Sustainable livelihood strategies in Tema Mawang

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Content

Overview of authors:

Chapter	Main author(s)	Contributing author(s)
Abstract	Mette	
Introduction	Mette	Ditte, Dorte, Lasse, Jimmi
Sustainable livelihood strategies	Mette	Ditte
Method	Lasse, Mette	Anja, Ditte, Jimmi, Dorte
Development and modernisation	Ditte	Mette
Livelihood strategies		
- Important crops	Dorte, Jimmi	Anja, Lasse
- Income strategies	Anja, Ditte, Lasse, Jimmi	Dorte
- Seasonal vulnerability	Anja, Dorte	Jimmi, Lasse
- Problems affecting the livelihood	Anja, Dorte	
- Organisation of the domestic work	Ditte	
- Migration	Ditte	Jimmi, Lasse, Anja
Impact on natural resources	Mette	Lasse
Sustainability discussion	Mette, Ditte, Anja, Lasse, Dorte, Jimmi	
Conclusion	Mette, Ditte, Anja, Lasse, Dorte, Jimmi	
References	Mette, Ditte, Anja, Lasse, Dorte, Jimmi	
Appendix	Mette, Ditte, Anja, Lasse, Dorte, Jimmi	

Abstract

The vulnerability of the livelihood strategies and their impact on the natural resources has been investigated in terms of sustainability in the village Tema Mawang in Sarawak, Malaysia. The livelihood strategies are determined based on the household economy, the farming base and the social structure of the household. The study is based on both overview methods such as a questionnaire survey and focus group interviews and on in depth case studies and samplings. The livelihood strategies among the households differ in terms of diversification, where the richer families have more activities and a broader range of crops to meet their needs opposed to poorer families with few crops and income sources. The effect of the livelihood strategies on the natural resources is measurable but not problematic, though future intensification of the farming system may degrade the natural resources markedly. The present livelihood strategy is in many ways sustainable because it can cope with stresses and shocks such as fluctuating prices on cash crops and floods. However, the poor families in the village have less capability to cope in these situations and their livelihood strategies can be characterised as being less sustainable.

Key words:

Sustainability, vulnerability, livelihood strategies, Sarawak, cash crop, rubber, soil fertility.

1. Introduction

Since the 1970's, focus on intensification and modernisation has affected the rural areas in Sarawak, Malaysia, resulting in rapidly expansion of oil palm plantations and huge areas of forest that have been cut down to clear for plantation sites (McCarthy & Cramb, 2007). Apart from oil palm, other cash crops such as rubber, pepper and cocoa have also been increasing, though also decreasing in some periods, because of the change in demand from the global market (McCarthy & Cramb, 2007). Introduction and promotion of cash crops to Tema Mawang and other villages in Sarawak have been highly influenced and controlled by the Government (McCarthy & Cramb, 2007). Free Government subsidies have provided farmers with fertilizers through agricultural schemes, for a more intensive cultivation of the land (Ngidang, 2002). The consequence has been that the area used for swidden cultivation of subsistence crops is generally all over Southeast Asia being replaced with perennial cash crops such as oil palm or rubber trees (Bruun et al., 2009). In a swidden cultivation system secondary forest is cleared and burned. The field is often used for only one year before it is left as fallow to become secondary forest again. This ecological development away from a fallow system is in line with the theory of Toledo (1990) who describes the transition of the traditional rural agricultural system (TRUS) as changing to a more modernized system, where it is going from a closed system with flows only within the system, towards an opening of the system with inflows of knowledge, products etc. from outside. As the state of the closed system only exists in theory, some interaction with the surrounding society will always occur; the transition of the TRUS can be seen as a continuous opening of the system, where the modern world affects the TRUS in a higher and higher degree. This transition is characterised by:

- A higher degree of disturbance of the natural environment.
- A shift of energy sources towards increased use of mechanic energy as a replacement for human power.
- A shift from producing everything locally to bringing in commodities to the system.

The local farmers in Tema Mawang are affected by this transition and their livelihood strategies will change to account for the new possibilities or challenges they meet. As their market orientation is increasing the in- and outflow between the household, the natural environment and the transformed environment (Figure 1.1) will change with the risk of over exploitation of the resources if the flows are not managed properly. An increased market orientation will also affect the labouring system, as more people will have the opportunity to migrate and do wage labour in bigger cities. This tendency can be recorded in migration studies where a rapid population growth in the major urban centres is expected for Sarawak until 2020. The rural population is today at its highest recorded level and still growing, but the growth rate is declining (Morrison, 1996).

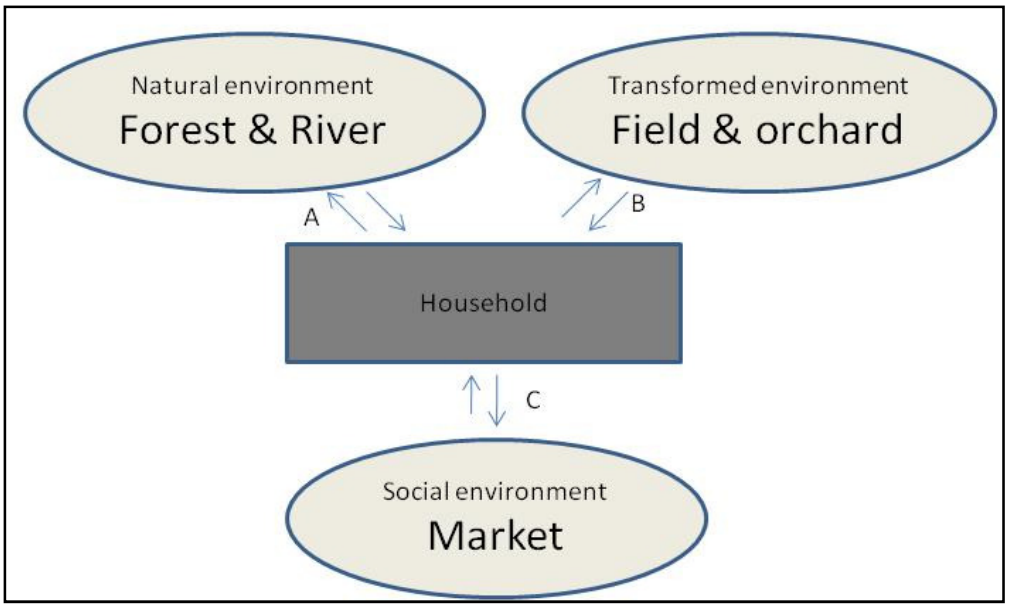


Figure 1.1 - Open rural agricultural system. A: Inflow of fish and forest products. Outflow of fertilizer, pesticides and waste. **B**: Inflow of agricultural products, fruit and vegetables. Outflow of fertilizer and pesticides. **C**: Inflow of cash, products and techniques. Outflow of agricultural products and persons (inspired by Toledo, 1990).

The sustainability of the livelihood strategies chosen for the individual household is investigated by analyzing the vulnerability of the strategy regarding seasonal or long-term changes and shocks and the impact on the natural resources. The households will be affected differently by changes in global market prices of both cash crops and commodities, by decrease in Governmental subsidies in terms of fertilizers and seedlings and by the occurrence of natural disasters like floods. Depending on their livelihood strategy they will be more or less vulnerable which will affect the sustainability. The livelihood strategy has an impact on the natural resources as the farming strategy regarding choice of crops and cultivation practise is a cornerstone in a farmer's livelihood strategy.

1.1 Objective and research questions

Based on this, the objective of this study is:

- To investigate and analyze the vulnerability of the livelihood strategies and their impacts on the natural resources in Tema Mawang in terms of sustainability.

In order to answer the statement of objective, the following research questions will be covered:

1. How are the Governmental rural development strategies affecting Tema Mawang?
2. What are the livelihood strategies and how do they affect the vulnerability of the households?
    a. How does the choice of crops affect the vulnerability of the livelihood strategies?
    b. How do different income sources affect the vulnerability of the household?
    c. How does the organisation of the household affect the vulnerability of the livelihood strategies?
3. What is the impact of the livelihood strategies on the natural resources?
    a. How will a change from swidden cultivation rice production to perennial rubber tree production affect the soil fertility?
    b. How has the livelihood strategies affected the water quality in the river and the water for household use?

1.2 Changed objective

The original objective was as shown in the synopsis (Appendix 2) to investigate how land use changes have influenced sustainability. We expected to see a land use change from subsistence farming to a more intensified farming system with oil palm plantations launched by Governmental schemes. But this was not the reality we found when we arrived in Tema Mawang. The land use in the village is instead a combination of subsistence farming and cash crop farming, with very limited land used for oil palm plantation, due to the villager's reluctance. This land use system has been used in the village for the last 50 years.

1.3 The case area

The study was carried out in the village Tema Mawang in Southern Sarawak, the Malaysian part of Borneo. Tema Mawang is located 1 degree north of Equator in a humid tropical climate. It is a mountainous location about 85 km from Kuching, 20 km from Serian, and 8 km north of the Indonesian border. The village is situated along the Kayan River. Tema Mawang consists of 103 households and is mainly inhabited by the native ethnic group Bidayuh - meaning "people of the interior". The Bidayuh grow rice in a swidden cultivation system combined with cultivation of cash crops such as rubber, cocoa and pepper (Sim, 2001).

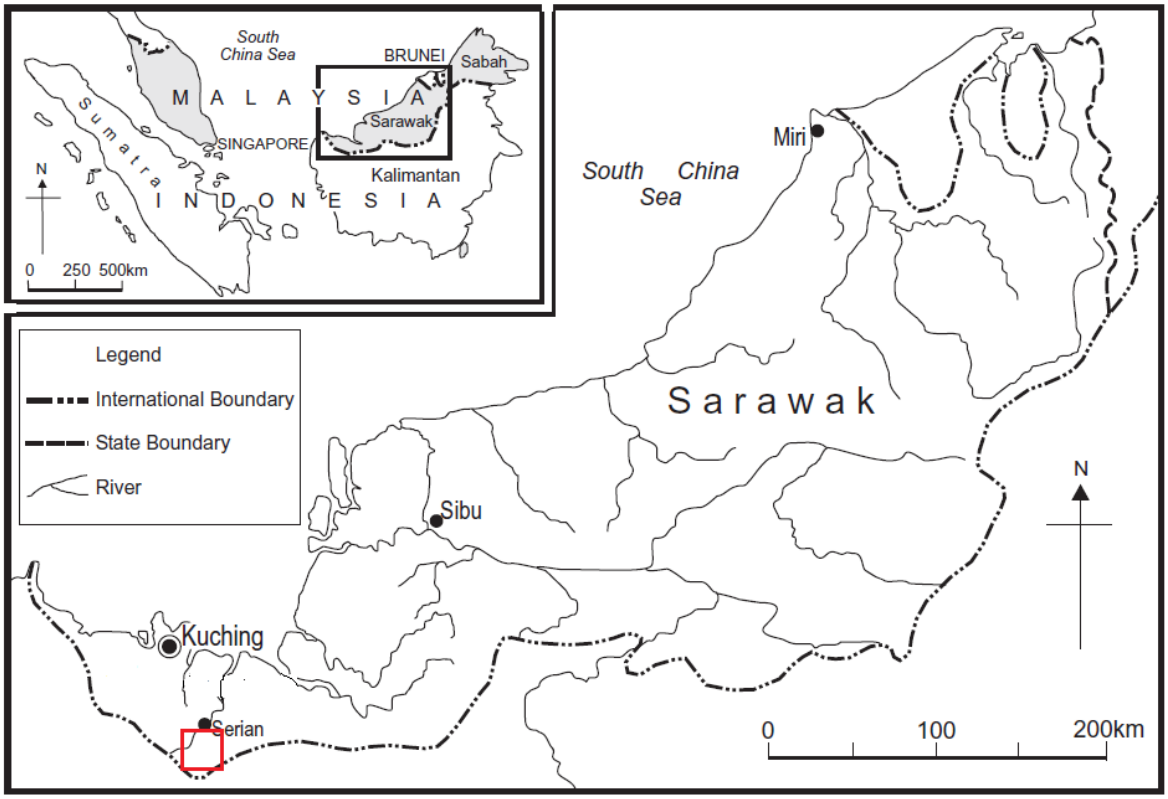


Figure 1.2 - Location of the study area in Sarawak, Malaysia (Morrison et al., 2006).

The Community map (Figure 1.3) shows that the river system is of big importance in Tema Mawang as it is the main way of transport. It also shows that they distinguish between primary and secondary forest where the fields with mostly rice, rubber, pepper and some oil palm are scattered close to the river streams. The crop markings on the map are examples of fields and do not give a full picture of the crop distribution in the area.

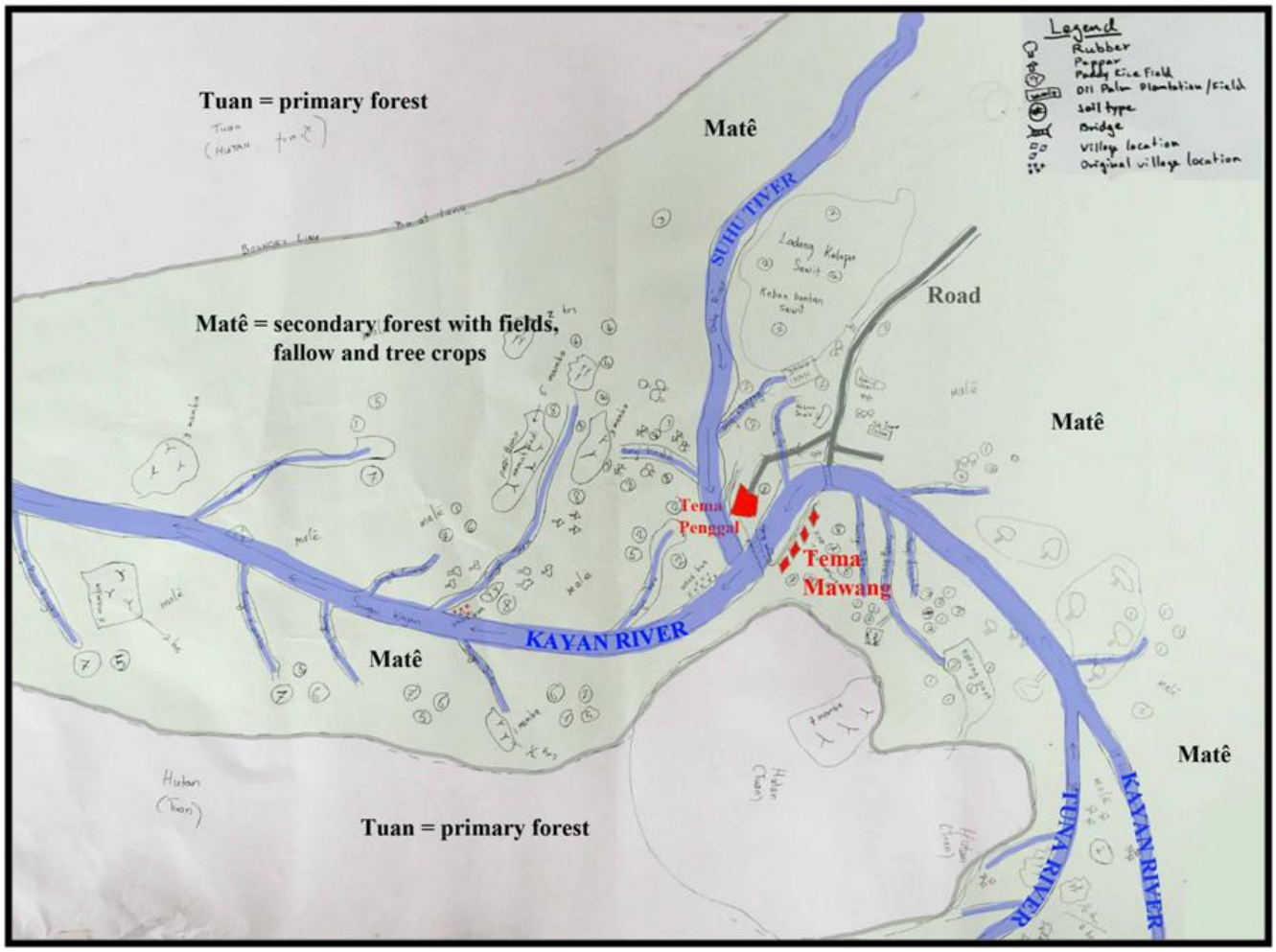


Figure 1.3 - Community map drawn by the villagers. The map has been modified by colouring of the river system, the villages and the area that is not primary forest. For original map see Appendix 1, III.

2. Sustainable livelihood strategies

For this study we assess the livelihood strategies on a household basis. A livelihood strategy is a very broad concept that incorporates all the activities a household comprises when trying to meet their changing needs (Messer & Townsley, 2003). Sustainable livelihood has been defined in various versions. We have chosen to use the definition given by Chamber & Conway (1991):

"a livelihood comprises the capabilities, assets and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets" (Chamber & Conway, 1991).

The livelihood strategy is the actual actions taken by the household to optimise its assets. For the household it can include the choice of crops and cultivation practice and the division of work in the household, for instance whether anyone is migrating or doing wage labour locally.

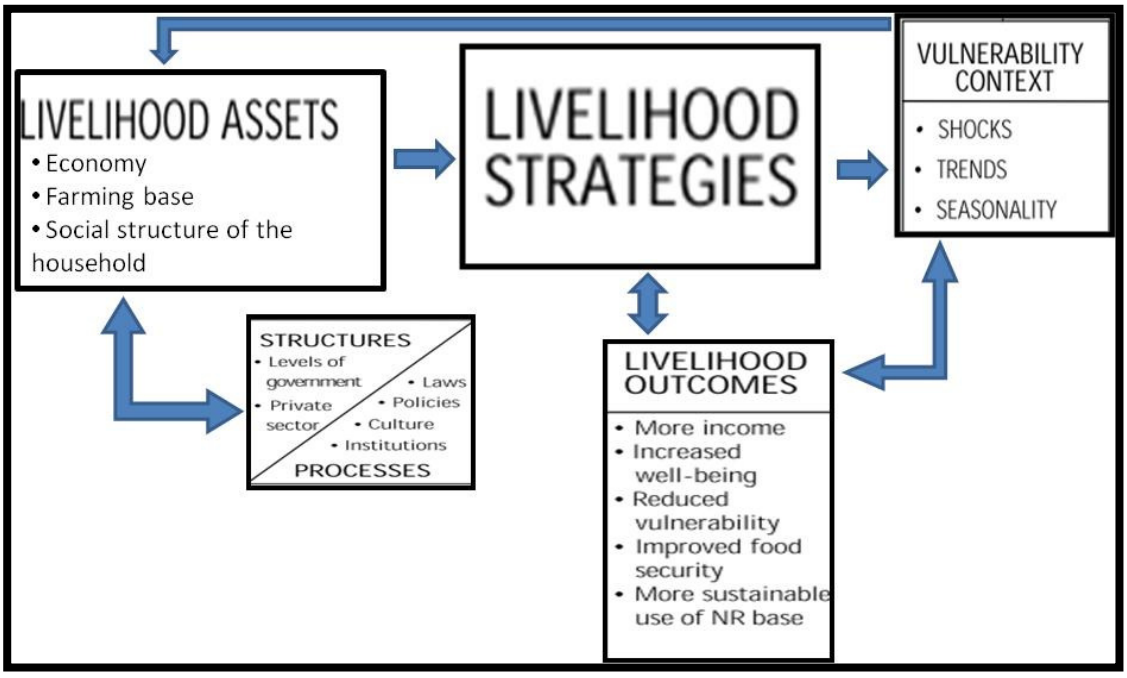


Figure 2.1 – Sustainable Livelihood framework. The aspects and interactions affecting livelihood strategies (modified from DFID, 1990).

We have chosen to use sustainable livelihood strategies as our main framework, as it gives the opportunity to work with the community in an interdisciplinary way. The framework includes many important issues and illustrates the interactions between these (Figure 2.1).

For this study the livelihood strategy will be determined based on the assets: economy, the farming base and the social structure of the household. The livelihood strategies will be analyzed in the relevant vulnerability context in the light of the policies and institutions that affect them. We have chosen not to look at the assets as combined of five capitals, as is the general livelihood framework, as we think that the three we have chosen are the most relevant ones for assessing the livelihood strategies in the village.

3. Methods

In order to answer the research questions a combination of social and natural science methods were carried out. A questionnaire survey gives a broad portrait of the village, while a case study of 12 households and soil- and water samplings are in depth studies elaborating on the results from the survey. Various interviews and PRA's (**Participatory rural appraisal**) give a general overview of the village, they are substantiating the case studies and samplings, as well as being used for triangulation of information.

3.1 General bias and difficulties

We arrived in the rice harvest season, the busiest season during a year, where many villagers were working in the field all day. This has affected our selection of informants for the various methods. Our intention of making a systematic sampling for the questionnaire from a list of the households (Appendix 2), was not possible, instead we chose to use the informants available in the village.

It was often difficult to get good information about the past as this information is affected of what the informants remember and find important. The villagers had likewise problems answering abstract questions which caused the need to simplify the methods.

Household studies are used in our questionnaire and case studies. We chose to use two different understandings of a household; the first includes persons sleeping in the house more than five nights a week. The second is a more extended understanding that includes persons that are considered as part of the household, but not living in the house permanent. The households often consist of both grandparents, parents and children. Many husbands are working in the city and returns only a few times a month. Some villagers count them as part of the household and some do not, this is an important bias on our interviews. The same is the case for the children going to secondary school (boarding school) that are not living in the house.

Furthermore, we became aware that among many informants, there was a consensus about portraying the village as a well-functioning village with few problems. Others had apparently talked about what information they should tell us, thinking that they could maybe receive help from us but this information is not verified.

3.2 Social science methods

3.2.1 Case studies

Twelve case studies with certain households were conducted to obtain a larger insight about the household livelihood strategies and to extend the knowledge from the questionnaire. All twelve focused on household economy, while six focused on farming strategies and six focused on women and domestic work. The case studies used various PRA's followed by semi-structured interviews. The case study was supposed to target a broad spectrum of households, and we chose to select an

equal number of households classified as poor, middleclass and rich. This stratification for the selection was advised by the villagers, our village guide and our interpreters.

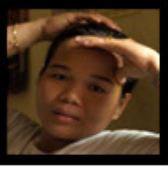
Household economy and domestic work				Household economy and farm strategy			
	Name and Information	Age	Code		Name and Information	Age	Code
	Anton ak Parsen Household: 5 persons: Extended HH: NO Relatives in the village:10 HH	39	HH 1 poor		Florance Ak Juan Household: 3 persons Extended HH: n/a	n/a	HH7 Poor
	Mariam ak Aput Household: 4 persons Extended HH: NO Relatives in the village: 11HH	31	HH2 poor		Deli Sundem Household: 5 persons Extended HH: 1 persons	66	HH8 Poor
	Lily Chin Household: 5 persons Extended HH: 1 person Relatives in the village: 5HH	37	HH3 Middle-class		Kana Ak Handuk Household: 2 persons Extended HH: 4 persons	65	HH9 Middle class
	Margeret ak Anyay Household: 11 persons Extended HH: 3 persons Relatives in the village: 13HH	50	HH4 Middle-class		Dachuk Household: 3 persons Extended HH: 2 persons	40	HH10 Middle class
	Janet Ak Busu Household: 5 persons Extendet HH 4 persons Relatives in the village: 14HH	50	HH5 rich		Singa Household: 8 persons Extended HH: 4 persons	56	HH11 Rich
	Salimah ak Kamven Household: 6 persons: Extended HH: 7 persons Relatives in the village: n/a	51	HH6 rich		Andang Anah Nyahie Household: 5 persons Extended HH: 5 persons	32	HH 12 Rich

Table 3.1 – Informants for case studies. One respondent represent each household. Household 1-7 have a focus on farming and household 7-12 have a focus on domestic work. Four households are classified as poor (p), 4 as middleclass (m) and 4 as rich (r). They will be referred to in the quotes as e.g. Mariam, HH2r.

3.2.2 Questionnaire survey

A questionnaire survey is an organized and easy way to gather data from a larger number of respondents. Although a questionnaire survey may be easy to administrate compared to other data collection methods, it is more costly in terms of design time and interpretation (Rea & Parker, 1993).

We conducted a questionnaire survey with 30 households corresponding to almost one third of the village. Before doing the actual survey, we did a pilot study with two villagers and modifications were made to optimize the survey. The sampling strategy was to get a geographically equal sampling of the households based on a map of the village (Figure 3.1). Due to the busy season we had to conduct the interviews with the people that were available at the expense of the theoretical sampling strategy.

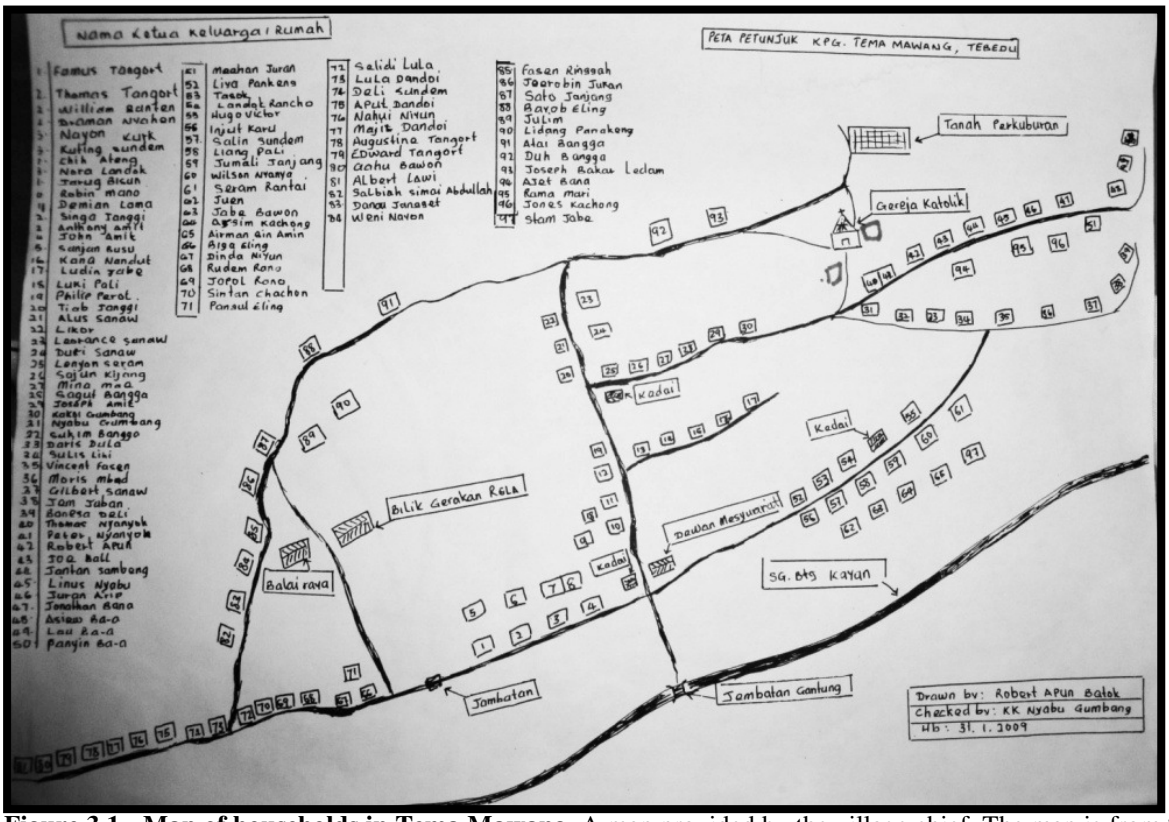


Figure 3.1 - Map of households in Tema Mawang. A map provided by the village chief. The map is from 2009 and it shows only registered houses.

3.2.3 Semi-structured interviews

A semi-structured interview is a combination of a structured interview and an open interview which gives the interviewer an opportunity to jump between themes, and the possibility to add new questions if the interview happens to open for a new and interesting direction (Kvale & Steinar, 1999). The semi-structured interviewees done were (see Appendix 1, IV for names and additional information of informants):

- A meeting with the Sarawak Administrative Officer (SAO) in Tebedu. **Concerning the rural development in the Tebedu-area and specific information about Tema Mawang.**
- **Sarawak Minister of Infrastructure, Development & Communication**.

- Two **interviews concerning water quality**. One with a fisherman regarding indicator species for water quality and the general use of the river system. One with a member of the water committee responsible for the water supply and quality.

- Five short semi-structured interviews with migrants from Tema Mawang to urban areas, to obtain a broader **understanding of how migration affects the village**. These were done on the last day of the fieldwork, where migrants were back in the village for the weekend.

- Semi-structured interviews **during our twelve case studies to follow up on the PRA-methods.**

3.2.4 Focus group interviews

A focus group interview includes a small group of people gathered together by an interviewer, in order to explore attitudes, perceptions and ideas about a certain topic. They are good for retrieving non-sensitive, non-controversial information as people will seldom speak about conflicts in the open. A problem with the focus group interview is that the informants will seek consensus, and details, variations and disagreements can be lost (Denscombe, 2003) (see Appendix 1, IV for names and additional information on informants). Focus group interviews were done with:

- Key informants from the various committees[1] to get an **overview of the important issues in the village**. Basic knowledge about the village was obtained and was used to modify our questionnaire survey and as basic information for the further study of the village.

- Key informants from the various committees to gain knowledge about **the decision making process and other subjects relevant to the specific committees**. After the meeting we learned that for the meeting to go smoothly, some people had been refraining from speaking out about certain issues since the headman was present. Thus, the most interesting information actually came after the meeting in informal talk.

- A group of women to target their **understanding of the community organization and the power structure in the village** and to triangulate the information obtained from the committee members. However, talking about underlying factors is very complicated. It is difficult to ask good questions and the translation made it even harder to conduct the interview. The interview is not used in the project. Nevertheless, it taught us how important good preparation and questions are and how it can affect the result and information obtained. It gave us inspiration to how an interview can be handled in future fieldwork.

- A group of twelve people (men and woman) **about general prices** for things in the village.

[1] The village has committees and the members are responsible for different areas such as welfare, water, culture etc.

- The young people to know their **plans for the future**. The young were shy and reluctant to be interviewed; therefore we made a focus group interview.

3.2.5 Participatory Rural Appraisal (PRA)

PRA includes various methods and approaches that enable rural people to present, share and analyze their own life. People are the central element in this method, and the idea is to include them through different exercises that will lead to an optimal understanding of their life, opinion, environment etc. (Mikkelsen, 2005). PRA's carried out were:

- **A timeline, a community mapping**, and a **scoring matrix.** In the scoring matrix the important crops were listed in a table and valued from 1-5 in different categories. The information gathered gave us an understanding of how the villagers perceive their community and different crops and how they understand the history. While doing the community map, only men were present which might have biased the map and the discussion.

