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FACULTY OF SCIENCE

ILUNRM – SLUSE Field Course

Modernization and adaptation in Sarawak

A study of key drivers and land use strategies in the village of Nanga Bekiok

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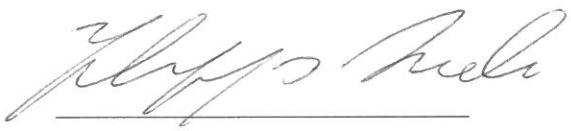

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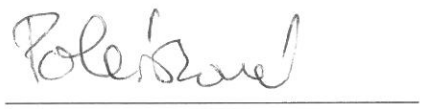

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Abstract

Rural livelihoods in the Malaysian State of Sarawak are under constant transformation due to development policies and broader global trends. This study sets out to identify key drivers affecting current livelihood strategies, in particular land use strategies, and assess how changes in land use affect the environment in the village of Nanga Bekiok, located in the district of Julau. The main findings are as follows: 1) Three main constantly transforming drivers influence the land use strategies of the farmers in Bekiok; the process of modernization encouraged by governmental policies, market prices and crop diseases. 2) A majority of the villagers in Bekiok rely on agriculture as an income source. However, most diversify their income with other types of activities. 3) The villagers in Bekiok are active agents in adapting to the context in which they live. However, people adapt differently based on the different assets they possess. This indicates how a process of modernization does not necessarily create equal opportunities for everyone to invest in more profitable livelihood strategies. 4) When assessing the environmental impacts of the changes in land use, a decrease in the quality of the river and soil quality (in an oil palm plantation) has been observed by the villagers. From our analysis, different agricultural activities did not show to have an impact on soil and water quality. Soil erosion from agricultural fields was, however, revealed as a potential risk to water quality.

Keywords: Livelihood strategies, land use, modernization, environmental impact, Sarawak

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List of Abbreviations

APP.:	Appendix
DOA:	Department of Agriculture
FCC:	Faecal Coliform Count
MPB:	Malaysian Pepper Board
NWQS:	National Water Quality Standards
PRA:	Participatory Rural Appraisal
RISDA:	Rubber Industry Smallholders Development Authority
SF:	Secondary forest
SLF:	Sustainable Livelihood Framework
SOC:	Total Carbon %
SOM:	Soil Organic matter
SSI:	Semistructured interview
TSS:	Total suspended solid concentrations
WQI:	Water quality index

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1. Introduction

This field study was carried out in the village of Nanga Bekiok, which is located in the Julau District in the southern part of the Malaysian state of Sarawak. Bekiok consists of a cluster of five longhouses, with a headman each as leader and spokesperson on behalf of the house. The longhouse Ruah Guntol, where we stayed, consists of 10 biliks (apartments) and three detached households, whereas there was a total of 44 households in all of Bekiok.

Figure 1: Aerial view of Nanga Bekiok

1.1. Context

To get an understanding of the area where our fieldwork was carried out, it is important to focus on the broader context in which the village of Bekiok exists. This has been done by studying the history and process of modernization in the state of Sarawak.

1.1.1. The region of Sarawak

Sarawak is located on the island of Borneo, and along with the state of Sabah, it makes up the Malaysian part of Borneo. The state of Sarawak mainly consists of areas of rainforest (80% of the total area of the state is covered by forest), both primary and secondary, along with some urbanized areas, which are mainly located at the coastal line or along the rivers dissecting the island (Sarawak Government 2018). The state of Sarawak still relies on its natural resources, and the people in the rural areas are still occupied within the agricultural sector (Oxford Business Group 2015b). This is also the case in Bekiok, where the production of particularly pepper still plays a role in the livelihoods of many of the villagers (App. 12).

1.1.2. Process of modernization

At the beginning of the 1990s, the Malaysian government presented the concept of Masyarakat 2020 – a vision of becoming a 'fully developed country by the year 2020' (Windle 2002). In 1984, Chief Minister Abdul Taib Mahmud stated:

> *"My vision for the next twenty years is to see modern agricultural development along the major trunk road with rows of plantations and villages well organised in centrally managed estates with a stake of their own in them".(Cramb and Sujang 2013)*

As evident in the statement, the establishment of new infrastructure and a focus on larger scale agricultural plantations have been two main political strategies to reach the 2020 vision and encourage rural development in Sarawak (Windle and Cramb 1997; Windle 2002; Cramb and Sujang 2013).

In previous years, the lack of a sufficient road network, connecting the rural areas to the major cities, has meant that most transports had to be done by rivers (Oxford Business Group 2015a). The improvement of the infrastructure as a necessity for the development of the rural areas in Sarawak is the main focus of the text by Cramb and Sujang (2013). It is argued that the construction of modern infrastructure, including road networks, gives a significant advantage to small-scale farmers in the production of cash crops.

The shift from a focus mainly oriented on the production of food crops to a focus on the production of cash crops is also an important factor in understanding the dynamics of rural livelihood strategies in Sarawak.

According to Masahiro Ichikawa (2007), the Iban approach traditionally relied on swidden cultivation, where fields were being burned and left fallow in order to regenerate the soil fertility (Mertz et al., 2009). This shift to a more permanent cultivation strategy has required an increased amount of external inputs in forms of agrochemicals, such as inorganic fertilizers and pesticides to sustain the soil fertility which can no longer be restored through a sufficiently long fallow period. It is therefore believed that permanent cultivation may affect soil quality and in turn also the sustainability of the farming practice (Bruun et al., 2009). For instance, results from a study by Tanaka et al. (2009) suggest that soil fertility might be affected by different cash crop farming practices. This means the strain on the environment has increased as well.

1.2. Research objectives

Our study had its beginning in the investigation of the impact of the infrastructures, in this case, the construction of a tar-sealed road and the access to electricity from the power grid 24/7, on the livelihood strategies in the village of Bekiok. Therefore, our preliminary focus mainly evolved around the accessibility in the area, and how the development in this area would impact the livelihoods of the people living in Bekiok. As our studies developed, and we were introduced to our study site, it became clear that there were many factors impacting the livelihood strategies of the people in Bekiok. Therefore, our objective moved to a broader perspective, as we decided to focus on the key drivers impacting livelihoods in Bekiok, in particular, the land use strategies, along with the impacts these drivers and land use strategies have on the environment.

1.3. Problem statement

These factors all contribute to our overall problem statement, where our focus will be on:

Identifying the key drivers affecting current livelihood strategies, in particular, land use strategies, and assess how changes in land use affect the environment in Nanga Bekiok.

This will be done by focusing on the following sub-questions:

1. What are the current livelihood strategies and how have these changed?
    - What are the current sources of income for the villagers?
    - What is the current use of natural resources?

2. What are the current key drivers affecting land use strategies?
    - What guides the decision about which crops to cultivate?

3. How do people adapt to the changes brought by the identified key drivers?
    - Who is able to employ different adaptation strategies?

4. What are the environmental impacts brought by the changes in land use?
    - How do current land-use strategies affect soil and water quality?
    - How are the environmental impacts perceived by the villagers?

1.4. Theoretical framework

1.4.1. Livelihood strategies

Through our analysis, we will refer to and use the 'Sustainable Livelihood Framework (SLF; see Figure 2). It is the intention to describe how various factors, such as relations, customs, rules and external factors affect the input in a given context into livelihood strategy, which then leads to a result consisting of various actions being taken, based on the interpretation of the original input, which again in the end could have an effect on the original input (Ellis 2000).

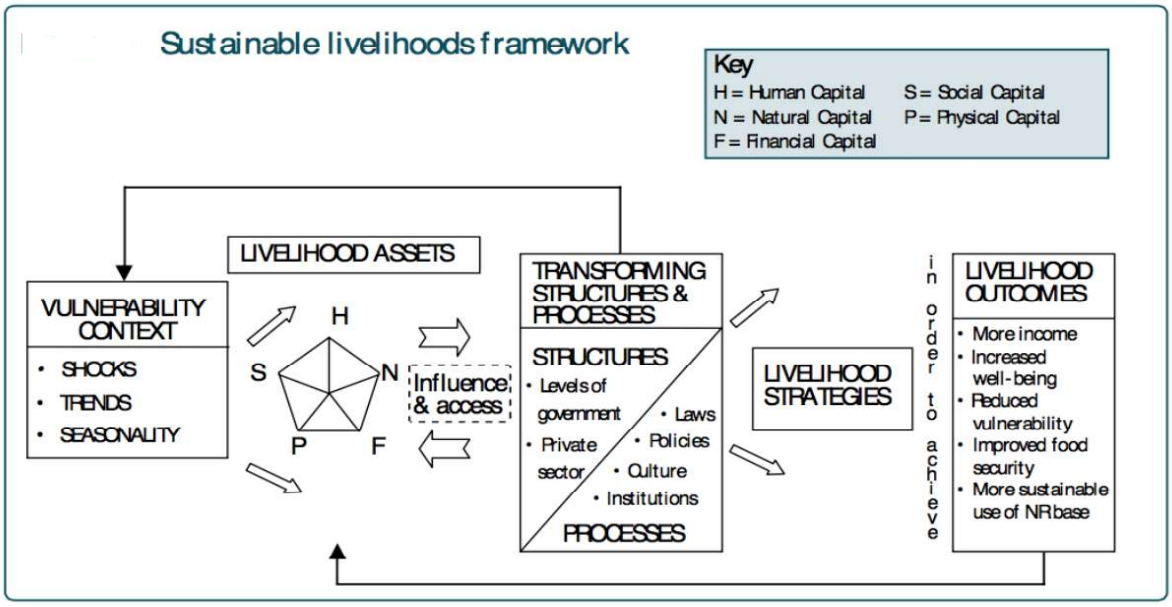


Figure 2: Sustainable livelihood framework (DFID 1999)

The SLF provides a vocabulary to identify the many factors that affect livelihoods, the importance of these factors and the way they interact (DFID 1999). In relation to our research question, this framework will help us analyse how the key drivers (a transforming structure and vulnerability context) have affected livelihood strategies, in particular, land use, of villagers in Bekiok.

Throughout this report, the focus on livelihood strategies is a recurring topic. Therefore, it is important to determine what the exact meaning of a 'livelihood strategy' is. Livelihood by itself makes up the essentials in order to provide for one's existence (Ellis 2000). This includes the natural -, physical -, human -, financial - and social capital, as well as access to these capitals. In brief, according to Ellis (2000), the different sorts of capital cover the following:

Natural capital: Natural resources, such as land, water and trees, that enable the owner to use them for production or consumption of products being produced in the area.
Physical capital: Resources that are the results of a financial investment, giving an advantage over the default setting, which could include the access to tools, equipment, roads, and initiatives produced as a result of this accessibility.
Human capital: The access to knowledge, education and healthcare.
Financial capital: The direct access to a flow of cash, or the possibility to obtain credit, which can be invested.
Social capital: The access to networks, and opportunities to interact with other people, which can contribute to the maintenance of a livelihood (ibid.).

The theory of livelihood strategies, on the other hand, sets out to explain the strategies and reasonings for the given actions in certain circumstances (ibid.). When using the 'sustainable livelihood framework' in our analysis, we are aware, that to systematize actions into analytical boxes, could possibly result in the data being obstructed in order to fit into the scheme. The purpose of the livelihood strategy approach is to explain and determine the various factors impacting the livelihoods observed in a given context. A fundamental approach for explaining the livelihood strategy is determining the available assets in the form of various capitals.

1.4.2. Definition of household

Large parts of the data that have been gathered during this field work, refers to households as units of analysis. Within our work, we base our understanding of the term ‘household’ on “*a group of people (normally family members) living under the same roof and pooling resources*” (Yanagisako 2001; PEN 2007).

1.4.3. Critical perspective of using household as a unit of analysis

Within a given household, relations and differences within the household can be difficult to observe and register, as they might not be visible during the periods when the given group is in focus. In cases where household members are not physically present but are still part of the household in an economic sense or in terms of kinship, it can also be challenging to obtain and interpret correct information (ibid.). This leads to a possibility of obtaining an average output, rather than being able to focus on the individual, which leaves possible important details out of the final product (Yanagisako 2001).

2. Methodology

This chapter provides an overview of the methodological approach that has been used during the fieldwork. Furthermore, it addresses the purposes, limitations and challenges of the applied methods and the possible external factors that could have influenced data collection.

A central part in our fieldwork and a keystone of the SLUSE framework is represented by the concept of interdisciplinarity; an approach that aims at "building up and realising an epistemological design, ideally corresponding to the deep nature of the object" (Rigotti. and Rocci, 2006). A wide set of different methods, coming from natural and social science has been used to collect both quantitative and qualitative data in order to answer our research questions. This wide range of methods, along with the differences in our academic backgrounds, allowed us to use data and methodological triangulation in order to obtain more reliable data (Mikkelsen, 2005).

To make use of our diverse background and to establish a common understanding across nationalities, we tried to carry out the activities in mixed groups, mostly formed by at least one student for each of the two counterparts. Furthermore, to prevent the interviewee from feeling intimidated by being in minority, some activities, such as questionnaires or semi-structure interviews (SSIs), were carried out by one student and one translator. Our collected data were shared and discussed during evenings, every day. Most of the time, the data were transcribed in digital form the following day, in order not to lose the contents.

2.1. Exploratory phase

In the first exploratory phase of our fieldwork, we focused on methodological activities that could give us an overview of livelihood strategies and the environment around Bekiok.

Questionnaires were carried out to collect quantitative data on various topics, e.g. general information about the household members, sources of income, types of crops cultivated, reliance on ecosystem services, rural-urban linkages etc.

A total of three trial questionnaire were conducted to verify the comprehensibility, possible translation difficulties and relevance of topics. Based on the feedback received from both villagers and translators, a final version was made. We managed to carry out 21 questionnaires out of 44 occupied households. To choose informants, we initially wanted to do random

sampling with informants from all five longhouses. Due to the absence of many villagers, we ended up including people that were available, still with a focus of representing all five longhouses. This can thus be categorized as a clustered convenience sampling (Brewer and Gregoire, 2009).

Meanwhile, two **transect walks**, one in the countryside and one in the forest, were carried out in the first phase to gain knowledge on cultivated crops and land management and on forest species richness and villagers' use of ecosystem services. We split into two groups, each with a local guide that helped us identifying plant species and describe their use

Three different **PRA methods** were used during the first phase of our fieldwork to facilitate the villagers to share their knowledge of life and livelihood strategies (Chambers, 1994). The **resource mapping** was used to better understand the geography around Bekiok and the location of the fields; the **timeline** was used to collect information on the main past events and changes in land management, crops and livelihood strategies; the **crop preference ranking** was used to gain understanding about villagers' perception of different crops in terms of income, labour intensity, proneness to disease, etc.

2.2. In-depth phase

During the second phase of our fieldwork, we applied methods that aimed to identify the key drivers affecting livelihood strategies and connected potential environmental impacts.

To investigate whether different crop cultivation affects soil quality (Tanaka et al., 2009), **soil sampling** was performed in rubber, pepper and oil palm fields as these represent the main cash crop cultivated in the village. The idea was to identify fields with the same cropping history and management practice. Moreover, the sampling plots were located in close vicinity to ensure similar soil property. As a reference point, 40 years old secondary forest (SF) was chosen as there was no primary forest left in the area. For each sampling site, one sample composed of 6 sub-samples of the top layer (8 inches) and 6 sub-samples of the second layer (8-16 inches) were collected randomly along the slope and mixed together to get a representative sample. Both air-dried and wet samples have been transported to Denmark and UNIMAS for the analysis.

To examine whether water resources are affected by land use transitions, we performed **water sampling** in four different stations: in a gravity feed, used as the village freshwater source (station 1 ST1); upstream of the oil palm field where soil samples were collected in the Pinang

River (station 2 ST2) as a reference point and downstream in Simpang Batang River (station 3 ST3); and in Merurun River downstream of Bekiok (station 4 ST4).

Some parameters have been measured in situ (temperature, dissolved oxygen (DO), electrical conductivity and salinity), meanwhile, chemical and biological analysis have been carried out in the longhouse (chemical oxygen demand (COD), turbidity, ammonia nitrogen (NH_3-N) nitrate ($N0_3^-$), nitrite (NO_2^-), phosphorus (P), total coliform count (TCC) and fecal coliform count (FCC)) with lab equipment provided by UNIMAS. Furthermore, **miniSASS** (stream assessment scoring system) was applied at the same sampling sites (except for ST1) to compare water quality data using two different approaches (Graham.et al., 2004).

To estimate the value of forests around Bekiok in terms of aboveground biomass and to learn about the biodiversity and health of the forest, **forest resource assessment** was carried out.

To triangulate the previously obtained data and to go deeper into topics that we considered relevant to answer our research questions, **semi-structured interviews (SSI)** were carried out. We selected the informants based on their work, knowledge on relevant themes, their role inside the community as well as their gender and age. Some were chosen based on their answers in questionnaires, while other informants were identified through intermediaries (snowball effect) (Noy, 2008).

Finally, we used two PRA methods in the last phase; a **seasonal calendar** to gain knowledge about land management and labour intensity and a **Venn diagram** to map both internal and external actors (institutions, organizations, committees, politicians) and their influence on the livelihood inside the village.

2.3. General limitations

Upon our arrival to Bekiok, each of us was housed in different *biliks* (apartments) in the longhouse of Guntol. Spending most of the time in one of the village's five longhouses, allowed us to create bonds with locals and gain access to information about members of the longhouse. However, this could also have resulted in an overrepresentation of the inhabitants of Guntol in our data collection.

One of the limitations we encountered was the difficulty in finding participants representative for the whole community. Ten out of 54 biliks were empty. Some villagers were often occupied with farming, while others were studying, working outside of Bekiok or offshore, rarely returning to the village. This made some informants participate repeatedly in several activities, affecting the representativity of the collected data. This might also have put too much pressure on particular informants, making some villagers refuse to participate in further activities.

Often, the activities were carried out in the *ruai,* the long common walkway within the longhouse. We soon realized that this could be a challenge if the aim was to obtain data on individual household characteristics. Several times, individual SSIs were joined by others sitting close by, who answered and discussed the topic together. Although for certain activities, like PRAs, such gathering of people may have helped the data collection, for the SSIs it represented a limitation affecting the data collection, since these had been aimed for specific individuals only.

Another difficulty that emerged was the villager's tendency to consider us as experts and to ask advice and opinions on the possible causes of, for instance, pepper vine diseases. Since we did not possess this knowledge, it was important to be careful not to create false expectations, even if this sometimes led to disappointment.

The limited time we had available to carry out the fieldwork prevented us to repeat the activities or to triangulate the obtained data. Furthermore, we were not able to observe possible trends and variations connected to the change of seasons or to compare the data coming from different years.

2.3.1. Language & the interpreters

The collaboration with the Malaysian counterparts, within an international and intercultural context, represented a central part on our fieldwork. Our group consisted of four UNIMAS students and us; four students from Copenhagen and Roskilde University. The collaboration benefited our work considerably since our colleagues could help us understand local customs and some of them were also able to speak fluently or understand Iban. Thanks to the counterpart's language skills, we were able to work in more groups simultaneously, allowing us to collect data faster. During some activities, however, such as the Venn diagram or the crop preference ranking, this has represented an issue since we were not able to follow the conversation, finding ourselves in the role of observers.

One of the main limitations of our fieldwork was related to translation. Since most of the villagers did not speak English, the translators were likewise essential for our activities. They made communication possible, introduced us to the villagers and helped us understand the cultural differences and customs of the place. In our case, one of the interpreters came from the village. She had a fundamental role as a gatekeeper in helping us to gain the trust of the village and to understand its internal dynamics, roles and customs. However, in the process of translation, parts of discussions and nuances of conversations were inevitably lost. Similarly,

misunderstandings of answers can have occurred at different levels of the translation. When transcribing our interviews, we wrote down the central meaning of each sentence, sometimes in a word for word account. The quotes included in the report have been slightly edited for grammar and linguistic mistakes in cases where the understanding could get lost. We are aware that the process of transcribing, and having several people doing this, while 'editing' the data, risk to distort the original meaning of the statements.

