (HH)
		2.2. Why did they choose rubber?	2.2.1. What external factors (policy, prices...) influenced the choice of rubber as main cash crop?	- rubber prices - value chain - policies - subsidies/schemes - pests/diseases - infrastructure - seasonality - tenure	- Focus Group discussion+timeline
			2.2.2. What were the expectations behind the choice of rubber?	projections / scenarios/ expectations/ a	- Focus Group discussion+timeline
		2.3. What is the current status of rubber cultivation?	2.3.1. What is the current level of rubber production?	paused /untapped rubber in the village,	- Questionnaire - Focus Group discussion - SSI (HH)

Objective	Research question	Subresearch question	Sub-sub question	Data required	Methods/Activities
			2.3.1. What are the benefits of rubber cultivation?	- Possible values/preferences: fx: social status, high income, culture, taste, non-seasonality	- SSI (HH) - Focus Group discussion+ Timeline +Ranking PRA - Key informant interview with headmen
			2.3.2. What are the constraints deriving from rubber cultivation?	- negative impact on lives/capitals fx: land opportunity cost, food security, vulnerability to market stresses...	- Focus Group discussion+Timeline - Ranking PRA combined with SSI - SSI (HH) - Key informant interview with headmen
		2.4. How is rubber production integrated with other household activities?			- SSI (HH) - Observation
	3. What are the socioeconomic and environmental impacts of rubber production?	3.1 How does rubber production affect the environment?	Water quality	- contamination, logging	Water sampling
			Soil Quality	- local perceptions on soil quality - pH, SOC, CEC, bulk density, profile, nutrient content, physical characteristics for the soil	- Mapping of the village PRA - Field walk - Volume specific soil sampling
			Biodiversity	- Different land use - Different species	Forest resource assesment GPS-mapping
			Forest status (area and biomass)	- area of the forest - volume of trees - species - density of the forest	Forest resource assesment GPS-mapping
		3.2. How does rubber production affect food security and income?	3.2.1. How is diversification of farm activities for food security and income influenced by rubber production?	- buying food - growing food (home garden) - change in nutriotional value of food, if they have change over time.	- SSI (HH)
			3.2.2. How are off farm / non farm income generation activities influenced by rubber production?	- work on other farms - work in a city or abroad - non-timber products - art-work and craft products - migration/remittances	- SSI (HH)
		3.3.How does rubber affect the social network in the village?	3.3.1.Social status in relation to land?	- perceptions about rubber production - social status/prestige and rubber production - social/cultural inclusion/exclusion	- SSI (HH)
			3.3.2.Security network in the village?	- ties to other villagers - security/insurance systems - emergency processes	- SSI (HH)
		3.4 How does that affect the human capital?		- health complications? - improved educational level?	- SSI (HH)

APPENDIX II - DFID LIVELIHOOD FRAMEWORK



(Source: DFID, 1999)

APPENDIX III - QUESTIONNAIRE GUIDELINES

Objective:	To gain general data on the village and land use + income on HH level
Timeframe:	1 hour for each "interview" - 1 whole day
Participants:	all 23 hh - 2 of us and the counterparts + 1 interpreter + member HH
Equipments:	Questionnaire, pen and paper
Outcome:	Identify possible respondents for: Participatory mapping, Participatory Timeline + ranking, SSI interviews. Later triangulation of the results.

For the interviewer

Household number:___
Longhouse or individual HH:___
GPS waypoint:___
Interpreter:___
Notetaker:___

INTRODUCTION TO THE STUDY

[text:introduction]

1. DEMOGRAPHIC DATA ON HOUSEHOLD AND HOUSEHOLD MEMBERS

Total n of members _	A.Interviewee	B.HH member 1	C.HH member 2	D.HH member 3	E.HH member 4	F.HH member 5
1.1.Name (M/F) *Head?						
1.2.Age						
1.3.Years of schooling						
1.4.Who is working on the farm?(X)						

1.5. Does any of you work outside your farm?
if yes: 1.5.1.What kind of work is it (off farm/non farm)?
1.5.2. Where?
1.5.2. How often do you do this work?
1.5.3.Do you get paid for it?

1.6 Does any of the household members live outside NK
if yes: 1.6.1.How many?
1.6.2.Do you receive remittances from them?