- **A seasonal calendar** to inform us about the general village activities during a year. It gave us insight about how the activities correlate. Women were present at our request but did not participate.

- Three **rankings** in the case studies; **income, expenditure and problem**. All of them were carried out with the following three steps (exemplified by income): Defining the different sources of income and writing them on each a piece of paper. Rank them with 20 small stones distributed among all the different pieces of paper whereby showing the importance of the different income sources.

- **A daily calendar** describing the work and activities of the women in six of the twelve case studies. The calendar was done for two different seasons: the rice harvest and not rice harvest.

- **A yearly calendar** showing income and expenditures during a year, where an overview of differences in vulnerability between households are shown. The calendar was a very time consuming task for interviewee and economic issues was sometimes too personal to go into details with. Therefore we only conducted two calendars.

- **Three farm-visits** to observe and obtain crop and farming practice information in situ. The visits were also used to gather information for selection of soil sampling plots. All the visits were supplemented with semi-structured interviews in-situ.

3.3 Natural sciences methods

3.3.1 Soil sampling

3.3.1.1 Selecting the field sites for the soil sampling

The aim of selection was to find a one year rice field that had been cultivated in accordance with the widely practiced swidden cultivation and a perennial rubber field that earlier had been a swidden cultivation rice field. For the two fields to be comparable, the texture and colour of the soil and the location in the surroundings regarding slope and position on the hill needed to be the same.

The selection of the rubber and the rice field was based on the farm visits where the decision was based on optimising the comparability factors and on accessibility to the fields. The two selected fields were very comparable on all the factors, increasing the reliability on the data.

3.3.1.2 Volume and horizon specific soil sampling

For each field three soil profiles were duck distributed at the same hill height to ensure that the average soil conditions were included. The depths of the profiles were app. 40 cm. As it is very weathered soils the B horizon will be very deep (up till meters thick) and it is therefore appropriate to stop at a depth where roots can no longer be found, instead of at the beginning of the C horizon. The horizons (and their depth) were determined for each profile as well as the colour, presence of roots, texture and other characteristics. One volume specific sample was taken for each horizon horizontally into the profile for two of the soil profiles, whereas three volume specific samples were taken in each of the horizons for the last soil profile. After the sampling, the soils were dried in an undisturbed, dry place with good air ventilation for a couple of days.

Parameter	Method
Density	Weighing of the volume specific sample (< 2mm)
pH	Measured in a 1:2.5 soil:water solution with a pHM210, Standard pH Meter, MeterLab
Al	Analysed with the colorimetric Aluminium Test kit, Merck
P	Analysed with the colorimetric Phosphorous Test kit (PMB), Merck
C	Analysed in a continuous flow isotope ratio mass spectrometer
N	Analysed in a continuous flow isotope ratio mass spectrometer

Table 3.1 - Methods used for laboratory analysis of soil samples.

3.3.3 Water sampling

Five water sampling points (TM1-5) were identified to measure the water quality of Kayan River and of water for consumption from the Duvûh River (Table 3.3). The water at the 5 sampling points was tested *in-situ* and water samples were also collected for laboratory analysis. The *in-situ* parameters (dissolved oxygen (DO), pH, salinity, temperature and total dissolved solids (TDS)) were tested using a portable water quality meter (Hydrolab). The water quality parameters analyzed in the laboratory include chemical oxygen demand (COD), biochemical oxygen demand (BOD_5),

total suspended solids (TSS), phosphorus, ammoniacal nitrogen, total coliform count (TCC) and faecal coliform count (FCC).

Parameter	Method
Phosphorus	(Orthophosphate)Phos Ver 3 Ascorbic Acid. Reagent: Powder Pillows/ AccuVac Ampuls
Nitrogen, Ammonia	Nessler Method

Table 3.2 - Overview of laboratory analysis for nutrients.

Point	Location	Coordinates	Water Condition
TM1	Kayan River Upstream	N01^{0}04'31.5" E110^{0}24'21.1"	Fast Flowing water, rocky, sandy banks, vegetation debris
TM2	Tuna River (inflow to Kayan River Upstream)	N01^{0}04'21.3" E110^{0}24'34.9"	Fast flowing water, rocky, sandy banks, clear water, vegetation debris
TM3	Kayan River Midstream (at the village)	N01^{0}04'21.3" E110^{0}24'34.9"	Fast flowing water, rocky, sandy banks, clear water, vegetation debris
TM4	Kayan River Downstream	N01^{0}04'21.3" E110^{0}24'34.9"	Fast flowing water, rocky, sandy banks, clear water, vegetation debris
TM5	Water intake point	N01^{0}04'21.3" E110^{0}24'34.9"	Cemented tank water, clear water

Table 3.3 - Locations and conditions of water samples.

Picture 1 – Fieldwork in practice. Top-left: Our interpreter instructing a respondent during a ranking exercise. Top-right: Creating a seasonal calendar with much participation. Bottom-left: Conducting the questionnaire-survey with our Malaysian counterparts. Bottom-right: Drying of our soil samples.

4. Development and modernisation

Focus on rural development started after the formation of the Federation of Malaysia in 1963 by the Sarawak States Government by introducing agricultural programmes and schemes (Ngidang, 2002). In Tema Mawang the first signs of modernisation came in the 1950's where a missionary "Father Husba" introduced new tools and cultivation techniques (Figure 4.1). The general rural strategy of Sarawak has in many decades focused on modernization and commercialization of the agricultural sector, based on an idea that increased productivity will reduce poverty in the rural population. The rural development strategies focus on large-scale production of cash crops such as rubber, pepper and oil palm (Banerjee & Bojsen, 2005). Rubber was introduced in Tema Mawang in the 1950's and pepper in the 1960's. In 1965 the Government began a policy with free fertilizers, which was the beginning of intensification of the farming practices (Figure 4.1). This practice may be changing in the future:

"We will not be able to keep up the level of fertilizer subsidies" (Mr. Jawong, Sarawak Minister of Infrastructure, Development and Communications).

If this is carried out it could change the farming practice substantially since fertilizers are used on all crops. During the 1980's former villagers of Tema Mawang returned with new knowledge and technology, and it became the decade where new technologies were mixed with the traditional practices (Figure 4.1).

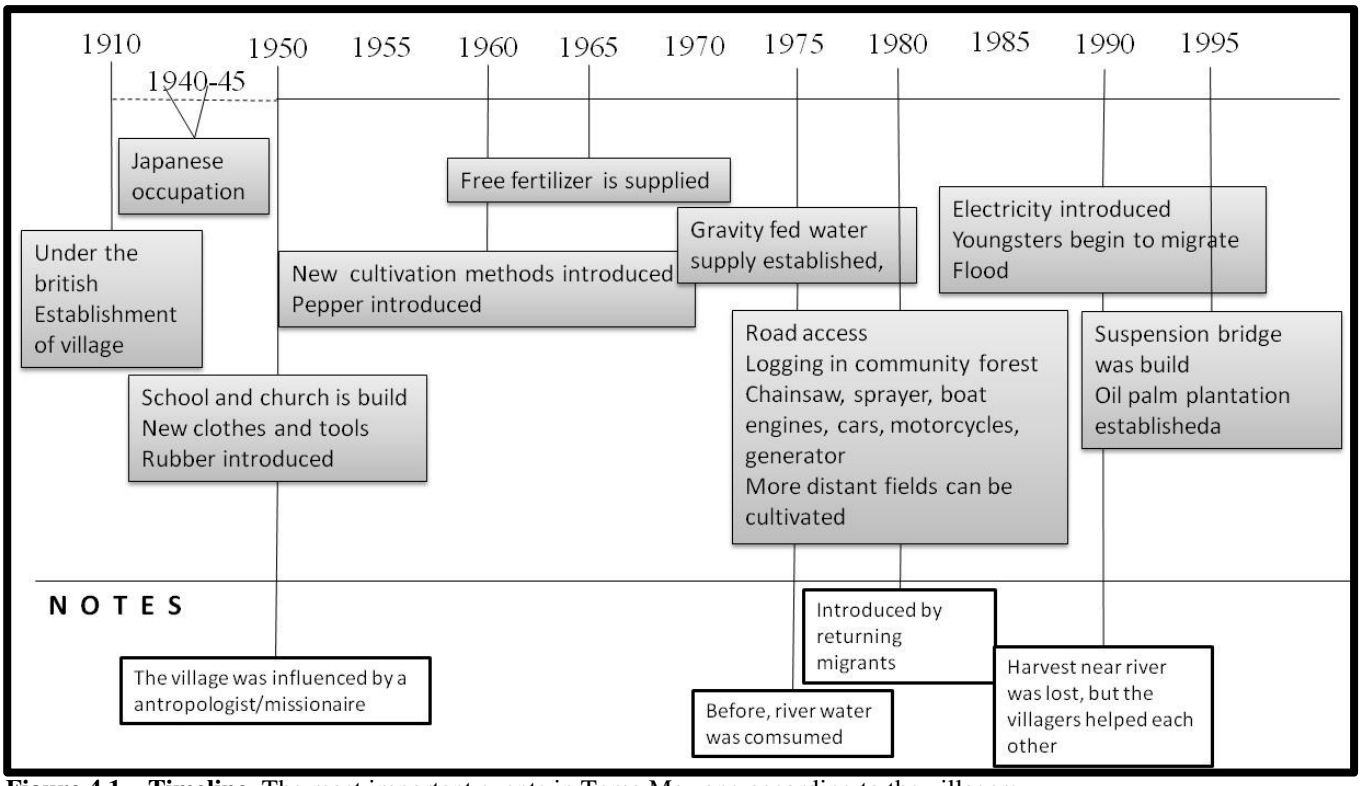


Figure 4.1 – Timeline. The most important events in Tema Mawang according to the villagers.

Large-scale cash crop production is still the main strategy for agricultural development according to the Sarawak Administrative Officer (SAO):

"Now they are doing shifting cultivation, every year they go to a new plot, but we can get better yield …. We are planning to do it on a big scale [cultivation of the cash crops rubber or oil palm, red.]…. That is the plan we have now. But they [the villagers, red.] still haven't come to a conclusion of what they want - oil palm or rubber" (Mr. Udin, SAO in Tebedu).

The villagers in Tema Mawang do not unconditionally share this idea as their farming is kept on a small-scale-basis. In 1995, an oil palm plantation by SALCRA (Sarawak Land Consolidation and Rehabilitation Authority) was established on a limited part of the community forest. The villagers are not satisfied with the plantation because they get too small dividends and they have decided not to establish more plantations. Decisions like this are made in two steps; the village chief and the deputy make a tentative decision which they present for the villagers. They vote by rising hands and if the villagers disagree, there will be a vote on a new suggestion. In this way the village has a democratic flat structure (Figure 4.2). Decisions about farming strategies are taken by the individual farmer. However, there is consistency among the villagers to follow common strategies determined in the village, for instance to refuse the planting of oil palm plantations. In many cases, the village chief is at the same level as the rest of the villagers and his function is more of an administrative role. All households registered by the village chief can apply for subsidies or compensation for natural hazards through forms given by the village chief.

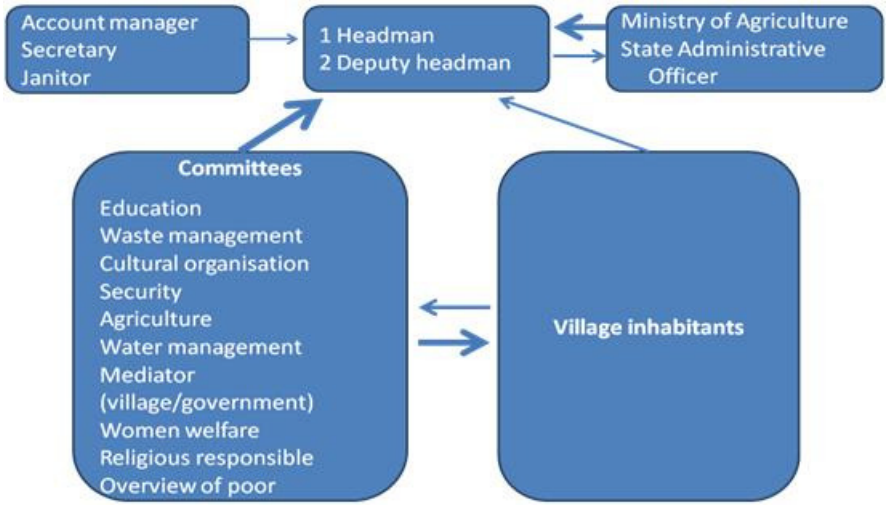


Figure 4.2 - The formal organizational pattern of Tema Mawang.

Infrastructure is very important for the development of rural areas. Good road connections are essential for the access to the market and thereby preventing small villages to remain remote (Windle & Cramb, 1997). A paved road was build in 1979 linking Tema Mawang with the road to Serian and Kuching and it seems like the villagers can look forward to more improvement of the physical infrastructure:

"Actually we are going to build a valley bridge …. This year …. The minister said ok we will do it… So it will not be necessary to park the car on the other side anymore" (Mr. Udin, SAO in Tebedu)

The bridge for cars will make transport and trade even easier for the villagers in Tema Mawang. In 1990 electricity was installed, making it possible to use more technology. Many families have television, and some of the richer have washing machine and other tools. But still some poor families do not have electricity to day.

All these changes indicate that Tema Mawang has experienced an opening towards the outside world in the last 60 years in terms of transport, technology and communication. Our impression is that the villagers wished to present the political structure and the decision-making processes more democratic and consensual than they actually are in practice. But even though there may be a lack of democracy in the decision process adaptation and changes of strategies are only made if there is a common belief that they are positive for the development of the village. Tema Mawang follows some common development patterns equal to the strategies for Sarawak, but at the same time they protect their own community by maintaining some of their traditions and strategies.

5. Livelihood strategies

The livelihood strategies in Tema Mawang influence the households' vulnerability and are sought covered in this chapter. Different elements like choice of crops, the degree of diversity in the income strategies and the organization of domestic work constitute the livelihood strategies, but influence the vulnerability in different ways. The households' vulnerability is therefore discussed from these elements.

The livelihood strategies can be characterised as based on crops for subsistence, on income sources such as cash crops and wage labour, and on some use of the forest products and fishing in the river.

Picture 2 – Most Important Crops. Left to right; rice, pepper and rubber.

5.1 Important crops

Rice is a very important crop for the villagers (Table 5.1), because it is their main food all year around and 97% of the respondents cultivate rice (Figure 5.4A). They grow it for own consumption and most villagers rely on having rice enough for the whole year. Fish for own consumption are also a very important food source (Table 5.1). Furthermore, most households have a home garden with cassava, beans, sweet corn, pumpkin etc. and fruit trees are found all over the village and along the river bank and fields. Vegetables and fruits are mostly for own consumption but are sometimes sold amongst the villagers.

	Income	Labour Intensive	Household food	Market expectations	Negative impact on environment	Pesticides and fertilizer
Rice	1	3	5	1	1	2
Rubber	4	2	1	3	1	3
Pepper	2	4	2	2	1	4
Seasonal Fruit	2	1	4	1	2	1
Fish	1	3	4	2	1	1
Cacao	2	3	1	3	2	3

Table 5.1 - Scoring matrix for crops. From 1-5, where 5 is highest.

Rubber is the most import crop for income (Figure 5.1) and 93 % of the villagers have rubber trees, either mature or still small (Figure 5.2). Rubber prices are high at the moment (Figure 5.5) which induces farmers to invest more time in this crop (Wadley & Mertz, 2005), and which results in the increasing area with rubber trees (Figure 5.1). Many farmers plant new rubber trees on the area where they cultivate rice. Rubber is a long term investment; when the trees are seven years old the tapping can begin and continues up until over 30 years of age, so the income of the newly planted rubber trees depends on the price in seven years, where the prices may have changed. The importance of rubber is emphasized in the scoring matrix, where rubber scores 4 out of 5 in income (Table 5.1).

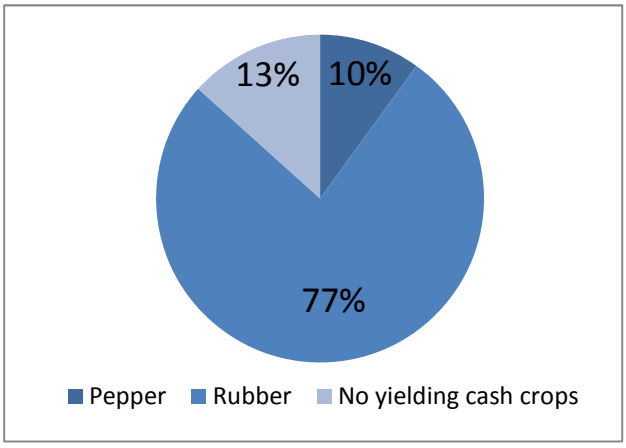


Figure 5.1 - Most important cash crops for the households. From the questionnaire survey.

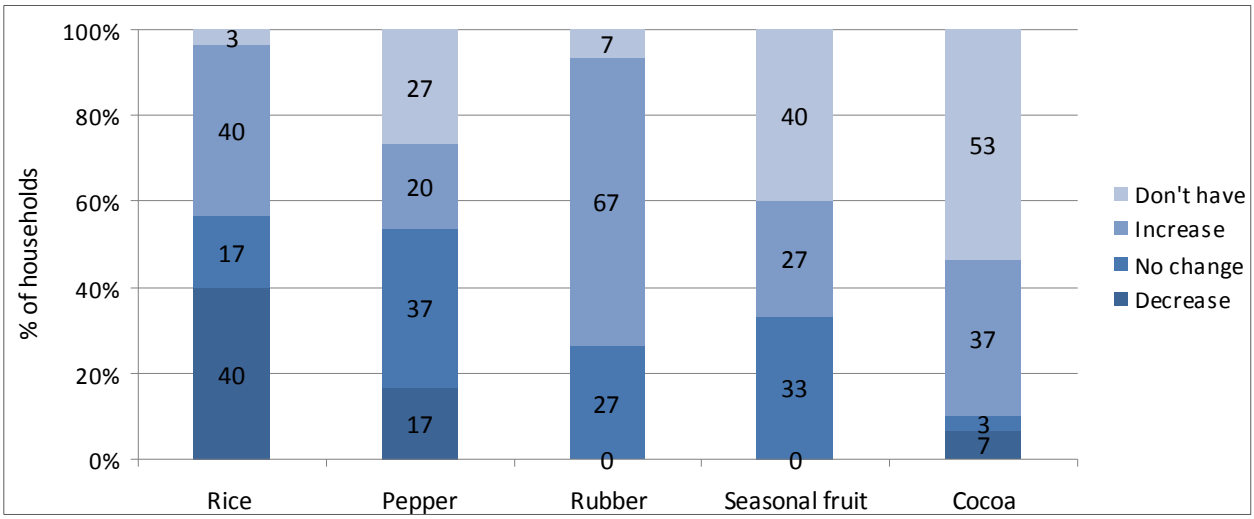


Figure 5.2 – Changes in crop area. From the questionnaire survey.

Even though pepper is not the most important crop for most households and it was not scored high in income (Table 5.1), 67% of the responding households have pepper plants, indicating that pepper does have some importance for the household income. The lower score of pepper is because of lower market expectations and high labour intensity compared to other crops (Table 5.1).

In 2010 many villagers planted cocoa trees subsidised by the Government. If the harvest of cocoa goes well, 37% of the farmers (Figure 5.2) will have an additional cash crop to rely on in a few years which will make them less vulnerable. The relatively high score for market expectations for rubber and cocoa indicates that the present good price has influenced the increase in these crops.

Almost no villagers grow oil palm, primarily because it is too hard work, and because most of them prefer rubber. SALCRA has a relatively large plantation south of the village, but almost no villagers work in the plantation and the wage for the work is considered to be very low.

The methods for cultivation in Tema Mawang has intensified during the last 15 years, both because of increased use of fertilizers and pesticides (Figure 5.3A) and because of the use and aid of modern tools like motor engine, chain saws and pesticide tanks. Almost all of the respondents own a motor engine for their boat and a pesticide spray tank (Figure 5.3B). With a motor engine the villagers are able to access fields far away much quicker and thereby reducing the transport time remarkably. About half of the respondents own a chainsaw and a rubber roller showing that the farmers are willing to invest money in new tools to ease the cultivation and increase the yield.

The increased use of chemicals is of big importance for the present farming system and allows the farmers to harvest more often and increase the yield. But it also makes the farmers more dependent on subsidies and influences the environment because a part of the chemicals are washed out (see chapter on Water quality). The majority of the respondents use the forest as a part of their livelihood (Appendix 1, XI) aside from the crops and vegetables they cultivate. The forest is used for gathering both food and construction wood, like bamboo among others.

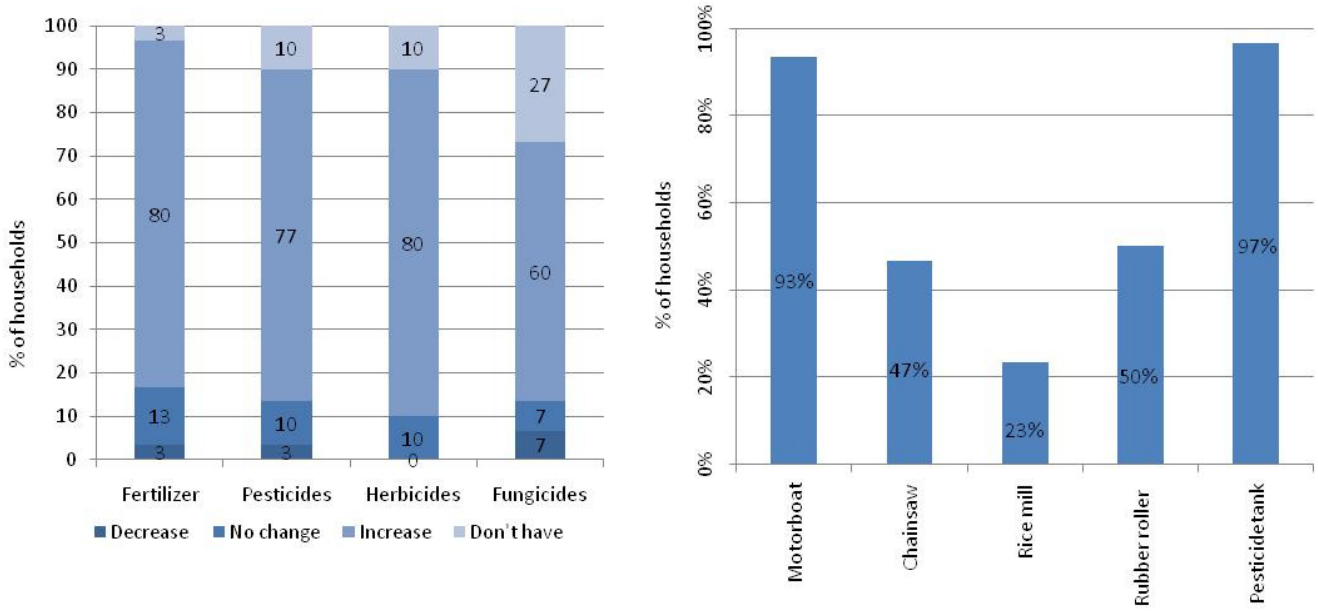


Figure 5.3 – A: change in fertilizer, pesticide, herbicide and fungicide use. B: Tools for agricultural use and Change in agricultural inputs over the last 15 years. Both from the questionnaire survey.

5.2 Income strategies

Almost all the villagers cultivate both subsistence rice and at least one cash crop (Figure 5.4A). The cultivation of rice makes the households less vulnerable because output of rice has a stabilizing effect on the farming system (Cramb, 1993). However, the diversification of income sources, with cash crops and wage labour, also influences the vulnerability of the households hence the households' income strategies are discussed in the following.

The majority of the households cultivate more than one cash crop, although some rely on rubber as their only income source (Figure 5.4AB). The main income strategy is diversification with two or three cash crops combined with wage labour.

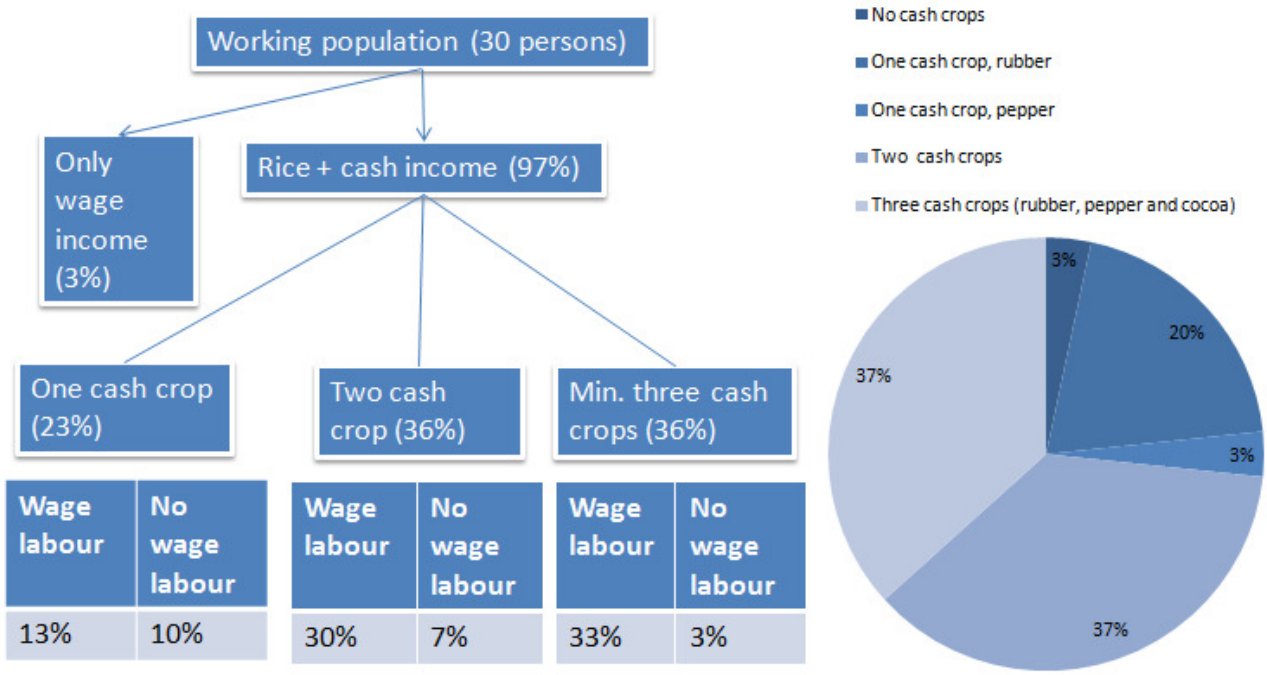
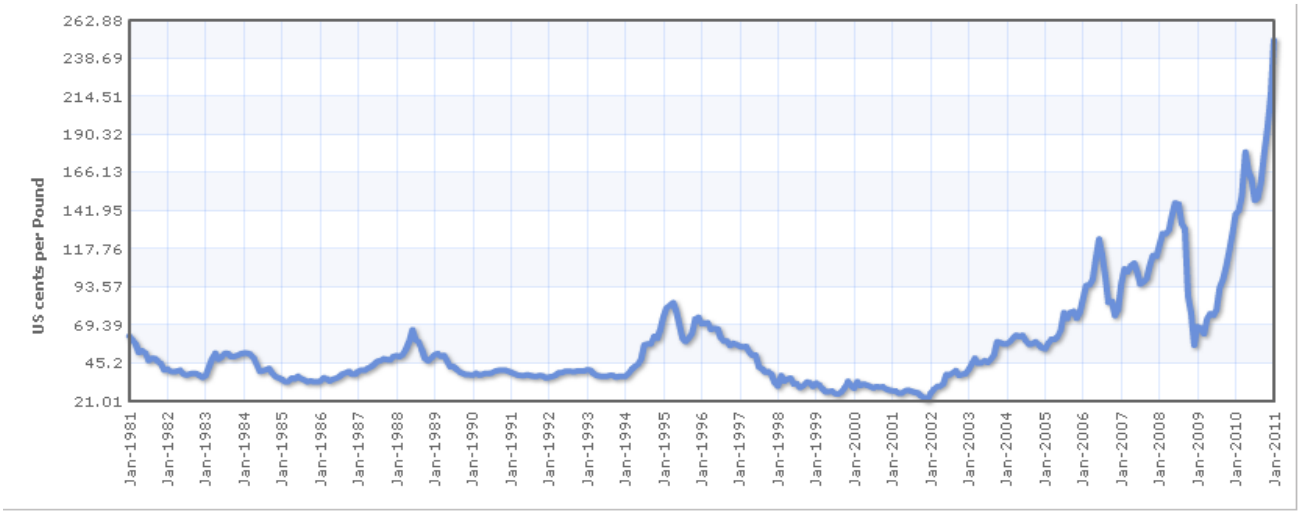


Figure 5.4 - A: Households divided in number of cash crops and wage labour in percentages. B: Households crop choices. Both from the questionnaire survey.

5.2.1 Reliance on rubber

Rubber is very important as an income source as mentioned above. The current high rubber prices (Figure 5.5) enables some to rely solely on rubber, but a drop in the rubber prices would mean loss of income for almost the entire village. Making the household vulnerable if they rely on rubber as the main income. However, during low prices the rubber tapping can cease and can be resumed whenever the prices rises, which makes rubber a resilient crop (Cramb, 1993) thereby decreasing the vulnerability.



Figur 5.5 - Monthly price for rubber from 1981 to 2011. Shown in US cents per Pound. (International Monetary Fund).

Picture 3 – Business as usual. Left to right; the local burger bar, the middleman weighing and buying rubber mats from villagers to sell in Serian and the shop of the village chief.

5.2.2 Reliance on different crops

The farmers try to diversify their crops when they have the opportunity, and thereby spreading out the risks involved with farming.

"Half of the cocoa harvest is lost to squirrels and deceases [...] I did know about this risk when I planted the cocoa plants. [...] I cannot depend solely on one crop" (Wilson, farm visit 3).

The general picture from the case studies (Appendix 1, VII) is that the richer families have several other cash products such as cocoa, vegetables, banana, oil palm and some even have fish ponds and in one case bird's nests[2], whereas the poorer households have fewer cash products and also a

[2] Bird's nests are a very expensive delicacy in Malaysia. Special houses are build for the birds to make the nests.

smaller yield from these. Table 5.2 and 5.3 show how large differences there can be in crop diversification between households. The tables also show that both farmers have planted new crops, thereby diversifying their income sources. Not all families have the opportunity to diversify their crops as discussed in Seasonal Vulnerability.