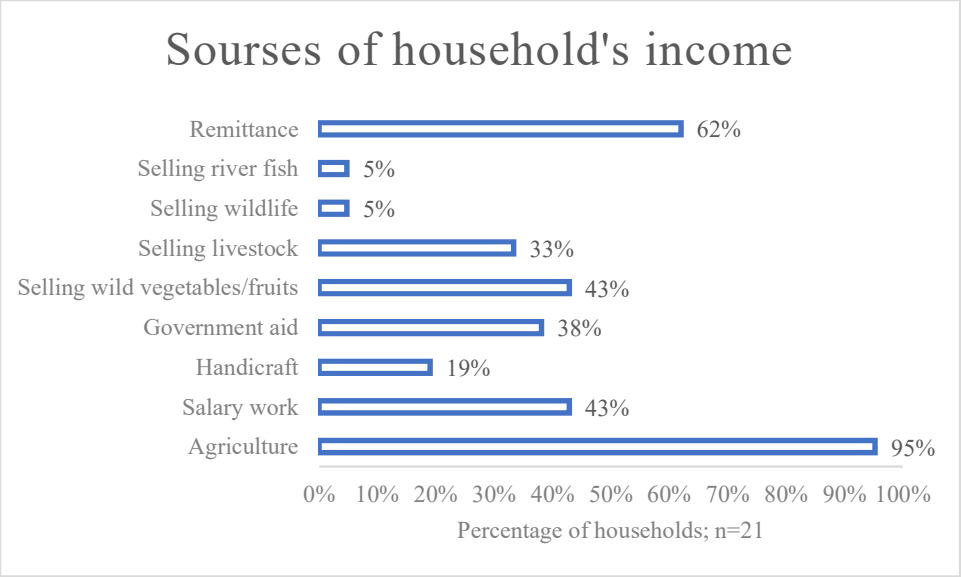
3. Livelihoods in Bekiok

This section will briefly introduce livelihood strategies of people in Bekiok, the organisational context they are living in and the environment that surrounds them. We will refer to these data later on in our analysis.

3.1. Livelihood strategies

Most of the households in Bekiok are, to different extents, involved in farming (95%; see Figure 3). Nevertheless, it is not the only livelihood strategy and the majority of the households additionally receive income from other types of activities, illustrating how they diversify their income sources (Ellis 2000; Ichikawa 2007). One household (5%) rely on farming as the only source of income. However, they likewise diversify by sustaining themselves with diverse forest products, fishing, wild vegetables and also food crops for self-consumption such as paddy and fruit trees (questionnaire).

Figure 3: Sources of household's income



The questionnaire data also shows how remittances from relatives working in the country or offshore play an important role in the household's income (62% households). From the timelines, we learned that the search for offshore work slowly started around 1977 when one man went to search for work in Brunei. Shortly after, he was hired by an offshore company in Singapore. Subsequently, he helped other villagers and since then, 23 men from Bekiok have been working offshore. Currently, there are seven of them (SSI Farmer 3). Despite hard

working conditions, it enables people to gain financial capital as illustrated by the following quote:

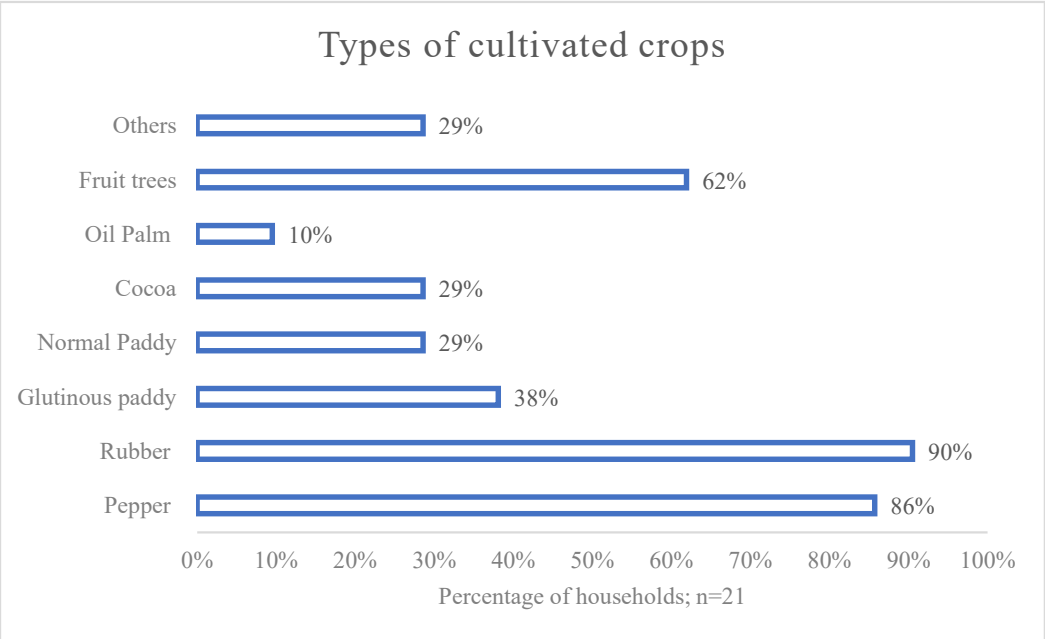
> *"He is saving a lot of the money he is earning in order to send his two children to school and give them better opportunities for creating their own future."*
>
> *SSI - offshore worker*

Income from remittances played also an important role in the possibility to increase physical capital and take advantage of the road. Compared to 1990, when only two people owned a car (app.11), the majority of the households nowadays possess at least one car (questionnaire). Moreover, the process of modernization opened up new livelihood possibilities such as aquatic cultivation (fishponds) or sale of river fish, which was not possible without the road and easier access to the market (app. 12.; SSI fisherman).

3.2. Current agricultural situation

The most commonly cultivated crops among the villagers are rubber and pepper (see Figure 4). Farmers, however, do not focus solely on these two and instead cultivate many other crops both for selling and self-consumption. Cultivation of oil palm started only 6 years ago and currently four people in the whole village focus on its cultivation (SSI Farmer 4). Similarly, cultivation of cocoa has started to increase while traditional paddy cultivation has declined (app. 11).

Figure 4: Types of cultivated crops



"Others" mainly refer to vegetables

Concerning cash crops, only 15% of the households rely exclusively on one type of crop (rubber, pepper or cocoa) whereas 50% of the households focus on a combination of pepper and rubber to which some add cocoa (25%) or oil palm (10%). Cash crops cultivation is, however, also supplemented with the cultivation of different fruit trees and vegetables, both for self-consumption and selling (questionnaire). This points to the importance of crop diversification.

The most important crop for income, based on both the questionnaire and the crop preference ranking, seems to be pepper (see Figure 5 and 6). Pepper is however connected with high production cost and is more prone to diseases compared to other crops.

Figure 5: The most important crop for income

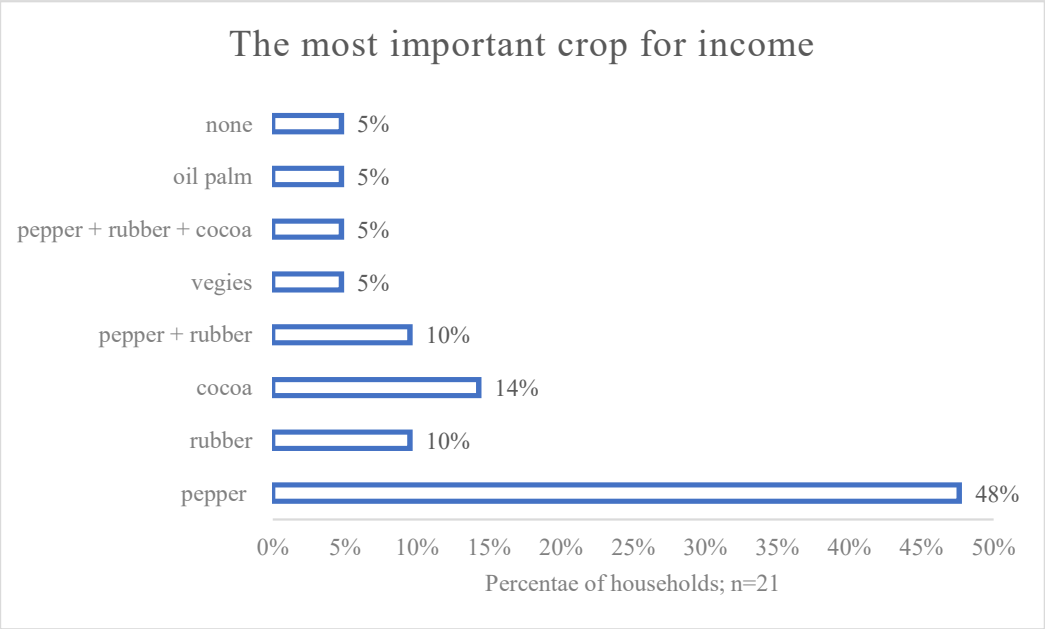


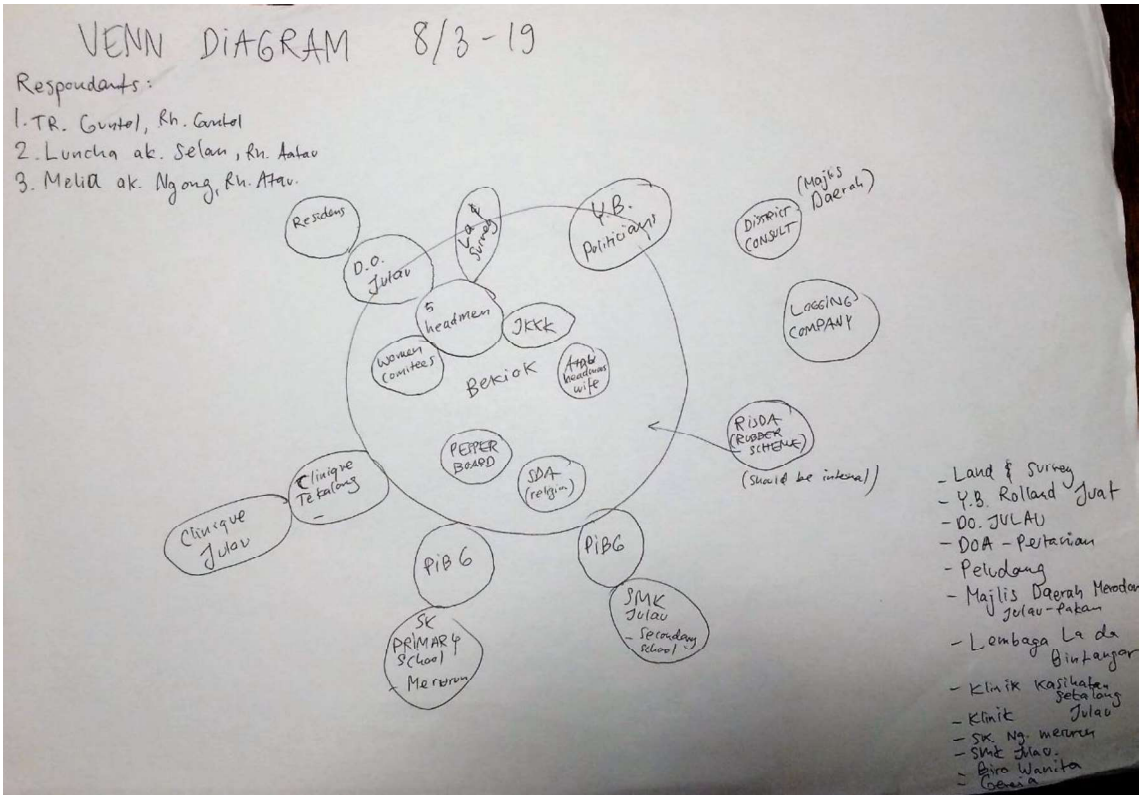
Figure 6: Crop preference ranking

Criteria/Crop	Pepper	Cocoa	Rubber	Normal rice	Glutinous rice	Fruit trees	Oil Palm
Income							
Fertilizer							
Pesticide							
Labour intensity							
Yield							
Production cost							
Subsidy							
Prone to disease							
Prone to pest							

3.3. Organisational structure of Bekiok

To investigate key organizations and institutions affecting livelihoods in Bekiok, we made a PRA session to construct a Venn diagram with a group of villagers (see Figure 7). When looking at the internal context of the village, the five headmen were highlighted as important actors responsible for facilitating a discussion between the villagers and external organisations as Department of Agriculture (DOA) and Malaysian Pepper Board (MPB). A women committee and a common organisation for all the longhouses, 'JKKK', were similarly highlighted as main institutions within the village. Related to land use strategies, the most important institutions mentioned was Rubber Industry Smallholders Development Authority (RISDA), a subsection of the DOA, providing the rubber scheme; the MPB, providing subsidies for pepper plant and training for the farmers; as well as the Julau District Council, providing assistance regarding drainage and waste disposal.

Figure 7: Venn diagram



3.4. Nature around Bekiok

From the questionnaire, we learned how forest plays an important role for many people in Bekiok. Many people collect wild fruits or vegetables (86% of the households), use timber for firewood (62%), go to the forest to hunt (38% households) or collect non-timber products (38% households), important for handicraft production (see Figure 8).

From our transect walk, we learned that local forest products can be used in a large number of ways. We identified among others 28 trees as food sources, 14 trees as construction materials or one plant used for medical purposes, which illustrates the importance of forest for the livelihood of the villagers. We identified among others 28 trees as food sources, 14 trees as construction materials or one plant used for medical purposes, which illustrates the importance of forest for the livelihood of the villagers (app. 15). Similarly, from the questionnaire, we learned how people are also using the river in many different ways such as a food source (86% household) and waste disposal (see Figure 9).

Figure 8: Uses of forest

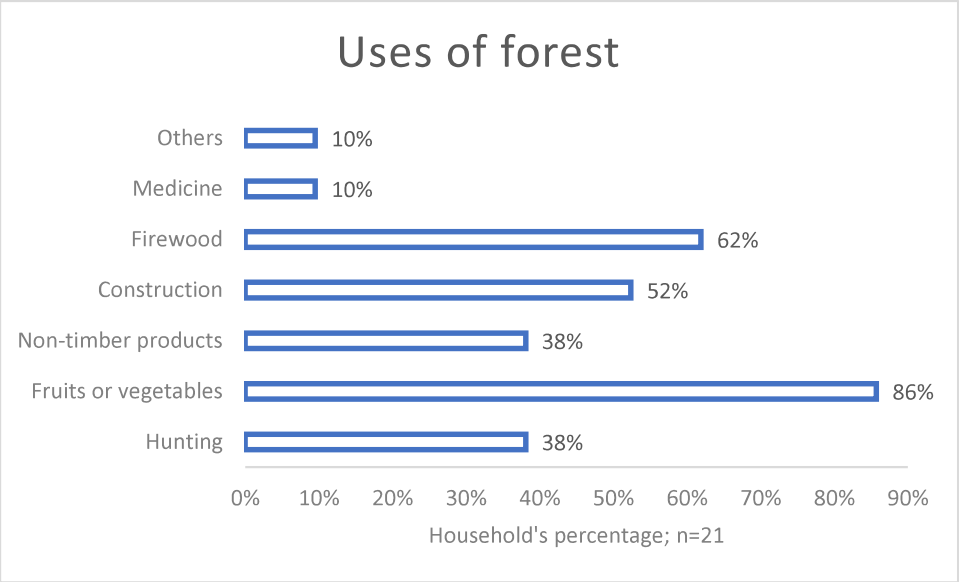
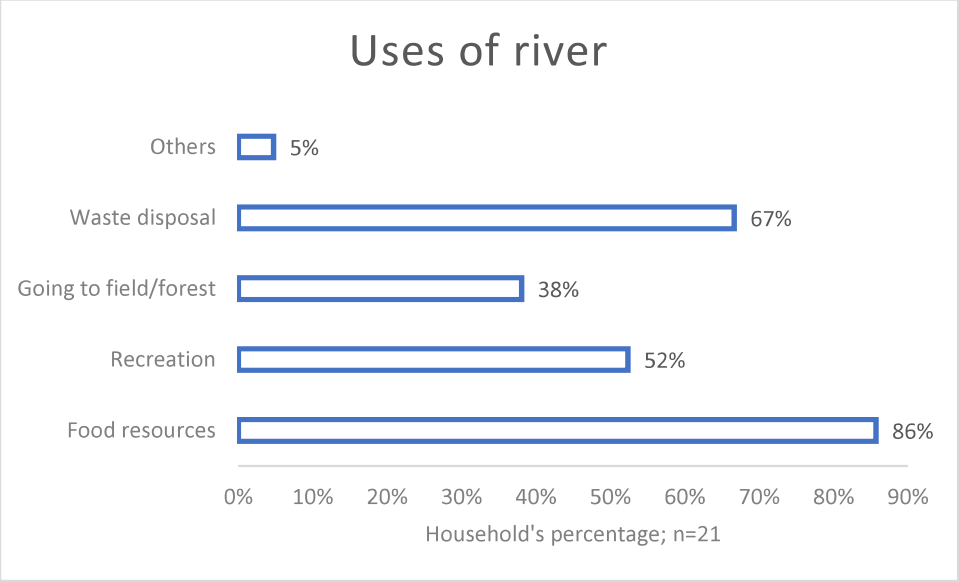


Figure 9: Uses of river



4. Key drivers affecting land use strategies

In the section above, we have presented the natural surroundings, the organisational structure and given a broad picture of the overall livelihood strategies in Bekiok. We will now specifically focus on land use strategies and look into three key drivers affecting these; a process of modernization encouraged by governmental policies, market prices and crop diseases.

To analyse the impact of the main key drivers, we will use terminology from the Sustainable Livelihoods Framework (DFID 1999). The policies and initiatives by the Department of Agriculture and the Malaysian Pepper Board will be analysed as a *'transforming structure'*, while the market prices and crop diseases will be referred to as constitutive for a *'vulnerability context'* for the villagers in Bekiok.

4.1. A process of modernization

The case of Bekiok illustrates how a process of modernization, encouraged by development policies foster change on a local scale. As mentioned in the introduction, the establishment of a road network and a focus on large scale agricultural plantations have been (and still are) two main political strategies to develop rural areas in Sarawak (Windle et al. 1997; Windle 2002; Cramb and Sujang 2013; app.10).According to one of our informants in a resource mapping session, "*things started to change with the road"* (app.12). The road, which was constructed in 1990 and sealed in 2014, have for some villagers meant easier access to the market (app.11), to the fields (SSI farmer 3), to schools (SSI fisherman) and more frequent visits to healthcare and other cities like Julau (app.5; app.11). Simultaneously, some of the villagers have pointed to how the road has impacted cultivation practices in the village. An important decrease in paddy cultivation and increase in pepper production came with easier access to the market whereas the buying cars became possible with the income from remittances (app.11). Several fields were additionally relocated in order to cultivate land closer to the road (app.11; app.12), as also observed in the study by Hansen and Mertz (2006).

From an interview with DOA, we learned how the governmental vision of 'big scale', 'commercialized' agriculture in addition to improved infrastructure is a dominant political strategy in the Julau district:

> *"In the past, when we did individual schemes, a lot of projects failed. Nowadays, we move towards commercialized. The project will run by the contractor. The contractor will do the work for the farmer. We are focusing on a big scale."*
>
> (Interview – Department of Agriculture)

In the case of Bekiok, the vision of 'big scale' plantations is reflected in the schemes and subsidies being provided to the village. In 2013, a 'rubber block planting' of 165 hectares was provided to Bekiok by DOA. The project was put out to tender and subsequently, a chosen contractor carried out the project for five years, during which Indonesian workers were hired to work in the field. All was done and provided without economic costs for the farmers, from clearing the land, terracing, planting new trees to applying the fertilizer. After the 5 years, the farmers in Bekiok should take over the management of the field (app.10).

Public organisations and the policies they implement can, using the terminology from the SLF, be conceptualized as *transforming structures and processes* affecting the land use strategies of the farmers in Bekiok. These structures and processes 'create assets' and 'determine access' for people (DFID 1999). In Bekiok, government policies have created assets by the investment in a road, increasing the physical capital of the villagers. The DOA and the MPB provide schemes and subsidies to selected farmers, in order to sustain agricultural production (leading to natural and financial capital), while advice and courses about cultivation practices are offered to provide knowledge (human capital) to the farmers. However, not everyone has access to these assets. For instance, not all farmers receive the subsidies they apply for. Not everyone has fields located close to the road, making them able to benefit from the improved infrastructure in terms of agricultural work. The difference in access and people's strategies to cope with this will be elaborated later on in the analysis.

The representative from DOA stated how three main crops; pepper, oil palm and rubber, are currently promoted by the government. As illustrated by the following quote, the donation of subsidies is one way for DOA to directly 'encourage' or regulate the land use decisions of the farmers:

" Last year we gave them subsidies for new planting. This year we just give maintenance. We don't encourage them to plant new pepper."
(Interview – Department of Agriculture)

It is thus within the constantly changing context of subsidies being given or refused that farmers need to navigate to make decisions about how to cultivate and manage their land. From interviews with farmers in Bekiok, the dependency on subsidies or schemes provided by DOA and MPB became clear. In an interview, women farmers explained how it was a major challenge not to receive subsidies from the government:

Maybe all of you could tell me something about the challenges of being a farmer here in Bekiok?

Basically, the most major challenge would be if we don't receive the scheme. [..] If you have the scheme, it will be the opposite way. Because you don't have to spend.