2. LAND USE / FARMING ACTIVITIES

2.1 CULTIVATED LAND (BESIDES HOMEGARDEN)

	A.Crop 1	B.Crop 2	C.Crop 3	D.Crop 4	E.Crop 5	F.Crop 6
2.1.1.Size						
2.1.2.Harvest time						
2.1.3.Food	[YES/NO]					
2.1.4.Do you sell it?	[YES/NO]					
2.1.5. If so, at what price?						
2.1.6.Fertilizer	[YES/NO]					
2.1.7.Herbicide/pesticide	[YES/NO]					
2.1.8.[rubber] tapping?	[YES/NO]					

2.2. Food security

2.2.1 Do you have a homegarden?

2.2.2 What do you grow?

Do you buy food from the market? (incl. food which they can cultivate themselves)

2.2.3.Food	A.	B.	C.	D.	E.
2.2.4Quantity					
2.2.5 Reason					
2.2.6.Notes					

2.3 FALLOW

	A.Field 1	B.Field 2	C.Field 3	D.Field 4
2.3.1.Size				
2.3.2.Years				
2.3.3.Previous crop				
2.3.4.Harvest				

2.4 FOREST

2.3.1.Do you collect products from the forest? List them (+NTFP/NWFP)
2.3.2. How far do you have to go?
2.3.3. How often do you go?
2.3.4. Is the forest on your land (community)? YES / NO

APPENDIX IV - INTERVIEW GUIDELINE FOR TR TINDIT AK RAN (HEADMAN OF THE VILLAGE)

Objective:	Obtain knowledge about characteristics of village and overall introduction to land use, land planning and decisionmaking on a village level.
Timeframe	2 hours
Participants:	All of us and all of the counterparts + 2 interpreters + the headman
Equipments:	Map of village, field note books and open minds.
Outcomes:	Find locals for transect walk, find people for the participatory mapping. Later triangulation of the findings.

Theme	Primary question	Secondary question	Notes	Hypothesis
Introduction of SLUSE **Presentation of fieldwork and aim of the interview**	Is it okay we take notes and use the information of the interview in our report?			
1.Personal information	Name, age, education, what is your responsibility/role in the village?			
2.Village characteristics	2.1.How would describe Nanga Kesit?	2.1.1.How big is Nanga Kesit? 2.1.2.What do you consider as a part of your village? 2.1.3.How many households/people are living here? 2.1.4.Do you have a primary school? 2.1.5.Is there a health centre? 2.1.6.Where is the nearest	Bring the map	

		shop/market?
	2.2.Can you describe the structure of the longhouse?	
	2.3.What are the main activities in the village?	2.3.1.What are the main income generating activities? 2.3.2.What farming activities are taking place? 2.3.3.Are villagers engaged in activities outside their own farm? 2.3.4.Are the engaged in other activities than farming? 2.3.5.Are there any other activities you would like to add?
	2.4.Do you experience people moving from the village to live other places?	2.4.1.Who is moving away? 2.4.2.Is it permanent or are the season workers? 2.4.3.Where are they moving?
	2.5.Do people from outside move to Nanga Kesit?	2.5.1.Why are they moving here? 2.5.2.Are they permanent or seasonal workers? 2.5.3.How many? 2.5.4.How many the past 1 year?
3. Historical information	3.1.When was the village established?	When did the village split into two?

	3.2.What are the biggest changes the village has experienced the past 10 years?	Farm, population, land use?
	3.3.When were the individual houses constructed?	Who lives there (characteristics)?
4.Village values	4.1.What is unique about this village?	
	4.2.What are the challenges for village?	
5.Natural resource management	5.1.Is there any pre-defined plan for the land use in the village?	Is the government involved in the planning of land use in this village?
	5.2.Do the village/farmers receive help/subsidies from the government?	Money, schemes, fertilizers
	5.3.What role does the river play for the village?	5.3.1.Drinking water 5.3.2.Washing clothes
	5.4.Has the land use changed the past 10 years?	Substantial (cash crop)
	5.5.Do you practice shifting cultivation?	

6.Decision making	6.1.Can you describe the decision making processes in the village?	6.1.1.Is it consensus? 6.1.2.Is it only the males/females?	
7.Case	7.1.We have heard that the village rejected to participate in a joint-venture oil palm project? Is that true?		
	7.2.How did the village make that decision?	On what background did you make the decision?	
	7.3.Why did some villagers choose to join a rubber scheme 3 years ago?		
	7.4.What benefits or constraints do you see in growing rubber?		