Crop	Harvest (amount)	Frequency
Rice	20 bags (of 40kg)	Once a year
Rubber	4 kg	Once a week
Pepper (new)	-	-
Cocoa (new)	-	-

Table 5.2 - Table of crops. Deli, HH8p.

Crop	Harvest (amount)	Frequency
Rice	30 bags	Once a year
Rubber	5-6 kg	Per day (6 days a week)
Pepper (new)	-	-
Vegetables	20+ kg	2 times a year
Sweet corn (maize)	1 (heavy) bag	Once a year
Lime (new)	-	-
Fish pond	1000 fish	Once a year
Fruits (new)	-	-

Table 5.3 - Table of crops. Andangh, HH12r.

5.2.3 Reliance on wage income

Most households have income from wage labour, but 80% ranked agricultural income as most important (Figure 5.6 and 5.7).

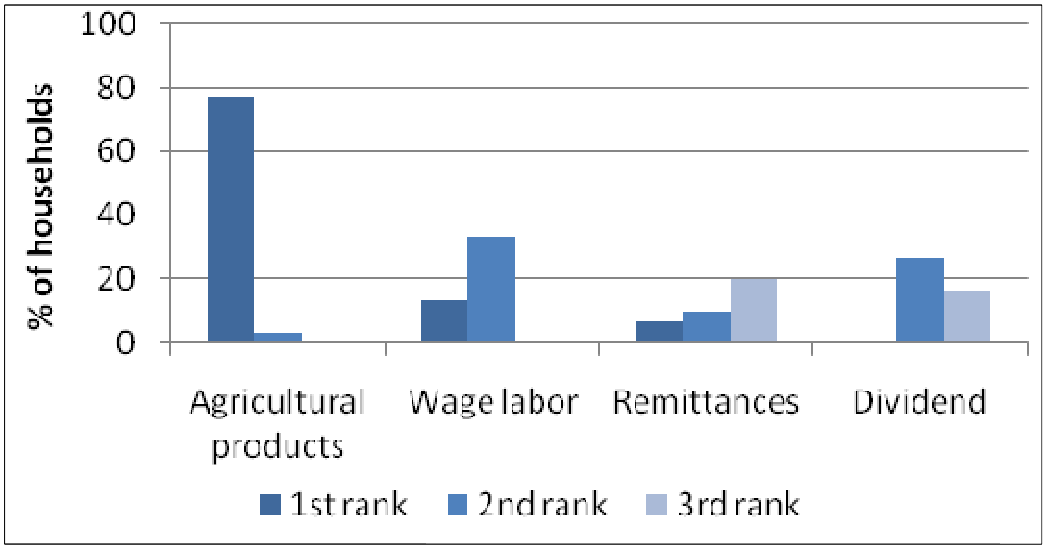


Figure 5.6 – Income sources ranked by their importance. From questionnaire survey.

For the households with only one cash crop wage labour is more important than for households with two or more cash crops (Figure 5.7). This may be because more crops demand more labour input leaving less time for wage labour, which indicates that income from cash crops has a higher priority than that of wage labour. As the villagers are farmers and the land is inherited and stays in the family, cultivation of crops is important. Most jobs are in Kuching, so the villagers have to move or spend extra money on transportation (see further discussion later in the chapter). This could lead to the priority of cash crops over wage labour.

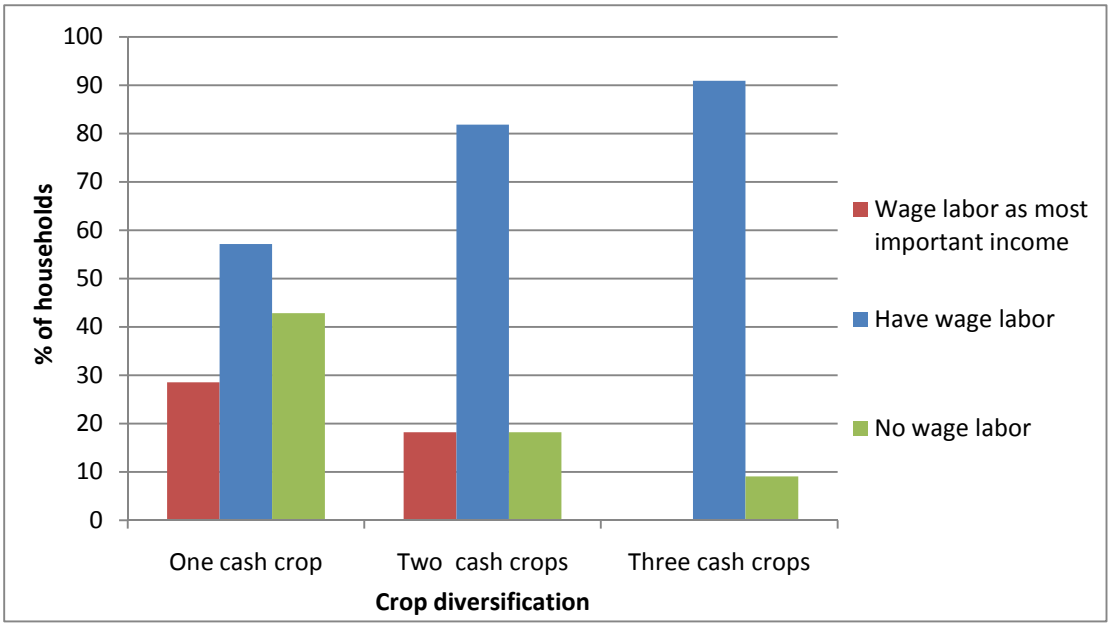


Figure 5.7 - Crop diversification and wage income. From questionnaire survey.

Wage labour is undertaken in shorter periods during the year, as a supplement to the income from cash crops, despite this priority of cash crops and some also have wage jobs all year around. But some of the poor households do not have the opportunity to take a wage job because they use most time just sustaining the household with the cash crops, that they are thus very dependent on. Other poor households are very dependent on the income they get from their wage income even though it is not secure.

"We only survive with wage labour. My husband works with some friends, just to survive; it is day to day work. If he has work, we have money and if not, then we don't have food." (Mariam, HH2p)

Having a wage job thus gives an economic security that makes the household less vulnerable to a bad harvest or dwindling prices on the cash crops.

5.2.4 Reliance on many vs. few income sources

In the case studies, the poor households generally rely on fewer different income sources than the rich households. This tendency is exemplified in Figure 5.8 where Mariam, HH2p rely on only three different income sources, whereas Janet, HH5r rely on a very diverse range of income sources.

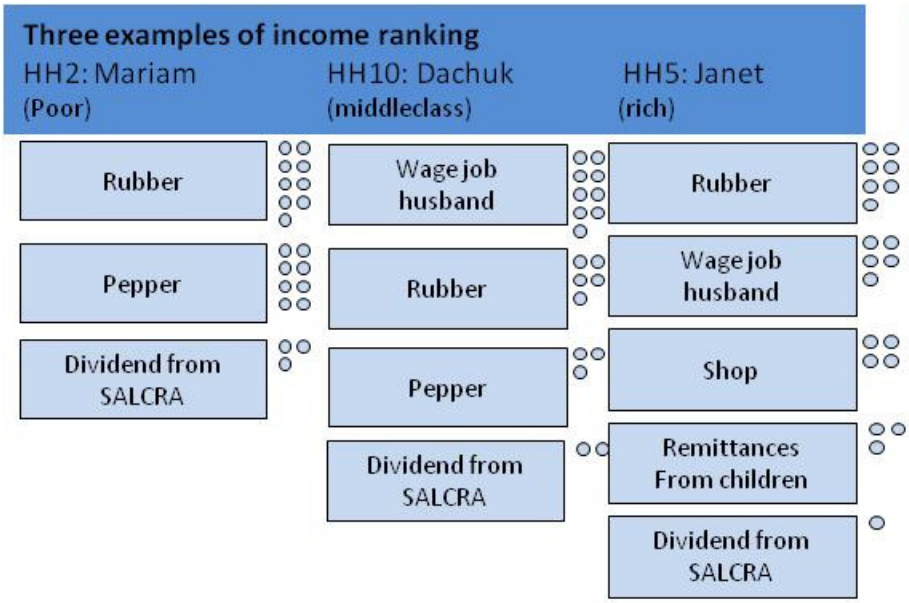


Figure 5.8 - Income ranking. Examples from three selected households: poor, middleclass and rich. The boxes indicate the rank of the importance of different income sources, and the dots make the propositional relation among the different income sources. All twelve income rankings can be seen in Appendix 1, VII.

Janet, HH5r has had the financial capital to establish a shop as many of the rich case households (Appendix 1, VII). Surprisingly, none of them rank it with a high importance, indicating that it is not a very stable nor high income. About a third in the questionnaire survey mentioned remittances as an income source and mostly as the third most important income (Figure 5.6). This picture is the same in the case studies, where only half mentioned remittances as an income source and it is generally ranked very low (Appendix 1, VII). Usually the remittances are smaller money amounts and gifts, such as food, meat, kitchen utensils and other things for the house and it is not considered a reliant income source.

"The children working outside they normally send 100-200rm, not every month, but just if they feel that they want to, they give something." (Salimah, HH6r).

It is important to mention that a major bias was identified due to the villagers' perception of remittances. Many informants see remittances as an obligation or kind of a cultural practice more than a source of income. Even though the income from minor income sources such as a shop or remittances does not seem very important, it adds an extra security to the household, compared to those households who only have very few income sources.

5.3 Seasonal vulnerability

As the livelihood strategies are founded in farming, the seasonality of crop production as well as income fluctuations changes the vulnerability of the livelihood strategies over the year.

November to February are months with heavy rain. This causes problems for the farming because transport on the rivers is inhibited and it can also cause floods destroying the harvest. When there is heavy rain, the latex from the rubber trees is polluted. With rubber being the most important cash crop, no rubber harvest results in reduced income. Pepper is also affected by heavy rain, because the flowers are destroyed, and the rice is in danger of lodging[3] (Figure 5.9). Furthermore October to December is the time for flu, cough and fever and it is the last months before the rice harvest, and for some families this means that the rice stock is empty. Because of this and the heavy rain the villagers are most vulnerable in the season November to February.

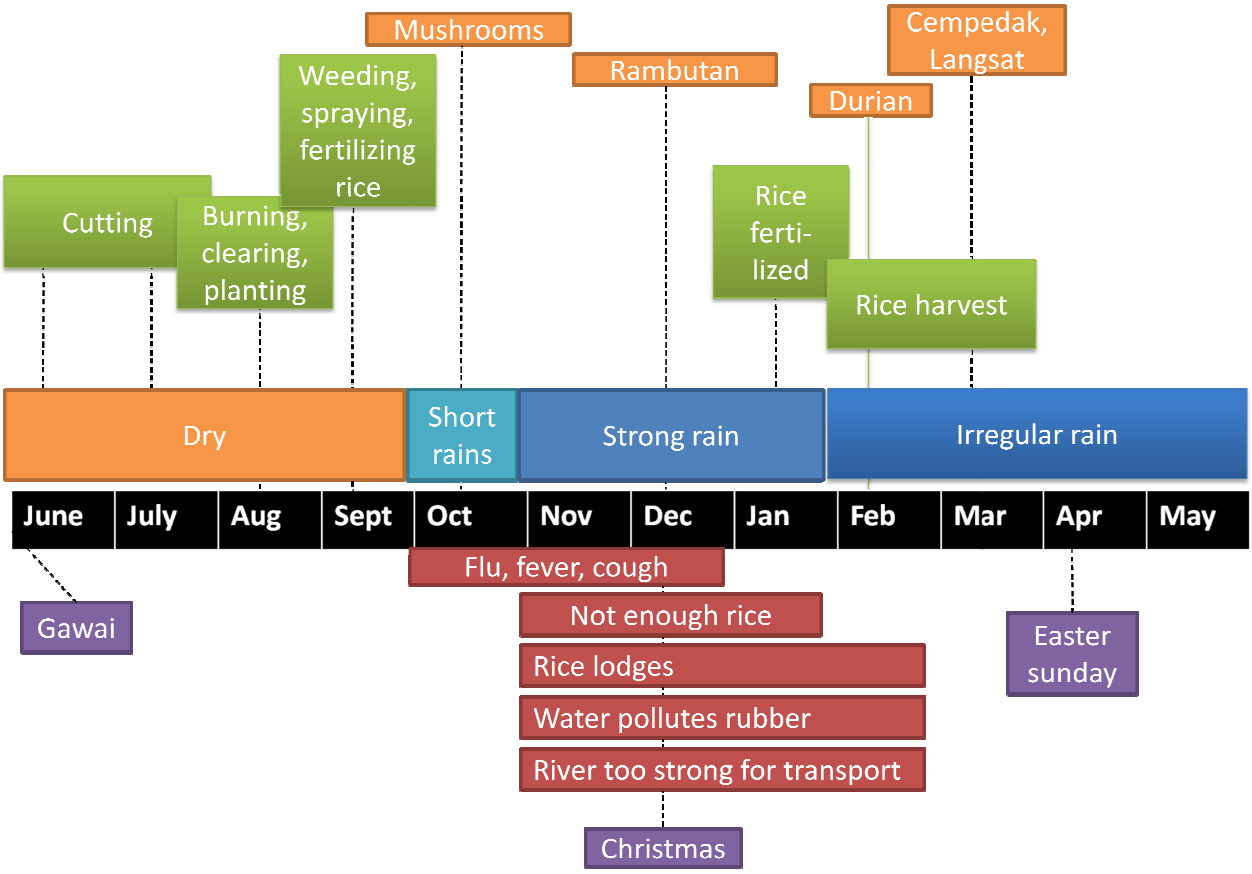


Figure 5.9 - Seasonal calendar showing weather, rice activities, collection of fruits, problems and holidays. Gawai is a festival celebrated in Sarawak on 1st of June every year. It is both a religious and a social celebration.

For most households in the village food shortage is not a problem. Nevertheless, some of the poor households do not always have rice enough for the whole year, mostly due to labour shortage or bad

[3] Lodging is when the rice straws falls.

yield, meaning that they have to buy rice. This leaves them quite vulnerable because they cannot use money on other useful things to improve their production as compared to other farmers. Figure 5.10 and 5.11 exemplifies these differences in vulnerability.

The household in Figure 5.10 lost most of the rice in the flood in 2009 and this influenced the household's economy a great deal. The family had to buy rice most of the year making the expenditures almost as high as the income and they were dependent on help from family members. A household like this is very vulnerable to price fluctuations on single crops and dependent on wage income in the critical months. Wage income was very important for the household, but it also added an extra expenditure for fuel for transport to the city. Fuel is generally a major expenditure for the case households (Figure 5.12 and Appendix 1, VII). It is crucial because it is used for transportation and for the motor engine, reducing the transport time to the fields. The increased need for transport makes the villagers dependent on cash for buying fuel, making some households concerned about the rising fuel prices.

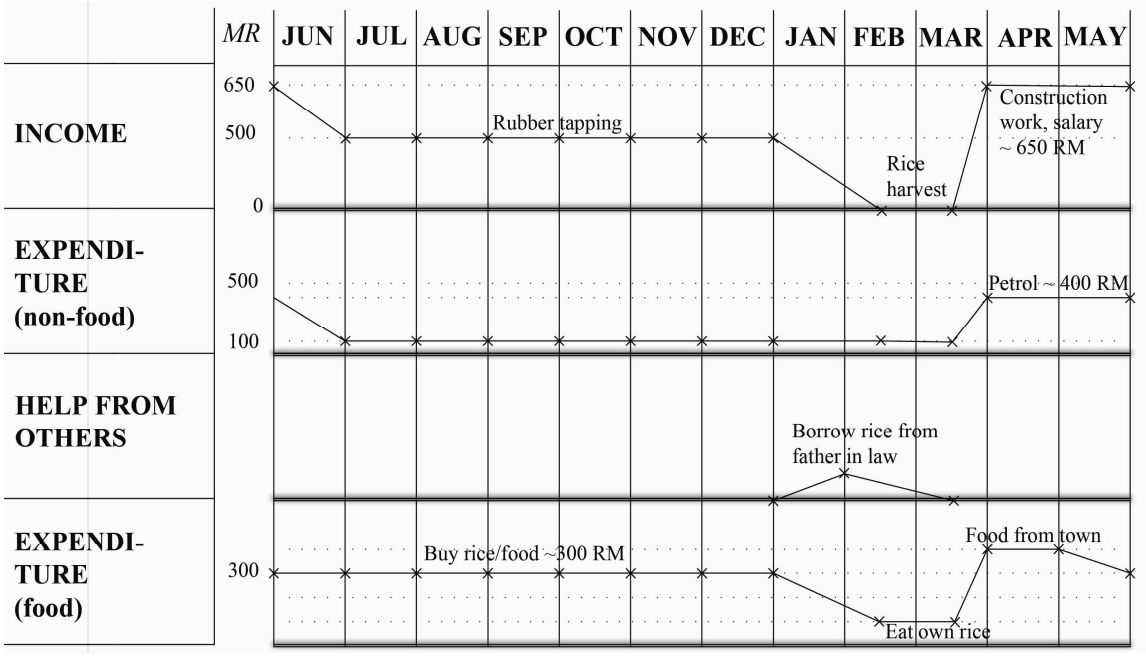


Figure 5.10 - Seasonal calendar. Florance, HH7p. Income and expenditure are plotted on a monthly basis. Data is based on last year (2010). The household is poor with a strategy of rice, rubber and newly planted pepper plants. The cash income is effectively one cash crop and wage income some months of the year.

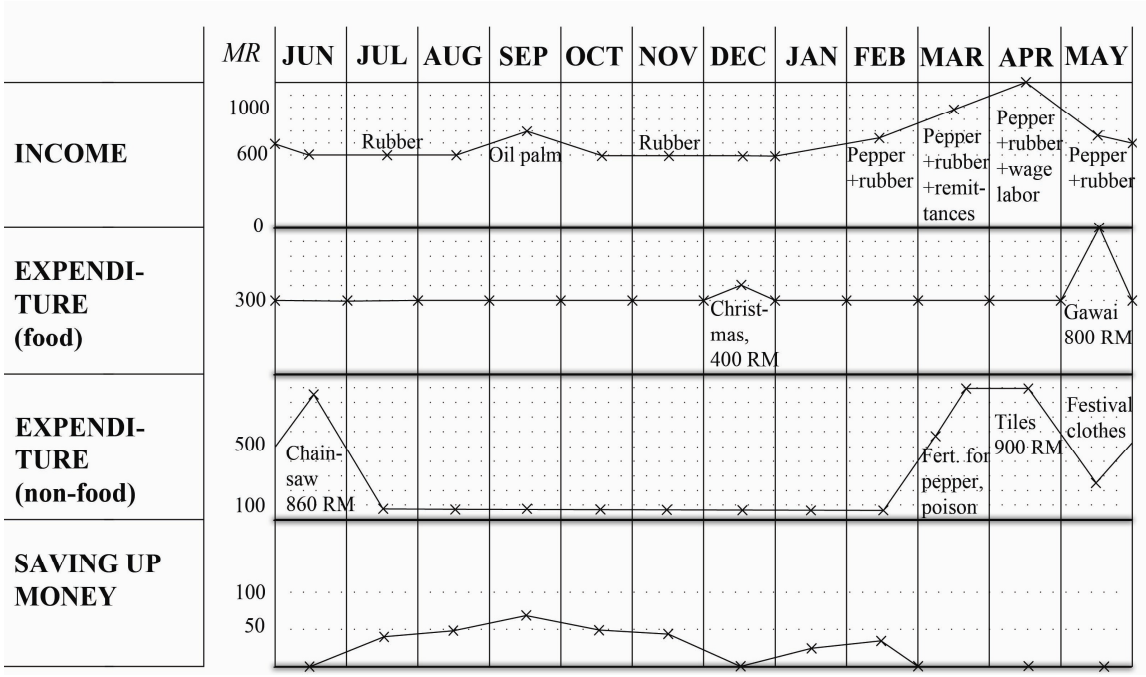


Figure 5.11 - Seasonal calendar. Singa, HH11r. Income and expenditure are plotted on a monthly basis. Data is based on last year (2010). The household is rich with a strategy of rice, three different cash crops (rubber, pepper and oil palm) supplemented by wage labour and remittances in one month of the year.

For the household with a strategy of more cash crops the situation is brighter. Figure 5.11 shows that the household can invest in new tools and inputs for cultivation and thereby improve the agricultural production. The multiple sources of income secures the household in all months of the year helping the household resist impacts like loss of harvest and price fluctuations, making the household less dependent on wage income.

These examples show that food is a large expenditure and it is actually the most or second most important expenditure for almost all the case households (Figure 5.12 and Appendix 1, VII), also stated by one of the women:

"Most of the money we spend is on buying food for the whole family. I usually to go to Serian two times a week" (Salimah, HH6r).

Forest products such as fruits, mushrooms and animals are still used for food (Appendix1, XI) and can be a help in difficult times, when there is not enough rice. All of those who had experienced a shortage of rice said that they used the forest more in that period.

"We used the forest more when we did not have enough rice [last year red.], to save money" (Deli, HH8p).

This statement shows that the forest products are important in difficult times, though it cannot replace rice and other food sources. A bias is, that by asking very directly about whether they used forest products more in bad times we might have prompted a 'yes' easily.

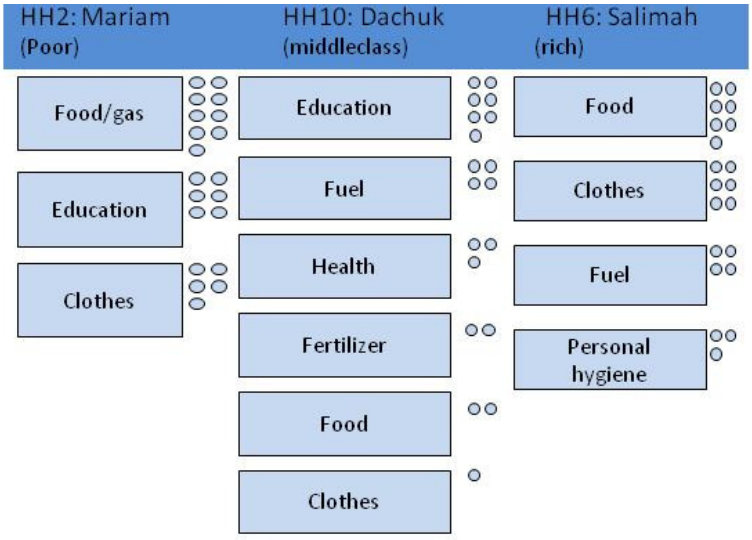


Figure 5.12 - Expenditure ranking. Examples from three selected households; poor, middleclass and rich. The boxes indicate the rank of the importance of different expenditures, and the dots make the propositional relation among the different income sources. All twelve expenditure rankings can be seen in appendix xx

5.4 Problems affecting the livelihood

This chapter focuses on the problems that the villagers are facing in their everyday life. Many farmers found it difficult to talk about 'problems' and our impression is that they usually accept the way things are, instead of perceiving it as a problem.

"There are not enough people to help me in the field, but what can I do about it?" (Deli, HH8p).

We therefore often had to explain very thoroughly before they could answer, and sometimes we made suggestions for what we meant by problems. This might have influenced the results. However, Figure 5.13 shows the ranking of the most important problems that were mentioned by the case households.

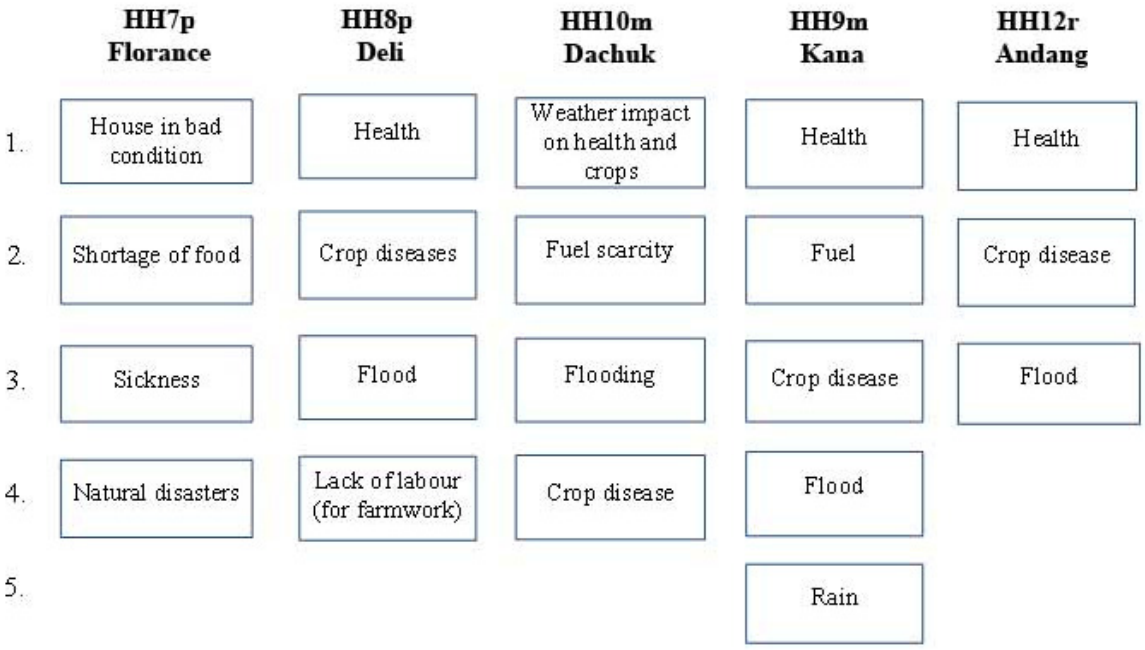


Figure 5.13 - Problem ranking, for five households: two poor, two middle and one rich. The boxes show the mentioned problems ranked for each household.

The problems mentioned were not remarkably different between the rich and the poor; health, crop diseases and flood were mentioned in almost all the rankings. However, there were big differences in the situation for the poor and the rich, especially in the severity of the problems.

Health problems were mentioned most frequently as the biggest problem. Health has a big influence on the household's agricultural practice because the farmer cannot work in the field while being sick. This means loss of harvest and thereby income, making the farmers more vulnerable, because there is no insurance covering the losses. For the poor farmer, Deli, HH8p, his wife's illness also results in an additional expenditure:

"My wife has mouth cancer and has to go to the hospital in Kuching every second month. The transport costs are very high." (Deli, HH8p).

For the households with a strategy of only one cash crop, bad health puts a constrain on their options. Because of lack of labour they cannot cultivate more crops and they are thereby retained in their situation, making them even more vulnerable. Despite this, only a few farmers mentioned lack of labour as a problem and it was ranked very low. The reason for this might be because the villagers accept the situation so it is not a 'problem'. To others it was not an issue at all. Andangh, HH12r, who has many cash crops, has money to hire labour whenever she needs help.

Most of the households also mentioned crop diseases as a problem. Rice is sensitive to the weather during flowering, where too dry weather can inhibit grain development. Many farmers also mentioned that rats ate the rice stalks. Pepper is also prone to diseases and a lot of pesticides need to be used, which add an extra expenditure. Rubber is considered a more stable crop with fewer complications and diseases. However, red ants attacking the root system is a problem that was

mentioned by most of the farmers. The ants usually attack old trees and sometimes the tree has to be cut down. In some cases the ants can be handled with pesticides/insecticides.

According to Wilson (Farm visit 3), cocoa is a risky crop and half of the cocoa harvest is lost to squirrels and worms. But the new cocoa plantations are Government subsidised, perhaps to accommodate for the risks involved.

The flood in 2009 affected most of the villagers and some lost their harvest and their crops were destroyed. Deli, HH8p, lost all his pepper plants and rice, because all his land is located in low lying areas. Only the rubber trees survived the flood, meaning that he now survives solely on the income from rubber and small jobs in the village. In this case the flood had severe consequences for the household's livelihood, but the flood was still only ranked as number three because:

"The flood is only sometimes, maybe every two to three years, but health problems are every day." (Deli, HH8p).

This supports the finding that flooding is perceived as a minor problem by most villagers. They say it is because they are used to handling it in the village when it occurs, whereas health problems, that are affecting them every day, is of greater concern.

Not all households were severely affected by the flood. The farmers with crops placed in the higher ground, did not get their harvest destroyed. Other households were aware of the danger from floods, and had taken the risk into account.

"Some of our padi [rice, red.] was destroyed in the flood last year, but we still had enough rice for ourselves. We always plant some padi in the high ground and some padi in the low ground." (Kana, HH9m).

This shows that the villagers live with the risk of floods and that many have taken precautions that make them less vulnerable. Even though the villagers are aware of the flood risk, they continue to cultivate the low lying fields. This might be due to other positive attributes such as closeness to the river bank, making the transport time for walking shorter. Better soil quality, due to more plant available water and a higher nutrient status because of erosion from the above areas, might also be a reason for keeping the low lying fields in spite of the increased flood risk.

5.5 Organisation of the domestic work

This chapter focuses on the domestic work, to discuss how non-income generating activities contribute to the livelihoods in Tema Mawang, and how it affects the vulnerability of the household.

The most important task for the women is to take care of the domestic work including; cleaning the house, washing the clothes and cooking (Figure 5.14). The amount of time used on each activity vary (Figure 5.14) depending on the size of the household, the number of small kids and the tools and techniques available for the domestic work. For the poor and middle class households (Figure

5.14) the fieldwork is a big part of the woman work and especially in the rice seasons (Appendix 1, IX) where they are busy with harvesting and clearing of new land. When working in the field there is less time for domestic work, but if there are small children in the house, most women stay home and do not participate in the fieldwork. However, it is an advantage for the household if both men and women can work in the field when necessary.

The women from rich households (Figure 5.14) have more spare time than the women from poor households because they can afford to employ workers in the busy seasons. If a family can afford to have a housewife who only is in charge of domestic work and has free time during the day for relaxing, they will often priority this (Sim, 2001). In contrast, the women in the poor households sometimes have to take additional day-to-day jobs, to make ends meet, even though this is not very appropriate for a woman.