Several farmers likewise presented the subsidies as determining for which crops to plant:

And about the future, would you like to plant any other crop?
If the government give me the subsidy I´d like to plant oil palm.
(Interview - Farmer/contractor)

These quotes illustrate how the agricultural policies, as a transforming process of modernization, determine access for people (DFID 1999). Through subsidies, DOA and MPB have to some extent power to influence, which crops people should grow. In a few cases, however, we observed how farmers with sufficient financial capital were able to invest in the cultivation of new crops without subsidies. During a visit to an oil palm field, we were told how this was established with the economic means of the farmer himself.

4.2. A Vulnerable Context

In Bekiok it became clear how, besides governmental policies, fluctuating market prices and crop disease in the pepper vines likewise affected people's assets and their land use strategies. The market price and pepper disease can, using the terminology of the SLF, be perceived as 'trends' and 'shocks' comprising the vulnerability context – 'the external environment in which people exists' (DFID 1999).

4.2.1. Market prices

The market prices of rubber and pepper, two of the main cash crops cultivated by the farmers in Bekiok (Figure 4 in 3.2.), have been constantly decreasing since 2016. The price for rubber is now only 3 RM/kg compared to 15 RM/kg 10 years ago (SLUSE 2019; app. 5) indicating how the rubber scheme provided by the government does not have a great economic impact for the local farmers. The graph below shows how pepper prices in Sibu peaked in 2015-2016, with 26 RM/kg for black pepper and 42 RM/kg for white pepper. Since 2016, pepper prices have drastically decreased. From our questionnaire, we learned how the farmers in Bekiok now get an average of 8.5 RM/kg for black pepper (questionnaire; app. 6). However, many farmers continue to plant pepper, since this is still one of the most profitable crops (app. 6).

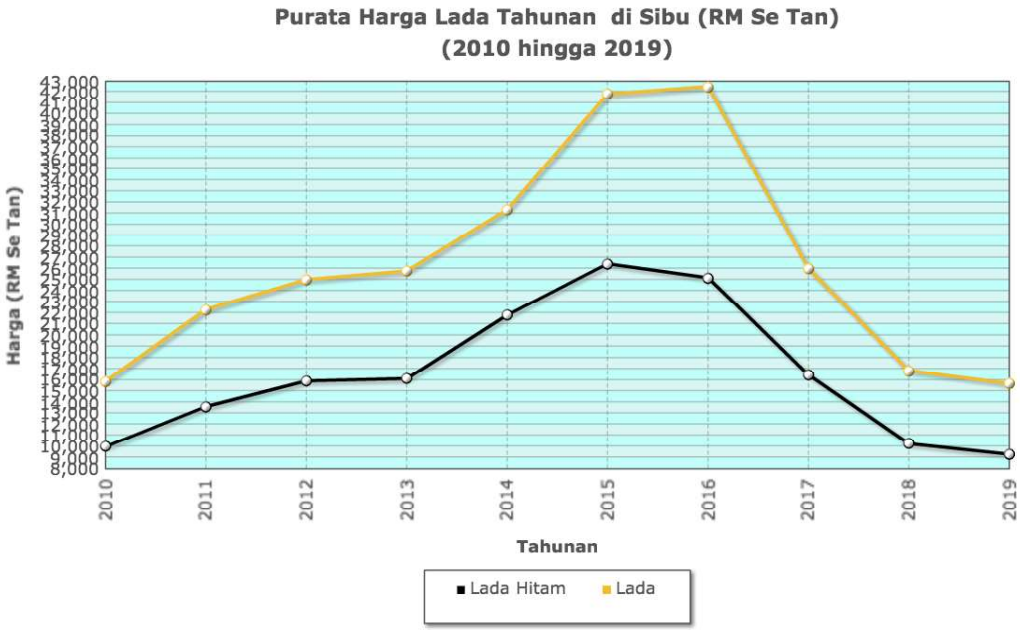


Figure 10: Average annual pepper prices (black and white pepper) (Malaysian Pepper Board, 2019)

According to the following statement of the headman, a decrease in market prices affect the assets; the financial capital possessed by the villagers. As stated in the quote, the drop in pepper price has now made the villagers more dependent on the remittances from off-farm activities of household members working outside of Bekiok:

Back then pepper had a good price; then it dropped; villagers are now struggling and some of them have a heavy reliance on remittances. *(Interview – Headman 1)*

This was evident both from the numbers of households relying on off-shore work and remittances of family members identified through our questionnaire (Figure 3 in 3.2.). The market price, as *an economic trend*, affects the number of returns from chosen livelihood strategies (DFID 1999). In this sense, the market price is an important factor mentioned by the farmers in relation to decision-making about potential new crops to grow:

Why did it [crop cultivation] change?

It used to belong to her parents, but after the dropping price of the rubber, she changed to pepper. Because the market price was quite good back then.

[..]

We are planning to focus more on cocoa. Because we heard that the price will be really nice.

(Interview - women farmers)

4.3. Pepper disease

Besides fluctuating market prices, a pepper disease was highlighted as a major challenge by the farmers in Bekiok. In terms of the SLF, the crops disease can be perceived as a 'shock', directly affecting people's assets (DFID 1999). The disease started to spread in 2017. This has badly influenced the yields of many farmers since (app.3, Figure 6, app.10, app.6). In a transect walk, one farmer showed us his pepper field where a large number of vines had died. Through a questionnaire interview, one farmer told us how he had lost 900 out of 1000 pepper vines because of the disease outbreak. In the resource mapping session, the participants stated that 'they are struggling to figure out exactly what is wrong with the crops, and they don't really know where to go for more knowledge' (app.12).

In relation to the SLF, it is described how organisations through policies can help cushion the impacts of external shocks (DFID 1999). In the case of Bekiok, this could mean providing political assistance to compensate for the drop in pepper prices and the lost yield from the pepper disease. However, when asked about how DOA face the drop in the price of pepper, the representative answered: "*Most people in the longhouses don't have any other option. They don't have another way to generate the income, they have to do pepper"* (app.10). Later in the interview, he explained how the department encourage farmers only to cultivate pepper on a small scale (200-400 vines) due to the risk of pepper disease (app. 10). Regarding oil palm, they do not support oil palm plantations, '*since the area around Bekiok is hilly, making the cost very high'*. These statements indicate how, in Bekiok, the impacts of external shocks, such as the drop in pepper price and the pepper disease, might not be cushioned by having any alternatives offered from a political level, in order to sustain agricultural production as a reliable livelihood strategy.

As argued in the paragraph above, farmers in Bekiok need to navigate their land use strategies within a vulnerable context, influenced by constantly transforming key drivers such as governmental policies, market prices and potential outbreaks of crop disease. In the following section, we will further examine land use adaptation strategies to these drivers employed by the villagers in Bekiok.

5. Adaptation strategies

To adapt to the changing environment in which villagers in Bekiok live, farmers have employed different land use strategies in order to 'survive and improve their standards of living' (Purpose of livelihood strategies in Ellis 2000). Cooke et al. (2011) point to the importance of perceiving local people as active agents, adapting to changing times. The following section will look into three possible adaptation strategies; the selection of cultivated crops, crop storage and the relocation of fields. Furthermore, we will discuss who is able to employ which adaptation strategies.

5.1. Selection of cultivated crops

In Bekiok, it was evident how many farmers cultivate more than one crop in order to be resilient to potential price reductions or decreases in yield (see Figure 4 in 3.2.). This is illustrated by statements as the following:

> *They do cocoa farm because it adds up to their variety of cash crops with minimum effort and less maintenance. This acts as a back-up for them if any of their other cash crops were to fail or face price reduction.* (interview - Farmer 1)

Multicropping is thus a way to have a 'back-up' and to prevent being 'vulnerable from only growing one crop' (app. 5). In an interview, a group of women farmers likewise stated how they, due to the pepper disease, stopped focusing on pepper and instead started to focus on other crops such as corn, eggplant and beans (app. 3).

The spreading of the pepper disease similarly entails a decision of what to replant in the fields of the dead pepper vines. From the agricultural transect walk, we learned how some farmers replaced the dead vines with yams, while others replanted with paddy. During the crop preference ranking session, we were told how some farmers plant pepper in the same fields again, hoping for the disease to disappear, while a few farmers change to oil palm since they experience that oil palms are not affected by the pepper disease (Figure 6 in 3.2)

Using the terminology from the SLF, these different strategies require different amounts of *capitals*. Since oil palm plantations are currently not subsidized in the area of Bekiok and thus, all the seedlings are bought by the farmers, the decision to plant oil palm require high financial capital (app. 4, 10; Figure 6 in 3.2.). To start an oil palm cultivation likewise requires

having fields near to a road network (physical capital), having sufficient labour force to carry the heavy fruit bunches to the mean of transportation (human capital) and, if the area is hilly, having enough financial capital to make terracing (app. 4, SSI farmer 3)

5.2. Crop storage

Another adaptation strategy presented by the farmers, mainly to face the drop in market prices, is to store their harvested pepper, in order to sell it once the price starts to rise again. This indicates how the crop can be used as a valuable deposit, instead of an immediate source of income:

I still store pepper in my apartment and I wait for a better price.
How long?
2 years
So you are still waiting for a better price?
Yes. I have 12 bags of pepper.
How many kilos?
1 bag is approximately 60 kg

Interview – Farmer 2

Since storage of pepper requires having enough financial capital from elsewhere for daily consumption and fertilizer investment, this is only done by some farmers. Thus, there is a difference between who can afford to store their crops until the price is right, and who is forced to sell it at the current market prices. Storage simultaneously involves a potential risk of losing the harvest, since stored pepper can go mouldy and the quality potentially can decrease (app. 6).

The strategy ’to wait for a better price’ is likewise evident in relation to rubber. Some farmers state how the rubber price is currently too low to tap the trees: ”*Now the price is too low. 3RM is not enough. If a person gets 10 kg is 30 RM per day. It is not enough”* (app. 5). However, not all farmers stop tapping the rubber and employ this strategy. In a participatory observation session, we went with a farmer to tap his rubber trees. Even though the income from the rubber trees was small, this was still done as an additional source of income.

5.3. Relocation of fields

As a response to the pepper disease, farmers that had several pieces of land in different places relocated their cultivation: *If the tree is affected, it cannot be cured, and the farmers will plant at different land* (notes - crop preference ranking). However, as the quote below illustrates, not everyone has spare land to employ this strategy:

> *In the pepper vines, she noticed the pepper started to die. She didn't do much about it, she decides to plant cocoa next to where the plant died. […]*
>
> *But she was also mentioned, those who have another land – they will usually ignore the ones that are dying and then they will start to plant the new pepper in the other land. If they have. Only if they have.* *Interview – Women farmers*

Some farmers with a high income but remote fields similarly abandoned old fields to cultivate land closer to the road (app. 12). To abandon old fields in order to begin to cultivate elsewhere requires either a large amount of land (natural capital) or financial capital to buy new land.

As illustrated in the section above, the farmers in Bekiok are active agents in adapting to the vulnerability context in which they live. However, people adapt differently based on the different assets they possess. The fact that not all farmers are able to adopt similar strategies points to how not everyone benefits from the process of 'modernization' carried out by the government. The improved infrastructure and the subsidies given do not provide the villagers with equal opportunities to cope with a decreasing market price or a potential outbreak of crop diseases. In contrast, the 'process of modernization' might lead to an increased inequality within the community, allowing some farmers to invest in more profitable livelihood strategies than others (Abdullah 2007; Mertz et al., 2013).

6. Impacts on the environment

Different adaptation strategies imply various ways to manage the land in terms of for instance external inputs of agrochemicals. Changes in land use management can put pressure on the environment and it's quality on many different levels. In this section, a few aspects of possible impacts and their perception by the local community will be discussed.

6.1. Changes in soil quality

Firstly, the possible impacts of different cash crop cultivation on the soil quality will be analysed.

6.1.1. Soil quality from villager's perspective

The perception of soil quality among villagers slightly differ. Generally, soil quality around Bekiok is viewed as 'medium' and some claim that soil quality "is not important"; 'as long as fertilizers are applied, any crops can be cultivated' (app. 9, SSI farmer 3). While some farmers do not see agricultural activities as a threat for the soil quality (app. 5), some, in contrast, express concerns about the excessive amount of fertilizers that need to be used to sustain intensified production (app. 4). A negative change in soil quality was only described in an informal interview by a farmer having oil palm field (where soil sampling was performed). He states that after three or four years of oil palm cultivation, the soil became harder and started to break.

6.1.2. Chemical parameters

Since only one composite soil sample was collected in each field, no statistical analysis can be made. The results can however still give an impression of major trends. In respect of colour and texture, all soil samples appeared to be similar and were characterized by light brown colour (see Figure 11). According to the field texture analysis (FAO, 2006), the soil was

Figure 11: Documentation of soil sampling

classified at the border of clay and sandy clay. Chosen parameters linked to soil fertility are shown in Table 1 and described individually.

Table 1: Soil quality parameters in different fields

Field		Bulk density /g cm^{-3}	pH	Total N /%	Total C /%	SOM /%	C:N ratio	c $P0_4$-P /mg kg^{-1}	c NH_4-N /mg kg^{-1}	c NO_3-N /mg kg^{-1}
Rubber 19 years	1st layer	1.20	3.9	0.17	1.98	3.41	11.65	8.98	6.68	0.9
	2nd layer		4.0	0.14	0.97	1.67	6.93	4.49	5.55	0.34
Oil palm 6 years	1st layer	1.32	4.0	0.15	1.35	2.32	9	6.76	5.34	5.21
	2nd layer		4.0	0.13	0.91	1.57	7	5.45	2.82	1.56
Secondary forest >40 years	1st layer	0.74	3.8	0.15	1.85	3.18	12.33	5.35	6.14	2.72
	2nd layer		3.9	0.14	1.16	2	8.29	4.77	4.89	2.03
Pepper 9 years	1st layer	1.13	4.0	0.16	1.37	2.36	8.56	5.33	0.87	9.96
	2nd layer		4.0	0.12	0.71	1.22	5.92	6.58	5.04	2.65

[a] SOM…soil organic matter

Bulk density

Bulk density indicates the level of compaction of a given soil and it is an important soil characteristic for structural support, solute and water movement, as well as soil aeration. According to Arifin et al. (2012), bulk density > 1.5 g cm^{-3} may implicate adverse effects as it can restrict root growth and water, air and nutrient (e.g. in form of fertilizers) movement through the soil. High compaction can further lead to reduced plant growth, reduced yield and can potentially enhance soil erosion on steep slopes. All measured values were below the threshold value of 1.5 g cm^{-3} indicating that soil compaction is probably not of major importance. However, a trend of increased bulk density at permanent cultivation fields; pepper, rubber and oil palm (1.13; 1.20; 1.32 g cm^{-3} respectively), when compared to secondary forest (0.74 g cm^{-3}), can be observed. The highest bulk density was found in the oil palm field, which is in line with results of Bruun et al. (2013) that show a significant increase in bulk density upon establishment of oil palm from swidden agriculture.

Soil acidity (pH)

Soil acidity determines the availability of nutrients for plants and affects microbial activity (Juo and Franzluebbers, 2003). As revealed from Table 1, pH was comparable in all plots and ranged from 3.8 to 4.0. This indicates that all sampled soils are acidic (pH < 7), which is characteristic for tropical regions and Malaysian soils that are highly weathered and have low fertility status.

The ideal pH for nutrient availability lies between pH 5 and 7, whereas high and low pH is detrimental for plant growth (Sung et al., 2017). Soil pH can be significantly lowered due to excessive use of nitrogen-based fertilizers as well as certain pesticides. In our case, all samples can be considered as strongly acidic (pH < 5.2) according to Juo and Franzluebbers's classification (2003), even though local farmer use dolomite ($CaMg(C0_3)_2$) after harvest to neutralize the soil at their fields.

Total N%

Nitrogen is one of the most important macronutrients for plants (Juo and Franzluebbers, 2003). The nitrogen status in soil is a short-term variable as it will vary with fertilizer application. Surprisingly, the levels of total nitrogen are comparable in all the fields even though the fertilizer application is not equal (see Figure 6 in 3.2.). A slightly higher percentage is observed in the first layer (0.15% to 0.17%) compared to the second layer (0.12% to 0.14%). According to Arifin's classification (2012), these values fall under "moderate and adequate levels" (0.1 to 0.5).

Total C% (SOC)

Soil organic carbon is another indicator of soil quality and it is positively correlated with the yield. It affects key processes in soil such as nutrient storage, erosion control, water holding capacity, and microbial activity and biodiversity (Cardoso et al., 2013). According to Arifin's classification (2012), SOC of 1.5 to 5% falls under "moderate adequate levels" which is the case for secondary forest and rubber soil samples from the first layers (1.85%; 1.98% respectively), whereas SOC < 1.5 % indicates "low levels possibly indicating organic matter loss", which is the case for first layer soil samples from pepper and oil palm fields (1.37%; 1.35% respectively). Lower SOC in pepper and oil palm fields could be explained by microbial breakdown stimulated by more intense application of mineral fertilizers or general soil disturbance compared to rubber and secondary forest (Bruun et al., 2009; Figure 6 in 4.2). It is however surprising that the rubber field has slightly higher SOC than secondary forest. In recent studies, a significant decrease in SOC was found in oil palm fields (Bruun et al., 2013; Rahman et al., 2018) which to some extent supports our limited data. SOC reduction might negatively influence the soil quality and have a negative effect on the long-term productivity of the soil and pose problems in future (Rahman et al., 2018).

Soil organic matter (SOM)

Soil organic matter (SOM) can be estimated from SOC value (by multiplication with a factor of 1.7) and follows, therefore, the trend of SOC values (FAO, 2006). Even though SOC and SOM are used as indicators of soil quality, their sensitivity to changes is low and thus will be revealed after a long-term period. The credibility of these parameters is therefore often discussed and criticized. Contrarily, soil microbial biomass seems like a promising tool to detect a rapid response in soil quality to a changed system (Cardoso et al., 2013).

Soil erosion

Intense rainfall characterizing tropical region can cause problems in terms of soil erosion and soil degradation (such as loss of soil organic matter), which is of concern in steep agricultural fields (Rahman et al., 2017). The soil erosion potential of the fields where soil samplings were performed is represented in Table 2. It is important to note that the method was developed for Canadian settings (Stone and Hilborn, 2015) and is therefore not perfectly suited for tropical regions, influencing the credibility of our results.

Table 2: Estimation of soil loss based on universal soil equation A= R x K x LS x C x P (Stone and Hilborn, 2015)

Field	Slope /%	Length of the slope /m	R[a]	K[b]	LS[c]	C[d]	P[e]	**A[f] / t ha^{-1}**
Rubber	35	250	340	0.5	3.9	0.05	0.50	**6.6**
Oil palm	35	100	340	0.5	2.7	0.10	0.50	**22.9**
Secondary forest	35	100	340	0.5	2.7	0.05	0.10	**2.3**
Pepper	35	100	340	0.5	2.7	0.30	0.25	**34.4**

[a] R…rainfall and runoff factor
[b] K…soil erodibility factor
[c] LS…slope length-gradient factor
[d] C…crop/vegetation and management factor
[e] P…support practice factor
[f] A…estimated average annual soil loss, metric tons per hectare per year

Although all fields had the same slope and length except for rubber field, the erosion potential differed. According to classification developed by (Manaf et al., 2016), the erosion potential of secondary forest field can be classified as “low” (1 to 5 t ha^{-1}), the one of rubber field as moderate (5 to 10 t ha^{-1}) and oil palm and pepper field as severe (20 to 50 t ha^{-1}), with pepper having the highest erosion potential. Soil erosion can have negative consequences on the environment. It can cause soil resource depletion and in turn decrease in crop yield. In long-term, it can lead to soil and water quality (e.g. turbidity, particle-born pollutants) decrease or disturbance of hydrological regimes (Labrière et al., 2015).

6.2. Change in water quality

Water quality can be adversely influenced by run-off of organic matter, sediment or leaching of nutrients and pesticides from intensively managed permanent fields (Bruun et al., 2009; Labrière et al., 2015).

6.2.1. Villager's perception of water quality

Some people in Bekiok are still relatively dependent on the river in terms of fishing and recreational purpose as discussed in section 4.4. From interviews with several villagers, it became clear how there is a perceived drop in the quality of the river water. The informants agree that the amount of fish and their size have decreased, and some fish have even disappeared from the river due to their sensitivity to clean water (such as Tor tambroides; *Empurau* in Iban and catfish Wallago attu; *Tapah* in Iban) (app. 7. 8; SSI fisherman). Hossain et al. (2008) show that the population of Wallago attu are endangered and declining due to both overfishing and environmental pollution, not allowing to conclude on the state of the river water quality. Moreover, some villagers state how water has become more turbid, muddy and shallower. The opinions about the reasons differ, but most people give importance to increased waste in water, as evident from the following quote:

> *The water before. It was really clean and really clear. But now. People throw in rubbish and waste, so maybe it somehow affects the quality of the water.*
>
> *(interview – Headman 2)*

It seems that in relation to the road access, the amount of waste increased as people are now able to bring "more waste back to the village" (SSI fisherman). Another perceived reason for the decreased water quality in rivers is logging activities (app. 5, 7; SSI fisherman). Lastly, while some disagreed that agriculture could have an impact on the environment at all (app. 5), some have seen soil erosion from steep rubber, pepper and oil palm fields next to the river as a possible reason (SSI fisherman).