Possible biases: Potential biases from interviewing the headman could be wrong intentions from his/hers side. It might be very difficult to rely on the information obtained by this person, though by triangulation with “regular” villagers, biases may be reduced.

APPENDIX V - SEMI STRUCTURED INTERVIEW (SSI) GUIDELINES

Objective:	To obtain in depth knowledge about the choice of rubber, benefits and constraints and how it fits into their livelihood. This is the main element in our data collection.
Description:	We will ask the persons we have identified through other methods if they would like to be interviewed. This can be combined with either ranking, seasonal calendar, farming system or field transect walks (not integrated in the interview).
Timeframe:	1-2 hours
Participants:	As many HH as possible (Palm oil farmer, rubber farmer, young people) 1 interpreter + at least 2 of us/counterparts.
Outcome:	Knowledge to answer all research questions. Triangulation.

Theme	Primary question	Secondary question	Notes	Hypothesis
Introduction of SLUSE **Presentation of fieldwork and aim of the interview**				
1.Background informations on HH	1.1.How big is your family?	Family size		
	1.2 What do you do for a living?Occupation			
	1.3 Educational level			
	1.4 Ownership and area of land			
	1.5 Food security			
2.Land use and farm activities	2.1 What do you use your land for?			

	2.2 What did you grow 5 years ago/10 years ago? 2.3 Who has the responsibility of what on the farm? 2.4 Can you draw a seasonal calendar on the crops and labour intensity in your field(s) 2.5 Where do you take the surplus products to?
Income generating activities	3.1 Do you have any income? from what? 3.2 What is the distribution of income generating activities (both labour intensity and types of activities) 3.3 Has this changed within within the last 5/10 years
Decision-making in relation with livelihood strategies	4.1 Why did you decide to use the land for xx/involve in xx income generating activities? 4.2 Who has been part of the decision? 4.3 How are the decisions made in this household in general? 4.4 Is this household influenced by decisions taken in the whole village?

For rubber farmers	
Benefits and constraints related to the production + ranking	5.1 What do you consider as benefits/constraints of rubber cultivation?
Livelihood diversification	6.1 How does the production of rubber integrate with your other household activities?
Finishing	7.1 Is there anything you would like to add?

APPENDIX VI - SOIL SAMPLING

CRITERIA FOR THE SELECTION OF THE FIELDS:

Consistency shall be pursued with regards to:

- land use history across fields (i.e. the previous land use of the field shall be comparable)
- land management options (e.g. fertilizer application)
- terrain characteristics such as slope, high/lowland, etc.

Rubber fields will be sampled according to differences in (one of the following, according to the context and options available):

- stand age (i.e. old generations vs new samplings)
- tapped (i.e. productive) vs untapped

Secondary forest (control) field will be selected according to the local context and land use history. If fallow land, Tanaka et al. (2009) suggest 5 yrs, whereas Ipor et al (2004) suggest canopy closure as threshold for the Belukar I stage, after about 8 to 15 years old.

By doing so, we aim at the comparability of the samples collected.

PROCEDURE - VOLUME SPECIFIC SAMPLING FROM SOIL PROFILE

With the permission and collaboration of the farmer/landowner, 3 soil profiles will be dug for each field. In order to avoid any disturbance to the cultivation and /or trees, when possible profiles will coincide with the center point between four adjacent plants (i.e. intersection of diagonal lines).

Volume specific soil samples (using 100cm3 rings) will then be collected from the **topsoil/A horizon** and **B horizon.** According to Shaliha et al (2012), the A horizon should reach a depth of 16 to 20cm. Sampling depth will be defined once the profile will be revealed and then kept consistent across fields.

Soil morphology properties such as **texture**, **color**, and **horizon depth** will be determined based on field observations. The soils will be air-dried, and then stored in plastic bags for further laboratory analysis to be carried out in Copenhagen. The soil samples will be passed through a 2mm sieve and grinded, then weighed, Doing so we will be able to calculate **bulk density**, a proxy indicator of water infiltration rate, porosity and root development. Laboratory analysis will determine **pH** values, **EC**, **Total N** content and **Permanganate Oxidizable Carbon (Pox-C)**.