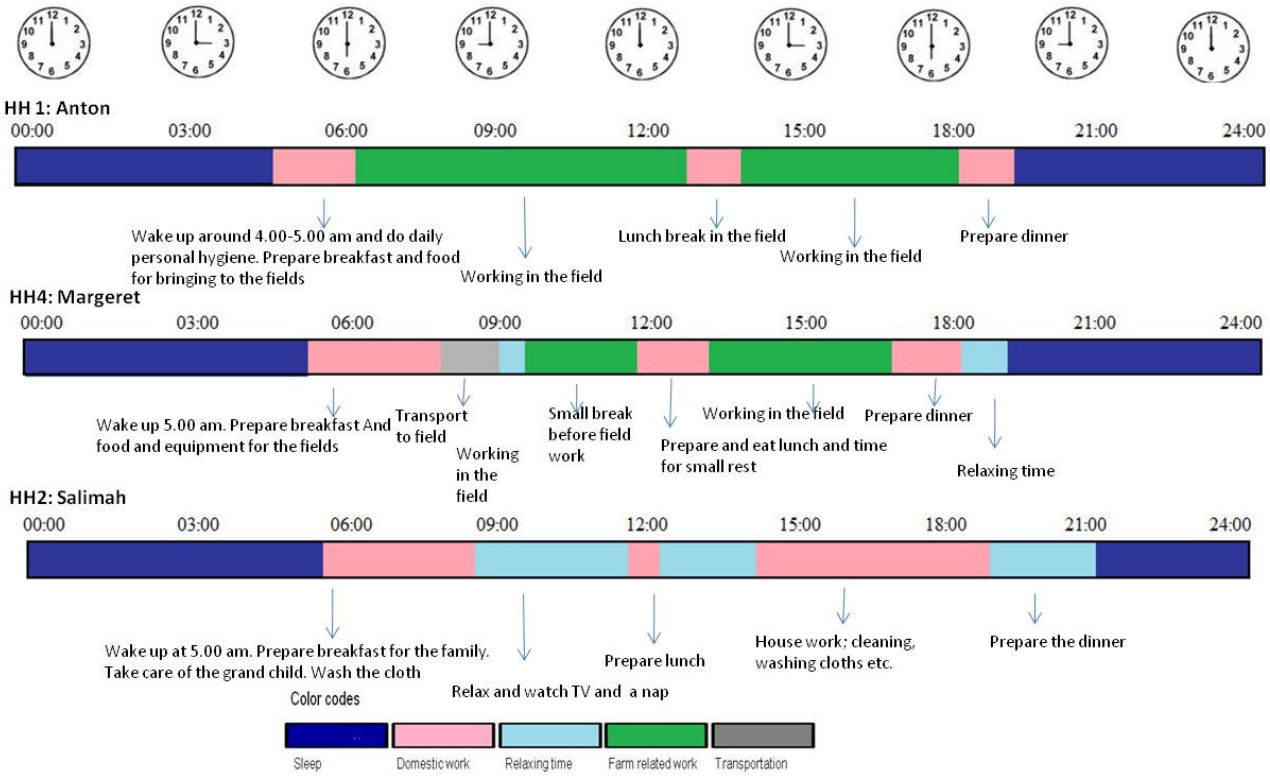


Figure 5.14 - Daily activity calendars for three women during rice harvest (more examples in appendix xx).

None of the women mention rubber tapping as included in their daily work routines.

"I wake up before 4.30 to prepare breakfast for the husband to go and collect rubber; I never go to collect rubber. It is only my husband working in the field, only sometimes if he needs it he employs extra manpower, but only if he needs it" (Janet, HH4r).

When triangulating this information with the men, the picture is different. All of them agree that it is very common that the woman is in charge of the agricultural work, including tabbing and working with the rubber, while the husband is having a wage job. These contradicting statements might be because the woman wants to present herself as a housewife, because it is seen as an

indicator of wealth. It is a sign of economic surplus if the family can afford to have a housewife that does not work in the field or have a wage job (Sim, 2001). In the poor families the women need to participate in the fieldwork, even though there are small children at home.

"When we go to the fields, the youngest child [three years old] is left at home.... and it is no problem, she can walk around the village, and when the oldest one [eleven years old] is off from school she can take care of her" (Mariam, HH2p).

In all six cases, the women mention that the domestic work is easier now, than it was 15 years ago. This can give more freedom in the daily schedule for relaxing and make the women more flexible. The main reason is that they now have gas for cooking instead of having to spend much time on gathering firewood. In addition, electricity has caused major improvements for the domestic work:

"There are many changes, […] now we use gas, and we don't have to go to the forest to collect firewood, and now we have better equipment, and a washing machine... So now life is easier." (Margeret, HH4m).

Not all families have experienced an easier life. The women in the poor households have to use the traditional ways of cooking with firewood, and the even poorer do not have electricity in the house. The modernization of the domestic work creates a demand for cash to buy new equipment and kitchen tools, which is important for their life now but can be hard to obtain for the poor households.

Picture 4 – Women at work. Left to right; a woman on her way to collect forest products, a woman processing rice and a woman spraying with a pesticide tank.

Even though most of the women mention that there are between 10-15 households in the village they consider as part of their family, there is no sign of work communities for either domestic work or farm work. This organization of the work makes the households more vulnerable, because they have to handle problems individually. However, the extended network of relatives in the village is in some cases working as a safety net (Li, 2009).

"Sometimes it is really difficult to get enough money and food. When we work in the fields, it is really hard for us to get enough food, so we have to go to the families to ask for food. Some of the family members are good and we don't have to give it back. Sometimes we have to give it back." (Anton, HH1p).

The social network can improve the social capital for the households and make them less vulnerable for changes because it makes them able to handle difficult situations in common (Lin, 2005). The rich families with resources to buy tools and techniques to assist the domestic work and field work are less vulnerable than the poor households who in difficult periods depend on help from relatives and day-to-day wage jobs.

5.6 Migration

Migration as a livelihood strategy in Tema Mawang is discussed in terms of the impact on family structure and the village development.

Migration for wage jobs is a common livelihood strategy for the villagers in Tema Mawang. Proximity to Kuching and the relatively good conditions of the road make migration an accessible strategy for many households (Windle & Cram, 1997). The main reason for migrating is lack of job opportunities in the rural areas, and the opportunity for cash income by working in factories, construction or in the service sector (Figure 5.15). Some young people also migrate to take an education. Kuching is the most popular destination for the migrants, as the migrants have the opportunity to come home in the weekends, but also other urban areas in Malaysia were mentioned.

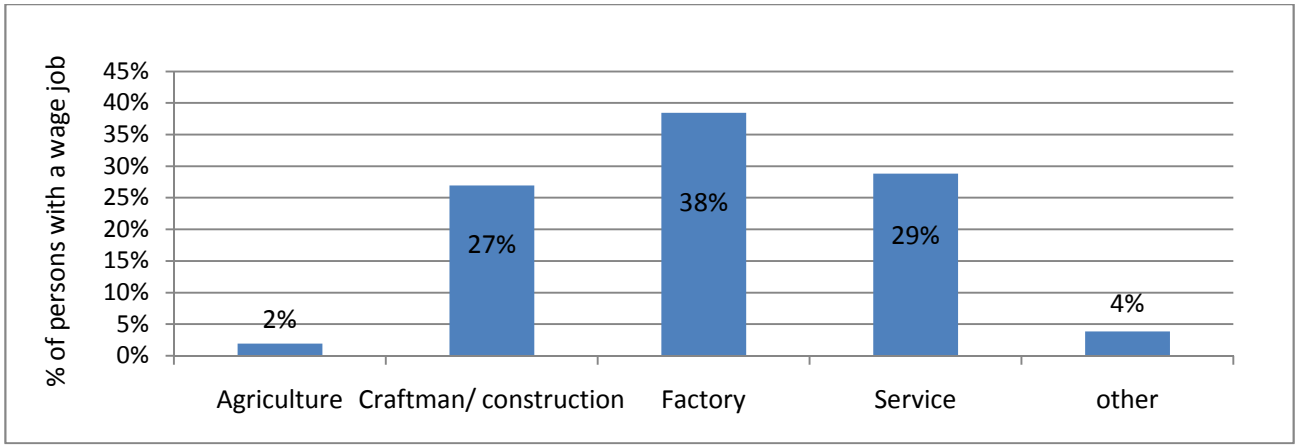


Figure 5.15 – Type of wage job. Some families have more than one person with a wage job.

A man in the village, working in a factory in Kuching, explains:

"There is not enough work in the village. [...] I´m planning to come back to the village to live, because I like better the life in the village [...] All the food we can get from the village and the land is free" (II1 Julimin, 28 years with wife and kids in the village).

This shows that even though many are drawn to the bigger cities, they still feel a strong connection to the village and want to come back at some point in their life. This illustrates a general tendency for many parts of Asia where migrants in urban areas return when the urban life is not adequate for them anymore (Li, 2009).

Establishing a new family can be very costly. Usually the young people have to work in the city for some years before they go back to the village and build a house and start a family.

"The children went to the city to have more experience and earn their living, but they will come back home.... I think that the children will come back and do the farming like the father." (Salimah, HH6r, 51 years).

The livelihood strategies, that include migration of household members with small children, are dependent on the grandmothers in the village as they have to take care of the small children. By offering this work, the grandmother gives her grown up children the chance to earn a living in the city for some years, to save up money to establish the new family when they come back. The migration has an impact on family structures, making them more multi-locational (Kee, 2007). Sometimes the husband stay away for long periods with the result that the children hardly know their father:

"He [the husband, red.] doesn't come back here because it is very far. [...] He has been working there many years, more than 10 years. He is home [for more days, red.] for Gawai and Christmas. He is free from work two weeks a year." (Lily, HH3m, 37 years old).

Some of the young people, who have taken an education, do not expect to go back to the village:

"I find the life in the village boring for young people. I hope that I will have the chance to pass my exams, so that I can get a job as medical assistant." (II3 Christopher 23 years, student in Kuching).

The SAO in Tebedu is not reluctant towards the young people migrating to the city, but at the same time he sees opportunities in them going back to the village to do big scale farming:

"We used to tell them this: Try to do something at home, instead of going, because the city life doesn't promise you all the roses. But after that we start to think again, what is wrong with that? They can go to the city to look for job. […] A lot of them now return with the money, they buy land, they can start to grow oil palm, a lot of them do it. But they have to go to the urban areas to look for job, and then they come back with the money." (Mr. Udin, SAO in Tebedu).

Growing big scale cash crops, such as oil palm or bio fuel, was also expressed by some of the young in the village as a wish for the future. This is in line with the government plans to intensify the agricultural system and do big scale cash crop farming. If this tendency will dominate, it will result in a big change in the livelihood strategies in Tema Mawang in the future.

The dominant livelihood strategy of Tema Mawang is subsistence farming supplemented by cash crop income primarily from rubber. The increased dependency on rubber makes the villagers more vulnerable to price fluctuations, but at the same time an increased crop diversification, supplemented by wage jobs, gives the households an extra economic security. Difference in livelihood strategy is often directly linked to the wealth status of the household, with the richer households having a more diversified strategy with more activities compared with the poorer households. Including migration in the livelihood strategy gives opportunities for jobs and

education, but at the same time family structures are challenged. On one hand the future development of Tema Mawang points towards an increased dependency on outside sources, such as jobs in the city, fertilizers and cash crop prices, but on the other hand, this development seems to go hand in hand with a continuation of the traditional subsistence farming.

6. The impact of the livelihood strategies on the natural resource

6.1 Soil fertility

To determine the sustainability of the livelihood strategies it is important to investigate the impact of the general change in production system from swidden cultivation rice production to perennial rubber tree production on the soil fertility. Different parameters are needed to be able to compare the fertility of the soil. Parameters determining soil fertility can be divided into inherent and dynamic parameters (Jensen & Husted, 2009). The inherent parameters include the texture and mineralogy of the soil; whereas the dynamic parameters include porosity, SOM, acidity, nutrients and water. For this study the soil from a rice field and a rubber field is compared regarding texture, slope of the hill and colour in situ to ensure the comparability of the two fields and the pH, the P, Al, C and N content is determined in the laboratory to compare the soil fertility. The rubber field is a proxy of what the rice field may be like in 10 years.

	Rice field			Rubber field		
	A	B1	B2	A	B1	B2
Hill slope (%)	20			25		
Land use history	Fallow, 1 year rice, 7 years of fallow, now: 1 year rice (with simultaneously planted rubber seedlings)			Fallow, 1 year rice, now: 10 years old rubber field		
Texture	Silt loam Clay: 10-27%	Silty clay loam Clay: 25-40%	Silty clay loam Clay: 25-40%	Compared to the rice field and found to be similar		
Colour	10YR 3/4 10YR 4/4 10YR 3/6	10YR 5/6	7.5YR 5/8	10YR 3/6	7,5YR 5/8	7.5YR 5/8
Horizon depth (cm)	9.3 ± 1.2	-	-	5.7 ± 1.2		
Max root depth of crop (cm)	8				15-20	
Density (g/cm^3)	0.91 ± 0.12	1.07 ± 0.09	1.17 ± 0.03	0.92 ± 0.12	0.91 ± 0.13	1.12 ± 0.14
pH	5.03 ± 0.10	5.02 ± 0.07	5.09 ± 0.32	4.54 ± 0.04	4.70 ± 0.09	4.80 ± 0.05
Al (mg Al/kg soil)	60	60	60	60	60	60
P (mg P/kg soil)	0	0	0	0	0	0
C (%)	3.09 ± 0.36	1.54 ± 0.17	0.94 ± 0.13	2.60 ± 0.54	1.55 ± 0.10	1.14 ± 0.10
C (kg/m^2)	2.6			1.4		
N (%)	0.207 ± 0.02	0.110 ± 0.01	0.059 ± 0.03	0.167 ± 0.03	0.109 ± 0.01	0.082 ± 0.01
C/N	14.9	14.1	16.0	15.6	14.2	13.8

Table 6.1 - Overview of results from soil analysis. The depth of the B horizon is not specified, as the depth of the profile was not deep enough to reach the C horizon or any other new horizon (this goes for all profiles, both in the rice and in the rubber field). B1 sampled at 15 cm. B2 sampled at 30 cm**.**

According to USDA's Soil Taxonomy the soils can most likely be classified as Ultisols even though the base saturation of the soils was not determined and the soil profiles were not dug deep enough to

investigate all the characteristic diagnostics required (USDA, 2006). The soils were not classified as Oxisols as the more yellow than red colour of the soil indicates a lower iron oxide content. Ultisols are highly weathered soils that have developed under moist conditions in warm to tropical climates, as in Sarawak (Brady & Weil, 2008).

Picture 5 – Soil profile. Soil profile dug on the rice field.

Based on the analysis both fields have the typical characteristics of tropical soils with low pH, high Al content and low P, N and C content. As the soils are highly weathered, the clay type will predominantly be 1:1 clays like kaolinite with low CEC values. The increase in density down the profile for both fields can be attributed to the increasing clay content. This indicates that the porosity of the soil decreases downwards. The high Al content in the soils is directly linked to the low pH. At pH below 5 the concentration of dissolved Al in the soil increases markedly as protons dissolve aluminium oxides whereby the risk of aluminium toxicity for the plants increases likewise (Brady & Weil, 2008, Borggaard & Elberling, 2007). High content of Al is toxic to plants as it interferes with many of the essential plant functions such as uptake and transport of nutrients, root respiration and some enzyme controlled functions (Jensen & Husted, 2009). Moreover, pH also controls the uptake and availability of many nutrients. The very low P content of the soils can be caused by the high Al content, as Al and P precipitate as highly insoluble aluminium phosphates (Borggaard & Elberling, 2007). As the content of P in the soil is so low, that the method cannot detect it, P may be the limiting nutrient of the essential nutrients for plant growth. The plants' uptake of the very important macro nutrients Ca and Mg can at the same time be inhibited by high Al concentrations (Jensen & Husted, 2009).

6.1.1 Change in soil fertility

The inherent parameters have not changed due to the land use change from rice production to rubber production, but the dynamic parameters have. The depth of the A horizon has decreased in the rubber field with 3.6 ± 1.2 cm compared with the rice field, but the rubber field has an 8 cm thick litter layer above the soil that was not present at the rice field. This may indicate that the organic material is being less incorporated into the soil despite of deeper roots in the rubber field. The C content in the A horizon is at the same time 1.2 kg/m^2 lower than in the rice field indicating a degradation of the soil fertility. The pH is higher in all horizons in the rice field than in the rubber field. This may be caused by a residual effect after the rice field was cleared and burned one year

ago. When the field is burned the pH increases dramatically and decreases slowly to normal levels, nutrients are at the same time released when organic matter is burned. Furthermore the availability of P and the base saturation increases in the soil (Andriesse & Koopmans, 1984). This positive effect of swidden cultivation is lost when changing to a perennial crop, though it is not possible to see any change in the analysed P and Al content between the two soils. This may be due to that the test kit method is not accurate enough to catch any smaller differences as it is always difficult to get very precise measurements when it is based on an estimation of a colour. If any small differences in concentration between the two field types were to be detected, a much more precise method must be used. The pH increases downwards in the rubber field because of addition of organic acids as the organic material in the litter layer and in the A horizon is decomposing. This effect is over shaded by the effect of the burning in the rice field. Normally the C/N ratio will increase when the pH decreases and the decomposition is limited (Brady & Weil, 2008). This is not seen as the C/N ratio is low for both fields in all horizons, indicating an easily degradable pool of organic matter.

The decline in soil fertility for the rubber field caused by especially the lower pH and the lower C content in the A horizon has also been found in more intensified systems, though at a more advanced stage. Zhang et al. (2006) found that intensive rubber production accelerated the chemical degradation compared to a grass field. The consequences were increasing Al content, decreasing pH, C content and P availability and loss of K and Ca by leaching. Furthermore, Tanaka et al. (2009) found no sign of decrease in soil fertility for an unfertilized rubber field in Sarawak compared with secondary forest. The findings of Tanaka et al. (2009) are not in contradiction to our findings of a decrease. There is a difference in comparing a rubber field with a rice field or with secondary forest, as only the rice field benefits from the swidden cultivation burning effect. Hence, the difference in soil fertility will be larger when a rubber field is compared with a rice field instead of secondary forest. The decline in soil fertility when rice fields are changed to rubber fields may therefore not be any more severe than the soil fertility change that would occur, if the rice field was left to become secondary forest again. But there is a risk of accelerating the soil degradation if the rubber production system is further intensified as the study of Zhang et al. (2006) shows.

6.3 Water quality

The rivers around Tema Mawang are extremely important for the villagers' everyday life. The rivers are used for transport to the fields, fish from the river are a source of food and the water supply for both Tema Mawang and Tema Penggal is from a dam in the Duwûh River. A plastic pipe leads from the dam to a buffer tank closer to the village from where one plastic pipe goes to Tema Mawang and another to Tema Penggal. When there is heavy rain, the dam is polluted with sediments and the water is redirected and the villagers have only the water in the tank available. Sometimes, especially during droughts and festive events, there is not enough water. The villagers have plans to expand the reservoir by building a higher dam, but the Government will not give support, so the villagers will probably pay for it themselves. To secure water quality, the villagers do not allow logging activities or agriculture in the primary forest in the upland to the Duwûh River (David Famus, water committee).

According to the local fisherman Jumali Janjang the fish stock is declining in the Kayan River. But indicator species for good water quality like Semah fish and snails are still present, so the decrease is thought to be due to overfishing and not to decreasing water quality.

Samples from the Kayan River and the reservoir were analysed for water quality parameters to investigate the effect of the villagers' livelihood strategies on the indispensible water resource. The parameters are compared with the National Water Quality Standards for Malaysia (NWQS), with the different classes:

Class	Description
I	Water bodies of excellent quality.
IIA/IIB	Water bodies of good quality. IIA: Water bodies used for water supply. IIB: Water bodies used for recreational use and for protection of aquatic species.
III	Water bodies suitable for protecting moderately tolerant aquatic species of economic value and is suitable for livestock drinking
IV	Water bodies suitable for agricultural irrigation, though not for very sensitive crops
V	Water bodies that doesn't meet the above standards.

Table 6.2: Description of the classes in NWQS (DOA, 2009). The river system near Tema Mawang should meet the standards of Class IIB, where as the water intake point for the water supply for the village should meet the standards of at least Class IIA.

Parameter	TM1	TM2	TM3	TM4	TM5	NWQS Class	*Class IIB of NWQS	Remarks
In-situ								
DO (mg/l)	7.80	7.42	8.43	8.68	8.09	I	5-7	High dissolved oxygen levels.
pH	7.02	7.03	6.58	7.18	6.08	I	6-9	Almost neutral pH levels.
Salinity (ppt)	0.09	0.10	0.09	0.09	0.08	I	I	No saline influence.
Temperature (°C)	25.30	25.47	25.34	25.71	25	Normal	Normal	Normal for tropical water.
TDS (mg/l)	121	134	128	127	115	I	1000	Very low TDS readings.
Lab. Analyses								
COD (mg/l)	0.03	0.02	ND	0.04	ND	I	25	Very low COD readings.
BOD_5 at 20°C (mg/l)	6.01	6.01	7.45	6.11	6.00	III	3	Moderately high BOD_5 levels.
TSS (mg/l)	0.4	0.4	0.4	0.4	4	<I	50	Very low TSS levels.
NH_3-N (mg/l)	0.167	0.106	0.115	0.100	0.090	<IIA	0.3	Low levels of ammoniacal nitrogen.
P (mg/l)	0.69	0.13	0.43	0.40	0.04	>IIA - >III	0.1	Low phosphorus level. TM5 is clean from any phosphorus contamination.
TCC (MPN/100ml)	2060	1240	2870	2480	580	<IIA	5000	Moderately low TCC levels. TCC level is highest at TM3.
FCC (MPN/100ml)	1500	403	1700	1426	130	IIA - <III	400	Slightly high FCC levels in TM1, TM3, and TM4 evidence of human or animal waste pollution. TM3 is relatively clean of faecal contamination.

Table 6.3 -Water Quality Analysis. Results for TM1: upstream, TM2: upstream (Tuna River), TM3: midstream, TM4: downstream, TM5: water intake point. *ND: Not detected *Compliance limits are extracted from Class IIB of the National Water Quality Standards (NWQS).

The in-situ parameters readings were all within Class I of the NWQS. The conditions are generally good with high oxygen levels and appropriate pH, salinity and temperature. The TDS level was very low. It can be a problem as a certain level of the different dissolved ions measured is needed for a well functioning aquatic life. As all measurements are much lower than the compliance limits given in the NWQS, the Hydrolab may have measured this parameter too low.

Picture 6 – The Duwuh river dam. Group member crossing the river dam.

The parameters analysed in the laboratory give a more detailed picture of the water quality situation for the five different locations. Generally all parameters are within Class I and III of the NWQS which means that the quality was within good to mediocre standard. The values measured for the three samples on the Kayan River (TM1, 3 and 4) are all very similar with a high level of BOD_5, P and coliform count. The high BOD_5 values show a high level of organic pollution in the river which could stem from waste water. The organic material is biochemically degradable and not chemically degradable as the COD is very low. The very low COD values may be an error. The high P levels imply a risk of eutrophication of the river system as P is most often the limiting nutrient for primary production in the water (DOA, 2009). Eutrophication can lead to oxygen depletion with devastating consequences for the aquatic life. Elevated P levels can be caused by fertilizer runoff into the river. The high coliform count is an indicator of the presence of many harmful organisms in the water (DOA, 2009). They stem from animal or human excreta contaminated sewage water or domestic waste water that is let into the river. The TM2 (Tuna River) sample has lower levels in P and coliform count than the Kayan River samples. The contamination of the river does therefore not stem from the Tuna River. The generally low levels of TSS for TM1-4 show that no erosion is to be detected. This parameter is extremely day-specific, and high levels of TSS could easily be measured in the river system if the sampling was done after a heavy rain fall. The medium-low levels of NH_3-N show that there is some runoff of N-rich fertilizers to the river system, but not alarmingly.

The quality of the water from the water intake point of the gravity fed water supply to the village is much cleaner than the river system with only few coliform counts and low levels of nutrients. The gravity fed water supply is therefore a safe water source for the village. The biggest problem concerning the water supply is most likely the risk of running out of water. If there is no rain input to the tank, it will be empty after only two weeks. In times with low precipitation the villagers have no other choice than to save the water, by using the river as an alternative water supply for washing a.s.o.

The increase in the area used for rubber production will not have a more negative effect on the soil fertility compared with rice production, than if the rice fields were just left to become secondary forest. The positive effects of swidden cultivation will be lost, but as long as the rubber production is not intensified further, for instance by terracing the fields, the increased focus on rubber

production will be sustainable in relation to soil fertility. However the increased use of fertilizers can be tracked in the river system as elevated levels of P. There are no signs that the villagers plan to use less fertilizers in the future, which implies that the risk of eutrophication in the river system will be increasing. The increasing use of fertilizers therefore affects the river system in an unsustainable way. The elevated levels of coliform imply that the waste management in the village is unsustainable. The waste water has to be treated before it is led into the river system and garbage should not be directly dumped in the river if this situation is to be improved in the future.

Picture 7 – River bath. Group members cooling down by the Kayan river.

7. Sustainability of livelihoods in Tema Mawang

The Government strategies for rural development place a significant pressure on small-scale farmers through its agenda; to modernise and intensify their cultivation system (SAO). In spite of this agenda, almost all villagers in Tema Mawang follow the strategy with fallow cultivation of subsistence rice in combination with one or more cash crops. This strategy is found to be sustainable by Cramb (1993). Where the official agenda is specialization, diversification is a major livelihood strategy among the households and it even characterizes the most well-off households. Intensification in terms of increased use of fertilizer and plant protection will first of all affect the natural resources. The water quality is already affected and further intensification will lead to a decrease in water quality and soil fertility. If the specialization into cash crops leads to a decrease in cultivation of subsistence crops, expenditures for food will increase the dependency on cash income.

Changes in global market prices can affect the income in the households significantly. The fluctuating rubber prices can cause a shock because it will affect most of the households. The households with an income strategy with more cash crops and wage labour will not be markedly affected, but the poor families and those only reliant on rubber will be severely affected. Therefore, heavy reliance on rubber might not be economically sustainable. On the other hand, choosing a livelihood strategy with rubber as the main cash crop also has advantages. It yields all year round, does not need much maintenance and planting rubber trees after swidden cultivation of rice does not degrade the soil fertility considerable. Furthermore, rubber is more resistant to flooding than pepper and cocoa. These points suggest that reliance on rubber as one of more cash crops is a sustainable livelihood strategy, which is also stated by Cramb (1993).

Increase in fuel price is another global market variable. It can affect the time used for transport to both fields and wage jobs. This can result in a lower profitability of wage labour and in increased outmigration for work that can lead to more multi-locational families. Moreover, it is likely that cultivation of proximate fields will be intensified, which can decrease soil fertility and water quality.

The livelihoods of the villagers highly depend on the subsidies for rice cultivation and for the establishment of new cash crops, but a decrease in subsidies is likely (SAO). This can result in a number of changes in the livelihood strategies; possible decrease in rice yield and less establishment of new crops. As a consequence the expenses on agricultural inputs will increase or the livelihood strategies will be less diverse. Poor households will be affected hardest because the rich households are more capable of changing their livelihood strategies, for instance by buying fertilizer to establish rubber plantations. In an ecological perspective of sustainability, less use of fertilizer can also be a positive change in terms of less pollution and a push towards more ecological farming.

The flexibility of the women to assist in the field work and wage income generation, when it is needed, is a force for especially the poor households. However, cooperation between the households is very limited both in terms of farm- and domestic work, so the ability to handle shock situations such as floods or insect attacks is limited by the individuality that characterise the organisation of

the work. This makes the households more vulnerable in the case of e.g. illness and loss of labour, especially the poor that have no other activities to fall back to. However, the extended family structure and the many relatives in the village create a security net.

8. Conclusion

The livelihood strategies in Tema Mawang are based on a combination of cultivation of subsistence crops and cash crops with wage labour as an alternative income source for the majority of the households. Rice is the primary subsistence crop and rubber is the primary cash crop. The primary difference in the livelihood strategies is the degree of diversification. Where the rich households have a very diverse strategy with many sources of income the poorer families rely on fewer activities.

Rubber is a sustainable choice of cash crop, even though it makes the households vulnerable to global market fluctuations, as it does not have a negative impact on the natural environment. Cultivation of rubber does not degrade the soil fertility considerably compared to rice cultivation. At the same time, rubber is not prone to be destroyed by floods. The use of wage labour as an alternative income source makes the households more sustainable as it decreases the household vulnerability in bad times, as long as wage labour is available. The more diversified livelihood strategies are more sustainable than the less diverse, as it makes the household less vulnerable towards changes or shocks. As the level of diversification is linked to the wealth status, it will be difficult for poorer families to increase their sustainability as they are very vulnerable to even small changes.

If the villagers choose to intensify and specialise the cultivation system, as the Government wants, the sustainability will decrease. Intensification will have a negative impact on the environment and the sustainability of the combination of subsistence crops and cash crops will be lost. The dependency on wage labour will increase, making the villagers vulnerable towards changes in job availability and migration will increase.