6.2.2. Physical, chemical and biological measurements

Table 3 reveals the measured values of six water quality parameters used to calculate 'water quality index' (WQI) (Anon, n.d.). The water gravity feed (ST1) has the highest water quality score and can be classified as class I (excellent). Similarly, downstream of the oil palm field (ST3) can be classified by quality class I (excellent), whereas upstream of the oil palm field (ST2) as class II (good). This goes against our hypothesis that intensive agricultural activities (oil palm field) might impact the water quality (Bruun et al., 2009). However, our data are questionable as they are limited by many factors such as the difference in sampling time, not enough repetitions as well as the fact that the running waters at individual sampling points are of different size and thus biased due to dilution. Water quality in the main river downstream of the village (ST4) can be classified by water quality class II (good). This sampling point was a consequence of miscommunication and we have therefore no reference point (upstream of the village) to be able to further elaborate.

Table 3: Parameters of DOE WQI (water quality index)

Parameters/ Location	Gravity Feed (ST1)	Pinang river upstream (ST2)	Simpang Batang river downstream (ST3)	Merurun river downstream Ng Bekiok (ST4)	Compliance limit[a]
pH	8.44	8.76	7.03	8.24	>7
DO /mg L	**5.64**	**5.19**	**5.91**	**6.02**	>7
BOD /mg L	0.6	0.21	0.98	0.92	<1
COD /mg L	0	**20.5**	2.5	2.5	<10
TSS /mg L	6	**30**	**62**	**103.35**	<25
AN /mg L	0	0.1	0.025	0	<0.1
Subindex					
SIpH	83.49	73.28	99.28	87.2	
SIDO	80.5	72.9	84.6	86.2	
SIBOD	97.81	99.49	96.17	96.43	
SICOD	99.1	73.84	95.78	95.78	
SITSS	94.22	82.6	70.32	58.63	
SIAN	100.4	99.97	100.29	100.4	
DOE-WQI	92.3	83.8	90.4	87.5	
Class	I Excellent	II Good	I Excellent	II Good	

[a] source (Anon, n.d.)

Table 4 shows the measured concentration of nutrients which might be leached from the oil palm field. The nutrient concentration from upstream ST2 is higher than from downstream ST3, which can be due to the same factors as in the case of WQI parameters. Nevertheless,

some detected concentrations are even under detection limit (ND) and all except for phosphate concentration at ST2 are under compliance limit, suggesting that the agricultural activities from the oil palm field do not influence the river water quality.

Table 4: Nutrients concentration

nutrients	ST1	ST2	ST3	ST4	Compliance limit[c]
NH_3-N /mg L^{-1}	ND[a]	0.1	0.025	0	0.3
$N03^-$-N /mg L^{-1}	NM	NM[b]	0.015	NM	7
PO_4^{3-} /mg L^{-1}	0.125	**1.06**	0.04	0	0.2

[a] ND…not detected
[b] NM…not measured
[c] source (Anon, n.d.)

Table 5 summarizes additional physical and biological water quality parameters (values in bold exceed National Water Quality Standards NWQS for Malaysia). When looking at individual parameters from Table 3 and Table 5, we can see that dissolved oxygen (DO) was above compliance limit for all the stations, falling under class II (good) according to NWQS. Moreover, chemical oxygen demand (COD) in ST2 was above compliance limit, falling under class IIA. Total suspended solid concentrations (TSS), usually originating from soil erosion, are also above compliance limit; According to NWQS, ST2 is classified as class II and ST3 and ST4 as class III. Furthermore, faecal coliform count (FCC) were above compliance limit for all stations except ST2 falling under class II. Class II implies that "very sensitive aquatic species" may disappear. (Anon, n.d.)

Table 5: Additional physical and biological parameters

Parameters/ Location	Gravity Feed (ST1)	Pinang river upstream (ST2)	Simpang Batang river downstream (ST3)	Merurun river downstream Ng Bekiok (ST4)	Compliance limit[a]
T /°C	25.3	26.0	25.5	25.5	
Turbidity /mg L^{-1}	8.5	2.5	7.5	11.5	<5
Conductivity /mS cm^{-1}	0.022	0.027	0.022	0.020	1
Salinity /ppt	0.01	0.01	0.01	0.01	
TCC /counts ml^{-1}	1825	1450	1975	1975	<5000
FCC /counts ml^{-1}	**675**	200	**575**	**650**	<400

[a] source (Anon, n.d.)

6.2.3. Water quality based on stream assessment scoring system (miniSASS)

Results from the general quality of water using miniSASS method are summarized in Table 6 (see app. 16 for more details). ST4 is missing as the river's width did not allow invertebrate sampling. The results suggest poor condition for ST2 and very poor condition for ST3 which is in contraction to DOE WQI results. There are however many possible factors that could affect miniSASS results as discussed in the methodology section.

Table 6: miniSASS score

	ST2 (Pinang river upstream)	ST3 (Simpang Batang river downstream)
miniSASS Score	5.4	5
River category	Poor condition	Very poor condition

6.3. Decreasing forest and its value

Forest plays an important role for many people in Bekiok as discussed in section 3.4. Informants from our interviews stated how the forest has decreased and is decreasing due to logging and agricultural activities (app 8; SSI fisherman). Many people are concerned about deforestation as they think it is the reason behind a warmer climate in the local area and less predictable weather patterns (app 4., 5). Others are worried that children will lose knowledge about trees and forest (SSI fishman), which is part of Iban culture and identity and points at cultural ecosystem service of forest (Fujisawa and Nakashizuka, 2012). Additionally, it seems that wildlife has decreased (app. 4). The loss of forest, therefore, represents an important pressure on the environment as well as on people's lives (Stas, 2014). On the other hand, the expansion of agricultural activities is essential for people's livelihood (Figure 3 in 3.1.) pointing to the complexity of the issue.

6.3.1. Forest resource assessment

During the forest resource assessment, 19 different tree species were identified, and the aboveground biomass was estimated to be 139 metric tons per hectare (app. 17). The Shanon-Weinner Diversity Index equals 2.6, indicating that the 40 years old secondary forest is healthy and species diverse (FAO, 1997).

Based on the results in the sections above, a clear conclusion of whether different cash crop cultivation affects soil quality in Bekiok cannot be made due to method limitations. Results from water analysis also do not support our assumption that extensive use of fertilizer might affect the water quality through nutrient leaching. Instead, our result suggests that water quality might be impacted by soil erosion based on the increased level of TSS, supported by villager's perceptions and the soil erosion potential results.

7. Critical perspective

As indicated in previous section, there have been various factors impacting the results we have obtained throughout this fieldwork. Some of these factors have been external such as the weather, while others concern the selection of relevant empirical data, which have excluded possible areas of focus. Concerning our soil analysis, we were only able to carry out limited sampling due to a lack of time and accessibility, not allowing a proper statistical analysis. Furthermore, we lacked a reference sampling site, in terms of both spatial and temporal variability (de Zorzi et al., 2008). We could only use a constructed baseline from a previously cultivated area (secondary forest) instead of an undisturbed area (primary forest), which made the relative comparison of our individual soil samples less reliable. The lack of a temporal baseline applies to all of our natural scientific gathered data. Concerning water sampling, due to a misunderstanding, the collection was carried out in two separate days which could have influenced our data, given abundant rain in the meantime. Along with these factors, it is also important to emphasize that we lacked detailed knowledge about land-use management as we were not able to carry out a focus group with farmers, as initially planned. This could have influenced the quality of our data.

Through selecting informants in the field and subsequently the data for the analysis, we have come up with our analytical findings. However, the reality presented might have looked different using another methodological and analytical approach. As mentioned in our methodological section, it was rather difficult to obtain a diversified pool of respondents, and reoccurring respondents in different exercises led to an overrepresentation of certain demographic groups. This, along with the fact that the majority of the available respondents worked within the agricultural sector, meant that our final analysis has a main focus on the issues concerning farming in and around Bekiok. By our observations, there were several examples of people leaving Bekiok to work and settle down elsewhere, but it was an issue that was difficult to emphasize on since we had few direct informants at our disposal. Related to this, it is also worth mentioning that the empirical data involving respondents working away from Bekiok, such as for instance offshore workers, has to a lesser extent been included in our analysis. Including this aspect, we would have been able to elaborate more on the migration issue related to Bekiok.

Additionally, a large part of our respondents was within the same age range, which also contributes to a more biased foundation for creating our data. If we could have managed to

include for instance a larger segment of youth among our respondents, other main key drivers and adaptation strategies would most likely have been ascribed more importance in our analysis. Likewise, it would have enabled us to focus more on future adaptation strategies in Bekiok in a broader context.

Finally, it is also worth to mention that only external drivers affecting the land use strategies were investigated. Given the short timeframe of our fieldwork, we were not able to get a deeper understanding of internal dynamics.

8. Conclusion

The aim of this study was to identify key drivers affecting livelihood strategies, in particular, land use strategies, in the village of Bekiok, and to assess how changes in land use potentially affect the surrounding environment.

Through our fieldwork, we learned how many different key drivers affect the villagers' livelihoods. In relation to land use strategies, we identified three main constantly transforming drivers influencing these; the process of modernization encouraged by governmental policies, market prices and crop diseases.

We addressed how the governmental policies, as a *'transforming structure'*, affect several livelihood capitals of the villagers in Bekiok. The process of modernization encouraged by political strategies is reflected locally in Bekiok through improved infrastructure and subsidies provided to farmers. Through subsidies, organisations as the Department of Agriculture and the Malaysian Pepper Board encourage the cultivation of specific types of crops influencing most farmers' decisions about how to cultivate and manage their land.

We have analysed how fluctuating market prices on pepper and rubber, as well as a disease among pepper vines, constitute a 'vulnerable context' within which farmers in Bekiok need to navigate their land use strategies. These external 'shocks' affect the financial capital of the farmers. Furthermore, we have discussed how, from a political level, the impacts of these shocks might not be cushioned in order to help the farmers sustain their agricultural production as a reliable livelihood strategy.

Despite the challenges connected to farming, we discovered how a majority of our informants relies on agriculture as an income source. However, most villagers diversify their income with other types of activities, such as aquatic cultivation, selling fruits and vegetables or remittances from relatives working in the bigger cities or offshore. We learned how the nature around Bekiok plays an important role in the lives of the villagers. Both forests and rivers provide provisioning service in terms of food supply.

In analysing how farmers in Bekiok actively adapt to the changing environment brought by the identified key drivers, we have focused on three main land use adaptation strategies; the selection of cultivated crops, crop storage and relocation of fields. We have pointed to how people adapt differently based on the different assets they possess and showed that the process

of modernization does not necessarily create equal opportunities for everyone to invest in more profitable livelihood strategies.

When assessing the environmental impacts of the changes in land use, we learned how a decrease in the water quality of the river, and soil quality (in an oil palm plantation) was observed by the villagers. Furthermore, the villagers perceived the forest as being decreasing due to both logging and agricultural activities. From our analysis, different agricultural activities (pepper, rubber, oil palm cultivation) did not show to have an impact on the soil and water quality. Soil erosion from agricultural fields was, however, revealed as a potential risk to water quality, corresponding to the villager's perceptions. However, our data are influenced by many limitations and a clear conclusion about the impacts of agricultural activities on the environment cannot be made.

The case of Bekiok illustrates how a village in a rural area of Sarawak responds to its connected global context. However, the reality and results presented might have looked different using another methodological and analytical approach. To be able to understand the full picture of impacts brought by the process of modernization on a local scale, a longer fieldwork should be carried out to capture the livelihoods dynamics and diversity among the villagers in Bekiok.

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10. Appendices

Appendix 1 – Table of applied methods

Methods	Replications
Semistructured interviews	22
Questionnaires	21
Transect walks	2
PRA sessions	6
Soil Sampling	4
Water Sampling	2
MiniSASS	2
Forest resource assessment	1
Estimation of soil erosion potential	4

Appendix 2 – Questionnaire structure

Date:
Longhouse:
Door number:
(Gender and status)
Name of the interviewers:
Name of the translator:

Introduction of the interviewers
Thank you for participating in our survey. The questionnaire and your answers will be used for our report about Nanga Bekiok as a university project. Your answers will be anonymous. If you don't feel comfortable answering the questions, you don't have to answer. It will take approximately 30-45 minutes to answer our questions, if you have any questions along the way, feel free to ask.

1. What is your age? ____
2. Please specify your religion. Christianity [ ] Traditional beliefs [ ] Islam[ ] Others:_____
3. Please specify your ethnicity. Iban [ ] Bidayuh [ ] Malay [ ] Chinese [ ] Other :_____
4. What is your marital status? Single [ ] Married [ ] Divorced [ ] Widowed [] Other:____

5. What is the highest degree or level of school you have completed? None [ ] Primary School [ ] Secondary School [ ] Certificate [ ] Diploma [ ] Degree [ ] Master [ ] PhD [ ]
6. What are your activities you do during the week?
Farming [ ] Salary work [ ] Handicraft [ ] Student [ ] Collecting wild vegetables/fruits [ ] Fishing [ ] Fishponds [ ] Hunting [ ] Housework [ ] Others:_____
8.How many people are in your household? (exclude respondent)

Family relationship	Age	Occupation	Does he/she contribute to household income?	How does he/she contribute?	How often are they present in Bekiok?

8. What are the sources of income for your household?
Agriculture [ ] Salary work, specify:_____ Selling handicraft [ ] Government aid [ ] Selling wild vegetables/fruits [ ] Selling livestock (chicken, fish from fishpond, pigs…) [ ] Selling wildlife [ ] Selling river fish [ ] Remittances from off-shore work [ ] Other remittances [ ] Others:_____
9. Does your household have a mean of transport? How many?
Car:___ Motorbike:___ Motor Boat:_____ Manual boat:_____

Change in the use of natural resources:
10. Do you cultivate any land in or around Bekiok?
Yes [ ] No [ ] Other (Comment):_____
11. Do you cultivate any land in other places?
Yes [ ] No [ ]
12. How many pieces of land do you have? _____

(Fill the table for the different crops)

Types of crops	Size (ha+number of vines/trees)	Consumption	Selling	Where do you sell? (Julau/Sibu …)	Price/kg	How often do you sell it?	How much do you usually earn every time you sell it	Fertilizer (yes/no)	Pesticide (yes/no)	Herbicide (yes/no)	What is subsidized? (F/P/H)
pepper											
rubber											
Glutinous Paddy											
Normal paddy											
cocoa											
Oil palm											
Fruit trees											

13. What is the most important crop for your income?_____

14. Which crops would you like to plant in the future?

_____

15. How do you get to your field?

Walk [ ] Boat [ ] Car [ ] Others [ ]

How long time does it take? _____

16. How do you transport your crops/wild vegies/handicraft… to the market?

By members of your household [ ] By other villagers [ ] By others from outside the village [ ] Other [ ] (Comment):_____

If not by your household, do you need to pay for transport?

Yes [ ] No [ ]

Are the crops/wild vegies/handicraft transported by road or water?

Road [ ] Water [ ]

17. Has your crop cultivation changed within the last 10 years (crop type, size of field)?

Yes [ ] No [ ] Other (Comment):_____

If yes, which?:_____

Use of ecosystem services

18. How does your household use the forest?

Hunting [ ] Fruits [ ] Vegetables [ ] non-timber products [ ] Construction [ ] Fire wood [ ] Medicine [ ] Others [ ]

19. How does your household use the river?

Food resource [ ] Recreation [ ] Going to fields/forest [ ] Waste disposal [ ] Others [ ]

Questions for interviewer from the respondent (if any)

Notes and remarks (if any)

Questionnaire and SSI structure for the headmen

Section A: Cross-check information

Village ID:	Headman:
No. of households/houses:	No. of residents:
Contact no.:	GPS coordinate:
Address:	

**GPS coordinate is taken at the outside of Tuai Rumah's house.*

Section B: Economic development

How are people earning an income (agricultural production or another source of income from natural resources) in this village?

Type	Please tick (√)
Oil palm	
Coconut	
Rice	
Rubber	
Agarwood	
Cocoa	
Pepper	
Pineapple	
Vegetables	
Hunting	
Traditional Mining	
Fishing	
Non-Timber forest products	
Other:	

Village structure:
- What is your job in the village?
- How long have you been headman?
- What are your responsibilities as headman?
- What is the organisational structure of the village?
- What are the roles of different actors?
- Are these committees involved in decision making?
- And what are the decision-making activities they can be involved in?
- Does the decision-making process include the community?

Note: use Land Demarcation/Declaration of Native Communal Reserve as a case to generate questions and discussions.
Does it involve one longhouse or all longhouses?
How have villagers been involved in this decision-making process?

Agriculture:
- How are people managing their land in the village?
- Are people cultivating their lands themselves?
- What is your relation to the surrounding nature?
- Is the nature around the village changing?

Village life:
- *Make timeline*: 'Major events that have changed people's income sources in the village' (suggest e.g. impacts of the first road, tor road, drop of pepper price, today… on land use, livelihood, mobility…))
- (How has people's sources of income changed in the village?)
- (How do people cope with....^ (different factors that influence income)

Appendix 3 – SSI with woman farmers

Interviewer: Mette
Translator: Pai

This interview began as an individual interview with a woman farmer, but very quickly more women from the longhouse joined. Thus, the session ended up as a focus group interview with 5 women while children and two men were watching.

Which different crops do you grow?
Pepper, rice and a little bit of cocoa. And also, enkaban trees.
Did you use to grow other crops on the same fields?
It used to be rubber
Why did it change?
It used to belong to her parents, but after the dropping price of the rubber, she changed to pepper. Because the market price was quite good back then.
Who made the decision to change?
Her father.
Did the location of the fields also change, or have they been in the same place always?
They have always been the same place. Even if the pepper died, she would plant new pepper the same place.
Did you have problems with the pepper disease?
Yes. One of the places are a little bit affected, but the other field is really badly affected.
Ah okay. Since when?
Since 2017.
So, what did you do when the disease happened?
She just grew it back
In the pepper vines, she noticed the pepper started to die. She didn't do much about it, she decided to plant cocoa next to where the plant died. Somewhere. To not make it too empty.
Does she sell the cocoa as well?
No, she just started. So not yet harvested.
And why do you plant paddy?
To eat.
Somebody told me that they plant paddy for traditional purposes. Is that.
Yes, also for traditional purposes. It has always been. Also, to make rice wine.
Can you tell me more about the tradition of growing paddy?
In the offering, what they call 'miring', it has always been a foundation of the IBAN community to have paddy in their living. There are really strong connections in terms of... The ways the community does it – they turn it into some kind of popcorn. If you burn the dried rice in oil it will pop. She will bring an example for you to see. So that's one thing they have to offer.
Could you stop planting paddy?
No. It is one of them believes. They need to have a paddy. There's no other way, not to have a paddy.
So, when you planted cocoa – did you talk to anyone before planting it?
She consulted with the husband.
[She shows rice]
How does it work with the offerings?
They usually have few things, that shall be offered. They usually put them on a plate. So this is one of the things.
Okay. So, what are the other things?