LIMITATIONS

One of the main source of uncertainty is the choice of space for time substitution technique. However the selection of such substitute plots will follow specific criteria of consistency in order to enhance the comparability of data obtained.

We are aware that because of the limited time the number of replicates will be limited, therefore affecting the significance and explanatory value of the data collected.

Lastly, it is important to take into account that it is not only and use affecting soil characteristics but also the other way around. Therefore care is needed when discussing the results and drawing conclusions based on the empirical data collected.

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APPENDIX VII - WATER SAMPLING PARAMETERS

Samples will be taken to uncover the water quality of Kesit River. The preliminary suggestion of the sample plots will be:

- Upstream and downstream of the village
    - Upstream where the water for household use is taken
    - Downstream where wastewater discharge enter the river
- Downstream of oil palm and rubber plantation
    - To examine the effect of fertilizer on water quality

On-site measurements and analysis will be carried out doing the fieldwork. The measured parameter will be compared to the National Water Quality Standards for Malaysia to conclude on the water quality of Kesit River.

The parameters that will be analysed through water sampling will be:

- Water temperature
- Dissolved oxygen
- pH
- Salinity (analyses 1- 4 is measured using Hydrolab Multiprob)
- Biochemical oxygen demand (BOD)
- Chemical oxygen demand (COD) (using Merck Environmental Kit, Model SQ118)
- Nutrients (ammonium-N, phosphorus, nitrate); measured using Hach Kit, model DR700
- Total suspended solids (TSS)
- Microbial level in water (Faecal coliform count (FCC) and total coliform count (TCC) using Paqualab system)

Appendix VIII - Gantt Chart

N	TASKS	Timefra	Who	February																									
				t	w	t	f	s	s	m	t	w	t	f	s	s	m	t	w	t	f	s	s	m	t	w	t	f	s
				3	4	5	6	7	8	9	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
1	**Land use change presentation**																X												
2	**Synopsis**																												
2.1	LR list					X																							
2.2	Draft synopsis													X															
2.3	Submission																				X								
3	**Research proposal**																												
3.1.	Research question									X																			
3.2	Key info needed											X																	
3.3.	Key methods																X												
4	**Arriving Kuching**																									X			
4.1	Meeting Malaysian gang and group discussi		All																								X		
5	**Arriving in Nanga Kesit**																											X	
5.1	Visit the headman TR Tindit ak Ran		All																									X	
5.2	Introductionary Village walk		All																									X	
5.3	Dancing with locals		All																									X	
6	**Agreement with the interpreters**		All																										
7	**Preliminary survey**	**2 days**	**All**																										
7.1	Key informant interview with headm	2hrs	All																										
7.2	Exploratory walk	1/2 day	All																										
7.3	Questionnaire	1h x 20	2 teams of 2+T																										
8	**Proposal presentation**	11:00-1	All																										
9	**FGD + mapping of the village PR**	2h	1T+3																										
10	**FGD + timeline PRA + focus on r**	4h	1T+3																										
11	**Semi structured interviews**	1/2h a	1T + 2																										
12	**Seasonal calendar PRA**	1h	^																										
13	**Field transect walk PRA**	2h	^																										
14	**Soil sampling**	1 1/2 d	1T+2																										
15	**Water sampling**	1/2 day	1T +2																										
16	**Forrest Assessment + Biodiversit**	1/2 day	1T + 2																										
17	**Focus group discussion**																												
18	**Final presentation (Batang Ai)**	1/2 day	All																										
19	**Farewell party (Nanga Kesit)**	1/2 day	All																										
20	**Farewell party (Kuching)**		All																										
21	**Data analysis (Copenhagen)**	1w	All																										
21.1	Soil sample analysis	1w	All																										
21.2	GPS data analysis	1w	All																										
21.3	Water data analysis	1w	All																										
21.4	Qualitative data analysis	1w	All																										
22	**Writing of the final report**	2w	All																										
23	**Submission final report**		All																										
	T: Translator																												