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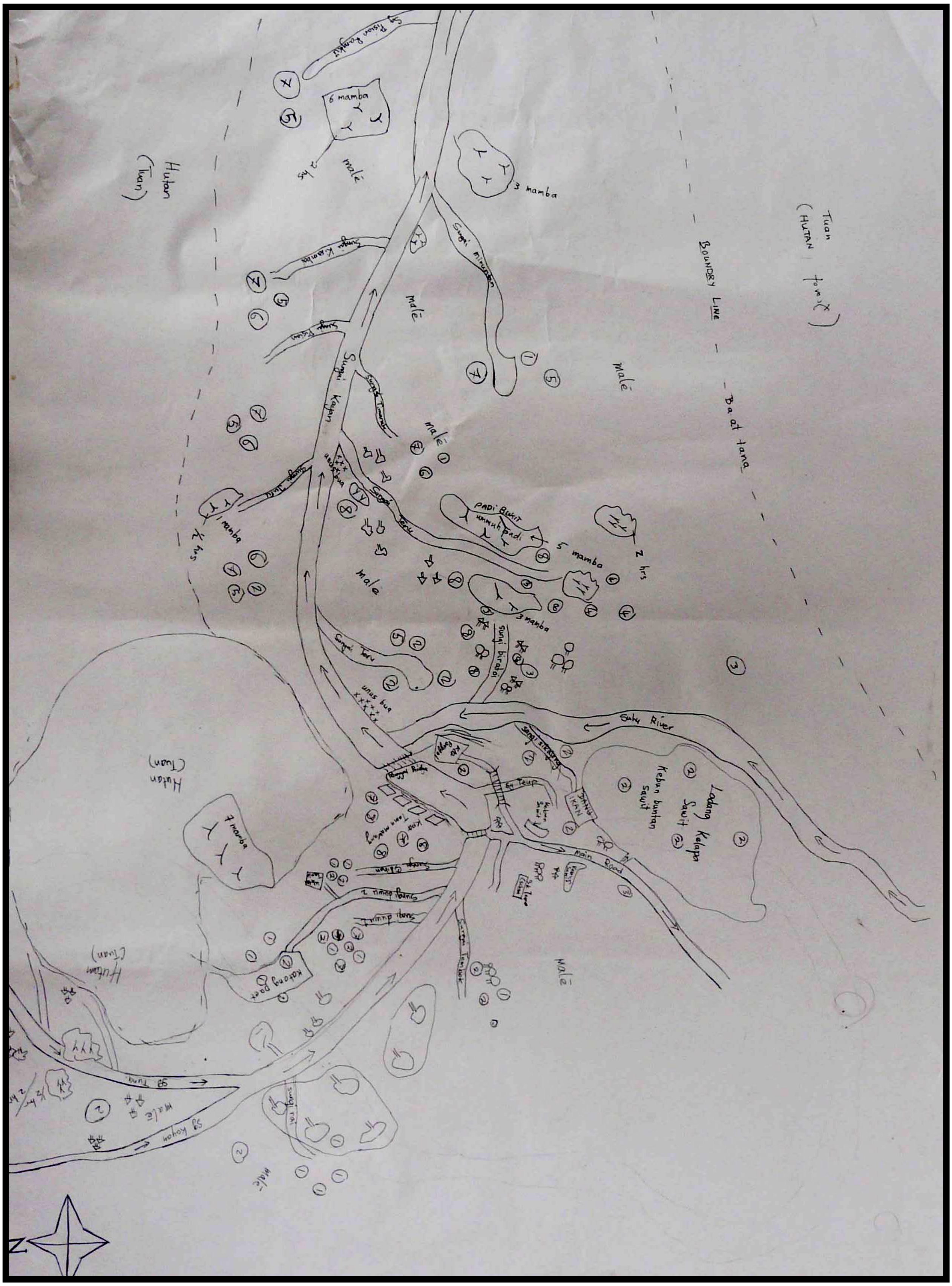
Appendix I

Table of contents

1. Method Overview

Method title	Specification	Amount
Questionnaires	Background	30
Case studies	Livelihood strategies	12
Semi structured interviews	Migration	5
	Case studies	12
	SAO	1
	Fisherman	1
	Water committee	1
	Minister	1
Focus group interviews	Background knowledge	1
	Women - community organisation	1
	Committee members– village organisation	1
	Committee members – village organisation	1
	Price list	1
	Youth and future	1
PRA	Community map	1
	Crop ranking matrix	1
	Timeline	1
	Seasonal calendar	1
	Community walk	1
	Income ranking	12
	Expenditure ranking	12
	Problem ranking	6
	Income/expenditure calendar	2
	Daily activity calendar	6
	Observations	
Soil Samplings	Rice	15
	Rubber	15
Water Samplings		5

2. Original community Map



3. List of informants

Informant's case studies

See scheme on page xx

Informant's migration interviews

-Christopher ak Duan 23 years old. Studying medical health assistant for two years and he will graduate this year

-Julimin ak Duudang 40 years old. Working at a factory in Kuching in totally 28 years, he comes back to the village at least three times a week.

-Bandana ak Angak 31 years old. Working as a contract worker building houses in Kuching. He has been in Kuching the last 16 years. He is not married

-William Daviy ak Bantin41 years old. Working as a machine operator in Kuching, the last 11 years. He has a wife and two children, he comes back every weekend.

Informant's women focus group interview

-Jenifer Leonia ak Leon
-Dinus ak Jarop
-Santi ak Junaidi
-Salimah ak Kamven

Interview with the committee

-KK Nyambu Ak Gumberg: Village chief
-Sukin Ak Bangga: Account manager
-Jonathan Ak Bana: Cultural organizer
-Weni Ak Nayen: Waste manager
-Willison Nyanja ak Rano: Agriculture responsible
-Gilbert Ak Sanau: Mediator between government and village.
-Alus Ak Sanau: Woman welfare
-Jem ak Jaban: Overview of poor
-Peter ak Nyanyou: Religious responsible

Farm visit

- Farm Visit 1: Augustine Tangort HH size: n/a Crops: rice, rubber, pepper, cacao. 51 years old
- Farm Visit 2: Alex anak James (our interpreter) HH size: 1 Crops: rubber. 28 years old
- Farm Visit 3:Wilson Nyanyo HH size: 6 Crops: rice, rubber, pepper, cocoa, banana. 50 years old

PRA – seasonal calendar:

Yeo Kok Hua
Rama Mari
Thomas Ben
Peter Maring
Elton Landok
Seelidy Lula
Pesa Seram

Brandy Jamlai
Robin Mano
(some people came and went as the exercise went on)

Other informants:

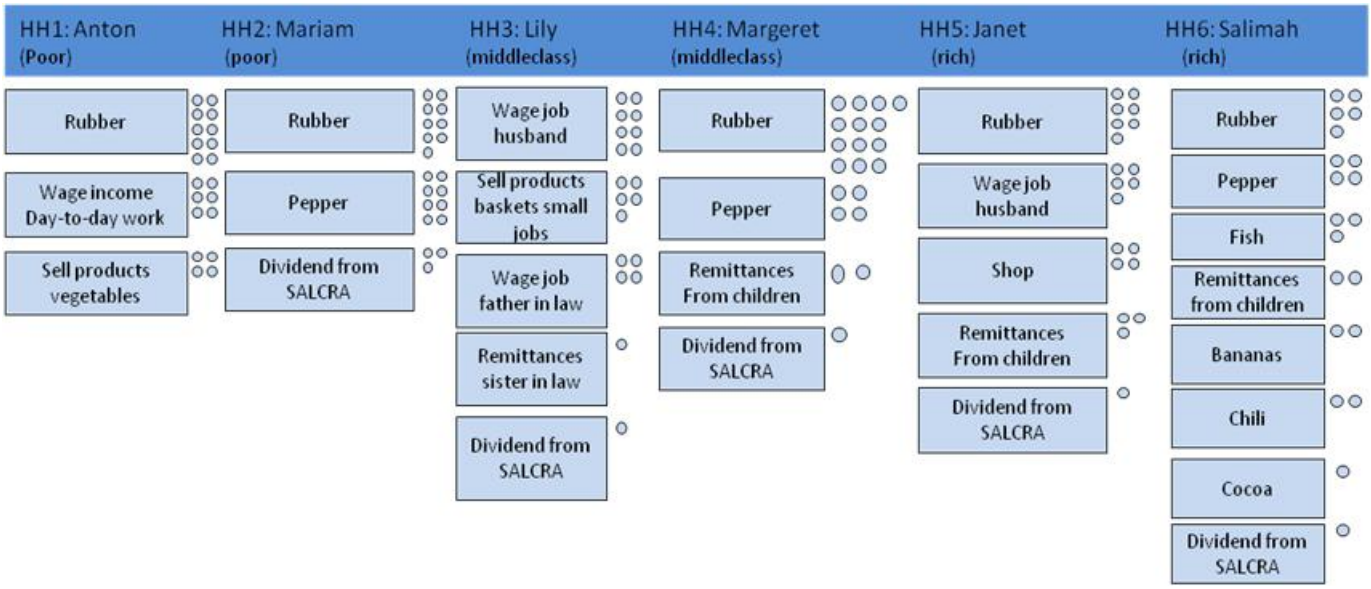
-Mr. udin: Mr. Bai bin Udin. Sarawak Administrative Officer (SAO) General info on the area
-Mr. Jawong: Datuk Seri Michael Manyin Anak Jawong. Sarawak Minister of Infrastructure Development and Communications
-Jumali Janjang:. Fisherman 53 years old. Household number 59.
-David Famus: Tema Mawangs member of the water committee

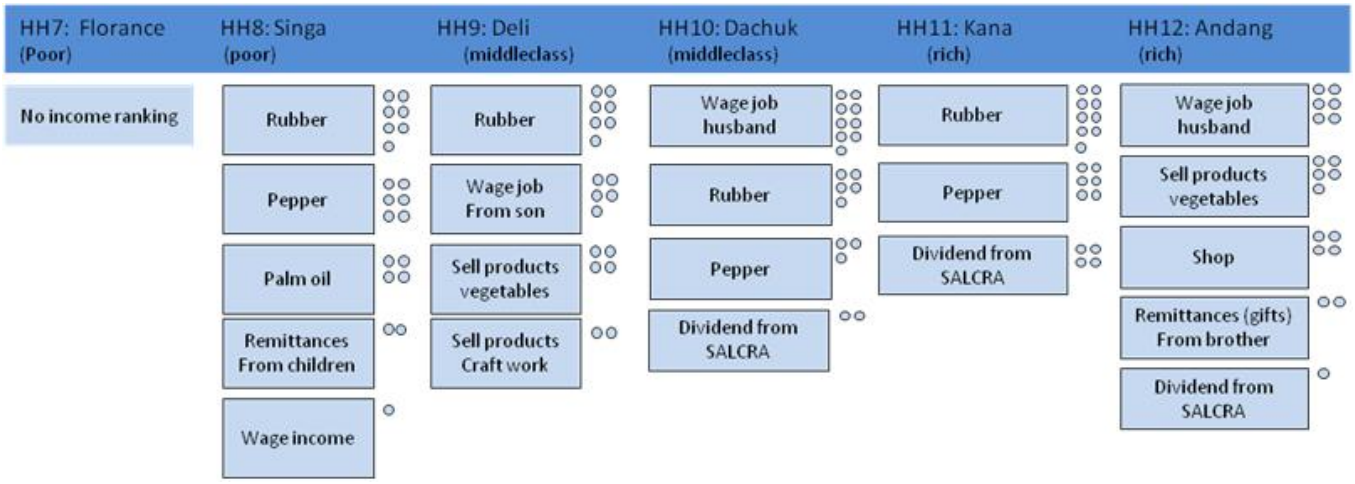
4. Price list for frequently used price, commodities and services

product	**unit**	**price/rm**
yearly school expenditures (primary)	year	600
yearly school expenditures (secondary)	year	1200-1500
yearly kinder garden expenditures	year	49
transport to Serian	return	12
transport to Tebedu	return	5
fuel for car or boat	1liter	2.5
gas	14 kg	27
chickens	1 kg	7
pork	1kg	15
fish	1kg	7
bottle water	1 l.	1.5
distilled palm alcohol	1/4 l	7
cigarettes	packet	2-10
washing powder	1 kg	5.5
doctor (government)	registration	1
oil for cooking	1 l.	3.5
boat	1	300
boat motor	1	2000 +
chain saw	1	300 +
gas ring	1	45
knife for rice harvest	1	15 +
rice mill	1	800-2000
fertilizer for pepper	50	150
fertilizer for rice etc.	50	90+
pesticides	1 l.	25
fertilizer for rubber	-	free

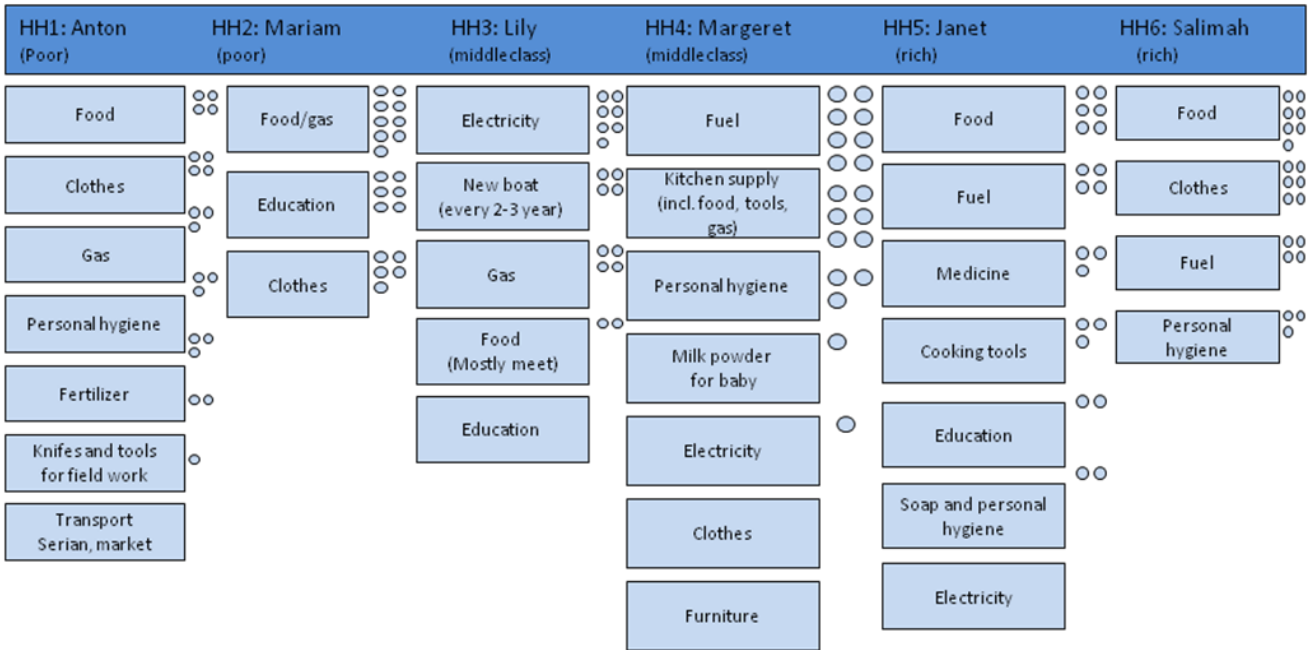
5. Income ranking

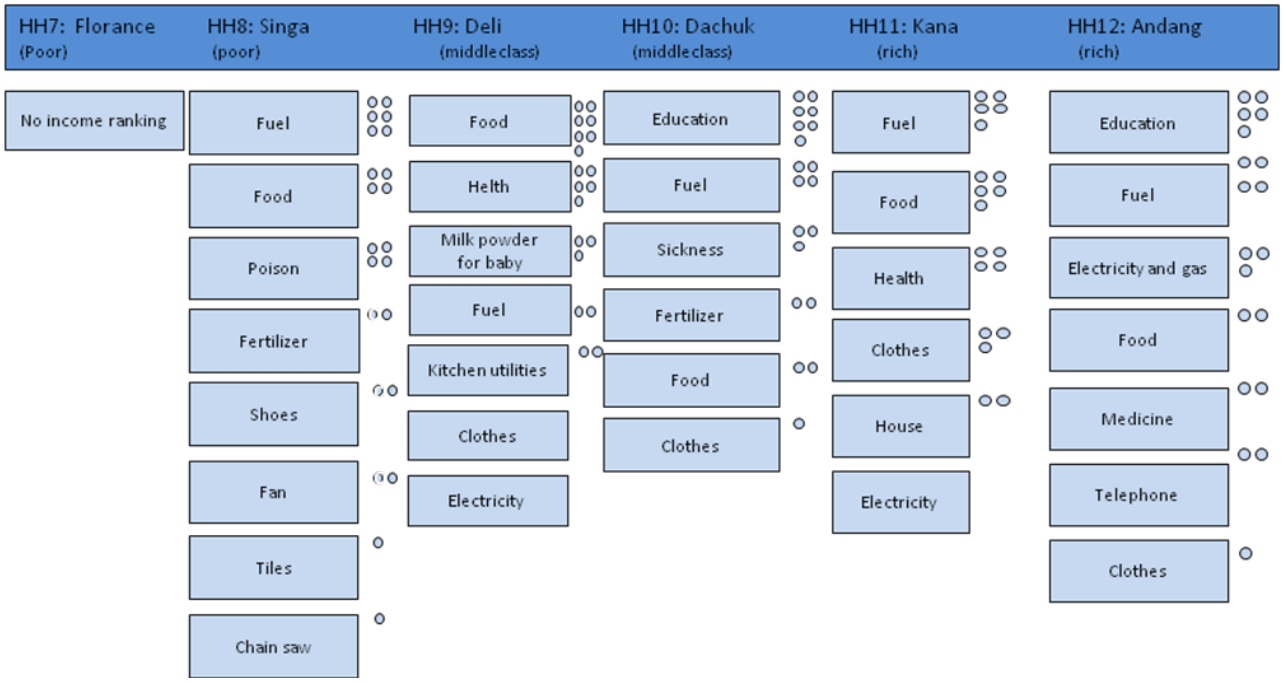
From case studies of 12 households



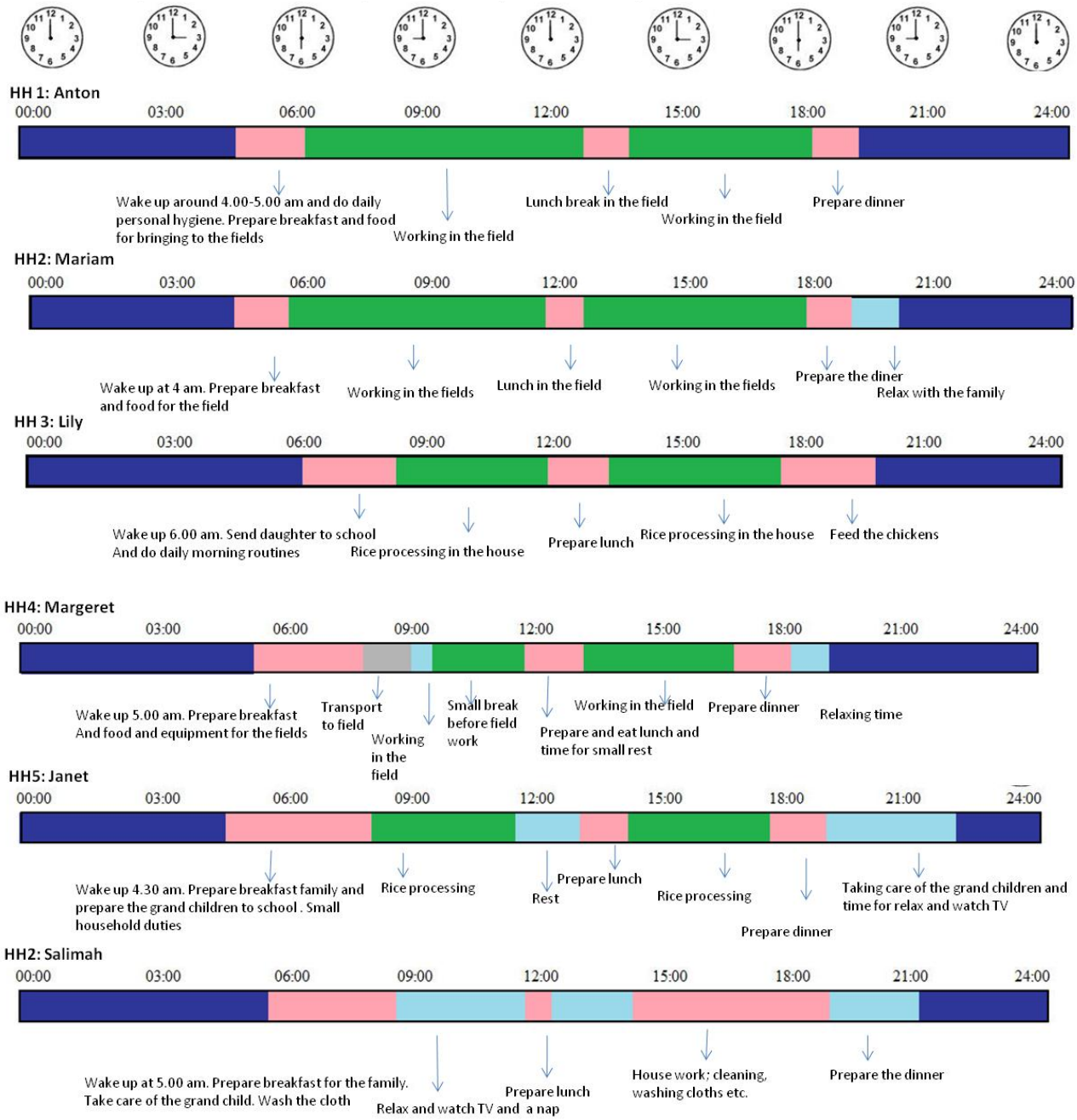


6. Expenditure ranking
From case studies of 12 households

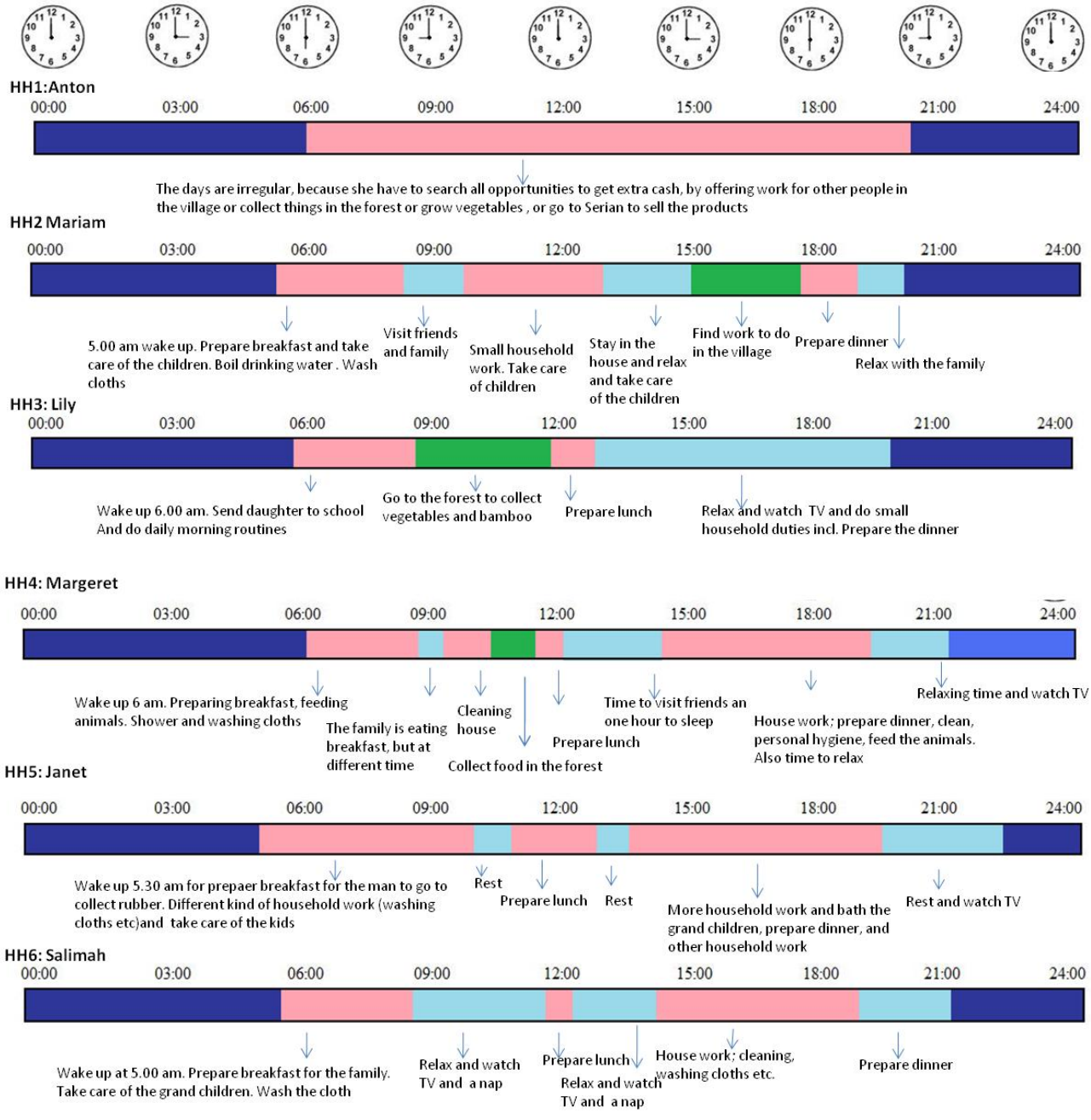




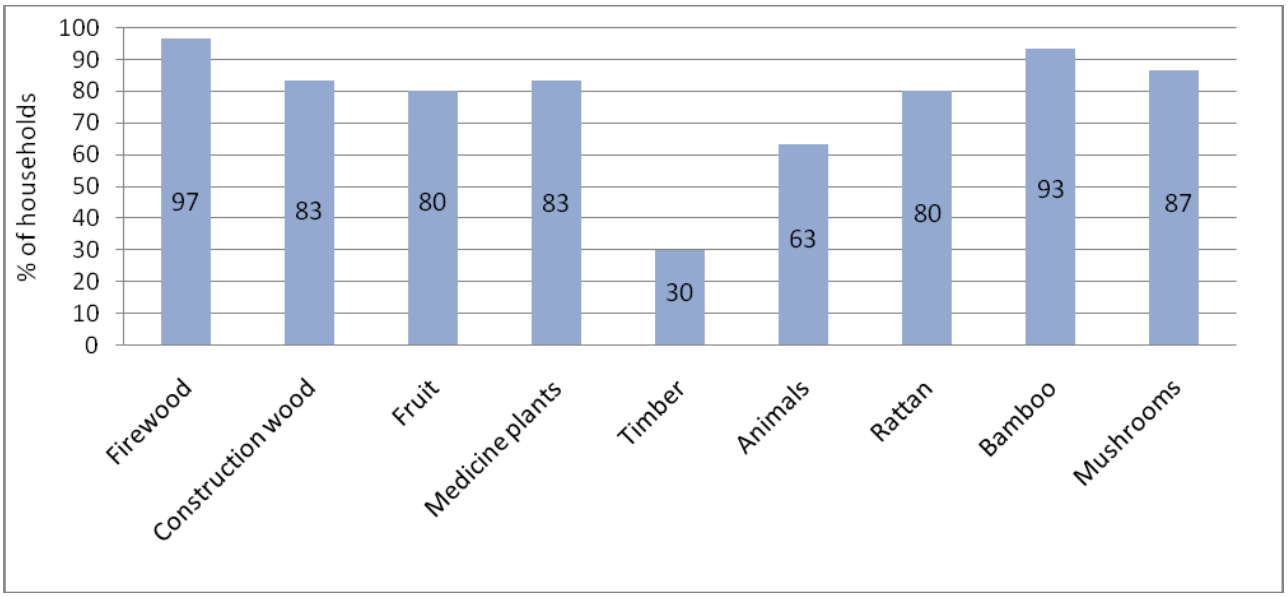
7. Daily activity calendar from six women (rice season)

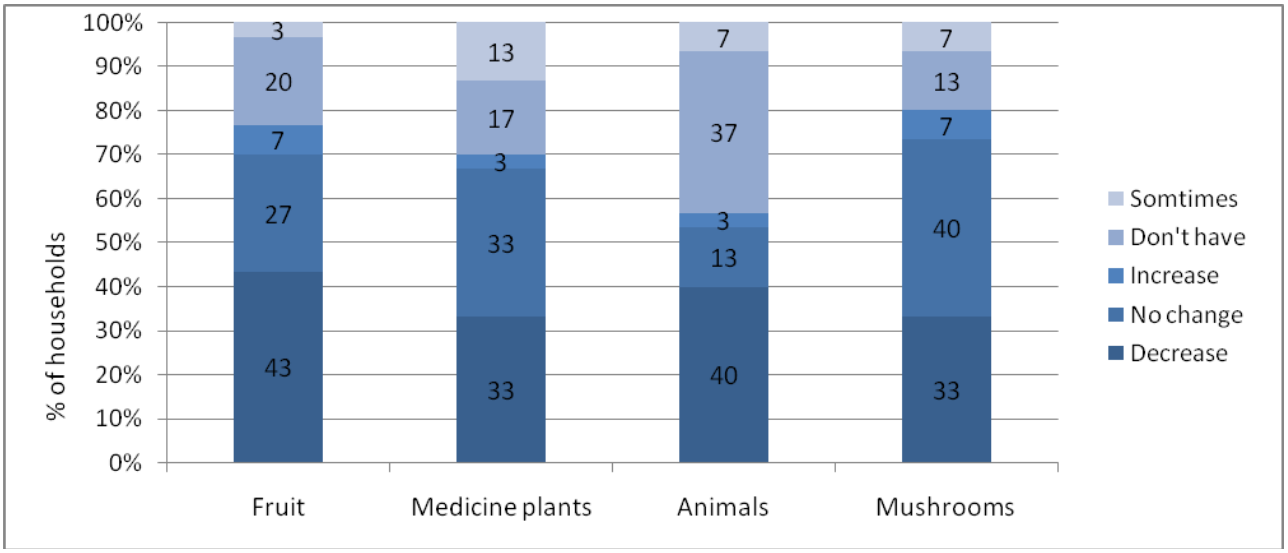


8. Daily activity calendar from six women (No-rice season)



9. Households who use or don´t use the forest products






100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% of housholds
3
0
3
10
83
3
17
23
43
13
0
20
27
23
30
0
7
27
43
23
Firewood
Construction wood
Rattan
Bamboo
Somtimes
Don't have
Increase
No change
Decrease

10. Income from cash crop (used for seasonal calendar over income and expenditure)

Florance (HH 7): Table of crops

Crop	Harvest (amount)	Frequency	Income from harvest
Rice	3,5 bags (~40 kg pr. bag = 140 kg)	Once a year	For house consumption
Rubber	4 kg	Per day (6 times a week)	~300 Rm/month
Pepper	No harvest yet	-	No income yet

Singa (HH 11): Table of crops

Crop	Harvest (amount)	Frequency	Income from harvest
Rice	8 bags	Once a year	For own consumption
Rubber	4 kg	Per day (4 times a week)	~ 600 Rm/month
Pepper	3 bags	Once a year	~ 150 Rm/Month (4 months a year
Oil palm (new)	1 ton	One time last year	~ 150 Rm (One time)

.

11. Questionnaire survey for Tema Mawang

1. Informant and household

1.1 Name of respondent and name of head of household (if not the same):_____

1.2 Street + housenumber:

1.3 Gender: M_____ F_____

1.4 What is your age? *Tick one option*

18-24	25-34	35-44	45-54	55-64	65-74	75+

2. Demographic Information

2.1 Total household size (people living in the house more than 5 day on a week including kids, anta, grandparents etc) *Tick one option*

0-2	3-4	5-6	7-8	9-10	>11

2.2 Extended household size (people living outside the household contributing to the household economy)

+ 0-2	+ 3-4	+ 5-6	+ 7-8	+ 9-10	+ >11

3. Land use changes

3.1 Total area of land you household cultivate this year (acres) *Tick one option*

0-2	2-4	4-6	6-8	8-10	>10

3.2 What crop is occupying (in acres) the most of your land.

Rank the most important crops. Rank the most important crop with a 1, the second important crop with a 2, rank the third most important crop with a 3 and rank the fourth most important with a four.