Another thing is the egg. And also, tobacco.
Where do you put the plate?
So – you have to have a special place like an altar. Where you placed it?
In the longhouse or in nature or?
Usually on the ruai. This is called a reach [points down the hallway]
Ah. And how often? When do they do it?
It works also as a modern religion. So, whenever somebody is going to work, you need to have blessings. This is in the sense of blessings. The two most major dates are on the harvest festival itself and on the new year.
Okay – so how will this help?
So, it is blessings. Whatever you wish for. It is also like a toast. So, what do you toast for? A new house or a husband or whatever. For example.
Okay. I have a few questions about the soil in Bekiok. How is the soil here?
It is good.
Okay. Has it changed?
[Discussion. Other women give their input]
She doesn't really know how to justify if it is good soil or not. Because they are not experts. But – as far as they know. Since they are planting things, so they always got the [?] of the fertilizer.
The soil here – is it better to plant some crops more than others?
[Discussion among the women]
They think – that for pepper it is better. But she also mentions the price. The better price. So, I suspect (Pai) that they plant what is more price. It is not like... I don't think the question should be... It is not so much about the soil; the soil doesn't speak. So yeah, maybe...
Okay - Do they need to irrigate their fields?
No [laughter]. It is only from the rain.
She mentioned the fertilizer. Do they have to buy it themselves or do they get subsidies from the government?
Only the paddy – she recently received the fertilizer. The rest of the crops – she has to buy it herself. Not everyone gets the scheme, that they apply for. She was giving an example: For example, if she receives, then I don't receive. Something like that.
So, it is not all the people that plants paddy here, that gets the fertilizer?
For paddy, it is everyone.
And how do you – do you have to apply for it or?
Yes, you have to apply. You need to fill out a form.
And do they go together and make one application or how does it work?
Usually, they have to fill it themselves. And then TR will collect all the forms and TR will send it to the pepper board.
The headman from this longhouse?
Yeah.
So, it is not together with the other longhouses?
….(?)
Do they sometimes experience that they don't get the fertilizer for the rice? Does the application sometimes get rejected?
[The women are giving beans to eat. Laughter.]
For the pepper, everyone fills [the application] but then they have a selection back at the pepper board. So – obviously – some get, and the rest doesn't.
Do they know why somebody gets and somebody doesn't?
They don't know. But they have were in and out. To be asked even the... they were saying. Maybe it's random – they said.

So – if they don't get these subsidies. Do they change which crops they cultivate?
No, they don't change. But they have to buy themselves.
Okay. Maybe all of you could tell me something about the challenges of being a farmer here in Bekiok? You mentioned already the subsidies.
Mainly the challenges... Basically, the most major challenge would be if they don't receive the scheme. So – if they in the future, after the harvest, then they will have the capital back no. So, from the capital, they have to divide to spend more on the fertilizer and such. But if you have the scheme, it will be the opposite way. Because you don't have to spend. So, you can have like 200% on your own. Or maybe 100% on your own. So, you don't have to put...
Does the weather also play a role?
Yeah. If it is too heavy rain it is not good. If it's too sunny days, it is also not good. So, it has to be balanced.
Okay. Did they experience a lot of challenges with the weather recently?
Apart from the badly affected pepper, the weather from last year was not really good. But this year it should be fine. This year it is okay, but they already have a lot of died pepper.
So, the yield this year – is it bigger or smaller than last year?
2017 was the best.
[Discussion among the women. Laughter]
In 2016-17 they didn't even have enough sacs. Because it's too much. It was really good.
Why did they think it was so good?
Because they had a lot of pepper. From the previous year. She and that guy [points] had so much pepper.
Ok – so do they sometimes store it and sell it later or do they sell it right away?
She doesn't store it. But she [points to another person] does. She stores it for now.
Ah – why?
So Maybe waiting for the price of pepper [to rising].
How have the changes in price been the past years?
Basically, all the crops that she has. She was explaining to me about the fertilizers for the pepper. The fertilizer is quite expensive. So, if you use the cheapest or the one with a reasonable price, then the pest doesn't really go off. But among all the crops – the question that you asked just before. She says, now the pepper is still the best price. It is the most expensive for now.
So – you said about the fertilizer. So, they buy the more expensive fertilizer to avoid the pest or?
No – she was just saying. If you buy the cheaper one the pest doesn't go away
So, you need to buy the expensive one?
Yes, you need to buy the expensive one. Because if you use cheaper pesticides, then it will always get back.
Okay – which ones do they use? Do they remember the names?
'Disease' is cheaper. Compared to 'Alika'. So, Disease is not good and Alika is the best. Alika is 160 RM for less than a litre. The disease costs 75 RM for one litre. But it is not good for the pepper. They use Amistad for the fungus. There is two different Amistad – Amistad and Amistartop. 250 for Amistad and 150 for Amistartop. If you use those, then you can be happy. Because it is really good.
Do they always have money enough to buy the good ones or do they sometimes need to buy the cheap?
So yeah. They will always buy the good one. Even though it is getting the disease. Still.
Okay. So, what do you do, when you face problems like this? With the disease or the low prices on crops or maybe bad weather. How do you deal with it?
So, for now, they stopped focusing on the pepper. Because in general, they can't do anything about it.
So, they stop focusing on pepper? And what do they focus on instead?
They are focusing on different things. On different crops. Now they are focusing more on the vegetables. Like corn or… eggplants or beans. Yeah, these things also, because they cannot get it from the forest. But she was also mentioned, those who have another land – they will usually ignore the ones that are dying and then they will start to plant the new pepper in the other land. If they have. Only if they have. Eggplants, chilli...

Do you sell it at the market or?
Yes, usually they sell the vegetables. They usually sell it in Julau, in the wet market. And also, in [?]. And sometimes they even have neighbours who want to buy.
Do they use also…
[A woman is bringing in fresh pancakes made with rice flour, normal flour and brown sugar. The conversation about the pancakes and about when we leave]
Did you see the papaya that we eat? It is from just out here. And coconut.
Do they sell fruits from the forest also?
Usually the fruits from the forest – they don't sell. It is only for self-consumption. But she was also mentioned – five years ago maybe... they were selling the enkaban oil. (44.40). Before the elderly people used enkaban as oil. Because it was too far to get palm oil or other oil. And it is also good for frying and other things. Because in older days the cooking method doesn't really include oil. Because they had bamboos to cook in.
I have one last question about farming. Would you like to plant other crops in the future?
They are planning to focus more on cocoa. Because they heard that the price will be really nice. And the cocoa – it is not a seasonal fruit. So, you can always harvest it.
How do they decide which crops to plant? Do they consult each other?
Usually, it is individual. But she was also giving me an example – if someone started it – they see whether it gives a good harvest – and eventually, others will follow. She was also saying. The other village has started hydroponics. A system. A cultivation system
Ah – with water and plants?
Yes. For ginger. And she was saying – the ginger has quite a good price and a high demand now so maybe... She envies the village and she would like to make a plan to do that, maybe with other crops, in the future. So – it is usually the concept of following what other people do.
So, they don't have to agree on what they plant?
No.
The major problem if they cultivate certain crops – the major problem would be to know exactly where to sell it. And to whom and how. That's the whole process because for example the pepper – it is easy because they are already used to the whole process of selling. It is quite easy because they already know who to sell it to. And how the prices will be.
So it is the knowledge about where to sell it and all the uncertainties?
She explains how the difficulties and knowledge have to be part of the process. It is knowing the right person or the right output to source the future crop.

Appendix 4 – SSI Headman 1

Interviewer: Nick Ng

Perception of Land-Use Management

How has the livelihood activities (activity sara hidup) changed over time in Bekiok?

- Back then pepper had a good price; then it dropped; villagers are now struggling and some of them have a heavy reliance on remittances.
- Now some of them also rely on rubber, but rubber prices are not better off as well.
- Some of the villagers seek ways to venture into oil palm plantation; however, such plantation requires relatively high capital

How do the lives between the younger and older generations differ?

- Younger generations have moved out to find a job outside, but they do provide remittances.
- Most of the younger generations lack the skills and interest to assist their parents on agricultural activities; they prefer technical labour ("bertukang": means being a mechanic or technicians) or go out for higher education.

Decision Making Process

How did the houses deal with land delegation of rubber scheme?

- Government representatives come and present the plants of the scheme with Tuai Rumah (Headman), and they begin surveying the land for the scheme.
- When the headman has had the introductory meeting with the government representative (representative from the department of agriculture), Tuai Rumah will invite the rest of the household to participate in the general meeting. For this particular rubber scheme, a total of 60 Bilek joined in the discussion.
- The delegation is based on who is keen to open their land for the scheme. According to Tuai Rumah Guntol, most who requested the scheme did get it.

What was your role in the rubber scheme, pepper scheme, or any other scheme?

- The role of Tuai Rumah is to guide/moderate the discussion between the government representative and the villagers.
- For rubber scheme, he was there with other villagers from 60 Bilek to discuss the land survey and which area to be developed.
- For pepper scheme, villagers will approach Tuai Rumah and request to apply for the pepper subsidy scheme. Hence in these cases, Tuai Rumah will act as a middle person.
- Some villagers do take the effort to apply for subsidies themselves. In these cases, Tuai Rumah will not be involved with the process.
- Tuai Rumah also deals with inquiries or internal problem from individual landowners; if there was any misinformation or any request to be part of the scheme, Tuai Rumah will then relay these inquiries to the representatives through formal.

Point to the map hanging on the wall and try to ask and understand.

- The map was the result of a perimeter survey done in 2017, which provided the title of Native Customary Rights (NCR) land for the land around NG Bekiok.
- The NCR will give power to the villagers against any authorized or unauthorized development of their
land.

Community Forest

Do you have any community forest (ex: Pulau Gulau)? How big is the area?

- Pulau Galau has already been harvested/logged.
- There is one community forest left which is Pungoh (the forest we went for forest inventory)

How do you manage/deal with community forest natural resources? Who can harvest and what is the process of getting permission?

- Outsiders will need to ask permission from the landowner and also villagers to harvest forest resources and conduct hunting activities.
- For local villagers, they are free to come in and out of the forest anytime to harvest and hunt.

Can you tell me about the history of logging activities?

- The license given to the logging company came from Temenggung Banyang (Temenggung is a title; higher than that of the Penghulu; given to a person in charge of whole Julau villages)
- All license for logging activities came particularly from this Temenggung.

How did you handle the logging company that harvested your timber?

- Logging company only provided reparation/compensation of RM10 per tonne of timber logged
- Villagers tried to stop the company from logging but were intervened by police officers saying that the company has all rights to log the villagers land due to the fact that they have obtained the proper license.
- The villagers were restricted by the police officers, so they could not do anything. This situation has been going on from the year 1977 to 2016 when the timber finally ran out.

How big was the area?

- Total of 200 hectares

Can you tell me about the history of the fire? Where did you get the resource to rebuild? Was there any backlash to your harvest in the efforts of rebuilding?

- Fire in 1969: they still had the timber to from the forest to rebuild their longhouse.
- Fire in 1997: they took Belian and Engkabang (which supposedly were strictly protected by the law for preservation) because they had no choice due to the logging company harvesting their timber resources. Government agencies gave them a warning but eventually turned a blind eye as the villagers were in a desperate situation.

Nature and Surroundings

In your opinion, how did the natural surroundings in Bekiok change in time? How did the weather change?

- In his perception, Tuai Rumah mentioned that the weather now is no longer predictable –the seasons changed (rain and dry season) annually.
- The temperature also falls in the extreme; it is extremely hot during sunny days and rains heavily all of a sudden.

Perception of soil quality and how it changes in time

- Back then they practice shifting cultivation to maintain the fertility of the soil. Since the practice is no longer feasible now due to lack of manpower, soil that is planted by permanent paddy practice now deteriorates.
- Nowadays, the land will not be able to sustain agricultural activities without the help of fertilisers. Back then, they did not need to rely on fertilisers to keep the plantations fertile. He suspects that after many years of permanent (non-shifting cultivation) agricultural activities, it has taken a toll to the soil.

How did the road and agricultural activities affect your resources?
Have the number of resources changed? How? (Ex: Fishes, wood, wild fruits and vegetables.)

- According to Tuai Rumah: after the road, there are much fewer fishes in the river. This applies to wildlife too.
- He mentions that this is due to the increasing hunting activities from outsiders (non-locals).

Appendix 5 – SSI with farmer/contractor

Interviewer: Filippo
Translator: Anita Muli

Name and age?
Jim, 56 years old.
Can you briefly describe the history of your fields?

Long ago I was planting paddy, rubber, cocoa.
I started planting pepper from 2000 until now.
Has been planting cocoa for 7 years.
I started planting rubber since I was 21.
I started planting paddy since I was 21 and stopped in 2000 when I started planting pepper.
Does the size or location of your fields change over time?
Both the location and the size of the field has always been the same. I haven´t bought new fields during the years.

Decision making
Can you choose yourself which crops to grow?
To decide which crops to plant I choose with my family.
Which are the criteria that you use to decide which crop to plant?
The crop that I have now have been planted a long time ago by my family, so the decision has already been made long ago.
The decisions are made inside the family.
Do you ask for consulting to someone extern?
NO

Soil management
How is the soil quality around Bekiok?
The soil quality around Bekiok is Medium.
How many pieces of land do you have?
I have 5 pieces of land.
Which is the steepness of your field?
The steepness of the pepper fields is around 10%. Before it was higher, but I asked the contractor to decrease the steepness of the fields. The contractor, in this case, was my brother in law and I didn´t receive a subsidy for this kind of job.
Do you have an irrigation system?
No, I don´t have an irrigation system, the fields are irrigated just by rains. I have a good drainage system both in the pepper and rubber fields.
Have you ever applied the shifting cultivation?
Yes, I changed the land in past from durian, rubber and rambutan plantation to pepper fields.
Do you use some fertilizer?
I think that my pepper is dying because of the fertilizer. 60 % could be caused by fertilizer.
Did you ever change the type of P, H, F.?
No, never changed.
Did you receive fertilizer from the government?
No, I bought it for myself.
Did you ever receive the subsidy from the government?
Just 3 times since I was 21 to now.
When you received the subsidies, how long did they last? How much did you get?
It depends, it changes from time to time. I received 10 bags of 50 kg of fertilizer the last time;
3L of herbicide and 30L of pesticide.
This amount last 2 times for a field of 500 pepper vines.
How is the procedure to receive the subsidy?
You take the subsidy [material/input] from the government store.
How much does it take from the submission of the application to receiving the fertilizer?
When I applied in January, I get it in July. So around 6 months.

Did you get the rubber scheme?
Yes, I received 5000 trees.
How was the process of decision making under the rubber scheme? Who decided who was going to benefit from the scheme?
It was the Thoi Ruma [Headman] who applied for the scheme for the villagers. It was not an individual application.
The government gives the job to the contractor and after 5 years the contractor gives the land back to the farmers.
Did you have to pay something?
No, I gave my land to the contractor and he worked on the land for 5 years, giving the fertilizer, pesticide, herbicide.
Were you satisfied with the scheme?
Yes, was the best thing made by the government in this area.
Do you have people working with you?
Yes
Are you tapping the rubber of the scheme?
No, I´m waiting because the tree is still small.
Now the price is too low. 3RH is not enough. If a person gets 10 kg is 30 RH per day. Is not enough.
Did the contractor give you the F P H even for the future years? [Fertilizer, Pesticide, Herbicide]
NO, just for the five years.
So, right now you´re putting money in rubber without getting some money back?
No, right now I'm not using F, P, H on rubber. I´m just waiting for the rubber to grow enough.
How many people work in your field?
16
Do they work full-time?
When they harvest the pepper is full time until the work is done. From April to August.
Otherwise, I call them if I need to plant new pepper vines [substituting the dying ones] and for the growing season.
Where do they come from?
Are local villagers. They come from some villages around Bekiok. If I take Indonesian worker I go to jail, you need permission to hire them.
How did the road change your lifestyle?
I´m very happy for the road to be built. Before it was muddy and was hard to go out. The crops and type of plantation didn´t change with access to the road.
Do you think the nature around Bekiok has changed?
No, is not changing, is the same as before. On the other side, the accommodation has very improved: road electricity and communication. Life quality has been improving for 30 years.
Do you think that agriculture affects the environment around Bekiok?
I think not, I think that the logging companies that take trees from the forest are really bad. The water is muddy, they destroy the jungle, they kill fish and wildlife. Not by the agriculture
Do you think the quality of water has changed during the year?
The logging caused the water to be muddy. Before it was transparent and clean.
Sometimes the temperature is so hot and it doesn´t rain as before. The climate is changing.
Why the climate is changing?
Because of the logging company, they cut the trees.
Someone think that is caused by the aluminium industry. The latter doesn´t change the climate but brings unhealthy air, instead.
What do you think are the main challenges for farmers right now?

- I grow only one type of crop, so I´m more vulnerable.

- The disease of pepper
- The drop in the price of pepper: from a vine I get 3 kg of pepper. Before I was making 90 RH for each vine. Now just 24 RH.

Which is the most important for you?
Disease
Do you store the crop before selling?
NO, I sell the pepper directly.
Do you have any other job?
Yes, I work as a contractor. When there´s a tender that I can apply for, I present an offer. If the offer is not too high and not too low, you win the tender and you have the job. I´m the owner of a company. I do civil and housing construction.
The last project that you made?
¨2018 I had 6 projects
To build a road, I got a tender for repairing a longhouse. A tender to make houses for poor people.
How many people work in the activity?
From 5 to 10. I work every day with them.
During the harvesting season is more my wife and my family that carry on the agriculture activity. If I´m not working as a contractor I help my family with the fields.
Which is your main income? Contractor or farmer?
Contractor
Were you the contractor for the rubber scheme?
NO, that one is a very big contractor.
And about the future, would you like to plant any other crop?
If the government give me the subsidy I´d like to plant oil palm.
How big?
According to the size of the land. I would say 1000 tree.

Appendix 6 – SSI with Malaysian Pepper Board (MPB)

Dolomite is to neutralize the soil – use chemical fertilizer npk cause the soil to be acidic.
Before they plant they need to put dolomite to dissolve in the soil. Chicken poop as organic fertilizer
To make the soil fertile by putting organic soil.
The above is after post-harvest.
After putting organic fertilizer, they will put chemical fertilizer NPK.
New farmer/ plant in a new area?
Usually is trial and error but do give advice on soil suitability. The soil is hard to find.
What soil are suitable?
The slope is between 20- 45 degrees. And soft soil, even in hilly areas they have to do irrigation to prevent clogging and prevent the flooding when raining.
How many longhouses do you monitor?
In Julau around 200 longhouses. Max only can cater to 3 longhouses depend on the farm location and manpower.
Emergency cases
The disease is very difficult to tackle. If farmer neglect, very hard to manage. The only way to avoid spread it has to be a mount. It can spread through the water. Bacteria phuxerioum?? The pepper will die within 1-2 months. It can be cured by using pesticide matalixil aka Racun kulat. This pesticide is for prevention not to kill.

Is it too late if disease strike?
Yes, it's too late. Just ask them to try to use pesticide to control it. Especially on healthy crops.
How to detect?
The leaves will turn yellow, the experienced farmer will check the root and put the pesticide. Nematode (worm) attack the root, the pepper will be injured, and the bacteria will attack.
Petotora bacteria – kills within in 2 weeks. Like virus
It can be carried by rain but very seldom. Symptoms are very quick. Once it attacks the leaves and branches will wilt. No yellowish. Alive to dead.
Record of disease and virus
Pytotora is very seldom, mostly is phuserioum. It is most serious in 2017 and not sure why. But according to our observation, almost all farmers admit they use too much herbicide (paraquat and Diran) they mix the two and it attacks the root and injured the root allowing bacteria to enter.
Mostly happen in Bekiok and Merurun and Untul Nanga Ruyak. Some in the Ulu Kanowit.
The most serious is Nanga Lijan. Rumah bayang. The disease started there.
How did it spread to Merurun?
It can be brought by animals, humans, once you step the soil there. They did mention that once they step on the soil that is infected the healthy one.
The only way to protect is the cleanliness of tools, shirts, must be hygienic.
Any idea of farmers forced to give up?
Some give up, but most don't due to the highest price now still. Oil palm rm0.3 pepper rm8.5. And able to manage by yourself.
Role in the price of pepper.
The price is controlled by international market under commodity the same as palm oil. Have no say. Malaysia is No 5 in producing pepper. 1 Vietnam, 2 Indonesia. Might be due to this competition the price is dropping, but the quality is higher in Malaysia. Sarawak still produces the most pepper. But in terms of the pepper tree, Johor is the biggest 11000 done by a company.
Most in Sarawak are 5000 vines.
The price changes on a daily basis depending on the market. But try to maintain the pricing, to help the farmers.
Why price drop so fast?
The commodity, the supply is higher than the demand.
Started in 2017. highest is black pepper RM38, white pepper RM52. but the disease is highest in2017. the disease only affects the yield.
Any support for a price drop?
No incentive but advice to produce better quality. Creamy white RM18 per kg.
Those who plant more pepper ca become entrepreneurs, they can sell the cutting, program SATU azam we provide pepper cutting.
Qualification to collaborate?
One azam is monitored by the state, they can give their names to MPB. The process starts at the district office, they fill forms for planting pepper, give names to MPB. The district office will choose based on the eKasih. So MPB will find cutting for them 200 cutting each farmer is based on the period.
MPB will only buy from farmers with healthy peppers. Unless no choice.
This time only Rumah adijumang after nanga bekiok and one in merurun have eKasih. Because they choose to plant other crops like cocoa, oil palm and etc.
MPB give pepper cutting and they farm themselves and only monitor.
Syngenta collaboration?
Not drop MPB. They do the promotion themselves. They can do the promotion even without permission from MPB. The pesticide is ok for pepper, but maybe the approach and method of mixing of pesticide is wrong. MPB never teach farmers to mix pesticide.