N	TASKS	March																												
		s	m	t	w	t	f	s	s	m	t	w	t	f	s	s	m	t	w	t	f	s	s	m	t	w	t	f	s	s	m	t
		1	2	3	4	5	6	7	8	9	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	3	3
1	**Land use change presentation**																															
2	**Synopsis**																															
2.1	LR list																															
2.2	Draft synopsis																															
2.3	Submission																															
3	**Research proposal**																															
3.1.	Research question																															
3.2	Key info needed																															
3.3.	Key methods																															
4	**Arriving Kuching**																															
4.1	Meeting Malaysian gang and group discussi																															
5	**Arriving in Nanga Kesit**																															
5.1	Visit the headman TR Tindit ak Ran																															
5.2	Introductionary Village walk																															
5.3	Dancing with locals																															
6	**Agreement with the interpreters**	X																														
7	**Preliminary survey**	X	X																													
7.1	Key informant interview with headm	X																														
7.2	Exploratory walk	X																														
7.3	Questionnaire	(	X																													
8	**Proposal presentation**			X																												
9	**FGD + mapping of the village PR**			X																												
10	**FGD + timeline PRA + focus on r**				X																											
11	**Semi structured interviews**					X	X	X	X																							
12	**Seasonal calendar PRA**						X																									
13	**Field transect walk PRA**							X	X																							
14	**Soil sampling**							X	X																							
15	**Water sampling**						X																									
16	**Forrest Assessment + Biodiversit**					X																										
17	**Focus group discussion**			X					(X)																							
18	**Final presentation (Batang Ai)**									X																						
19	**Farewell party (Nanga Kesit)**									X																						
20	**Farewell party (Kuching)**										X																					
21	**Data analysis (Copenhagen)**																X	X	X	X	X											
21.1	Soil sample analysis																X	X	X	X	X											
21.2	GPS data analysis																X	X	X	X	X											
21.3	Water data analysis																X	X	X	X	X											
21.4	Qualitative data analysis																X	X	X	X	X											
22	**Writing of the final report**																X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
23	**Submission final report**																															
	T: Translator																															

N	TASKS	April								
		w	t	f	s	s	m	t	w	t
		1	2	3	4	5	6	7	8	9
1	**Land use change presentation**	S							E	
2	**Synopsis**	U							X	
2.1	LR list	B							A	
2.2	Draft synopsis	M							M	
2.3	Submission	I								
3	**Research proposal**	S								
3.1.	Research question	S								
3.2	Key info needed	I								
3.3.	Key methods	O								
4	**Arriving Kuching**									
4.1	Meeting Malaysian gang and group discussi									
5	**Arriving in Nanga Kesit**									
5.1	Visit the headman TR Tindit ak Ran									
5.2	Introductionary Village walk									
5.3	Dancing with locals									
6	**Agreement with the interpreters**									
7	**Preliminary survey**									
7.1	Key informant interview with headm									
7.2	Exploratory walk									
7.3	Questionnaire									
8	**Proposal presentation**									
9	**FGD + mapping of the village PR**									
10	**FGD + timeline PRA + focus on r**									
11	**Semi structured interviews**									
12	**Seasonal calendar PRA**									
13	**Field transect walk PRA**									
14	**Soil sampling**									
15	**Water sampling**									
16	**Forrest Assessment + Biodiversit**									
17	**Focus group discussion**									
18	**Final presentation (Batang Ai)**									
19	**Farewell party (Nanga Kesit)**									
20	**Farewell party (Kuching)**									
21	**Data analysis (Copenhagen)**									
21.1	Soil sample analysis									
21.2	GPS data analysis									
21.3	Water data analysis									
21.4	Qualitative data analysis									
22	**Writing of the final report**									
23	**Submission final report**	X								
	T: Translator									

APPENDIX IX - OTHER METHODS' GUIDELINES

Exploratory walk	
Objective:	To get overview of the land: Size, different plots and crops, land use, farm activities. Triangulate the information from the headman.
Description:	We walk around the land of the village with GPS
Timeframe	½ day
Participants:	All of us and the counterparts + 2 interpreters + at least 2 locals - preferable old people
Equipment:	GPS, Map of village, marker for laminated
Outcome:	Identifying SSI-respondents
To do before leaving:	Buy markers

Focus Group Discussion (in combination with PRA land use mapping)	
Objective:	Stimulate discussion over land use, introduce the PRA mapping exercise
Description:	Group discussion with group of 6-8 people
Timeframe:	2h
Participants:	6-8 people + All staff
Equipment:	Paper and markers
Outcome:	Identify possible topic to be discussed within SSI, interesting fields to be explored, baseline infos on land use in the village

Focus Group Discussion (in combination with PRA timeline)	
Objective:	Stimulate discussion over important events and major changes that interested the village over the last 10-15 years, while introducing the PRA mapping exercise. Further focus will be on rubber, leading the discussion to schemes and policies, decision making processes, benefits and constraints.
Description:	Group discussion with group of 6-8 people
Timeframe:	2h
Participants:	6-8 people + All staff

Equipment:	Paper and markers
Outcome:	Identify possible topic to be further discussed within SSI.