Rice	Pepper	Rubber	Seasonal Fruit	Cocoa	Other

3.3 Have there been any changes in the area dedicated to the following crops the last 15 years (new bridge)?

Tick one option for each crop.

	Decrease	No change	Increase	Don't have
Rice				
Pepper				
Rubber				
Seasonal Fruit				
Cocoa				
Other				

4. Land use change –subsistence/cash crops

4.1 What crop is the most important for your household's selling/income? *Tick one option.*

Pepper	Rubber	Other

4.2 Do you have any private oil palm plantation?

Tick one option.

Yes	No

4.3 Is/have/ any of the family members employ/employed on SALCRA (seasonal)?

Yes	No

5. Land use change – intensification

5.1 Have there been any changes in the yield of different crops per acre the last 15 years (new bridge)?

	Decrease	No change	Increase	Don't have
Rice				
Pepper				
Rubber				
Seasonal Fruit				
Cocoa				
Other				

5.2. If there have been changes in agricultural inputs, how have the changes been? *Tick one option for each input.*

	Decrease	No change	Increase	Don't use
Fertilizer				
Pesticides				
Herbicides				
Fungicides				

5.3 What tools or techniques do you have to use to increase the agricultural production?

Motorboat	
Chainsaw	
Mobile Rice mill	
Rubber processer machine	
Other	
Pesticides tank	

6. Agriculture and occupation

6.1 Over the past 10-15 years (new bridge) have there been any changes in households average time used on agricultural production? *Tick one option for each person.*

	Decrease	No change	Increase	When?
Women				
Men				
Children				
Old fam. members				
Other				

6.2 Does someone in the household have a wage job? *Tick one option*

Yes	No

6.3 If yes: What kind of job is it?*Tick one option for each person*

Occupation	Pers1:	Pers2:	Pers3:	Pers4:	Pers5:	Pers6
1. agriculture						
2. craftsman/wage labour						
3.factory						
4. trade						
5. service						
6. other						

7. Income

7.1. Which activities contribute most to the households income during the year?
Rank the most important crops. Rank the most important income source with a 1, the second important income source with a 2, rank the third most important income source with a 3

Agricultural products	Wage labour	Remittances	Dividen	Other

8. Forest

8. 1. Have there been any changes in households use of product from the forest (mate, hutan) the last 15 years (new bridge)? *Tick one option for each input*

	Decrease	No change	Increase	Don't have
Firewood				
Construction wood				
Fruit				
Nuts				
Fodder				
Medicine				
Timber				
Animals				
Rattan				
Bamboo				
Mushrooms				

12. Question guide I

For semi structured interviews concerning income/ expenditure ranking and farm strategies

The interviews were semi-structured, so the following questions are meant as a check list, to cover all relevant themes. Questions were added according to the different interviews.

To understand the choice of crop:

Which crops do you have?
Why do you choose to plant these specific crops?
How many bags do you get from each crop? (ask for each crop)
How much is one bag (kg)?

To assess vulnerability of low prices:

Do you have rubber?
If yes to have rubber:
How much is your average earning from rubber in a week?
When the rubber prices were low, did you still do rubber tapping?
If yes: how much money did you get in a week?
When the rubber prices were low, did you do other activities to get income (than rubber)?
If prices were low again, would you still tap rubber?

If no: What would you do to get an income?

Vulnerability of harvest
Have you experienced any problems with your harvest?
Have you experienced any floods/ low prices/ crop diseases/ not enough labour/ falling rice (lodging)? If yes: When was that? What caused it?
What did you do to get money when you did not have you crops to sell?

(Specific for the seasonal calendar)

***Income ranking**
What sources of income do you have?
Which crop is the most important for your household income?
How much is your average income from one bag?
How much is your income from different crops in a year? (ask for each crop)

On average, how much is your average income in a month?
Do you have other income such as remittances? If yes: how much will you get from remittances per month?
Can I say that your income is approximately ...?

***Expenditure ranking**
What are your expenditures? (on: school/ electricity/ transportation/ fertilizer/ pesticides/ other)
How much do you spend on average in a month?
Do you save up money? Every month?
How much money do you save up in one month on average?
Do you save up money from one specific crop (rubber/pepper/other)

Is all your income sufficient to sustain all your expenditures in one month?
If no: How do you cope to get the money to pay for the extra expenditure?

Has there been any time in the last 15 years where you did not have food enough for yourself/your family? If yes, why was that?

***Problem ranking**

Do you have any problems related to your daily lives, the farming, the crops, the income/ expenditure?
Which are they?
Which are more important/ have a larger impact?

13. Question guide II

For semi structured interviews concerning income/ expenditure ranking and domestic work

Theme/ what will I know	Primary question	Secondary question	Notes
Presentation of us, and why we will like to talk to them.	We are students from Kuching and Denmark and we will like to understand your village and way of life		
Basic info of the household member (demographic info)	Who is living in the house? Any person who is not sleeping here but still contributes to the household economy? Do you have family living in the village? Have you always been living in this village?	Parents, grandparents, kids, uncles etc, (migration) What kind of job are they doing?	
Household activity/work calendar. _____ **Before/now** _____ **IF** more time used on agriculture **Working together** **_____** **Domestic work** _____ **Migration**	*First we will like you to fill in this lines about what you normally do on an average day?* _____ Would you have drawn the same figure for 10-15 years ago? Do you have the time you need to do social activities and meeting with other people? _____ Do you work together with other people in the village? _____ How have the house work (domestic work) changed? Is it changed who is doing what? _____ Why do you think that young people are moving to the city? Is it normal to go back to the village How do the young people feel about the village in general?	First we need to identify different times a year, do you have any periods were your daily life is different from other times a year? _____ Why are you using more/less time on agriculture What new things take time? Man/woman/kids/elder< How and when do you work with other people in the village? _____ Processing food, cooking, kids, cleaning, shopping. _____ Work, city life, boring in the village? How is the opportunities for work in the city? How is the life in the city Can young people find work outside agriculture and where? Why?	
Income in the household _____ _____ **IF** high income from agriculture	*Can you mention the 5-7 most important sources of income? And then rank them (using small cards)* *Can you distribute these 20 stones relatively between the different sources of income, to illustrate the different amount from the different sources* _____ Would you have drawn the same figure for 10-15 years ago? Or would it have been different? Can you describe the changes? /Can you describe the changes in the different sources of income? _____ Can you describe more about the crops you sell? Do you have several crops to rely on?	Do you have income that you don't receive in cash? (ex fertilizer). Do you lent money Can you describe the different income sources and the importance for your household? _____ From where do you get subsidies? How necessary are they for your HH? How was the economic situation before? Are your income from agriculture from only one crop or more different? _____ Are there any problems related to sell the crops (access to market, change in	

Mono/multi crops	Have you had any experiences that you didn't get the income from your crop that you were counting on? Are there any of your income that you only receive few times a year?	price, restrictions/laws, or competition)?	
Market /Vulnerability	Do you save up the money for periods when you don't have any money? Did you try that you couldn't sell your products?	Are there any time a year where you don't have enough money? How did you manage that situation?	
Food	What is the most important food, you produce (for eating)? How much of your food do you produce yourself?	Is it a permanent job? (transport, investment, risk, hard work, no spare time etc?	
IF Off farm	Do you have a stable income from non-farm jobs? Are there problems related to this job Can you describe more about the money you receive from migrated relatives?	What do you use the money for? (daily life, luxury goods, save up)	
Remittances	Is it a stable income?		
Expenditures in the household We will like to know more about each category	*Can you mention all the expenditures in the household? Can you rank the 5-7 biggest expenditures in one year (using small cards)? Can you distribute these 20 stones relatively between the different expenditures, to illustrate the different size of the expenditures?* Can you describe each category, and give some examples?	(Food, house, transport, health etc) Are there many new things that you have to use money on?	
Have it changed	How have your expenditures changed?	Do you think food is expensive? Where do you buy food?	
Food	Do you use more money on buying food? How much money do you use for school, hospital, doctor, medicine etc?		
Social/ service	Is there access to this services?		
Basic needs / Vulnerbility	What do you do when you can't buy what you want? Are there something that you can't afford, that you really would like? Are there some time a year where it is difficult to pay for everything? What will you do if you had a lot more money one month?	Is it a big problem How are the banking facilities?	

Appendix II

Table of contents

Land use changes in Tema Mawang#

Jimmi Lutete Larsen
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Thematic course: Interdiciplinary Land Resource Management

Table of content

1. Introduction

The Malaysian state of Sarawak has been subject to massive land use changes (LUC). Since the 1970s oil palm plantations have expanded rapidly and huge areas of forest have been cut down (McCarthy & Cramb, 2007). The Malaysian government has pushed towards this development in collaboration with private companies, by leasing land from the farmers for oil palm plantations and provided the farmers with fertilizers, for a more intensive cultivation of the land (Ngidang, 2002). Land where shifting cultivation is practised is considered as unproductive land by the government, who are promoting the production of cash crops and intensification of the agricultural practises (McCarthy & Cramb, 2007). Apart from oil palm, other cash crops such as rubber, pepper and cocoa have been increasing, though also decreasing in some periods, because of the change in demand from the global market. In the last decade, the demand for palm oil have increased on a global scale, both for consumption and for bio-fuel, and the Malaysian government pushes towards expanding the plantations even further, sometimes against the wishes of the local population (McCarthy & Cramb, 2007). The LUC in Sarawak are therefore a result of both decisions on a household level, village level and in a regional political regi, but are also strongly influenced by the rising and falling demand for specific crops on a global scale (Ngidang, 2002; McCarthy & Cramb, 2007).

The focus of this study is on the village of Kampung Tema Mawang in the state of Sarawak. The village is a Bidayuh village in rural Sarawak with 103 households. Their economy is based on agriculture, forestry and remittances and they cultivate a range of different cash crops such as rubber, pepper, cocoa, fruit trees, and an increasing amount of oil palms. The village has a connection to the market in Kuching through a road connecting the village to the main road to Kuching (Bruun & Juel, 2011).

Since the 1980's a number of development steps have taken place in the village of Kampung Tema Mawang (Bruun & Juel, 2011). In 1984, 40-50 ha oil palm plantation was established, by the mixed government- and privately owned company, Sarawak Land Consolidation and Rehabilitation Authority (SALCRA), who is pushing towards an intensification of agricultural practices. The rubber plantations, that had been expanding in the 1980's, took a down-turn in the 1990's due to falling prices on the international market. Many farmers abandoned this crop and cut the rubber trees down, in favour of other cash crops, but some have regretted this because of rising prices in the last 4-5 years. The amount of fertilizer, subsidised by the government, has increased, and the consumption of fertilizer in connection with agricultural practises has increased substantially. Government agencies, such as the Agricultural Department, are visiting the farmers on a monthly basis, and influence the agricultural practises in a larger degree than earlier.

The road connecting Kampung Tema Mawang with the main road was built in 1979, making transport of goods to Kuching easier, but also limiting the transport on the river through Kampung Tema Mawang, which was a major mode of transport. There has been an increase in emigration to the bigger cities because of new job opportunities in the manufacturing sector.

These substantial changes make it interesting to look into consequences of the agricultural LUC that have occurred in the period 1980-2011 in Kampung Tema Mawang. By taking an interdisciplinary approach to the study of LUC and its consequences, this study focuses on how the LUC have influenced the village concerning both socio-economy and the impact on the natural environment. The issues are treated in the context of sustainability.

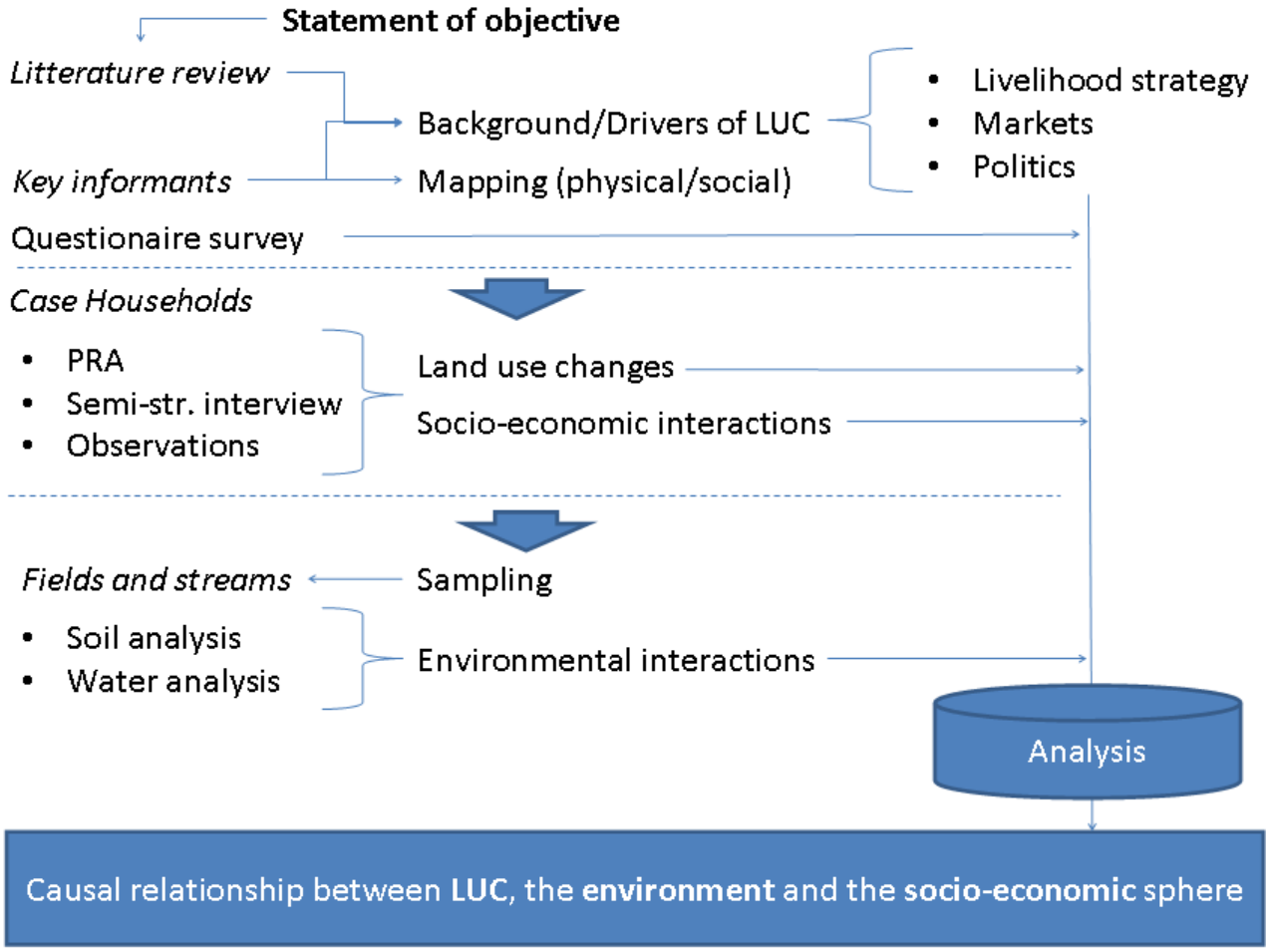
Based on this the statement of objective is: **How have recent land use changes influenced the sustainability of the socio-economy and natural environment in Kampung Tema Mawang?**

In order to answer the statement of objective, the following research questions should be covered:

1) How is the land use in Kampung Tema Mawang?

2) How has the land use in Kampung Tema Mawang changed in the period from 1980 to 2011?
3) How has the socio-economy interacted with land use changes?
4) How has the natural environment been influenced by land use changes?
5) Are the land use changes leading to a sustainable development, concerning both socio-economy and natural resource issues?

The structure of the research looks as follows:



Figur 1.0

2. Definitions

To specify the use of the different terms in the statement of objective, the research questions and other terms used throughout the study, each term is shortly defined below:

Land use
Land use can be defined as human activities that directly affect or change the physical environment. In this project we will only look into the aspects of land use concerning agricultural production.

Sustainable development
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own need" (Brundtland Kommissionens Rapport, 1988)

Socio-economy
It is the study of the interaction between society and economy in its local context. For this study, we will look at the socio-economy as issues concerning the household economy.

Natural environment
Natural environment is for this study defined as the soil fertility and the water quality. These two parameters are chosen, as they are both highly linked to land use.

Soil fertility
"The capacity of soil to support plant growth, under the given climatic and other environmental conditions." (Young, 1997).

For the soil to support plant growth toxic elements for plants cannot be available in too high concentrations and essential nutrients have to be plant available, not be bound in complexes with organic matter or Fe/Al-oxides.

Water quality
Water quality is used in terms of suitability for drinking water and for supporting the fish stock. We analyze the chemical characteristics of the water, especially concerning chemicals that are harmful for humans when used as drinking water and habitat for fish.

For definition of other terms used in the study, see appendix.

3. Theoretical framework: The land use framework.

3.1 Defining Land Use and Land Cover

Land use/cover change is a multidisciplinary approach for working with human-nature relationship and their interaction on the spatial and scalar changes of the land use and land cover (Lambin & Geist, 2006).
It is important to understand the distinction between land use and land cover. Land cover can be defined as the attributes of the Earth's land surface, including biota, soil, topography, surface/ground water, and human structures (build environment), whereas land use has been defined as: the human practices of exploiting the land cover. It covers both the ways in which the biophysical attributes are manipulated and managed and the underlying intentions to do so (Lambin & Geist, 2006).

Land cover: Natural and biophysical attributes on the earth surface.
Land use: Human activities that directly affect or change the physical environment.
(Lambin & Geist, 2006)

In this study we focus on land use changes and not land cover changes. We are aware, that *land use* is a broad term, as land can have many functions. The function of interest for this study is the *production function* of land e.g. the biomass production of different commodities utilized by humans.
In this project we will use this approach to land use change as a framework that will form a theoretical and overall methodical framework for our field work and project. This framework presents a way of organising and understanding a complex set of a) causes for land use changes, b) actual land use changes, and c) the further impact and interaction with the human and natural environment (Geist & Lambin, 2001).

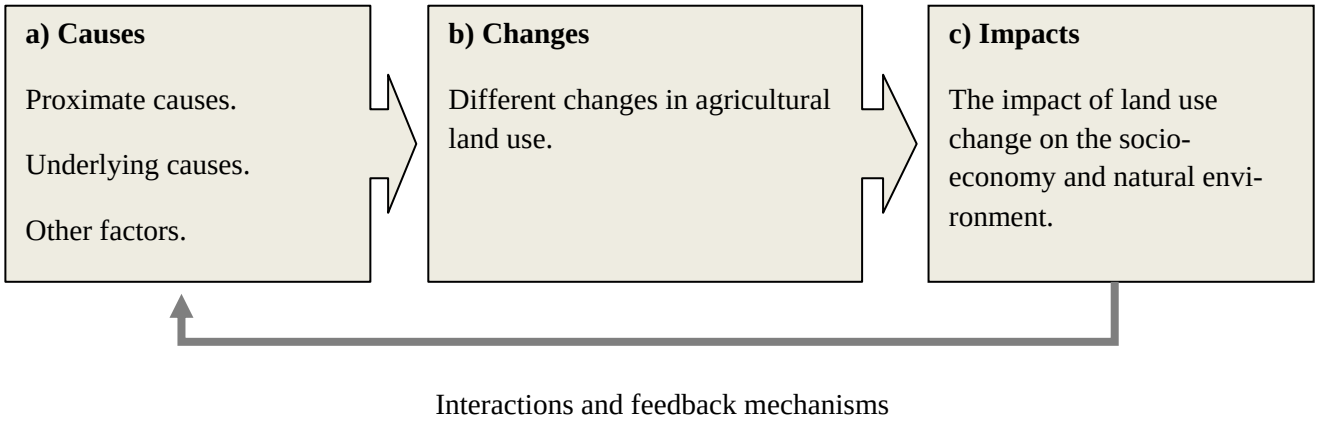


Figure inspired by: Geist & Lambin, 2001.
Figur 3.0

The dynamics of land use are complex. There are different factors that have an impact on the pattern and changes in the environmental transformation in terms of driving forces that act globally, regionally, and locally. It is important to understand the multifaceted set of actions, factors and rationales involved in land use change. Both natural and human causes interact with land use change in different geographical and historical contexts (Geist & Lambin, 2001).

3.2 Proximate causes

Proximate causes are human activities that directly affect land use. In terms of scale, proximate causes are seen to operate at the local level e.g. by changing forest to plantation, often resulting in further environmental consequences for the ecosystem and natural surroundings. The changes often lead to feedback effects on other elements in the environment and land use (Geist & Lambin, 2001).

3.3 Underlying causes

Underlying driving forces (also called social processes), can be seen as a complex of social, political, economic, technological, and cultural variables that form different conditions in the human-environmental relations. The underlying causes are multi scalar operating both at the local level, the national or global level. Therefore it is difficult to clarify the direct links between underlying causes and land use changes, because there can be many levels and intermediate causes - the relationships between causes, changes and impacts are less direct. There is a number of different underlying causes: Demographic factors (human population dynamics), economic factors (commercialization, commodification of labor and land, economic growth or change), technological factors (technological change or progress), policy and institutional factors (change or impact of political-economic

institutions, institutional change), and a complex of socio-political or cultural factors (values, public attitudes, beliefs, and individual or household behavior) (Geist & Lambin, 2001).

3.4 Other factors

The group of other factors is composed mostly of environmental factors, biophysical drivers and land characteristics such as soil quality and topography that can drive and shape changes in land use. Social triggers can also be found under other factors. By social triggers is meant rare events such as natural catastrophes, civil war, political and economic crises etc. The group of other factors includes heterogeneous variables concerning the temporal (and spatial) dynamics of land use and land cover changes (Geist & Lambin, 2001).

3.5 Working with Sustainability

There has been a long debate on the definition of sustainability, and there are many ways to understand and work with the concept. In the project we are working with land use in a dynamic way, as we look at changes, therefore it is relevant to use a dynamic approach to sustainability. The Brundtland Report defines sustainable development as development that *"meets the needs of the present generation without compromising the ability of future generations to meet their own needs"* (in Kajikava et al., 2007). Sustainability is lexically defined as *"the ability to maintain something undiminished over some time period"* (LéLé & Norgaard in Kajikava et al., 2007). It is important to emphasize that sustainability is not a goal; it is a constraint on the achievement of other goals and changes. Sustainability means different things to different people. Therefore, sustainability is susceptible of several interpretations, and the content may differ from context to context. It is important to conceptualize how we will work with sustainable development and which indicators we see as important to understand the development of the village and whether it is sustainable (Kajikava et al., 2007).

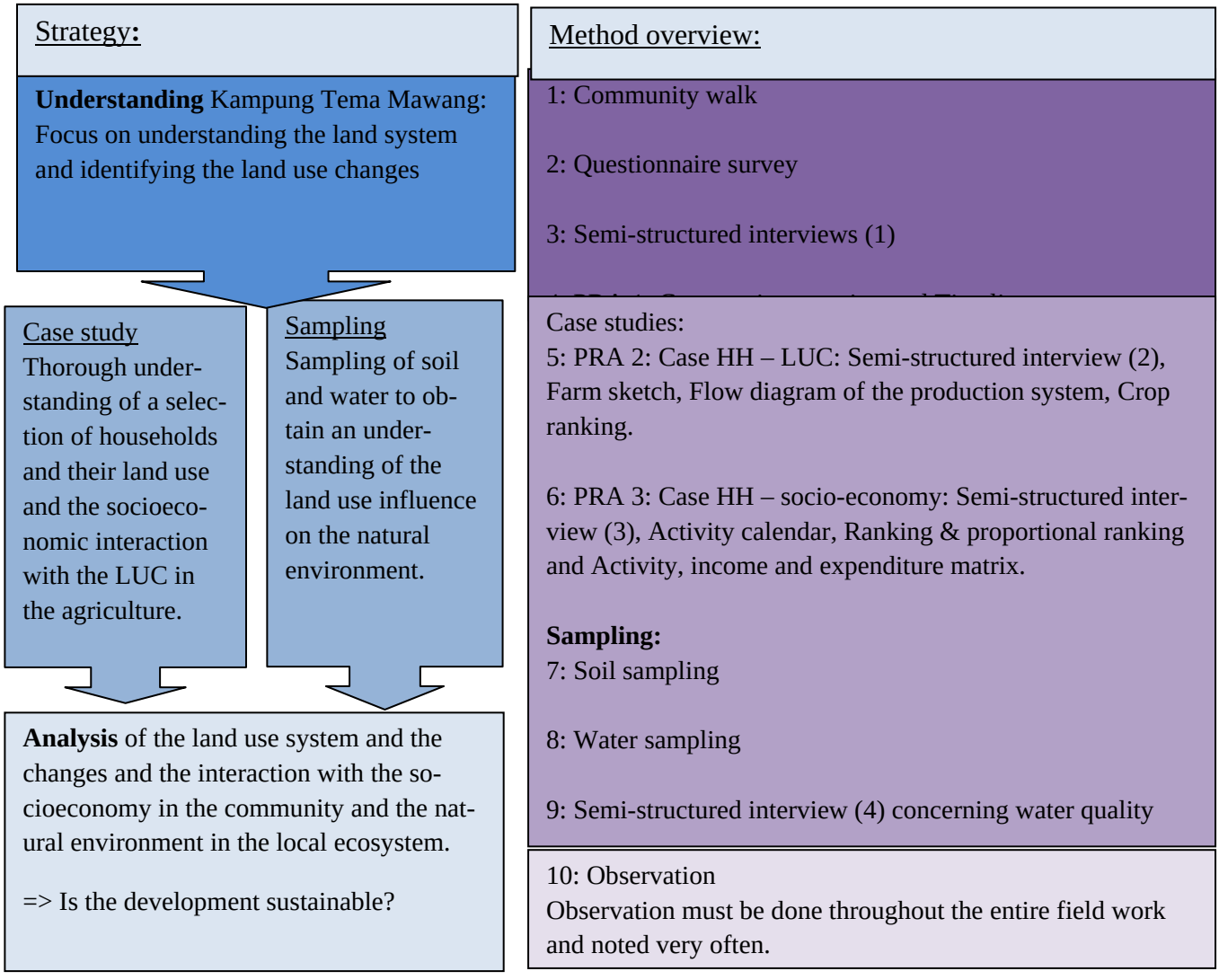
Here are some indicators relevant to the way we analyze sustainable development for the households:

- Resilience: in terms of external shocks and stresses (such as price fluxes, natural events, harvest failure, etc.)
    - ability to change their strategies (regarding sources of income, crop types etc.)
- Dependency: on external support or income
    - ability to cope with decreace/changes in subsidies (e.g. fertilizers), remittences and wages from migrated family members
- Long-tearm perspectives: maintaining productivity of natural resources for further generations
    - cultivation without major degradation of the natural resources (regarding soil fertility and water quality)

4. Methods

Taking an inter-disciplinary approach, by incorporating methods from both natural and social science, the study will shed a light on the interrelatedness of LUC, the environment and the socio-economy. The research takes a point of departure by identifying the drivers of LUC, namely the political influence, pressure from the market, and other underlying rationales behind the households' decisions for LUC.

From interviews with key informants of the village the study grasps the overall structure of the area, with regards to both the social, economic and physical capacities. This overview allows the carrying out of a questionnaire survey. The overview also allows stratification for choosing case households. These households provide the research with information relevant to our questions on socio-economy and on land use and LUC. Furthermore, soil and water samples are to be collected for laboratory analysis to observe the status of the environmental conditions.



Figur 4.0

Method descriptions following the numbering from the method overview above, while detailed method descriptions can be found in the appendix:

4.1 Community walk

By taking a walk/boat trip through the village with an informant, this method gives an overview and first impression of the village land use, social patterns and other relevant knowledge.

4.2 Questionnaire survey

The questionnaire will provide information on household level, for a broader understanding of land use and changes of land use and its impact and interaction with the local environment. Questionnaires are an easy way to gather data from a larger number of respondents. Our choice of method will be the in-person questionnaire, to limit misunderstandings, and to make sure that illiterate people are not excluded.

4.3 Semi-structured interview (1)

The semi-structured interview is a mix of a structured interview and an open interview that gives interviewers a opportunity to jump between themes, and ability to add new questions if the interview happens to open for a new interesting direction. We have chosen this type of interview to create a more dynamic interview from an expectation that it will allow more spontaneous and lively response from the informant, and it keeps the possibility open for gaining unexpected information (Kvale & Stinar, 1999). The informants in these interviews are key informants from the village, e.g. the village chief. The goal is to obtain background information for the further study.

4.4 PRA 1: Community mapping and Timeline

Participatory rural appraisal (PRA) is a group of methods and approaches to enable rural people to present, share and analyze their own life. It is a method to include local people actively in the process of gathering knowledge about them.

Community mapping

A community map is a PRA. Using interactive methods, a map of the village is created by those who live in the village. It can be done with stones on the ground, on paper, or other visual tools.

Timeline

The timeline PRA is a tool to draw up the various significant events that has had an impact on the village.

4.5 PRA 2: Case HH – LUC: Semi-structured interview (2), Farm sketch, Flow diagram of the production system, Crop ranking

Semi-structured interview: Case HH - LUC – see method description 4.3 above.

Farm sketch

The household members draw a map of the farm on a piece of paper. The information that can be included is among others farm dimension and boundaries, topography, land use, crop distribution and production sub-systems and location of houses (Selener et al., 1999). The farm sketch can be combined with a GPS mapping of the fields.

Flow diagram of the production system

A PRA method where a sketch of the farm is drawn and a diagram showing the relationships in the production system is made with lines and arrows.

Crop ranking

The farmer will rank different crops from 0-10 (depending on the number of crops) in a table in terms of importance of the crops produced on his/her farm for market sale and for food consumption in the household for the present and past. It is a relevant method, because it will show if there has been a change in crop preference in the household.

4.6 PRA 3: Case HH – socioeconomy: Semi-structured interview (3), Activity calendar, Ranking & proportional ranking and Activity, income and expenditure matrix

The PRA (see 4.4) will include the following methods: 1) An activity calendar on various persons in the household. 2) A ranking and proportional ranking of income and expenditures. 3) A comparison of activity, income and expenditure in a monthly calendar.