Best pesticides that they can use for grass Basta 15, soil Metalixil betalocy, the amount must be not more than the label on the bottle. The application of pesticide must be scheduled, within 2 weeks. First is one type, after 2 weeks the other. Parquat is too dangerous and harmful for human.

Challenges

How to maintain the farmers to carry on planting.

The no of farmers is decreasing, now they still maintain and eager to plant.

There is no research done on the specific 2 diseases, very different method and even there is a collaboration with UNIMAS but so far in progress. Come to the field in Nanga Ayam.

Not sure about the research is done, to know more can go to the research centre in pending Mr Jhon.

Collaboration with UPM Serdan, how to advise farmers going on the field. They give a talk on how to be an effective resource person. No other collaboration with other NGO.

Only the planning department in the main office can give the number of farmers, only started to include and register GPS and farmer names in the last 2 years.

There are more farmers planting pepper, but the land is smaller. Last time when pepper price was high a lot of people wanted to plant. They give the advice to maintain what they plant and not wait until the price is high and are disappointed when the harvest period is too late. They can store pepper for 10 years by processing it well, only the good seed they keep and must dry it enough. Overdry doesn't affect the quality. The drier, the better.

No major project. When you monitor the pepper what do you do?

The scheme is for minimum 500 vines and can apply to MPB. Pepper blower, spiral separator, trashier(to separate pepper from the) it depends on the MPB budget, give priority to those that apply in the group.

Harvest is all manual, no machines.

How to maintain the price?

At least its not very far from the market. Trading department of MPB arranges the pricing.

Pepper market

Still relevant for another 20 years or so. Now they try to research about how to use pepper in medicine done by MPB research department. Not sure on the cures of using pepper.

Fertilizer schemes provided only for a new planter with at least 200 plants but plant have to buy themselves. The first year 4 bags NPK, dolomite 1 bag, incentive rm3 per cutting, rm5 per post. They buy first then give incentives. The second year will give the fertilizer (a bit more). The scheme is only for 2 years, and they have to apply, the project is for RMK11 only.

Advertise scheme?

Broadcast in radio due to a rural area, started in 2015 RMK11 5 years programme.

Main role

Assist the farmers in planting pepper, buy and sell pepper, research.

There's a difference between the branches pricing of different plants.

Regarding the price, we can refer to the daily price on the website and it is based on the location's price.

Last time in 2004, the price was high but cannot recall. Before the rise in the price, the price also dropped drastically. Can refer to bahagian perancangan on the website.

Once visited nanga bekiok, last year with research officer when the disease was severe.

Appendix 7 – SSI with Headman 2

Interviewer: Mette

Translator: Pai

So if you don't have any questions, we can just start…

[he starts talking]
He was explaining about.. fertilizer. After the paddy field – they will replace it with pepper.
So they replaced paddy with pepper. So you have pepper now. And do you have oil palm?
No
Does somebody have rice hear anymore?
Yes
And the rubber?
There are 200 kg per year the paddy. Only him alone.
And do they have cocoa?
Yes.
And pineapple trees?
Yes
And coconut palms?
No.
Rubber, yes?
Yes.
Does he also go hunting in the forest?
Not anymore – he is a little bit sick now.
Okay – but people in the village go hunting?
Not any more – not in this longhouse?
And fishing?
A little bit of fishing.
Do you sell the vegetables you find in the forest?
No, they don't sell it.
[A woman in the longhouse interrupts]
How many households are there in this longhouse?
He will take a book [takes a guestbook for me to write in]. He wants you to sign the visitor's book.
9 pintus in this longhouse.
Do you have some pintus that are not in this longhouse but are attached to here?
Three outside.
And how many people altogether?
He is not quite sure. Around 100. Including the elders and youngsters.
How long have you been a headman?
20 years.
Ah – and what is your job as a headman?
To make sure that there is no argument about all the traditions, customs and beliefs. And also motivational things. To motivate the villagers to work.
Okay. Does he have other responsibilities as a headman?
Not – only that one. But they also have the Rumah Banjai (?) organisation. The longhouse. It is an organisation of the villagers. If there will be any cases in the future. He will be the one that is responsible for many cases. It could be malaria.
The organisation of the longhouse. What was the name again?
JKK. The organisation of xxx.
Okay. So – what is the purpose of this organisation?
To take care of of.. to remind all the. To take care of the emergency that happens. Like a fire happening in the longhouse. And to remind people to switch off the light.
And that organisation is only for the people in this longhouse?
Yes.
And he is also the leader of that organisation?

The leader of this organisation is called Mr Peng. He is a teacher.
Okay – and he lives here as well?
Yes [He points at one of the doors]
Okay – and he is the only leader?
He is only responsible for this house. There is also a nurse. She is from the Clinique. She is responsible for healthcare in the longhouse.
And she is a part of the organisation?
Yes, related kind of.
Are there other people that have other responsibilities in this organisation?
Only JKK.
How do you make decisions – when you have to make a decision about this longhouse. How do you agree?
He is responsible for the main house. If someone is getting sick – he is also responsible for the whole house. He gets to inform the ministry of health.
So – how have they decided how to distribute the agricultural land?
Usually, it is inherited from the ancestors. From the elderly and then it is passed down to the next generation. That is how they divide the land.
Okay. And is there also some communal land – like open access where everyone can take from fruit trees and such,
No, there is only individual land
Okay. And can you have landed in other ways than inherited? Is it possible to get land in other ways?
There is only one other way. By selling. If someone agrees to buy, then they will sell. Because the land has not been given a title by the government. So it is cheaper to buy. And once it got a title, it gets more expensive.
Okay. Is there a lot of land without title here?
Mostly here – the land has not had a title yet.
Okay. So – if there are two people in the longhouse that wants to sell or buy land, does the headman have to be involved in that decision?
Yes. He has to be the middle man. That is also a part of his responsibilities as a TR.
Okay. And what is the purpose of being a middleman?
He acts as a – witness.
I like to know a little bit more about decision-making. So if they want to change anything in the longhouse. If they want to change the floor for instance. How do they agree?
If they want to change the teils – it is up to them. They don't need to inform him. But if it is too not practical you need to change
If somebody has a field where they before planted paddy and now they plant rubber – does the headman have to be involved as well?
No, it is up to them to do whatever they want.
Okay. So – are people here cultivating their land themselves or do they have people to work for them in the field?
Before – in the rubber plantation – they did receive help from the government. The government provided 5 Indonesian workers – but up to 5 years only. So after 5 years then they quitted. Only themselves are cultivating now. And he was mentioning – one day is 30 RM to pay one of the Indonesian workers. That's the wages.
And before – the government paid it?
Yes.
Okay. Do they sometimes help each other in the field or do they mainly work in their own field here?
Only themselves.
Does he think that the nature around Bekiok – has it changed a lot the last 10 years?

If you compare it to ten years ago – he was stating that before it was really hard because they need to use a boat and nowadays – after the road access – it is usually easier to get to town. Now he just needs to use a shirt and short past and he can arrive at the town easily. Before it was more expensive to travel by the boat. Before they spent usually 100 RM to go to town.

And now – how much?

Now it is like 12 or 6 RM.

So that is the difference.

Has the forest also changed? Is there more forest of less forest around here?

So – now the forest is getting less.

Due to?

He was explaining about the timber. Deforestation happens. That's a huge difference. And the enkaban fruit – they won't sell it. It is only for their own use. And – you can also use the oil for sickness and [?].

Okay. What about the river? Has the river changed?

Before – there was easier access to the river. Because everyone used it. The river was the road before. Now it is not really good compared to before. Now there is erosion – and you can see a lot of trees and stones in the river. Because of the road, people do not really put the focus on the river anymore

Do they still use the river to get to the city sometimes?

No, they don't use it to go to the town anymore – only for fishing.

Okay. And has he noticed any change in relation to the quality of water?

The water before. It was really clean and really clear. But now. People throw in rubbish and waste, so maybe it somehow affects the quality of the water. Before it was nicer.

And do they get the same fish now as before?

We still have the same fish in the river. But quantitive-wise - before there was more fish.

Where did you normally take your waste before the road came?

If you have unwanted waste – you just throw it near the river.

And that's the same as now?

Before they tried also to dig it in the ground. He was saying – because he is TR – he tries not to take it to the river, although he knew that most of the villagers did. He tried not to.

And it's the same now?

There is a special place where you can throw it now. A place after this house.

And the wastewater from the toilet and kitchen? Where does it go?

They have a drainage system. Because with the toilet and the kitchen, the government has provided a tank on the ground. So all the waste will go to the septic tank. Somewhere behind the longhouse.

Appendix 8 – SSI with farmer 1

Introduction of the farmers

What is the history of your field?

The decision of what crops to plant come from a long line of heritage. However, their Oil palm and cocoa plantations are relatively new. These were influenced by market availability and values, also as an alternative should one of these crops fail or face a drop-in price.

What crops do you grow?

Oil palm, pepper, cocoa, paddy (normal), Paddy (glutenous, very little)

What crops did you use to grow in the fields before? When did it change? (Why did you change?)

Most of the fields used to be paddy and pepper.

[not sure when it changed as they could not recall every agriculture activity they do. Further investigations needed]

Has the size of your fields changed? Has the location of your fields changed?

The size and locations of their field remained the same through the years; until recently this year where they opened up a new land capable of planting 3000 to 4000 pepper plants. They're planning to plant 300 pepper plants in that land and diversify it with fruit trees and paddy.

Decision making

Can you choose yourself which crops to grow?

Yes, there were no consultations done prior to any agricultural activities that they have done. Most of the knowledge was passed down from generation to generation. There were also no courses or training given to them regarding this matter.

How do you decide which crop to grow? (price, labour, soil quality, subsidies…)

Mostly dependent on the market value and market availability. Also, the cost to maintain agricultural activities such as the cost of fertilisers.

For paddy, they chose to stop due to lack of manpower. Back then, it was a requirement to stay in the field and only go home once a month; so usually, it's a collaborative effort between different Bilek(s) to be able to take care of paddy field from monkeys and other pests. Thus, they decided to reduce the amount of paddy field and convert it to pepper instead.

Why did you choose (these) specific crops?

They chose oil palm due to market availability. Also, the rocky soil structure of some of their land was suitable for oil palm.

They do cocoa farm because it adds up to their variety of cash crops with minimum effort and less maintenance. These act as a backup for them if any of their other cash crops were to fail or face price reduction.

As for pepper, the price back then made it very much profitable to plant it.

Do you consult with anyone when making decisions?

Nope.

Soil/land use strategies

What types of soil are around Bekiok? (What is your perception on the soil quality/good/medium/bad) What crop is suitable on these?

Black and yellow land:

- Suitable for oil palm & cocoa

Rocky Ground:

- Suitable for pepper & paddy

Are there different land management?

For oil palm, fertilisers, pesticides, and herbicides are all applied once a month. There usually will be harvest twice a month. The terrain needed for oil palm is rocky ground. This is the same case for cocoa. There were no subsidies for these plants given by the government.

For paddy, the harvest is once a year. Pesticides, herbicides, and fertilisers applied only once a year. They made a "scarecrow" to scare the birds and monkeys away (note: There are no crows in Bekiok); but this is not enough for large scale paddies because monkeys will come in large quantity and they will not be afraid of scarecrows. A long time ago [need confirmation when specifically], they actually did shifting cultivation every one harvest (one year) and they will use the same plot again 4 years later after the soil regenerates. However, shifting cultivation is no longer feasible as there are lesser people in the longhouse now.

(Do you irrigate? How? Where does the water come from? How often? Does the soil hold water? Which fertilizer/price/amount?)
How has this changed?

- No irrigation, they rely mostly on rainwater.
- For pepper, they used a fertiliser with the brand called "Jambatan" and switched to "robotic" as they suspected the main cause of pepper disease is from the use of different fertilisers.

Now cultivation more permanent, before shifting cultivation? How many fertilizers do you need? And how much did you need before?

1. **How long did you cultivate before you left it fallow?**
2. **How soon could you return to the same field?**

- For shifting cultivation: usually, land is used only once for paddy before they shift to another land. The land is then left fallow for a few years as they will keep shifting their paddy to another land nearby. Fertiliser for paddy was the same back then during shifting cultivation as compared to the permanent paddy: they only apply fertiliser once a year.

Do you receive subsidies/scheme?

- They do not receive a subsidy for oil palm plantation and cocoa
- They receive a subsidy for paddy (fertiliser, herbicide, and pesticide for once a year); and pepper (fertiliser, herbicide, and pesticide for once a year).
- In 2009, they had been introduced by a company (they could not recall the exact name of the company) a type of plant called Pokok Jarak that is capable of being a process to make biodiesel. The company had given them seedlings that could occupy 4 hectares worth of land. However, when it comes to the process of harvesting they were told that the company had no processing mill/factory so the harvest cannot be sold locally and had to be transported to Peninsular Malaysia. 5 years later, they decided to chop down the tree.

What is the procedure to receive a subsidy?

- Mostly they have applied the scheme themselves through the agricultural department (for paddy) and pepper board (pepper subsidy).
- After sending the application, a representative will come to survey their land. However, they claim that this representative does not really step on the land; but only conduct a simple interview with them. So this opens up opportunities for others to cheat. (for example, some of the villagers apply for pepper subsidies without actually planting them).

Do you tap the rubber from the rubber scheme?
No

Perception of environmental impacts

Is the nature around Bekiok changing? How?

- The river used to be deeper, now it is shallower. There were big rocks around the river and inside the water with a lot of fishes swimming around it. Now the rivers are filled with small stones and sand and at times, mud. And there are far lesser fish now.
- There used to be Empurau (a very rare and expensive fish sensitive to its environment and requires very clean water to survive) under the Merurun bridge, now it is no longer there.
- The wet and dry season is no longer consistent as it used to be.

Do you think that agriculture affects the environment around Bekiok? How and why?

- Yes. In their opinion, the opening up of new land caused fewer trees and made it hotter in Bekiok.
- They also say that the agricultural and logging activities have caused mud to slide to the river which caused it to be shallow and muddy.

Is forest decreasing because of agriculture around Bekiok?

- Yes. The forest is still declining as people are opening up new land to venture to new plantations such as oil palm.

The problem for the future?

Hunting?

- Hunting is getting much lesser as there is less wildlife now. Also, they were told that hunting of certain types of meat pelanduk (lemur) and rusa (deer) are illegal.
- Selling game meat is also considered illegal; back then it was more lenient as the villagers will sell the meats in the market.
- Outsiders have also gone into their forest to hunt from time to time despite the villagers warning them to as for permission.
- All these factors have decreased the villager's means of income and consumption level from hunting activities.

Fishing in the river?

- They no longer fish in the river as they have started their own fish pond which consists of 20 Empurau and 800 Baung fish. They do not receive any subsidies for their fish ponds.

Challenges and adaptations

What are the challenges with farming? *(rank them)*

From their perspective (1 is toughest):

1. Market price
2. Planting cost (fertiliser, herbicide, pesticide)
3. Disease

What do you do when you face these challenges? (solutions)

(market price drop, pepper disease/manpower -used to hire people, young generation leaving-labour force)

- For the market price, they diversify their crops to cover up the losses of other crops. For example, if pepper price dropped, they will start selling oil palm more.
- For planting cost, it also depends on the market price. If the market price is high, then the cost can be covered. If not, they will reduce the intensity of fertiliser and consider buying cheaper fertilisers and also herbicide and pesticide. They will increase the intensity of planting materials if any one of their crops increases the price.
- As for disease, they do not have any measure to counter the problem. The only thing they could do was changing the fertiliser and reduce plantations around the infected area.
- They do not face much problem with labour force as their younger generation stayed (making himself is 26 years old)
- However, the decreasing labour force in other household caused the shifting cultivation of paddy to stop. As they used to work together with other households to maintain a huge patch of paddy plantation by actually staying there and coming home only once a month.

Are you able to generate enough income from your crops?

Yes, they have diversified agricultural practices.

Do you store the crops before selling them? (waiting for a better market price)

Yes, they store their pepper to wait for the price to go up. But only pepper.

Future:

Which crops would you like to plant in the future (if you have the opportunity)? Why?

For now, they do not have plans to venture into new plantations as their oil palm and fish pond ventures are relatively new. They would like to focus on that first.

Appendix 9 – SSI with farmer 2

You grow pepper, rice and paddy, right?
Yes
What is the history of your field? Has it changed?
No. I always planted pepper, rice and paddy. Paddy is almost 20 years old, then I started to plant pepper starting in 1988 and rubber I started to plant 7 years ago before the scheme. Then I changed to the scheme.
Has the location of the field changed?
No change. It was always there.
How did you decide which crop to grow?
I planted all these crops for consumption and for the selling.
Did you consult somebody when making the decision?
I didn't. But it was an idea of me and my husband.
Can you tell me what do you think about the soil around Bekiok? Is it good or bad quality?
Type of soil in Bekiok is medium soil. You can plant anything.
Is the quality of soil different in your field?
There is a difference in soil. For example, if you always plant paddy, the soil is not fertile. After you plant paddy in this field, you need to plant paddy in other fields so the soil is fertile.
Do you mean the shifting cultivation?
I always moved to another land when planting paddy. Pepper and rubber field stays always there. The only paddy is shifting.
So how is the soil in your pepper field?
There is no problem in the pepper and the rubber because we always give fertilizer to the pepper and rubber.
Are specific crops suitable only on specific soils?
No. If you want to plant pepper, you need to find a type of soil with a young young stone which is good for the pepper plantation.
Are there different land management you need to apply for specific crops? (different types of fertilizers)
How has land management changed in your field?
No.
So you always used fertilized for rice?
Yes
Do different crops need a different amount of fertilizer?
Yes. I give more fertilizer to the pepper compared to paddy and rubber.
How often do you put fertilizer to the pepper?
I give fertilizer to pepper four times a year until the pepper produces pepper seeds.
And for the rubber and paddy?
For the rubber, I don't give frequently in small amounts until the trees become mature. I feed paddy twice until the harvest of paddy.
You also receive a rubber scheme. What is the procedure to apply for it?
I have rubber scheme. The person who gives the rubber scheme is from Rubber board.
How can you apply?
We apply to the Department of Agriculture.
Where did you learn to farm?
I learned from the elders.
How did you decide to become a farmer?
I had no choice. I needed to do something to produce income for my household.

Your parents were also farmers?
Yes, I learned from my parents.
Do you think that the nature around Bekiok is changing?
Yes, there is a change in nature around Bekiok.
What change?
For example, when I want to bring fertilizer to the field, it is easy, because there is access to the field.
Ok. Do you think that agriculture affects the environment?
No.
Do you think that the forest is decreasing around Bekiok?
Yes, the forest has decreased because there are people who don't go to the forest. There is change around the river. Because 20 years ago there are big trees around the forest, but they're not there anymore.
Why there are not big trees?
We needed to cut them to plant.
Do you go to the forest? Do you use it for hunting or collecting non-timber products?
No. I don't practice hunting.
What will happen in the future if there is no forest? Will it be a problem?
Yes. Because there are many people planting.
What will be the problem?
No problem.
What are the challenges you face when farming?
There is no challenge.
Did you experience the pepper disease?
My paddy field there is pepper with the disease. But not all pepper got the disease. Only a few trees.
What do you do about it?
I use a fungicide.
And when the price of the pepper and rubber dropped, how did you react? What did you do?
I still give fertilizers to pepper even though the price has dropped.
And are you able to generate enough income from your crops?
Yes, I can produce a few income capacities to provide my household.
I've heard that you can store pepper for 10 years. Do you store some of the crops before you sell them to wait for a better price and sell it later?
I still store pepper in my apartment and I wait for a better price.
How long?
2 years
So you are still waiting for a better price?
Yes. I have 12 bags of pepper.
How many kilos?
1 bag is approximately 60 kg.
Wow, that s a lot. Do you also tap the rubber?
I don't tap rubber because I only live alone in this apartment. No manpower who could help.
So you are alone for all this work?
Yes
Do you have anybody to help you?
If my husband comes back from off-shore, then he helps.
Did you use to hire people?
No.
And are your children helping you?
Children are helping only during school holidays when they are at the longhouse.
So you would like to plant cocoa and oil palm in the future, I would like to ask why?

I would like to plant these two crops so they can generate more income for the household. These plants are waiting for my husband after he retires from working off-shore.
Just a last question. Why do you still grow paddy? So many people don't grow paddy anymore.
I love to plant paddy.
What do you love about it?
During the harvesting, you can feel good by looking at the paddy.
Is it the glutinous or normal paddy?
It is glutinous paddy for Gawai *(harvesting festival).* I plant glutinous rice to make rice wine.

Appendix 10 – Interview with Department of Agriculture (DOA)

STRUCTURE

INTRODUCTION

1. What is the area of your responsibility?
2. What are your daily tasks?
3. What is the role of the Agricultural Department?