Participatory mapping of land use (within FGD)	
Objective:	To get an overview of the land use in the village and fill out the "rest" of the map, in case we didn't see all the land around the village. OBS: ask them if they already have a before. Get knowledge about: *Land use, what crops they have, drinking water, interesting areas, resource flow.*
Description:	We are sitting in a circle around the map and talking about the different land use. 1) Draw the outer boundary, river, roads, mill, hh 2) Draw fields (crops), dwells, animals, forests, grazing areas, shifting cultivation, fallows,
Timeframe:	2 hours
Participants:	4-6 local farmer (oil palm, rubber, crop, spatial distribution) + 1 interpreter + 3 of CPH-team
Equipments:	Paper, pen and crayons
Outcome:	A nice map of the different land use, identify possible SSI-respondents
To do before arriving in NK	Kuching: buy papers and pens

Participatory Timeline (within FGD)	
Objective:	Village history and important event/ major changes in the village.
Description:	First we will make them make a general timeline (historical events, major changes, elections, palm oil schemes, market stress?) and then focus on rubber (schemes, new plantations, decision making)
Timeframe:	2 hours
Participants:	4-6 Rubber farmers (elders). app. 3 of us + 1 interpreter (2 if possible). Notetaker

	may note if benefits/constraints pop up during the timeline.
Equipment:	Paper and pen
Outcome:	A nice timeline with a focus on rubber production activities and decision making.
To do before arriving in NK	Look into rubber market prices and make the fluctuation chart → Sara made that.

Ranking of rubber production (combined with SSI)	
Objective:	To identify factors affecting their choice of rubber.
Description:	Interviewee will identify benefits and constraint of rubber cultivation.
Timeframe:	1 hour
Participants:	1 interpreter + at least 2 of us/counterparts. (Palm oil, rubber, young people)
Equipment:	Pen and paper. Stones/candy for ranking.
Outcome:	Factors to use in the SSIs.
To do before arriving in NK	Nothing

Seasonal calendar (combined with SSI)	
Method:	PRA Seasonal calendar
Objective:	To obtain knowledge about labour intensity, income stability,
Description:	Interviewee will draw on the template (made by us after talking to key informant) and show what there is to do each month/season. We will discuss with them about what they have done each season/month and what will they do next.
Timeframe:	1 hour
Participants:	1 interpreter + at least 2 of us/counterparts. (Palm oil, rubber, young people)
Equipment:	Pen (different colours) and paper

Outcome:	Triangulation.
To do before arriving in NK	Talk with counterparts about how to make a template (seasons/rain/months - what the fuck do they measure time in?)

Field transect walk PRA (combined with SSI)	
Objective:	Land use history, local perception of soil quality
Description:	We will go on a field walk with the owner of the land. While walking around one of us is drawing and one of us is talking. We will ask the owner where the good soil is and where the bad soil is and take samples there. The transect walks should never be done without taking soil samples, but soil samples could be collected without transect walk.
Timeframe:	2 hours
Participants:	1 interpreter + at least 4 of us/counterparts (incl. the people collecting soil samples). (Palm oil, rubber)
Equipment:	Pen and paper, see soil sampling
Outcome:	Land use history to inform soil sampling site selection, comparison with our measured soil quality.
To do before arriving in NK	Read up on transect walks.

Forest Resource Assessment	
Objective:	Assess the forest resources availability (incl. NTFP) in Nanga Kesit and examine how different cash crops leaves marks in the landscape and influence the availability of non-timber forest products.
Description:	Observe and ask the villagers what non-timber forest product they collect and how the diversity and intensity may have changes in time due to the increased rubber and oil palm production.
Timeframe:	1 day

Participants:	2 of us/counterparts together with villagers experienced in collecting NTFP
Equipment:	Clinometer, relascope, tape measure, pen and paper
Outcome:	An overview of the villages use of non-timber forest products, calculate above ground biomass in secondary forest vs rubber plantation.
To do before arriving in NK	Acquire the needed equipment