4.7 Soil sampling

Soil samples will be sampled horizon and volume specific for three soil profiles in two different fields. The objective is to investigate any change in soil fertility due to LUC from an extensive to an intensive farming system. In the field the texture will be investigated while pH, P, Al and SOC will be investigated in the laboratory in Denmark.

4.8 Water sampling

Water samples are taken in both the Dua and the Kayan river including upstream from the village, centre of village and downstream from the village. Samples from smaller inflows to the big rivers are also taken, to see if there is a difference in water quality. The water samples will be examined in the field with help from the water expert from Unimas. We hope to be able to analyze for chemicals that are important for the water for drinking purposes and as a habitat for fish. Levels of pesticides, N/P, euthrofication and amount of silt blocking the water flow will hopefully be analyzed. The spots where samples are taken are marked with a GPS, and the surrounding land use and other observations noted in a table along with the sample results. This is done to be able to discuss whether the surrounding land use or uses of the river has an impact on the water quality.

4.9 Semi-structured interview (4) concerning water quality

These semi-structured interviews are aimed at the villagers that use the river for different purposes, such as fishing, washing and as drinking water. The purpose of the interviews is to get knowledge on how the water quality has changed in the period 1980-2011. This is done to be able to discuss whether there is a connection between water quality and LUC and how this development might have influenced the villagers. The first interview is aimed at a member of the water committee, to get an understanding of the water management in the village. The next interview is focused on the fishermen and other users of the river e.g. washing ladies, to get an understanding of their perception of the water quality and if they have experienced a change in the period.

For a description of semi-structured interview method, see 4.3.

4.10 Observations

Observations should be done at all time. The participant observations enhance the quality of the data obtained during the field work and enhance the quality of the interpretation of data. The observations can be used during the entire fieldwork to formulate and reconsider the research questions.

5. Sampling strategy

5.1 Questionnaire

By using a **probability sampling** where there is an equal probability to get picked for each household, the sample can be used to generalize about the population.

Unit of analysis: Households. Population: 103.

The sampling strategy is to do a **systematic sampling** with the assumption that the list of the households is randomly distributed. The households are selected within equal intervals beginning with a household number equal to a random number. The interval is determined by dividing the total population with the sample size, where any decimal is not rounded to avoid including households not existing in the population (with numbers higher than 103).

Sample size: Based on wanted level of confidence and confidence interval. A sample size of 30 households would correspond to a 95% level of confidence with a 15% margin of error. Normally a

maximum of 10% error is accepted, but our fieldwork limits the possibility of improving these levels.

5.2 Selection of case households

The different households in the village will first be **stratified** by separating them into mutually exclusive groups based on differences in land use. The separation of the households will be based on knowledge obtained from the headman of the village, from the PRA 1 method and from the community walk. The selection of the case households within each exclusive group will be based on advice from key informants and from inspiration from the first finished questionnaires, which may point out interesting households. The probability for each household to be selected as a case household will thereby not be equal for all households. The selection must also take into account that the household members are willing to participate, since we will take up some of their time, whereby the selection has to be based on convenience as well. For each stratification group two households are selected – one to participate in the case study of the LUC at farm level and one to participate in the case study of the socio-economy.

The number of stratified groups will be based on the appearing stratification of the households. The aim is to cover both the most typical LUC and the more extreme ones. The selection of households should not cover the average of the village LUC, but give examples of the differences within the village.

6. Time schedule

A proposed time schedule for the different field work can be seen in the appendix.

7. Planned collaboration with counterparts

There has been established contact to the two Malaysian students via email. Their study areas are environmental science and aquatic resource management. They have been introduced to our fieldwork plans, which they were positive about. They were especially interested in the importance of the river for the village. This perspective can easily be further incorporated into our research questions when we have a chance to discuss the details in person, when we meet in Sarawak.

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Synopsis appendix

1. Project Matrix

Research question	Sub questions	Underlying questions	Informant/s	Activities/methods	Output
1. How is the land use system in Tema Mawang (TM)?	What is the history of the village?	Any important trends/events?	Elderly people	Focus group PRA, timeline	A historic timeline, "history of land use" timeline
		How is the social pattern of the village?	Village chief	Semi structured interview	Knowledge of village. Stratification parameters for choosing households for 'farm'-surveys.
	What is the present land use in TM?	Which crops are cultivated?	Elderly people/ other people	Focus group PRA - village map, seasonal calendar	seasonal timeline, community map of village and types of fields
			Case HH LU	Farm sketch	Map of the fields and present land use on the farm. Spatial knowledge of how the land use have changed.
			30 households	Questionnaire	List of crops
		Which crops are important in the village?	Village chief	Semi-structured interview	importance of different crops
		Which cultivation methods are used?			use of swidden cultivation
		What is the land use along the main road? / the river?	Village chief/local guide/ ourselves	Village walk with GPS	Village map, list of the crops cultivated around the village
2. How has it changed in the period from 1980 to 2011?	How was the LU before 1980?	How were the cultivation methods? Seasonal weeding pressures?	Case HH LU 30 households	Semi struc. interview Questionnaire	Cultivation methods before
	How has the land use of different households changed?	Has there been a change in crop preference?	Case HH LU 30 households	Semi struc. interview Questionnaire	List of crops preferred now, list of crops preferred before
		Has there been a shift in extensive/intensive cultivation?			The intensive vs. extensive cult.

	What is the change in fertilizers and pesticides?	Use of fertilizer, insecti-, fungi- and herbicides?	Case HH LU 30 households	Semi struc. interview Questionnaire	Overview of use of fertilizers and pesticides
3. How has the socioeconomic settings interacted with land use changes?	How is the household economy?	How is the activity of the household?	Case HH soc	Semi struc. interview PRA; daily activity calendar	Information of the activity of the household
		How are the household income expenditures?		PRA; ranking, proportion ranking	Information the household economy and the relation between income and expenditures
		How is the monthly distribution of activity, income and expenditures in the different household?		PRA; monthly calendar	A monthly calendar showing the seasonal fluctuations of the household in different periods of the year
	How has the household economy changed due to land use changes?	How has the activity of the household changed?	Case HH soc	Semi struc. interview	Information of the changes in the activity of the household
		How has the income and expenditure changed?			Information of the changed patterns in household economy
		How has the monthly distribution of activity, income and expenditure changed?			Information on changed patterns of seasonal fluctuations
4. How has the natural environment in terms of soil and water been influenced by LUC?	Has the soil fertility changed due to agricultural intensification of the land? How has it changed?	Has terracing and extensive use reduced the soil quality and soil fertility compared to prior land use? (E.g. oil palm, rice, pepper, rubber…)	Spade and shovel	Texture, pH, P, Al, SOC	Soil samples from two field plots to be studied in the laboratory when we come home.
	How has the water quality in the river changed due to land use changes?	How is the water quality in the river now?	Glasses for water sampling	Level of pesticides, level of eutrophication, N/P level, siltation level.	Test of the water quality in the laboratory
		How has it influenced the fish stock?	Fishers/ villagers along the river	Semi struc. interviews	
		How was the quality of the river earlier?			

	What is the overall land use along the river?	Is any crop/ land use dominant? Is there in sign of degradation/ runoff of sediments in the fields connected to the river?	GPS	GPS mapping of the river and the present land use along the river	To discuss whether there is a connection between pollution/ silting in the river and a specific land use.
		Was the water clearer before? Is there any change in stream (faster/slower)?	Fishers/ villagers along the river	Semi struc. interviews	Knowledge from interviews to get an impression of how they have experienced the change, and what impacts it may have on their lives.
		Is there any illness from drinking the water compared to earlier?			

2. Detailed method description

1. Community walk:
By taking a walk/boat trip through the village, this method gives an overview and first impression of the village land use, social patterns and other relevant knowledge. When doing the community walk with an informant, additional and more in depth knowledge about social issues and land use can be achieved. Using a GPS for marking the main road/river and the land use along the path will give us a basic spatial knowledge of the village and the land use.

2: Questionnaire survey:
Questionnaires are an easy way to gather data from a larger number of respondents. It is a way to reach a number of opinions/data large enough to use a statistically analysis of the results. The usefulness of the questionnaire is highly dependent on a good setup and execution. Every step needs to be designed carefully to limit misunderstandings and to improve the results. Although questionnaires may be easy to administer compared to other data collection methods, they are more expensive in terms of design time and interpretation (Rea & Parker, 1997)
The survey must be produced in a short and precisely form that will make it possible for the informants to understand all questions without doubts. It is very important that additional questions are not added during the interview and that the interviews are following the order of the questionnaire.
There are different considerations on how to do the survey. Especially two major forms are considered; in-person interviews and non in-person interview. The two approaches have different strengths and weaknesses. But also different circumstances in situ must be considerate (Rea & Parker, 1997). In person interview: limits the misunderstandings of the question, and makes it possible to include illiterate people. There is a better security for the respond percent. But at the same time it is very time consuming, and there is a need for interpreting all the time, instead of just having the questionnaire translated. The non in-person interview also has the advantage that the interviewers interests, gender and power relation not are included in the same degree (Rea & Parker, 1997). We are doing an in-person questionnaire.

3: Semi structured interview 1:
The semi-structured interview is a mix of a structured interview and an open interview that gives interviewers an opportunity to jump between themes, and ability to add new questions if the interview happens to open for a new interesting direction. The purpose of this type of research interview is to acquire knowledge through a conversation under a certain structure in which the interviewer has a higher degree of freedom (Kvale & Steinar, 1999).
We have chosen this type of interview to create a more dynamic interview from an expectation that it will allow more spontaneous and lively response from the informant and it keeps the possibility open for gaining unexpected information. The semi-structured interviews are based on an interview-guide that serves as a leading instruction on the themes to be discussed but is not as highly ordered as a structured interview. It allows the researcher and the informant to have the freedom to discuss issues that are not directly specified in the interview guide, but may have importance to the research (Kvale & Steinar, 1999).

4: PRA 1: Community mapping, Timeline
Participatory rural appraisal (PRA) is a group of methods and approaches to enable rural people to present, share and analyze their own life. It is a method to include local people actively in the process of gathering knowledge about them. People are the central element in this method, and the idea is to include them through different exercises that will lead to an optimal understanding of their

life, opinion, environment etc. (Pra tool 1 from Absalon).
A **community map** is a PRA. Using interactive methods, a map of the village is created by those who live in the village. It can be done with stones on the ground, on paper or other visual tools. The purpose is to get familiar with villagers mental map of their village and to get acquainted with important reference points and classifications of land.
A community map can generate two-fold knowledge. On one hand it can generate knowledge of the spatial properties of the different village elements and on the other hand it provides an (informant-dependent) mental map of the village. The first knowledge serves for orientation and learning to speak the same "spatial language" as villagers. The second knowledge gives an understanding of the hierarchy of importance attributed to spatial elements in the village, i.e. small importance = small area. A village map can also identify differences relating to gender.

Timeline

The timeline PRA is a tool to draw up the various significant events that have had an impact on the village. Basically it consists of gathering the designated interviewees to sit down and talk and together draw up the major events within the lifetime of the village. It will be supported by a semi-structured interview.
Semi-structured interview, see 3.

5: PRA 2: Case HH – land use change: Semi structured interview (2), Farm sketch, Resource flow map, Crop ranking.

Semi-structured interview : Case-study on land use

A semi-structured interview (see 3) serves the purpose of gaining information on specific questions and at the same time allowing additional knowledge obtained in a more 'loose' conversation.
The purpose of this semi-structured interview is to ask introduction questions when we arrive and to ask additional questions that are not included in the PRA methods, to get knowledge on which land use changes have happened and why. We hope to also get additional knowledge on how land use changes have influenced the present situation, but this is not the main objective.

Farm sketch

The farm sketch results in a map showing the present land use for the household. It gives an overview of the land cultivated by the household, including which crops are cultivated, and a spatial knowledge of the distance between the house and the fields.
The method is a PRA method where the household members draw the map over the farm on a piece of paper and preferably both the men, women, and children contribute to the map drawing. The information that can be included is among others farm dimension and boundaries, topography, soil quality, land use, crop distribution and production sub-systems and location of houses (Selener *et al*., 1999). This method is good because it gives the members of the household a possibility to communicate their knowledge while they are controlling the course of the exercise instead of being asked about the details by the facilitator (Selener *et al.*, 1999).
GPS-mapping: By using a GPS we will make a farm map, showing the spatial distribution of the fields and the present land use. This will be done in connection with a Farm Sketch from a case study of land use, and will give us a more spatially correct map over land use, crop types and crop distribution on area.

Flow diagram of the production system

The flow diagram of the production system results in a sketch showing the resource flow of the farm/household. It gives an overview over which crops go to the market and which go to the food supply of the household.
The flow diagram is a PRA method where the household members draw a sketch of the farm (symbolic, not spatially correct) and then combine the different aspects of the production system with lines and arrows showing the relationship between the parts of the system. It can show which inputs come into the system, how labour intensive different crops are, and which crops go to the

market and which to household consumption. It will give an overview over cash crops and subsistence crops, over the distribution of fertilizer and pesticides and show if the production system of the household is diverse or specialized (Selener *et al.*, 1999).

Crop ranking

Crop ranking is based on the methodology of the 'Preference matrix' (Selener et al, 1999, 4.2 p. 76) and the purpose is to identify and analyse preference concerning issues of importance.

The farmer will rank different crops from 0-10 (depending on the number of crops) in a table in terms of importance of the crops produced on his farm for market sale and food consumption in the household. For analysing the change in importance, we will make two tables, one for 'before' and one for 'now'. It is a relevant method, because it will show if there has been a change in crop preference in the household.

6: PRA 3: Case HH – socioeconomic: 'Semi structured interviews (3)', 'Activity calendar', 'Ranking & proportional ranking' and 'Activity and income/expenditure calender'.

The PRA will include the following methods: An activity calendar on various persons in each household, a ranking and proportional ranking of income and expenditures and a comparison of activity, income and expenditure in a monthly calendar.

1) Drawing of daily household occupation/work calendars from different seasons. The idea is to make the participants draw their own **activity profiles and daily routines**, to summarize data and start a discussion of the activity and their time spend on, domestic work, farm work, wage work, spare time, community activities etc.

2) A **ranking and proportional ranking of income and expenditures** (two different exercises one on income, one on expenditure). The idea is to let people rank their different income sources and expenditures, and let them reflect on the composition of their income and expenditures. First the informant from each household are asked to mention all kind of income that contribute to the total household. After that the informant should rank the 5-7 most important income sources, and after that by using stones the informants have to make a proportion rank on the income. Same procedure for the expenditure case.

3) The **activity and income/expenditure calendar** shows the monthly trends in a typical year. It will show the monthly distribution of incomes and expenditures related to their immediate activity. Furthermore this allows the research to have insight into issues of vulnerability and economic sustainability.

The PRA will be followed up by a **semi structured interview**. For methodical description on semi-structured interviews see part 3.1.

7: Soil samplings

The objective is to investigate any change in soil fertility due to land use change from an extensive to an intensive farming system.

As it is not possible to go back in time and investigate the field before the land use was changed, the fertility of an intensively cultivated field will be compared to an extensively cultivated field. The extensively cultivated field will be a proxy of what the intensively cultivated field could have been before. To get as good a proxy as possible, the two fields should have the same texture and be located at similar surroundings regarding slope and position on a hill (middle, top, bottom). This is done because we are aware of that transport of soil, nutrients, water a.s.o. down a hill can influence soil properties markedly, disguising any changes due to land use changes, if fields are compared at dissimilar surroundings.

Parameters determining soil fertility can be divided into inherent and dynamic parameters (Jensen & Husted, 2009). The inherent parameters include the texture and mineralogy of the soil; where as the dynamic parameters include porosity, SOM, acidity, nutrients and water.

Parameters wanted to investigate in the soil sampling:

In the field:

- Texture — To determine how good a proxy the extensive field is, combined with the slope and the surroundings.

In the laboratory:

- pH (acidity) — Highly affects nutrient availability, toxicity of Mn and Al, fixation rate of P and base saturation (BS).
- P — Most likely the limiting nutrient of the essential nutrients (Liebig's law of the minimum) (Jensen & Husted, 2009).
- Al — Risk of toxicity for the plants at high concentrations.
- SOC — A good proxy for soil quality. An indicator of soil erosion risk. Does the soil act as a sink or source of CO_2 due to LUC?

Selecting the field sites: Based on the knowledge obtained from the earliest methods carried out, fields that are extensively and intensively cultivated are identified. The two comparable fields selected needs to have the same soil texture and be located at similar surroundings as described above. To determine the texture, soil samples are taken at different spots in the field with augering for comparison. The texture is determined in the field by testing the clay content by rolling the soil between the fingers.

Volume and horizon specific sampling: For each field three soil profiles are duck distributed around the field to ensure that the average soil conditions are included. The depth of the profile does not have to be more than 50 cm deep, as recent land use change has no effect on the soil properties deeper than this. The horizons (and their depth) are determined for each profile as well as the colour and other obvious characteristics. One volume specific sample is taken for each horizon horizontally into the profile for two of the soil profiles, whereas three volume specific samples are taken in each of the horizons for the last soil profile. This is done to determine both the variation between the three profiles and within one profile.

8. Water sampling

Water samples are taken from the main rivers (Duan and Kayan) and from smaller inflows which will be defined when we get there. We will take samples from different places along the river both upstream from the village, centre of village and downstream from the village. We want to measure water quality on two parameters: To what extent the water is a good habitat for fish and to what extent it is safe drinking water. Our hypothesis is that land use change has affected water quality, because of an increase in pesticide use and an increase in erosion leading to siltation of the river. In order to compare land uses, it will be optimal to compare streams from smaller uplands with land uses where we might be able to see a connection between water quality and the specific land use in the upland area. The most important source of drinking water is from the Dua River, and therefore we take samples from that river and look at the water quality for drinking purposes. We know, that villagers used to fish in the Kayan River, but the fishing population has dwindled thus fishing is almost no longer practiced (Bruun & Juel, 2011). Therefore, water tests in the Kayan River are taken in order to estimate water quality as a habitat for fish.

The samples will be taken with help from the water expert from Unimas. He will also bring tools for taking the samples and the water analysis will be carried out in the field. We do not know what exactly we can analyse for yet, but we hope to be able to look into the level of pesticides, N/P, siltation and signs of eutrophication. While taking the samples, GPS way-points will be marked, to determine if there is a pattern showing that levels are higher in some parts of the river compared to others. Additionally, observations of the land use practises and uses of the river will be written down in a table in connection with the GPS points.

The purpose of analysing the water quality is to define whether land use changes have had an impact on the water quality. The comparison with the past is difficult to make, because we do not have water samples from the past to compare with, meaning that we can only get a picture of the

present situation. To discuss whether there has been a change in water quality, we will supply the water sampling with local knowledge by making semi-structured interviews to determine if the people using the river have experienced a change.

9. Semi-structured interviews (4) concerning water quality

A semi-structured interview (see 3) serves the purpose of gaining information on specific questions and at the same time allowing additional knowledge obtained in a more 'loose' conversation.

The semi-structured interviews concerning water quality will be conducted on a member of the water committee, 1-3 fishermen and 1-3 users of the river (e.g. washing ladies). There will be three different interview guides for the three different types of informants. The purpose of the interviews is to achieve knowledge on the past and present use of the river, the past and present perceptions on water quality and the past and present fish stock in the river. By this knowledge we will be able to discuss, whether the land use changes have had an impact on the water quality and how this might have affected the livelihood of the villagers using the river for different purposes. We will especially look into the water for the purpose of drinking and the river as a habitat for fish, influencing the source of income for fishermen.

10. Observations

Observations should be done at all times. It can be done in many different ways. Observations can be made when participating in the normal life in the village, e.g. by joining people in their work in the fields, going to the market with someone, going on walks in the area or joining social events. But observations should also be made when not participating in the village life. The important thing is to take notes and systemize the notes frequently. Taking photos in the process is a good way to document the observations.

With observation is mend a method in which we as researchers in the field take part in the daily activities, rituals, interactions and events in the village, as one of the means of learning the explicit and tacit aspect of the life and routines in the village. The participant observations enhance the quality of the data obtained during the field work and enhance the quality of the interpretation of data. The observations can be used doing the entire fieldwork to formulate and reconsider the research questions (DeWalt & DeWalt, 2002).

3. Concerns and practicalities for the methods

	1. Community walk	2. Questionnaire	3. Semi structured interview 1 (background info)	4. PRA 1	
				Community mapping	Timeline
Data/information output:	We expect to get an overview of the village and achieve knowledge about present and past land use, crop types, yield, tenure, seasonal patterns of land use/occupation, social structures, institutions and other relevant issues.	The questionnaire will provide information on household level, for a broader understanding of land use and changes of land use and its impact and interaction with the local environment. The purpose of the questionnaire is to gain data that can be used for quantitative methods. The information collected from the questionnaire should be representative for the village so that it can be used for making statistical presentation of the village	The interview should serve to obtain information about the village on a more general (village) level. The interviews should inspire the selection case households.	The Participatory Rural Appraisal should serve to get an understanding of present and past agricultural systems and land use changes in the village.	We expect to get an overview of the history of the village, and from there on we might be able to gain an understanding of the underlying reasons behind any particular land use change.
Informant/s:	1-3 Guides or key/important people.	30 represents from 30 different HH in the village.	2-4 key informants (ex. village chief)	3-5 elderly people who are willing and able to assist in the exercise, selected by consultation with the village chief.	1-3 Elderly people
Materials/ preparing/ interpreting needed:	GPS and a list of overall questions for a very open interview. Camera for taking pictures of settings observed.	Questionnaire produced. Questionnaire (coded) for later analyses in SPSS. Translation of questionnaire. Version of SPSS for statistical analyses. Questionnaire printed on 30 papers (printer)	A question guide for each interview. Translation of all interviews. Digital reorder. Notebook.	Paper. Different coloured filtpens. (Manifold). Notebook. Camera.	An interview guide. Some A3 paper. Some coloured pens. A camera for taking pictures of the timeline produced.
Estimated time and when:	Some hours to half day, depending on how scattered the village is. The walk must preferably be done on the first day.	1-2 days. The questionnaire survey must be done in the first or second day on the fieldwork	1-2 hours pr interview. To be carried out in the beginning of the field work.	3h – half day. In the beginning of the fieldwork.	1-3 hrs depending on participants.

Concerns/ difficulties:	Some fields can be very remote, and there is a great possibility that it only will be possible to see a limited part of the village. A part of the walk may be done by boat, to access remote areas. There is a possibility that only good/positive places will be shown.	There is a big challenge making the questionnaire logic and easy to understand, so that possible misunderstandings will be limited. The selection of informants must be considered and can be limited of various factors such as access to remote villages, selection strategies, time scale etc	The information that we obtain can be affected of the informants interest in show and telling about the positive sides of the village	Who leads the pen? Is it just one persons map? Or just one genders map? Or is it mostly focused on e.g. rubber? It is important to control the colours to that each color is assigned to a meaning e.g. agriculture.	Gathering these different people to join up at a particular time can be difficult. There might be a tendency in the narratives of the past that 'everything was better back then'.
Group members responsible:	Mette	Ditte, Lasse	Lasse, Ditte	Lasse, Jimmy	Lasse, Jimmy
Theoretical references on methodology:	Apradley, 1979	Rea & Parker, 1997.	Bryman, 2004; Kvale, 1997		Mikkelsen, 2005
Appendix nr:					

	5. PRA 2			
	Semi structured interview (2) – land use change	**Farm sketch w. GPS mapping**	**Resource flow map**	**Crop ranking**
Data/information output:	Knowledge on which land use changes have happened on the specific farm and why it has happened.	The farm sketch results in a map showing the present land use for the household. It gives an overview of the land cultivated by the household, including which crops are cultivated, and a spatial knowledge of the distance between the house and the fields. A GPS mapping of a farm.	A sketch showing the resource flow of the farm/household. An overview over which crops go to the market and which go to the food supply of the household, and over inputs in form of fertilizer and labour.	The purpose of this method is to get a ranking of the different crop types on farm-level 'before' and 'now'. The output is two tables, one for 'before' and one for 'now', showing a ranking of importance of the different crops from 0-10 (depending on the number of crops) for market sale and for food consumption in the household.
Informant/s:	Farmer or household member.	Household members from each case households for information on land use.	Household members from each case households for information on land use.	Farmer or household member.
Materials/ preparing/ interpreting	A printed semi-structured interview guide. A digital recorder. Interpreting needed.	A3 paper sheet, coloured markers. Interpreter needed. A GPS. Interpreter needed.	A sketch for inspiration? A3 paper sheet. Coloured marker. Interpreter needed.	Two printed/drawn tables for crop ranking, one for 'now' and one for 'before'. The specific crops may be

needed:				different for the households, why it should be easy to change crop types in the table. The different crops should either be drawn or written in Malay/Bidayuh, but we find out when we get there. Pen to fill out. Interpreter needed.
Estimated time and when:	The semi-structured interview serves as a guideline throughout the household study, combining the different PRA methods. Seen in isolation from the other methods, the expected time of the semi-structured interview is ½-1 hour.	While during the case studies on land use. About 1 hour. About 2-3 hours dependent on size and distribution of fields. Any time during the field study.	While during the case studies on land use. About 2 hour.	Estimated time is half an hour, maybe less. The table is made very simple, so it should not take too much time. The crop ranking is made in connection with the other PRA methods for the household case-study on land use during the main survey-days.
Concerns/ difficulties:	If the informant is very shy/not talking much, the interview might not lead to a deeper understanding of the specific land use changes that we wish to gain.	It might take time to draw up all the fields and the fields might be spatially separated so the map has to be scaled right. If swidden cultivation is practiced the farm sketch might just be a snapshot in time, if the fields are different from season to season. It might be time consuming, therefore only one or two households is chosen.	Many things (inputs, flows) are considered, it might be difficult to remember all significant	It might be difficult for the farmer to remember the importance of each crop in the past, and therefore it might not be a very accurate picture. We should be aware that the crop ranking should not take too much time.
Group members responsible:	Anja, Dorte	Dorte, Anja	Dorte, Anja	Anja, Dorte
Theoretical references on methodology:	Selener, D., Endara, N., Carvaja, J., 1999, What is participatory rural appraisal and planning? IRR Quito	Selener *et al.*, 1999	Selener *et al*., 1999	Selener, D., Endara, N., Carvaja, J., 1999, What is participatory rural appraisal and planning? IRR Quito
Appendix nr:				

	6. PRA 3			
	Semi structured interview (3)	**Activity calendar**	**Ranking and proportional ranking**	**Activity, income and expenditure matrix,**
Data/information	Information of the household economy, the	Information of the activity,	Information of the households	Seasonality and vulnerability

output:	semi structured interview is following up on the PRA's. In the interview the relation to earlier will be mention an therefore the changes due to land use changes	and work of different members of the household	income sources and the expenditures of the household	
Informant/s:	3-5 individuals (preferable more than one person) from case households. Maybe the women of the household.	3-5 individuals (preferable more than one person) from case households. Maybe the women of the household.	3-5 individuals (preferable more than one person) from case households. Maybe the women of the household.	3-5 individuals (preferable more than one person) from case households. Maybe the women of the household.
Materials/ preparing/ interpreting needed:	Translation, Digital recorder Question guide for semi-structured interview	Translation, Digital recorder Figures and forms for PRA exercises. Paper and collared markers	Translation, Digital recorder Small papers squares for ranking. 20 Stones.	Translation, Digital recorder Figures and forms for PRA exercises. Paper and collared markers
Estimated time and when:	3 hours per interview (including the 3 PRAs)	30-45 min	30-45 min	30-45 min
Concerns/ difficulties:	Information about things such as income can be hard to define, because measures on wealth and income can be different. It can be a taboo subject for the villagers.	It can be difficult to get people to understand what kind of exercise you want them to do, and to make them do the exercise correctly (in your way).	It can be difficult to get people to understand what kind of exercise you want them to do, and to make them do the exercise correctly (in your way).	It can be difficult to get people to understand what kind of exercise you want them to do, and to make them do the exercise correctly (in your way).
Group members responsible:	Jimmi, Ditte	Jimmi, Ditte	Jimmi, Ditte	Jimmi, Ditte
Theoretical references on methodology:	(PRA text from Absalon)	(PRA text from Absalon)	(PRA text from Absalon)	(PRA text from Absalon)
Appendix nr:				

	7. Soil samplings	**8. Water sampling**	**9. Semi structured interview (4) concerning water quality**	**10. Observations**
Data/information output:	Texture, pH, P, Al, SOC. Soil properties that makes a fertility comparison of an extensively and an intensively cultivated field possible.	Drinking water quality: Level of pesticides, level of eutrophication, N/P level and siltation level, water borne diseases e.g. coli bacteria. Water for fish habitat: Level of pesticides, level of eutrophication, N/P level and siltation level.	The purpose of the interviews is to achieve knowledge on the past and present use of the river, the past and present perceptions on water quality and the past and present fish stock in the river. The first interview will be with a member of the water committee, giving us a background knowledge on what the different rivers are used for (household	It is very important to keep the eyes open an collect as much data as possible; to generate a general knowledge about the society and cultural context we are working in.

			water, drinking, fishing, transport) and an idea on where to take different water samples.	
Informant/s:	Informal conversations with local farmers to determine where comparable fields are located. Advice from soil expert from Unimas on field selection.		Member of water committee, 1-3 fishermen, 1-3 users of the river (e.g. washing ladies)	All
Materials/ preparing/ interpreting needed:	Reclosable plastic bags, marker, spade, auger, volume specific metal rings, a rubber hammer, Munsels soil colour map, measuring tape, brick trowel, slope measurer.	Glasses for sampling. Where are the laboratory analysis carried out? GPS. Tilde said that the UNIMAS water expert would be helpful providing tools for the samples, so no tools should be brought.	Firstly we need to get some knowledge on the uses of the different rivers, before we select place and informants for the interview. Three different interview guides. Digital recorder.	List of things that could be interesting to keep an eye on. System to organize observation. Sharing of observations. Note book.
Estimated time and when:	Time needed to determine and select the fields: ½-1 day. Time needed to do the soil sampling: 1-2 day. Within the last five days of the field work.	The water sampling will take ~ 3-4 hours, including GPS data. The interviews will take maybe half a day. A whole day with 2-3 persons involved.	The first interview will be with a member of the water committee. We expect this to take 2 hours. The next interviews will be with the fishermen and the users of the river. We expect this interview to take 1 hour per informant. Interpretation needed.	All the time
Concerns/ difficulties:	Soil samples taken at two different sites at present time are compared to describe a before and after land use change situation ideally on the same field. This demands that the fields are very comparable. This can never be 100% achieved. The number of samples is limited and cannot include all variations.	It might be difficult to take the samples if it is a big river with a tough stream. Concerns about where, along the river cross section the samples are taken, should be taken into account, as well as time of day. We do not have much experience with taking water samples, so we have to rely on help from the water expert from UNIMAS and our Malaysian counterpart who study Aquaculture.	There might not be many fishermen anymore, why it will be difficult to ask some of the questions.	It can be importunate to follow people, and it is very important to accept their privacy, and keep distance. At the same time interviews, questions and other types of joining people in their doings can be disturbing.
Group members responsible:	Mette,	Anja, Lasse	Anja, Lasse	All
Theoretical references on methodology:			Selener et al., 1999.	DeWalt & DeWalt, 2002.