GENERAL ASSISTANCE TO SMALL SCALE FARMERS

1. In what ways does the department provide aid to small scale farmers in the area?
2. How are the decisions made? Who's involved in the decision-making process?

- 165 ha of rubber schemes

3. What is the process of providing aid? Has the process changed?

- If yes, when and in what way?

4. Who is eligible for aid? (what are the criteria)

How was aid delegated? (within the houses)

5. How do the villagers apply for aid?

SPECIFIC QUESTIONS REGARDING BEKIOK

1. Does the office have any activities in Bekiok?
2. In what ways does the department provide aid to the villagers in Bekiok?

Subsidy [] Plantation Scheme [] Training [] Financial Aid [] *mention B40*
Others: _____
What kind of aid (fertilizer/herbicide/pesticide/cash?) was given and how much?

3. What kind of crops involved in the aids?

Rubber [] Pepper [] Paddy (normal rice) [] Paddy (Glutenous rice) [] Cocoas []
Others: _____

4. Did the road access change the procedures or the amount of aid provided in the area?

(What is the department's take on the environmental impact on the oil palm?)

FUTURE PLANS

1. What are the future strategies/policies regarding smallholders/small scale farmers?

NOTES

There are around 900- 1000 longhouses in Julao. The farmers involved are around 3500. Most of them focus on planting cash crops like rubber, pepper, paddy, oil palm.

Livestock: this is a remote area and not developed, so livestock is not a source of income for the local population.
The main source of income most of the time comes from the pepper.
In Bekiok a big project of "rubber block planting" has been carried out in the past due to government decision to promote this kind of cash crop.
This year is the final year (2019). The project budget was around 1.000.000 RH.
In the past, the farmers didn't manage properly the land so the small-scale projects failed. The crops were not growing well. In one hectare there should be 450 trees. Since the number of trees planted was less the project had been considered failing.
Within five years the rubber should be gathered.
The pepper has is own board, the pepper board.
There are two types of funding: state found and federal funds. The state found is easy to manage. The federal found is harder to manage since the AD [Agriculture Department] must stick to the rules.
Fruit Industry: Individual planting. The AD gives the participant: Rambutan, Durian, *Diamond Longan*. Udol has the industry of Fruit.
In this industry, we have a scheme that provides 1ha to the participants. 20 Durian, *Diamond Longan* 30.
This industry doesn´t make any profits to the farmers since there is no industry that processes the food. The AD doesn´t encourage this industry. It´s hard to find the market. The farmers that produce fruit doesn´t have knowledge in the sense that most time they don´t follow the criteria of the importer and so they can´t export their product. So, the export is not a viable solution.
Young people mostly migrate to find jobs, they don't want to do the planting.
Nick: *More about your job position?*
Overall, I control every section. There are 4 sections;

1. Extension site (field and projects)
2. Administration
3. Industry Community development
4. Officiary section

I´m an office uncharged and I take care of all the sections.
Nick: *Which are your daily tasks?*
I have to know which are the progress of every section. The most critical section is the account section because we have to follow the rules from the federal accounting system. Once we receive the funds they ask us to spend them before 31 December. Our financial here is very critical because we have to provide the input and tool to the farmer. Sometimes this fund is hard to manage because the government ask to spend less.
Mette: *You mention about the subsidy, regarding Bekiok, how does it work the process of giving subsidy?*
We are giving them in term of input, planting material.
Mette *How does it work do they apply?*
Our staff will supervise them once every 2-3 months they receive a visit to the field. After we give them the input, they have to take the input from our store, we give them the planting material and input. They will do the field work. This applies for the individual project.
Mette *Do they have to make an application? Who can apply?*
Only farm family. Only one per household. One farmer in one door. We receive the application form and then we compile them. The application period goes from 1 January to 31 October. The headquarters will receive the application and will decide on them.
Nick: *The planting material that you mention is only for Fertilizer or you cover also Pesticide and Herbicide?*
It covers all. We are giving all in term of material, not cash.
We cover even paddy

All the paddy plants are not sold. The plant is for their own consumption. We cannot call it a scheme because we just give them the fertilizer.
In Julao, less and less farmer plant paddy. It doesn´t generate income for them. They plant it on a small scale. Our morphology is hilly and not appropriate to plant paddy.
Filippo: *Are there other criteria to decide who get the subsidy?*
The applicants have to be from Sarawak.
Above 18 and less than 60 years old.
Mette: *Do they need to have a specific size of land?*
No. Sarawak is a big area and many lands have not a title. Most Ibans have their own piece of land.
The piece of land has to be certified by the Thoy Ruma (official headman of the house). He needs to certify that the land belongs to the applicant.
Only the certified headman of the longhouse can certify.
Anna: *How much do you give them?*
We give them only one hectare for one participant (like vegetable scheme and fruit scheme)
We have to follow the scheme mechanic.
For example, for pepper, we give them one hectare. For one hectare we allocate 26.000 RH. whit this money we buy all the input that they need. We purchase it for them. And they will collect it from us.
Only one hectare per farmer.
We give them in 2 years: the first year we give them 20000 and then 6000 the second year.
They can apply again only after 5 years from the previous application.
Mette: *What´s the difference between scheme and subsidy?*
No difference. we call it subsidy or scheme. Are the same.
Nick: Are you involved in oil palm plantation?
Yes, in Bekiok there are some oil palm plantations. Our department does not encourage them to plant oil palm since the area is so hilly, so the cost is very high. They need to do terraces. The oil palm is managed by their own board. We assist them but the project is carried out by the oil palm board.
The oil palm scheme is financed by the federal government.
State funding and federal funding have different heads, different managers. Every section of the AD has a different manager in the headquarters.
Nick: Out of subsidy, do you provide any other assistance like training or financial help?
Yes, we prepare some courses for them.
We visit the fields
And we provide technical supervisor e.g. how to apply certain fertilizer.
Nick: Are some of this training going on in Nanga Bekiok right now?
No, the courses are centralized. We inform the farmers to attend a particular course.
The central division is in Sarikke.
Do you give some financial help in Nanga Bekiok?
No, our department don´t provide financial aid.
Mette: Many farmers in Bekiok reported pepper disease. How are you dealing with this issue?
We advise them to refer to pepper board, they are better informed.
Sometimes we give some advice to prevent the disease in the way it doesn't spread out. We suggest which pesticide or insecticide to use.
Mette: Who decides which insecticide or pesticide to provide?
Our first staff. They are traded. We have attended some courses organized by the headquarters. We can assure simple disease. We know about basic fungicides.
Nick: about the decision making, who decides for the scheme? Federal government or state?
The state. The state will send the plan to the federal government to ask for an allocation of funds.
The government only want to have a report about progress and financial situation
Mette: Do you include the farmers in the process asking them what they want to cultivate?

For us (state), we include farmers. The federal want to know how much we spend. The acceptance of the project depends on the state headquarters. They will decide if the project will benefit the applicants.
Anna: How did you decide e.g. in 2013 to invest in rubber scheme project?
Pepper project: to convince the federal about the source of fund to the pepper project. We had to report everything to the federal about our study regarding rubber
Mette: Are there future strategies regarding Bekiok right now?
We are now focusing on pepper projects.
Nick: what are the challenges that you faced or the limitation?
Young generations don't want to farm. They don't want to continue the farm activity, lack of manpower.
Filippo: Are subsidy and scheme the same category?
Yes, the same.
Mette: How do you face the drop in the price of pepper?
Most people in longhouse don´t have any other option. They don´t have another way to generate the income, they have to do pepper.
Last year we gave them subsidies for new planting. This year we just give maintenance. We don't encourage them to plant new pepper.
Mette: Do you encourage them to plant any other type of crop?
Yes. Our minister asks them to plant at least three crops: pepper, oil palm and rubber
They have to do multi-cropping
Nick: after the road in Bekiok was built, there has been any kind of change in the type of subsidies or schemes provided?
Before the road, they were using the river. During that time the scheme was huge. A lot of funding.
The funding decreased so drastically in the last years.
Nick, So there´s a correlation between the construction of the road and the drop in quantity of subsidies?
The is not a correlation with the road.
It's because of government policy. In past when we did individual scheme, a lot of projects failed.
Nowadays we moved towards commercialized.
The project will run by the contractor. The contractor will do the work for the farmer. We are focusing on a big scale.
Nick: So after the road was built the policy changed to big scale projects?
Yes.
The projects include the farmers. The only thing that changes is that the contractor is part of the project. The funding for the individual scheme becomes less and less.
Thorben: The rubber scheme in Bekiok was a contractor project?
Yes, in this case, was a contractor of rubber block planting. The contractor had to carry out the project for 5 years. After 5 years the job is done and the farmer have the land back
Who is the contractor?
Is a local contractor. All the contractors who have the licences apply for the project and then the headquarters decide who is going to do the job.
Mette, What is a contractor?
They do the work in the field on behalf of our department. We pay them to do the work.
The contractors don´t have decision power, they have to follow our instruction.
The income goes to the farmers. The rubber then belongs to the farmer.
Some of the land in Bekiok didn´t get the rubber scheme. Who decides?
They apply for the project. They come to our office and discuss with us. They know who owns the land. People in longhouses share this piece of land. We then will do the perimeter survey. We don´t know who owns the block. Only the chief knows the division of the land inside the longhouse.
Professor: Is there any project for the pepper?
We don´t encourage big project for pepper because of the disease.

We promote them on a small scale. Just 200 to 400 vines.
Nick Are there any government initiatives to help them to change from pepper to something else?
There is no policy to change. They are just talking about these three crops rubber, pepper, oil palm.
Professor: since in Julao we import a lot of livestock, is there any project to implement livestock farm in the area?
For Julao area, the government don't allow us to reallocate land to livestock use since in very hilly. The livestock now is fully under the pet department. Before was with agriculture but now no more. The is no plans right now. The government focus on cash crop like oil palm.
Professor: Do you think that Julao has potential to grow?
In the area people don't like to commerce with livestock, because they don't have the knowledge, the cost is very high.
Nick: Does the department know why the pepper has been attacked so bad?
There is not a cure right now. The disease spread since 1999. we don't know from where it comes. The only we can do is prevention.
Professor: what about terraces funding?
About the funding to do the terraces. Our government don´t provide funding for that. Because to grow pepper you don´t need the terraces. Pepper needs a hilly terrain in the
way water can flow easily. Terraces make movement and managing easier, but since it´s not needed we don't provide funds.
Most people in Julao community have no other works to do out of farming. There are no choices. Since we are in a remote area there are no companies where to search for other jobs. No alternative.
Torben: In the community, a number of people are moving out to find jobs. Most of the people in the longhouse are elderly people. There is a lack of manpower that we need to face.
If we go to the longhouses there are a lot of elderly. The younger generations don´t want to stay.
Professor: Do you think that organic pepper could be a future possibility?
It´s a good idea. We never introduce this idea to the farmer. Our headquarters now is focusing on vegetables organic farming.
Organic farming is a good market. Our agriculture sector has a lack of knowledge about this sector.

Appendix 11 – PRA methods - Timeline

First timeline
Interviewer: Filippo, Jennifer
Translator: Anita
The participants of this activity were 3 elderly women from different longhouses. We tried to gather some men but the majority of theme were out, working on the fields. During the activity, a fourth woman joined.

1979 the longhouse fire
The types of crops cultivated back in that time were:

- Paddy
- Rubber
- Pepper
- Fruit trees

Before the first fire, there was no migration.
People used to live close to the village.
Before they were living in Tapang Tabong
No one moved out of the village after the fire occurred (no migration occurred).

Between 1979 and 1998 moved to Nanga Bekiok (*1980 from the second timeline*).
In that time the crops were still the same as before the first fire in 1979 (paddy rubber, pepper fruits)
When they first moved to NG Bekiok the community was living in only one longhouse with 34 households.
At that time they had 1 generator provided by the government. They were using gasoline as an alternative source of energy.
The students were going out to study in boarding school and coming back to the village just once every two weeks.
Even before the second fire, the muddy road was used to transportation together with the river.
Before the second fire, the road was still under construction and the condition was bad.
A group of soldiers helped them in building the first LH in Bekiok.

27 May 1998 second fire.
After the fire, they split into 5 longhouses.
The reason was apparently due to governance. The government found difficult to rule over such a big longhouse and the second reason is related to security. In case of fire not all the inhabitants were affected.
It took 1 year more or less for them to build the separate LH and split into 5 LH.
After the second fire happened, the government provided them with some sort of subsidy: they had to choose between a roof and a jigsaw.
The government provided kitchen utensils as subside.
They used timber from the forest to build the longhouses.
The longhouses were initially built using timber, after some years they changed with concrete as well.
They started selling of pepper to Julao Market.
Only one villager had a 4WD to reach Julao.

Between 2005-2009 the access to road increased because the road changed from muddy to gravel.
It took 7 years for the government to build a better road (more than 2005-2009).
In the last ten years, more people started to migrate out to search for a job.
In this period some of the students were walking back home from school since the road was still in bad condition.
In the last ten years they haven't been using the river as the main way of transport to reach the Julau village, but the road instead.
In 2005-2009 the price of rubber was 10 RH/kg
They´ve been selling cocoa for 2 years. The price is ranging between 3-5 RH/kg
The construction of the tar sealed road increased the number of people moving for work.
The tarred road leads more cars to be bought. The parents were better off in taking the children from school and more children went to school
Since 2-3 years the major part of the longhouses doesn´t plant paddy anymore.
The school where the children go is near to Ruma Panjang Jimi in Nanga Skalo. In Julao there are 2 primary schools, one is very far from here: 1 hour by car.

In 2017 they get access to electricity
The rubber scheme lasts for 5 years, providing the fertilizer for rubber. It started in 2014.
To face the death of rubber they started migrating even more.
The vine peppers started to dye 3 years ago.
The pepper started dropping 2 years ago.
The rubber price started dropping 3 years ago.

Second Timeline

Interviewers: Jennifer, Filippo
Translator: Anita

The second timeline has been carried out with a group of three men from different longhouses. We tried to identify elderly participants since we thought they were able to give us information further back in time. We decided to make a second timeline activity because during the first one, the participants were the only woman and they were uncertain when they had to answer questions regarding remittances, agriculture strategies or income sources.

1979

In both of the timelines, we have been asking the participants to start with a past fact or event that they considered important, we just told them that it should have happened before the access of the road. In both cases, the groups started telling from the first fire which happened in 1979.
At that time they were still living in another village called Tapang Tempung close to the actual location of Nanga Bekiok. At that time the Headman was TR and there was only one longhouse made out of 18 households (bilik).
They didn´t practice any religion out of the "old belief". There were still no Christians.
The only way to get to the local market was by motorboat or simple boat.
At that time, no one was still working abroad; the only exception was represented by Brunei, where the men were going to work in industries getting paid 2.5 Brunei Dollar per day.
There was no shifting cultivation applied. They were planting paddy for their self-consumption.
They were planting: paddy, pepper, rubber

1980

After the fire occurred, the villagers moved to Nanga Bekiok, where at that time there was nothing built. The spot was decided because of the location in a junction between two rivers.
The Headman was still TR
At that time they were already using machines to work with paddy (not specified).

1990

The junction road that connected Ng Merurum to Ng Sekalong opened. It has been financed by some local politician after he gets elected. The budget to build the road was RM 120.000.
At that time, only 2 people owned a car. The primary means of transport was still the boat.
At that time they received a one-time subsidy for pepper worth 250 RH.

1998 May 28

The second fire occurred.
They consequently split into 5 longhouses.
The reason why they split (as they said) is that it would have been safer to manage in case of another fire. As the participants said, the government suggested them to split even because it would have been easier to manage the separate longhouses from a financial point of view.
The migration increased, and people started to move abroad to work for off-shore companies.
However, the internal migration in Sarawak overcame the one abroad.
The increase in migration was connected to the need to look for other sources of income: during that time the villagers misunderstood the price of pepper that the government set down. The mistake was related to the different unit of measurement that the two were using, where one was almost the double of the other,

and consequently, the price that they expected was the double compared to the real price that has been offered to them.
They started growing more pepper and rubber and less paddy.

1999
The logging companies started to come to the village, forcing the villagers to sell the timber for a very low price (the company asked for 3RH/ton and the villagers didn't want to sell the timber to a price lower than 10RH/ton). The aim of the company was to buy the timber and then plant oil palm.
The Headman fought them and tried to stop them from cutting the trees.
This issue with the logging company is still going on nowadays.

2005-2009
Change of the road from muddy to gravel.
Easier access to the local market.

2013
The cell tower was built

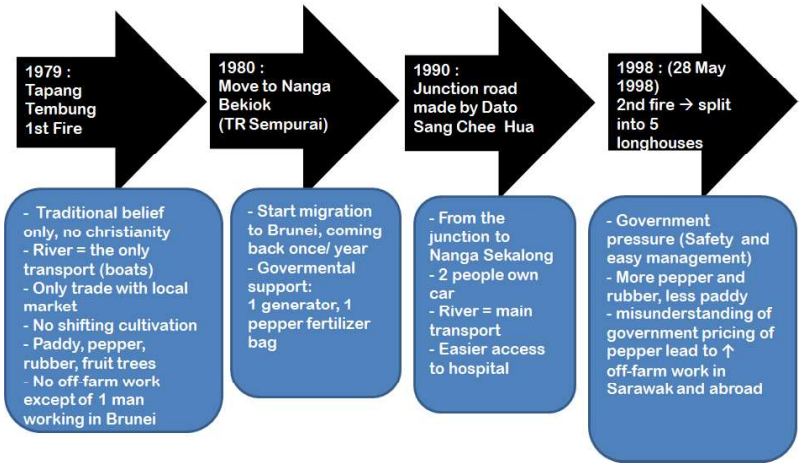
2014
Tar sealed road construction completed.
Easier connection with local market and schools.
The rise in the price of pepper and rubber:

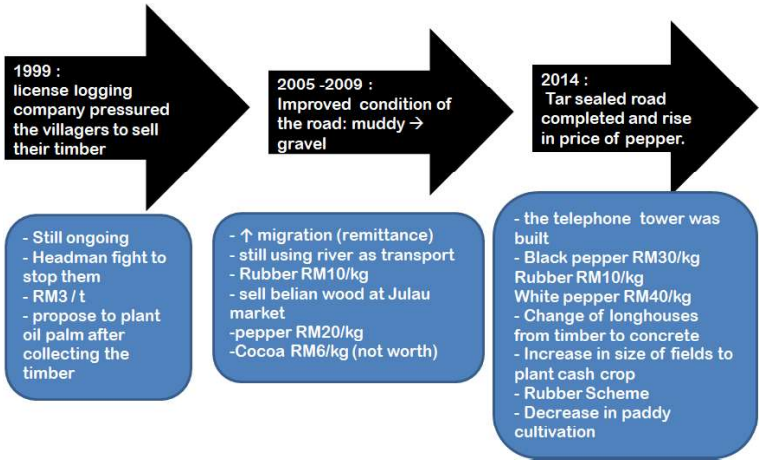
- Rubber RH 10/kg
- Black pepper RH30/kg
- White pepper RH 40/kg

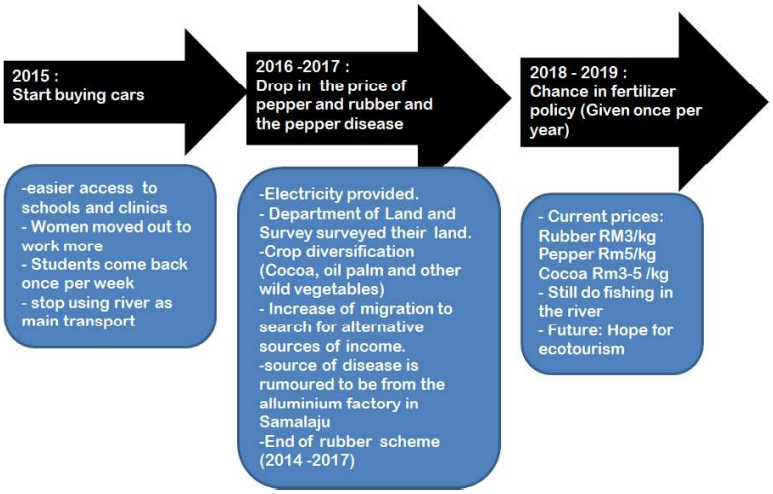
The road made them easier to sell the crop to the market and the surplus of money+ money coming from remittances and off-shore activities made them possible to buy cars and to increase the production of pepper.
Barely anyone has been using the river as a way of transport after the tar sealed road has been created.
Huge decrease in paddy plantations and increase in cash crops (rubber and pepper)
Rubber scheme of 165ha started

2016
The price of pepper started going down
Pepper started to die because of the disease
Section 6 (?) did the land survey for the area around Bekiok
The farmers started planting more crops like cocoa, oil palm and other wild vegetables to face the drop in price.
There was no help from the government for what concerns the dying of pepper. The government came to monitor the situation.
Farmers suspect the wind to be the carrier of the pepper disease, coming from the air discharges of an aluminium factory. Their hypothesis is even based on the fact that the fishermen around the factory complained about the dying out of fish consequent to the factory´s pollutants discharge into water.