Appendix nr:				

4. Time schedule

Everyday we have a morning meeting after breakfast and an afternoon meeting after dinner.
Every time an activity is finished, a summing up of important findings should be written down in our camp.

	Activity	**Result/aim**	**Informant**	**Tools**	**Person responsible**	**Est. hours**	**Stu-dents**	**Interpr.**
24.02	**Meeting in Kuching**							
25.02	**Meeting up with Malaysian counterparts**							
26.02	**Arriving in Tema Mawang**							
kl 13-14	Welcome ceremony in the village							
Kl 14-17	Semi-structured interview	Introduction to the village	Village chief	Semi-structured interview guide. Digital recorder	?	3	All	yes
Kl 14-17	Community walk	Observations of village. GPS mapping	Village chief or guide	Semi-structured interview guide. GPS. Digital recorder	?	4	All	yes
Evening	*Final preparations for questionnaires and PRAs*							
27.02	**1st day preliminary survey**							
kl 9-12	Questionnaire survey	Choosing households	Village chief	List of households.	Ditte	4	3	yes
kl 9-12	PRA - focus group	Knowledge of village and land use changes	3-5 elderly people	Question guide for the interview. Figures and models for map, timeline. A3 Paper for drawing of big maps. Coloured markers for drawing a map (5 sets of 4 colours; red, blue, green, yellow. Digital recorder.	Lasse Jimmi	4	2	yes
kl 9-12	Semi-structured interview	Knowledge of village and land use	Key informant	Semi-structured interview guide. Digital recorder	?	3	2	yes
kl 13-17	Community walk	Observations of village. GPS mapping	Key informant/ourselves	Semi-structured interview guide. GPS. Digital recorder	?	4	2	yes
kl 13-17	Questionnaire survey	Statistics.	Villagers	Printed questionnaires. Pens. GPS	Ditte	4	3	yes
Evening	*Looking at results from questionnaire*							
28.02	**2nd day preliminary survey**							
kl 9-12	Questionnaire survey	Statistics.	Villagers	Printed questionnaires. Pens. GPS	Ditte	4	3	yes

kl 9-12	PRA - focus group	Knowledge of village and land use changes	3-5 elderly people	Question guide for the interview. Figures and models for map, timeline. A3 Paper for drawing of big maps. Coloured markers for drawing a map (5 sets of 4 colours; red, blue, green, yellow. Digital recorder.	Lasse Jimmi	4	3	yes
kl 13-17	Questionnaire survey	Statistics.	Villagers	Printed questionnaires. Pens. GPS	Ditte	4	3	yes
kl 13-17	PRA - focus group	Knowledge of village and land use changes	3-5 elderly people	Question guide for the interview. Figures and models for map, timeline. A3 Paper for drawing of big maps. Coloured markers for drawing a map (5 sets of 4 colours; red, blue, green, yellow. Digital recorder.	Lasse Jimmi	4	3	yes
Evening	*Looking at the results from questionnaire survey. Making stratification for case-studies. Preparing presentation.*							
01.03	**Meeting with officers**							
kl 9-12	Proposal presentation							
kl 13-17	Meeting/discussion with related officers							
02.03	**1st day main survey**							
kl 9-12	Case-study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		3	yes
kl 9-12	Water: Semi-structured interview	Water management	Member of water committee	Interview guide. Pen. Digital recorder.	Anja		2	yes
kl 9-12	Soil: Finding fields	Finding fields	soil	Map	Mette		2	no
kl 13-17	Water: Finding places for water sampling	Finding places	river	Map	Anja		2	yes
kl 13-17	Case-study: Land use PRA	Land use/crop changes	Farmer/ household	Interview guides. PRA guides. Pens. Digital recorder	Dorte		3	yes
kl 13-17	Case study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		3	yes
03.03	**2nd day main survey**							

kl 9-12	Water sampling	Samples on water quality parameters	Water expert	The water expert will bring tools and knows how to measure parameters 'on the spot'. Table for results. GPS.	Anja		3	no
kl 9-12	Soil: Digging)	Soil samples	soil	Shovel! Soil 'instruments'. Table for comments. GPS	Mette		3	no
kl 9-12	Case-study: Land use PRA	Land use/crop changes	Farmer/ household	Interview guides. PRA guides. Pens. Digital recorder	Dorte		3	yes
kl 13-17	Water sampling	Samples on water quality parameters	Water expert	The water expert will bring tools and knows how to measure parameters 'on the spot'. Table for results. GPS.	Anja		3	no
kl 13-17	Soil sampling	Soil samples	soil	Shovel! Soil 'instruments'. Table for comments. GPS	Mette		3	no
kl 13-17	Case-study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		2	yes
04.03	**3rd day main survey**							
kl 9-12	Soil sampling	Soil samples	Soil expert	Shovel! Soil 'instruments'. Table for comments. GPS	Mette		2	no
kl 9-12	Water: Semi-structured interviews	Knowledge on perceptions on water quality/ consequences	1-3 fishermen or users	Interview guide. Digital recorder. Camera	Anja		2	yes
kl 9-12	Case-study: Land use PRA	Land use/crop changes	Farmer/ household	Interview guides. PRA guides. Pens. Digital recorder	Dorte		2	yes
kl 13-17	Soil sampling	Soil samples	Soil expert	Shovel! Soil 'instruments'. Table for comments. GPS	Mette		2	no
kl 13-17	Semi-structured interview with fishermen/users	Knowledge on perceptions on water quality/ consequences	1-3 fishermen or users	Interview guide. Digital recorder. Camera	Anja		2	yes
kl 13-17	Case-study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		2	yes
05.03	**4th day main survey**							
kl 9-12	Case-study: Land use PRA	Land use/crop changes	Farmer/ household	Interview guides. PRA guides. Pens. Digital recorder	Dorte		2	yes
kl 9-12	Case-study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		2	yes
kl 13-17	Case-study: Land use PRA	Land use/crop changes	Farmer/ household	Interview guides. PRA guides. Pens. Digital recorder	Dorte		2	yes
kl 13-17	Case-study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		2	yes
06.03	**5th day main survey**							

kl 9-12	Case-study: Land use PRA	Land use/crop changes	Farmer/ household	Interview guides. PRA guides. Pens. Digital recorder	Dorte		2	yes
kl 9-12								
kl 13-17	Case-study: Socio-economic PRA	Household activities/ income	Farmer/ household	Interview guides. PRA guides. Pens. Stones. Digital recorder	Ditte		2	yes
Evening	*Preparing tomorrows presentation*							
07.03	**Presentation**							
kl 9-13	Research findings presentation							

5. Definitions of other terms used in this study

Livelihood is a way of securing the necessities of life

Resilience "Resilience can be described as the capacity to endure stress and bounce back. It also implies a capacity to manage or maintain certain basic functions and structures during disastrous events. This means that individuals or communities have the ability to survive the challenges of day-to-day life. In order to be able to do this they need a range of skills and resources which open up options, and allow them to adapt to changing circumstances, i.e. they have the capacity to cope." (Practical Action, Webpage)

Household is all the people who occupy a particular housing unit as their usual residence. In our definition we will expand the definition to include family members living away from the housing unit but still contribute to the household economy.

Household economy Is the overall economic system of a household, including all kind of income and all kind of expenditures (monetary and non-monetary). The concept includes also all kinds of values and services generated from domestic work, farm work and off farm work.

Household income: Can be defined as monetary and non-monetary recompense derived from the productive activities of members of the unit or from other sources such as rent, transfer payments, subsidies, help, or gifts.

Daily activity: Refers to the patterns and combination of all different activity for one person, including all types of work, domestic activity, social events leisure time etc.

Domestic work is all kind of activities within or in relation to the household, and that contribute to the household economy.

Farm work all kind of activities in relation to the agriculture of the household, including the processing of own farm products

Off farm work all kind of income generating activities performed away from the farm

Development a process in which something passes by degrees to a different stage

Vulnerability
In the context of Disaster Risk Reduction (DRR), vulnerability can be considered as the extent to which an individual or group is susceptible to the impact of a defined hazard. It defines the ability to anticipate, cope with and recover from the impact of hazard or stresses. It is not the same as poverty but the poor are often the most vulnerable due to their lack of or inability to access resources and/or assets, coupled with limited livelihood strategies. (Practical Action, webpage)

Farming system: "A population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate." (FAO, webpage)

6. Method guides

6.1 Questionnaire survey

1. Informant and household
1.1 Name of head(s) of household:
1.2 Street + housenumber :
1.3 Location: Coordinates: N 1o E 110o .
1.4 Gender: M/F *
1.5 What is your age?

18-24	25-34	35-44	45-54	55-64	65-74	75+

2. Demographic Information

2.1 Total household size (people living in the house and people outside the household contributing to the household economy, by e.g. sending money)

0-2	3-4	5-6	7-8	9-10	>11

2.2 Number of children under 18 living in the household

0	1	2	3	4	5	6	>6

3. Land use changes

3.1 Total area of land cultivated, inclusive leased landha/acres/other

0-2	2-4	4-6	6-8	8-10	>10

3.2 What crop is occupying (in ha) the most of your land.
Rank the most important crops. Rank the most important crop with a 1, the second important crop with a 2, rank the third most important crop with a 3 and rank the fourth most important with a four.

Oil palm	low land rice	high land rice	Cassava	Fruit	Pepper	Cocoa	Rubber	Other

3.3 Have there been any changes in the area dedicated to the following crops since year 2000?
Tick one option for each crop.

	Decrease	No change	Increase	When?	Don't have
Oil palm					
low land rice					
high land rice					
Cassava					
Fruit					
Pepper					
Cocoa					
Rubber					
Other					

4. Land use change –subsistence/cash crops

4.1. Which of your crops is the most important food source for the household?
Rank the most important crops. Rank the most important crop with a 1, the second important crop with a 2, rank the third most important crop with a 3 and rank the fourth.

Low land rice	High land rice	Beans	Corn	Fruit	Other

4.2 Have there been any changes in the household's daily consumption of self produced crops since year 2000?
Tick one option for each crop.

	Decrease	No change	Increase	Don't have
low land rice				
high land rice				
Cassava				
Fruit				
Pepper				
Cocoa				
Other				

4.3 What crop is the most important for your household's selling/income
Rank the most important crops. Rank the most important crop with a 1, the second important crop with a 2, rank the third most important crop with a 3 and rank the fourth.

Low land rice	High land rice	Beans	Corn	Fruit	Other

5. Land use change - intensification

5.1 Have there been any changes in the yield of different crops pr ha since year 2000?
Tick one option for each crop.

	Decrease	No change	Increase	Don't have
low land rice				
high land rice				
Cassava				
Fruit				
Pepper				
Cocoa				
Other				

5.4. If there have been changes in agricultural inputs, how have the changes been?
Tick one option for each input..

	Decrease	No change	Increase	When?	Don't have
Fertilizer					
Pesticides					
Herbicides					
Fungizides					

5.5 Have there been any new tools or techniques used in the agricultural production since the year 2000 and if yes, what kind of tools/ technique?
Walking tractor
Irrigation pump
Rice thresher__

6. Agriculture and occupation

6.1 Over the past 10-15 years have there been any changes in households average time used on agricultural production?

	Decrease	No change	Increase	When?

Women				
Men				
Children				
Old fam. members				
Other				

6.2 Does someone in the household have a wage labor?

Tick one option

Yes	No

6.3 If yes: What kind of job is it?

Tick one option for each person

Occupation	Person 1:	Person 2:	Person 3:	Person 4:	Person 5:	Person 6
1. agriculture						
2. craftman						
3. wage labourers						
4. trade						
5. service						
6. other						

7. Income

7.1. Which activities contribute most to the households income during the year?

Rank the most important crops. Rank the most important income source with a 1, the second important income source with a 2, rank the third most important income source with a 3

Agricultural products sold on the local market	Agricultural products sold to further trade	Wage labour	Remittances	loan	Subsidies	Other

8. Forest

8. 1. Have there been any changes in households use of product from the forest since year 2000?

	Decrease	No change	Increase	Don't have
Firewood				
Construction wood				
Fruit				
Nuts				
Fodder				
Medicine				
Timber				
Animals				

6.2 Semi-structured interview 1

THEME/ WHAT WILL I KNOW	PRIMARY QUESTIONS	SECONDARY QUESTIONS	NOTES AND/OR BACKGROUND INFO
PRESENTATION PRESENTATION BY THE INTERVIEWER, THE SLUSE PROJECT AND THE AIM OF THE INTERVIEW			
REGISTRATION **Registration of the informant**	NAME, AGE, POSITION CAN YOU PRESENT YOURSELF?		
VILLAGE **Organization in the village** **Help** **Religion** **Transportation**	CAN YOU DESCRIBE THE VILLAGE TO A FOREIGNER? - Are there different committees responsible for e.g. water, sanitation, forest, road etc.? How are decisions taken? Do villagers organize work in each others fields? (Increasing/decreasing?) What is the religon of the people in the village? What are the means of transportation used in the village?	WHAT DOES KAMPUNG TEMA MAWANG MEAN? Who decides what? Does everybody belive? How often are people going to church? Are there some of the young people that dosent belive? Boat, cars, moppets, public transport, biks, walking etc? Are there any problems for any persons in the village?	

HISTORY /TIMELINE	CAN YOU TELL US ABOUT SOME MAJOR EVENTS THAT HAVE HAD IMPORTANCE FOR THE VILLAGE	POLITICAL CHANGES ? Administration changes? Climate/nature events? Subsidies? Infrastructure? Mobility /care /boats etc? Is it negative or åposetive?	
AGRICULTURE	CAN YOU DESCRIBE THE DIFFERENT TYPES OF AGRICULTURE IN THE VILLAGE? (INCLUDING RUBBER & OIL PALM) Can you make a list of the different crops?		
LAND USE CHANGE **Presentation of the overall changes in the land use/land cover** **Forest** **Understand if the changes of land use change also affected the common forest**	WHAT ARE THE MOST IMPORTANT CROPS IN THE VILLAGE FOR THE NUTRITION OF THE PEOPLE? What changes in the latest 10-15 years? What are the most important crops for selling? What changes in the latest 10-15 years? Have there in the last 10-15 years been a change in the forest area? What role does the forest play for the village	Do you think that decrease in the forest land is a problem?	
METHODS OF CULTIVATION	ARE THERE NEW METHODS OF CULTIVATION? ARE THERE ANY NEW TOOLS USED IN	MORE OR LES SHIFTING CULTIVATION More or les fertilizer?	

	THE VILLAGE WITHIN THE LATEST 10-15 YEARS? Are there used any new techniques in the village? - What are the main crops? Which groups produce which crops?		
CAUSES/DRIVERS OF LAND USE CHANGES	CAN YOU MENTION SOME REASONS FOR THIS CHANGE?	PROXIMATE CAUSES? Infrastructural	PROXIMATE/ UNDERLYING
SOCIO/ECONOMIC CONSEQUENCES GETTING AN IMPRESSION OF THE SOCIO-ECONOMIC CHANGES IN THE VILLAGE VILLAGERS OCCUPATION IN **agriculture** **Migration**	ARE MORE PEOPLE EMPLOYED IN AGRICULTURE? Can you list the different incomes in Tema Mawang?	ARE PEOPLE EMPLOYED IN AGRICULTURE ON OTHER FARMS THAN THEIR OWN? IS IT A PROBLEM OR A FORCE FOR THE VILLAGE THAT THE YOUNG PEOPLE ARE MOVING AWAY FROM THE VILLAGE	
NATURAL/ENVIRONMENTAL CONSEQUENCES SOIL	- Which types of soil du you have in Tema Mawang?		
BANKING	- HOW ARE THE FACILITIES FOR BORROWING/LENDING MONEY? DO PEOPLE USE THEM?	WHAT HAPPENS IF A HOUSEHOLD LOOSE INCOME AND CANNOT SUSTAIN ITS MEMBERS? (BANK, NEIGHBOURS?)	
CONTACTS	- WHEN IS THE EXTENTIONIST AVAILABLE (PHONE NUMBER?) - WHEN DO THE DEPARTMENT OF HEALTH AND THE DEPARTMENT OF AGRICULTURE VISIT? (DO THEY ARRIVE WHILE WE ARE HERE?) 3-5 elderly people for an interview (timeline)?		
FUTURE			
WATER	- WHERE DO PEOPLE GET DRINKING WATER?	ARE THERE ANY POLLUTION?	

	-what do you use the river for?	What do you do to prevent pollution?	

6.3 PRA 1

Community mapping

The facilitators (us) do not draw anything on the map. But in order to get the best result, the following procedures are followed when doing the map:

We start by drawing major reference points like the two rivers, the village boundaries, the road, the forest, the school, the longhouses and other important points of orientation.

Then more details like clusters of households, wells, minor roads or paths can be drawn. That is done with a black.

Then a manifold is put on top of the first map. On the manifold, major differences in soil are sketched. This is done with a red.

Then different land use land uses are classified (we decide on different symbols for oil palms, rice, forest etc.) Green.

Where does the drinking water come from, where do you wash clothes. Where do people fish? Blue.

Timeline

THEME/ WHAT WILL I KNOW	PRIMARY QUESTION	SECONDARY QUESTION	NOTES AND/OR BACKGROUND INFO
REGISTRATION Registration of the informants	NAME, AGE, POSITION		
PRESENTATION Presentation of the interviewer, the SLUSE project and the aim of the interview.	Only here to learn. we want to gain an understanding of the village history with special regards to the changes in land use. Time perspective is unlimited to allow for free narration (e.g. not only 1980-2010).		
INFORMATION Getting to know the person	Can you please present yourself?	What is/was your occupation/position in the village?	
PRA Timeline:			
Verbal narration and, drawing on A3 paper of events and according to year	Can you please talk about when Tema Mawang was established? What are the important events of Tema Mawang?	What importance did the village have then (e.g. commerce, trading point, good soil, well connected infrastructure, good landscape for cultivation, political motivation?) What effect did it have on tema mawang?	
AGRICULTURE	What cropping systems characterizes the agriculture of Tema Mayang? What crops did people used to cultivate?	Did the cropping systems change? Did the crop types systems change? What crops did they change with over time? Why did they change?	
FOREST	WHAT IS THE HISTORICAL IMPORTANCE OF THE FOREST?	Was there any great changes with regards to the forest? What resources did you retrieve from the forest? Did its importance change as a consequence of LUC?	
River	WHAT IS THE HISTORICAL IMPORTANCE OF THE RIVER?	What has been its main functions historically? Did its importance change as a consequence of LUC?	
INFRASTRUCTURE	Which great historical changes have taken place with regards to transport (roads, river, border, airstrips)?		
ECONOMY	Did you experience any great economic changes in Tema Mawang?	Did people at some point experience trends of poverty or wealth?	
OTHER	Are there any other important events outside the categories?		

6.4 PRA 2 - guide to semi-structured interview with Case HH land use

Activity	Questions	Keywords	Notes
Farm sketch	Can you please draw a map over your farm? Where are the fields located? Which crops are on the fields? Where are the good fields in terms of soil quality?	The house Location relative to the river Fields Crops Soil quality	
	What is your main crop?	Changes? Crops on good soil, Crops on poor soil	
	How big an area do you cultivate? Distributed on different crops?		
Semi-structured interview	Why did you choose the crops you have? How much fertilizer do you use? Which yield is the biggest? Which problems are related with harvest? Do market prices influence your choice of crop?	On which crops? Relative between crops? Crop wise	
Crop ranking	Which are the most important crops? Which were the most important crops in 1980?	For household, For market For household, For market	
Flow diagram of the production system	Draw the house as the centre Draw arrows and boxes to symbolize the flows	Crops, village, market, fertilizer	
	Which crops do you use in the household? Which do you sell on the market? What do you 'use' for cultivating the different crops?	Inputs: fertilizer, tools, labour	

Crop ranking

Example of crop ranking table. The crops are ranked from 0-10 (depending on the number of crops), where 0 is when the farmer does not have the crops at all. The purpose is to get a picture of which crops are most important for market sale and which are important for own consumption in the household. The table is preferably drawn on the spot, to be able to add new crop types that we were not aware of. Two tables will be made for each household, one for the present importance, and one for the past importance (~1980).

Crop type	Market	Food consumption in household
Rubber		
Oil palm		
Rice		
Pepper		

6.5 PRA 3

Socio-economy question guide

It is important to keep in mind that all questions have to be translated, therefore questions are kept simple. Following, it is important not to pose leading questions.

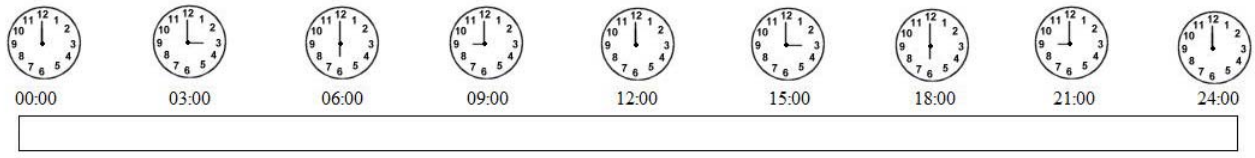
Theme/ what will I know	Primary question	Secondary question	Notes/or background
Presentation of us, and why we will like to talk to them.	We are students from Kuching and Denmark and we will like to understand your village and way of life		
Basic info of the household member	Who is living in the house? Any person who is not sleeping here but still contributes to the household economy? Have you always been living in this village?		
Household activity/work calendar. See below scheme for *'daily routines and work calendar'.* **Before/after** **IF** more time used on agriculture - Domestic work **IF** Market/shopping - Working together - Spare time Young people (questions preferable asked to the young people if present, if not it is OK to hear the parents opinion)	*First we will like you to fill in this lines about what you normally do on an average day?* - Is it possible for you to draw the same for other members of the household? - Would you have drawn the same figure for 10-15 years ago? - Can you describe the changes in the last 10-15 years? /Can you describe the changes in the different sources of income? - What are the most stable incomes? - Why are you using more time on agriculture - How have the house work changed? Is it changed who is doing what? - Who is going to market to sell/by products? - Do you work with other people in the village? - Do you have the time you need to do social activities and meeting with other people? - Is it normally that young people help in the fields? - Dose the young people have more free time and what do they use it for? - How do the young people feel about the village in general?	*First we need to identify different times a year, do you have any periods were your daily life is different from other times a year?* What new things take time? Man/woman/kids/elder How and when do you work with other people in the village? How does that impact the HH? Can young people find work outside agriculture and where?	
Income in the household **Yearly economy calendar** We will like to know how income and expenditures are distributed in one typical year with relation to activities? *See below*	*First we will like you to fill in* *1) what is the main activity for the agriculture* *2) how is your income and how is your expenditures? Please mark level and then by the end draw a line to show yearly distribution*	(Agricultural products, wage income from agriculture occupation, wage income from manufacture/service) Do you have income that you don't receive in cash? (ex fertilizer)	

'schema for income/expenditures' We will like to know more about your job and how important it is for you (type, security etc.) - Before/changes **IF** high income from agriculture - Mono/multi crops - Market - Vulnerability - Food **IF** Off farm job in agriculture **IF** Off farm job in production, service etc.) **IF** migration **IF** subsidies - Seasonality of income/ vulnerability - Comparison	*Second we will like you to:* *Can you mention the 5-7 most important sources of income? And then rank them (using small cards)* *Can you distribute these 20 stones relatively between the different sources of income, to illustrate the different amount from the different sources.* - Would you have drawn the same figure for 10-15 years ago? Or would it have been different? - Can you describe the changes? /Can you describe the changes in the different sources of income? Can you describe more about the crops you sell? Do you have several crops to rely on? Where do you sell your yield surplus? - Have you had any experiences that you didn't get the income from your crop that you were counting on? - What is the most important food, you produce? - How are the possibilities to find jobs? - Can you describe the type of job? - Who owns the farm/plantation? - How do you like the job? - How is the job, can you describe the type of job? - Does any of the family HH live away from the village? - From where do you get subsidies? - How necessary are they for your HH? - Are there any of your income that you only receive few times a year? - Are there any time a year where you don't have enough money? - Do you save up the money for periods when you don't have any money? - Do you see your family as a rich, average or poor family in the village?	Can you describe the different income sources and the importance for your household? How was the economic situation before? Are your income from agriculture from only one crop or more different? Are there any problems related to sell the crops (access to market, change in price, restrictions/laws, or competition)? How common is harvest failure, and how does it impacts your economic situation? Did you try that you couldn't sell your products? How did you manage that situation? How secure is the job? How is the salary? How does it affect your own farm management? How often do they come home? Do you think that they will move back and live/work in the village? Are there jobs for them here? Are there food enough for them?	
Expenditures in the household	*Can you mention all the expendituresin the household? Can you rank the 5-7 biggest expenditures*	(Food, house, transport, health etc)	

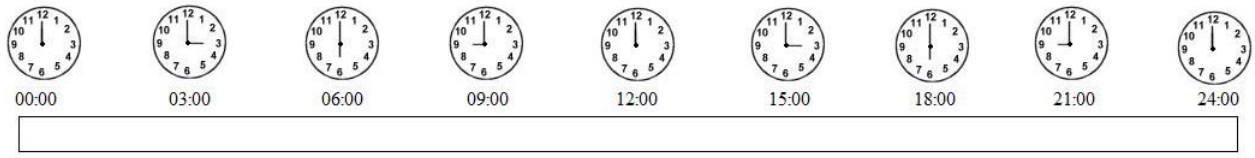
	in one year (using small cards)? *Can you distribute these 20 stones relatively between the different expenditures, to illustrate the different size of the expenditures?* - Can you describe each category, and give some examples?	Are there many new things that you have to use money on?	
We will like to know more about each category Have it changed - Basic needs - Food	- How have your expenditures changed? - Do you use more money on buying food? - Are there some time a year where it is difficult to pay for everything? - What do you do when you can't buy what you want? - Are there something that you can't afford, that you really would like? - What will you do if you had a lot more money one month? - What type of food do you buy on a regular basis (in a normal week)?	Do you think food is expensive? When? Is it new? Is it a big problem How are the banking facilities?	

Daily routines and work calendars

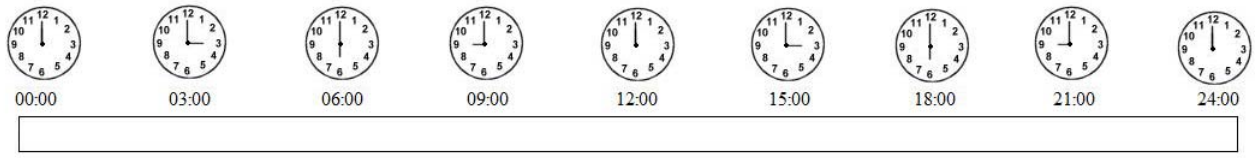
Season 1



Season 2



Season 3



PRA Schema for income/expenditure

To be done most likely with the '2nd' case study grouping

This schema makes for an overview of the relationship between incomes and expenditures on a yearly basis, with connection to the agricultural production activities. In this way we can gain a better understanding of the household economy with relation to food security and socio-economic sustainability. We hypothesize that a household whose economy has an even flow of income and expenditures is more sustainable than one whose income curve fluctuates more. Furthermore it can provide us with information about how land use change has affected the flow of incomes and expenditures, if there is a tendency to monocropping because of focus on cash crops for instance.

	January	February	March	April	May	June	July	August	September	October	November	December
Main activity of the month												
Income High Medium Low												
major income sources												
Expenditure High Medium Low												
Major expenditure sources												

6.6 Soil samplings

Soil description

Date	
Waypoint	
Coordinates	
Profile number	
Slope	
Photo	

Vegetation	
Land use history	
Comments	

Sample ID	Horizon thickness	Sampling depth	Colour	Comments

6.6 Water sampling

Table for results of the water sampling.

Sampling nr.	GPS coordinates	River/area	Land use	Observa-tions	Pestizi-des	N	P	Euthrofica-tion

6.7 Semi-structured interviews on water quality

Purpose of semi-structured interviews with the fishermen/users of the river:

To determine whether there is a connection between the dwindling fish-population and land use changes, and to get an understanding of how this development has affected their livelihood. In order to triangulate the information, we ask a fisherman,
washing lady
member of the water committee (probably exist)

KEY INFORMANT	FISHERMAN
Name, Age, Residence, Sex	
Is/was fishing your main income? (What are your other incomes?)	
How many fish do you catch in a month on average? Compared to earlier?	
How many fishermen were there 'before' (1980)? How many now?	
Where do you fish? (Dua River), (Kayan River), (Where on the river?)	
Have the fishing conditions changed? (Other species), (Increase/decrease in number)	
In which year did the fish stock begin to decline? When have the fishing stock increased/decreased?	
What do you think is the reason for that?	
How have the change in fish stock affected you life (income, food security?)	
Do you perceive the water as a source of diseases? (Which?)	
In 1979, the new road was build, and fewer people use the river for transportation. Can you describe, whether that has changed the fishing stock?	
What else do you use the river for? (Drinking water/ washing clothes/ transport)	

Hopefully the interview will lead to a more loose conversation where we might get additional knowledge that we weren't aware of.

KEY INFORMANT	WASHING LADY
Name, Age, Residence	
Do you always wash your clothes here? (Why this place?) (Why this river?)	
Is the water good for washing clothes? (Cleaniness)	
Do you ever use it for drinking water?	
Do you perceive the water as a source of diseases?	
In 1979, the new road was build, and fewer people use the river for transportation. Can you describe, whether that has changed the water?	
What else do you use the water for?	
How long time does it take to wash this clothes? (We won't take more of your time…)	

KEY INFORMANT	WATER COMMITTEE MEMBER
Name, Age, Residence	
When was the water committee established?	
What is the functions of the committee?	
What are the sources of drinking water? (Where) (Number)	
Is the water getting better or worse? (For drinking)	
Do you perceive the water as a source of diseases?	
What can go wrong with respect to drinking water? (Prior pollution) (Change in quality)	
In 1979, the new road was build, and fewer people use the river for transportation. Can you describe, whether that has changed the water?	