2017
More plantations of oil palm started to appear even though the people were not receiving oil palm subsidies from the government.


1979 : Tapang Tembung 1st Fire
- Traditional belief only, no christianity
- River = the only transport (boats)
- Only trade with local market
- No shifting cultivation
- Paddy, pepper, rubber, fruit trees
- No off-farm work except of 1 man working in Brunei
1980 : Move to Nanga Bekiok (TR Sempurai)
- Start migration to Brunei, coming back once/ year
- Govermental support: 1 generator, 1 pepper fertilizer bag
1990 : Junction road made by Dato Sang Chee Hua
- From the junction to Nanga Sekalong
- 2 people own car
- River = main transport
- Easier access to hospital
1998 : (28 May 1998) 2nd fire → split into 5 longhouses
- Government pressure (Safety and easy management)
- More pepper and rubber, less paddy
- misunderstanding of government pricing of pepper lead to ↑ off-farm work in Sarawak and abroad


1999 : license logging company pressured the villagers to sell their timber
- Still ongoing
- Headman fight to stop them
- RM3 / t
- propose to plant oil palm after collecting the timber
2005 -2009 : Improved condition of the road: muddy → gravel
- ↑ migration (remittance)
- still using river as transport
- Rubber RM10/kg
- sell belian wood at Julau market
-pepper RM20/kg
-Cocoa RM6/kg (not worth)
2014 : Tar sealed road completed and rise in price of pepper.
- the telephone tower was built
- Black pepper RM30/kg
Rubber RM10/kg
White pepper RM40/kg
- Change of longhouses from timber to concrete
- Increase in size of fields to plant cash crop
- Rubber Scheme
- Decrease in paddy cultivation


2015 : Start buying cars
-easier access to schools and clinics
- Women moved out to work more
- Students come back once per week
- stop using river as main transport
2016 -2017 : Drop in the price of pepper and rubber and the pepper disease
-Electricity provided.
- Department of Land and Survey surveyed their land.
-Crop diversification (Cocoa, oil palm and other wild vegetables)
- Increase of migration to search for alternative sources of income.
-source of disease is rumoured to be from the alluminium factory in Samalaju
-End of rubber scheme (2014 -2017)
2018 - 2019 : Chance in fertilizer policy (Given once per year)
- Current prices:
Rubber RM3/kg
Pepper Rm5/kg
Cocoa Rm3-5 /kg
- Still do fishing in the river
- Future: Hope for ecotourism

Appendix 12 – PRA methods - Resource mapping

The main crops are pepper and rubber. The division in the fields are about 50/50, but the most important crop is pepper.
They use timber from the forest, but mainly for building boats, which is not that common anymore, since most transport is done by road.
They still depend on the river, but in a more local context, since they use it for transporting to the fields around Bekiok and for fishing.
The pepper fields are mainly in the same place, but some of the more remote fields have been abandoned in order to cultivate land closer to the road.
The production in the fields has increased, and there has to be produced more products in the same area of space.
In 2017/18 the pepper started to become diseased.
They are struggling to figure out exactly what is wrong the crops, and they don't really know where to go for more knowledge.
They feel like the weather has become more extreme (Warmer and heavier rainfall).
They would like to deforest more land for oil palm, but it is more labour-demanding to maintain than the pepper and rubber.
Things started to change with the road.
The main gravel road was established in 1998
It was sealed in 2013
The gravel road was very rough and didn't contribute to frequent commuting.
They still used the river for transport and had to go through a vagal system in order to get to Julau.
The connection is quite recent, so they are still getting used to the new patterns.
Since the completion of the road, pepper production has increased as well, which has clashed with the decreasing pepper prices.
For every 100 vines, it normally requires 50 kg of fertilizer a year to have a sufficient harvest.
The pepper plants normally produce for around 20 years, before the ground is too depleted for further production.
At the moment, they are considering switching to cocoa and oil palm instead of pepper, because of a steadier crop price.
The supply/demand ratio doesn't make sense to the locals in Bekiok.
They can file for a five-year sup
port program from the government, where they receive aids in the form of fertilizers and pesticides for their crops.
The land is distributed equally among the villagers and inherited through generations.
They used to rely more on hunting, but it's expensive having dogs, so it's not that common anymore.
The road has changed the way in which they interact with the surrounding areas.
They use other cities, like Julau, for recreational purposes.
They visit the doctor more frequently due to easier access.

Appendix 13 – PRA methods - Seasonal calendar

It goes for all crops, that the most intense labour-period is when harvesting.

Rubber

The rubber is very dependent on the rain, the more rainfall, the more rubber liquid. This also means that there is more liquid in the trees in the months around November and December, where the rainfall tends to be heavier. You have to cut the grass around the plants.

Pepper

It takes approximately one year from the fertilizer has been spread onto the ground, until the peppercorns are ready for harvest. Once harvested, it takes approximately another year before the vines are ready for harvest again. You have to cut the grass around the plants.

Cocoa

It takes three years from the seed is planted until it gives its first product. The flowers require care at least once a month. The plants also require pesticides once a month. You have to cut the grass around the plants. You cannot use herbicides around cocoa.

Oil palm

Takes three years before first produce. It's quite rapid in its production, but it also takes a lot of seeds to make an income. 100 trees will generate about 1,5 tons of oil in a single harvest. The plants produce seeds once a month. After ripening for the first time, the palms will produce seeds for four years.

Paddy

Rice is not a beneficial crop since it takes quite a lot of labour and doesn't give much of revenue, so therefore it's mainly for self-consumption. It also takes a lot of fertilizers, since it has to be fed once a month.

Appendix 14 – PRA methods – Venn Diagram

Pulau Galau/Communal Land

They used to have communal land but now they do not have it anymore. Because of the illegal logging started by the senator (Mr Thom). He possesses Licence C for logging. This logging is possible because the ancestor in Nanga Bekiok decides not to apply for the perimeter survey. The initial perimeter survey falls under Section 6 of Land Code where the landowners and state have right on the land. So they decide not to apply. Thus, the logging of the communal land continues even until now (every 5 years whenever the tree is mature enough to be log). The people have no say for the deforestation. Sometimes they get paid and sometimes they do not. Paid for RM10/ tonnes.

In order to stop this logging activity, the people of Nanga Bekiok agree to apply Section 6 of the Land Code. To get an individual title, they will then apply for Section 18 of the Land Code. TR will ask around the village who want to apply for the title and he will go to L&S to apply.

Before that, TR will also try to ask for help and funding from YB to do the survey. Then the YB will ask for help from the State Government or Federal Government. Once the fund is there, the land survey will ask permission from the District Office (D.O.) to enter the village and do the survey.

District Council

They provide assistance regarding the activities outside of the house. (Drainage, Waste disposal). Any matters regarding the village with district council through TR.

RISDA

Based on TR, it is a subsidiary of DOA providing for the Rubber Scheme. The villagers are asking help from DOA for the scheme. And DOA also asks whether the villagers want to join the rubber scheme. The decision made is individual for the landowner.

MPB

The villagers asking help from the MPB. Apply for a subsidy through letters. Sometimes, they headman will collect all the forms and send them to the MPB but some do send themselves because they scared that the headmen discard their application. MPB also provide training for the farmers. They will send their names and the MPB will decide.

Based on an informal interview with TR, the headman decide who are going for the training based on the effort of the farmers and the size of their pepper farms (for each longhouse). He also mentioned that he will send a different person who has not to participate in the training before (giving opportunity to others).

Project E-Kasih and MRP was given by the government to the villagers.

Decision Making in the Longhouse is mostly decided by the TR. They usually gather money and whenever its enough the build it. Type, design in and out of the longhouse was determined by the TR. TR also act as a representative for the villagers to interact with the D.O. Whenever a new project came into the village, the villagers will gather around and discuss whether to receive or reject the project. The final decision then is made by TR.

They have gotong-royong, at least one people per door to clean up the water tank/gravity feed. During the construction gravity feed/water pipe, the people of Nanga Bekiok decide to collect RM1 per door for every month. Then the money is used to buy the pipe.

Health clinic activity, the community of the longhouse decides and gather themselves to join the activity conducted by the clinic.

In school they have Persatuan Ibu Bapa dan Guru (PIBG), they include parents for the school activity. (Sarana Sekolah)

During the arriving of the SDA (Christian), each individual decides on their own whether they want to become a Christian.

The women committee for each longhouse is making their own decision without intervention from TR. Whenever there is a big event (YB datang), all of the women committee from 5 longhouses will work and discuss together.

The only committee that exists in the 5 longhouses is JKKK and women committee.

People in Nanga Bekiok often share their land mostly to their relatives. The decision was made by the landowner and they only let the borrower plant paddy because paddy needed to be harvest once a year. In a sense, it shows that the landowner still owns the land.

Appendix 15 – Transect walks

Transect walk agriculture

TW1: Lading's pepper farm

- Planted pepper, yam, sweet potato,
- Problem with dead pepper plants – disease (maybe from the air)
    - Observation: Pepper plants were clustered together
- Before the road used to transport the pepper 4 hours to market by road
- Now: 30 minutes with car

Pesticides/fertilizer:

- One representant from the department of agriculture recommended Ridomil. Accodring to Lading – did not work
- To maintain/prevent the disease to get worse: Amistartop/Alika

Adaptation strategies:

- If pepper does not work: He will turn to rubber (now RM/kg 3) and jackfruit (not big market)
- When pepper plant died: Replaced with yam plants (sell at the market as well)
- 5 years – he used to have paddy in the pepper field

Market

- Chinese middlemen in Julau -
- If you want to sell more than 500 kg sell it directly at the factory (But more petrol)

Also grow: Tapioka, Lemongrass, sweet veggies

Q:

- How many vines do you have?
- How much does one pepper plant yield?

TW2: Fish ponds –

- 4 years ago – cleared area
- Tractor to dig the holes – RM 2000 after compensated by the government
- At the beginning (and occasionally) the government provide fish eggs and subsidize fish fertilizer/food
- Price for fish:
    - Patim: RM12/kg (6 months to mature – depend on food as well)
    - Catfish RM 10/kg
- Pests: Eagles, hawks, monitor lizards
- Would not be possible to sell fish without the road
- Pig farm – given by the government
    - Originally a pair of pigs
        - Sold it for quick cash

Q:

- Which department supports the fish?
- Why only 1 pig?

TW3: Paddy field –

- Glutinous rice (sticky rice) – easier to care for
- Paddy replaces dead pepper vines
- Rice used for offerings and consumption (to times a year: For Harvest festival and new years eve)
- Need workforce to cultivate rice
- Fertilizer: Organic from the government

TW4 – Oil palm

- Three people in village cultivating oil palm (Belawan) – planted by himself
- Less than 2 years old

TW5: Rubber tree

For 5 years: from 2012-2017: Government-subsidized Indonesian workers, fertilizer to rubber plantations,

- Sell to Chinese middlemen in Julau
- RM 3/kg

Q: Who is able to benefit? Everyone?

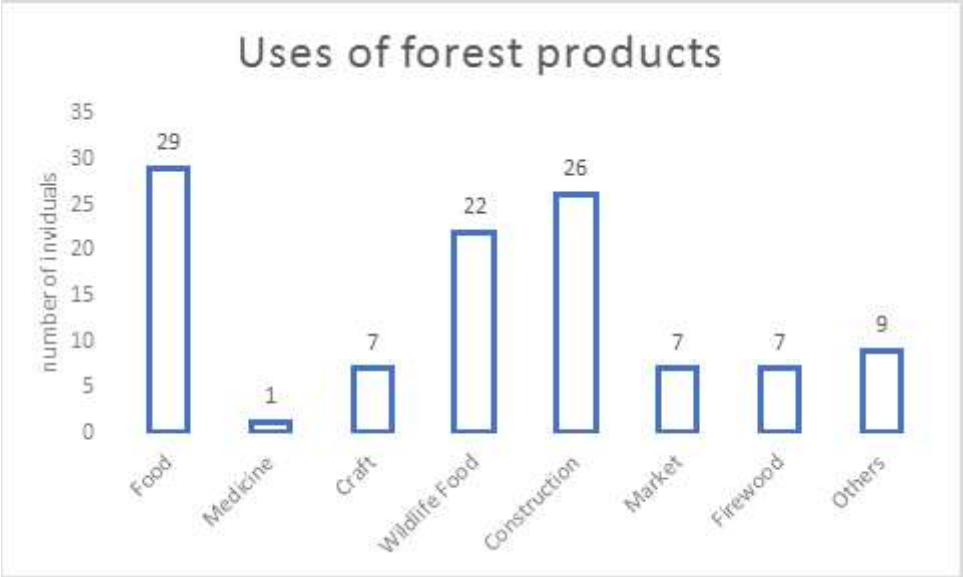
Antonio: Has oil palm one hour away.

- Belongs to in-law
- Government started plantation
- Started two years ago
- Impossible without road: ”If there’s no road, it is hard to work”
- Drop in oil palm prices: In 2008: Drop from RM 800-200.

<u>Transect walk forest</u>

Transect walk, forest

Figure: Uses of forest products

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Appendix 16-Results from miniSASS

		ST2			ST5		ST3	
groups	points	replicate 1	replicate 2	replicate 3	replicate 1	replicate 2	replicate 1	replicate 2
snail	4	1	1	0	0	0	0	0
crab	6	1	2	2	0	0	0	0
shrimp	6	9	7	4	0	1	0	0
damselflies	4	2	0	0	1	0	0	0
beetle	5	1	0	0	3	2	3	5
total score		25	16	12	9	11	5	5
number of groups		5	3	2	2	2	1	1
average score		5	5.3	6	4.5	5.5	5	5
miniSASS Score		5.4			5		5	

Appendix 17 – Results from Forest Resource Assessment

To conduct the study, we divided a plot of 20mx20m in 4 sub-plots, we measured the diameter (DBH) of the trees, counting only those that exceed 5 cm, estimated height and identified tree species with the help of a professor.

DBG > 5 cm

Local Name	Species Name	DBH /cm	HT /m	BA /cm^2	Ws /kg	Wb /kg	Wl /kg	AGB /kg
Geronggang	Cratoxylum	42.0	20.0	33.00	452.23	94.36	14.12	560.71
Entangor/Bintangor	Calophyllum	35.0	20.0	27.50	317.12	64.54	10.95	392.62
Ubah	Acmena acuminatissima	7.0	15.0	5.50	13.82	2.26	0.99	17.07
Medang Pawas	Litsea elliptica Blume	10.0	8.0	7.86	27.68	4.75	1.71	34.14
Entangor	Calophyllum	11.0	9.0	8.64	33.32	5.79	1.97	41.09
Medang Merah	Sctinodaphne sp	23.0	12.0	18.07	140.05	26.92	5.97	172.94
Pawas	Litsea elliptica Blume	6.0	10.0	4.71	10.24	1.64	0.78	12.66
Ubah Merah	Syzgium kunstleri	7.0	9.0	5.50	13.82	2.26	0.99	17.07
Getah	Hevea brasiliensis	7.0	11.0	5.50	13.82	2.26	0.99	17.07
Ubah Merah	Syzgium kunstleri	11.5	15.0	9.04	36.33	6.35	2.11	44.80
Pawas	Litsea elliptica Blume	5.0	8.0	3.93	7.18	1.12	0.59	8.89
Pawas	Litsea elliptica Blume	7.0	8.0	5.50	13.82	2.26	0.99	17.07
Ubah	Syzgium	7.8	7.0	6.13	17.06	2.83	1.17	21.06
Geronggang	Cratoxylum	47.0	18.0	36.93	562.92	119.27	16.44	698.64
Ubah	Syzgium	9.2	9.0	7.23	23.53	3.99	1.50	29.03
Ubah Putih paya	Syzgium acuminatissimum	10.6	12.0	8.33	31.00	5.36	1.87	38.23
Ubah Merah	Syzgium kunstleri	5.2	8.0	4.09	7.75	1.22	0.63	9.59
Tampoi Hitam (Botung)	Baccaurea	5.3	8.0	4.16	8.04	1.27	0.65	9.95
Ubah Merah	Syzgium kunstleri	9.2	12.0	7.23	23.53	3.99	1.50	29.03

Medang Sasi	Litsea sp	38.3	36.0	30.09	377.92	77.87	12.43	468.21
Ubah Merah	Syzgium kunstleri	7.5	12.0	5.89	15.81	2.61	1.10	19.52
Ubah Merah	Syzgium kunstleri	6.1	9.0	4.79	10.57	1.70	0.80	13.07
Merampak	Bhesa sp	31.0	20.0	24.36	250.40	50.13	9.22	309.74
Merampak	Bhesa sp	25.0	20.0	19.64	164.73	32.02	6.75	203.51
Merampak	Bhesa sp	22.5	20.0	17.68	134.18	25.71	5.78	165.68
Merampak	Bhesa sp	25.0	20.0	19.64	164.73	32.02	6.75	203.51
Merampak	Bhesa sp	21.0	20.0	16.50	117.32	22.27	5.22	144.82
Terantang Chit	Buchanania	6.2	6.5	4.87	10.91	1.75	0.82	13.49
Ubah Merah	Syzgium kunstleri	8.8	9.0	6.91	21.58	3.64	1.41	26.63
Merampak	Bhesa sp	30.0	20.0	23.57	234.91	46.82	8.80	290.53
Ubah Merah	Syzgium zeylanica	10.6	12.0	8.33	31.00	5.36	1.87	38.23
Ubah Merah	Syzgium zeylanica	5.1	5.0	4.01	7.46	1.17	0.61	9.24
Ngeludok/timonies	Timonius	14.5	13.0	11.39	57.05	10.30	3.00	70.35
Merampak	Bhesa sp	21.2	34.0	16.66	119.51	22.72	5.30	147.52
Merampak	Bhesa sp	23.2	16.0	18.23	142.43	27.41	6.05	175.89
Merampak	Bhesa sp	17.4	30.0	13.67	81.36	15.05	3.95	100.36
Tangsang-lang	Engelhardtia	10.0	9.0	7.86	27.68	4.75	1.71	34.14
Mak	Fordia sp	13.5	14.0	10.61	49.64	8.87	2.69	61.21
Ubah Merah	Syzgium kunstleri	6.0	7.0	4.71	10.24	1.64	0.78	12.66
Medang Sasi	Litsea sp	21.6	12.0	16.97	123.93	23.62	5.45	153.00
Medang Sasi	Litsea sp	32.1	24.0	25.22	267.98	53.90	9.69	331.58
Pudu/puduh	Artocarpus kemando Miq.	27.1	13.0	21.29	192.74	37.88	7.59	238.21
terentang chit	Buchanania	15.0	14.0	11.79	60.94	11.05	3.16	75.15
Kemayau	Dacryodes rostrata	6.3	7.0	4.95	11.26	1.81	0.84	13.92
Nyalin	Xanthophyllum sp	6.3	8.0	4.95	11.26	1.81	0.84	13.92
Ubah Merah	Syzgium kunstleri	5.3	8.0	4.16	8.04	1.27	0.65	9.95
Ubah Merah	Syzgium kunstleri	9.7	16.0	7.62	26.09	4.46	1.63	32.17
AGB total /kg								5547.9
AGB total[a] /metric ton ha^{-1}								138.7

[a] AGB total/ metric ton ha^{-1} calculation: $\frac{5547.9}{400}\frac{10000}{1000} = 138.7\ metric\ ton\ ha^{-1}$

Appendix 18 – Soil sampling

Soil sampling notes:

SS1: Oil palm
Area of oil palm 15 ha, 6 years old
Forest till 1965 → paddy → 2013 → oil palm

SS2: Rubber
Management:

- Fertilizer every fourth month
- Every month: Removal of grass/plants

3ha
Forest till 1999 → Paddy till 2000 → Rubber till 2015 → Rubber from rubber scheme

SS3: Pepper
1000 vines
(300 vines in other location)
Species: Kuching varity
Construction:

- Terraces
- Planted in rows (increase in soil loss)
    - But high content of clay – good for slopes

Managment:

- Fertilizer every fourth month
- Only two workers (him and his wife)
- Got seedlings from a friend
- Made terraces by himself

Harvest:

- Last year: 20 sacks (1 sack: 55-60 kg)

- Sell individually
- 2018 – june: 12 sacks → get back capital to buy fertilizer/pesticides

Market:
- Sell to pepper board
- Transport by himself
- Still store from last year
- Can last 2 years before quality gets low
- Only doing the black pepper

Income:
- Average income/year: 200.000 RM
- When price were high: 25 RM/kg

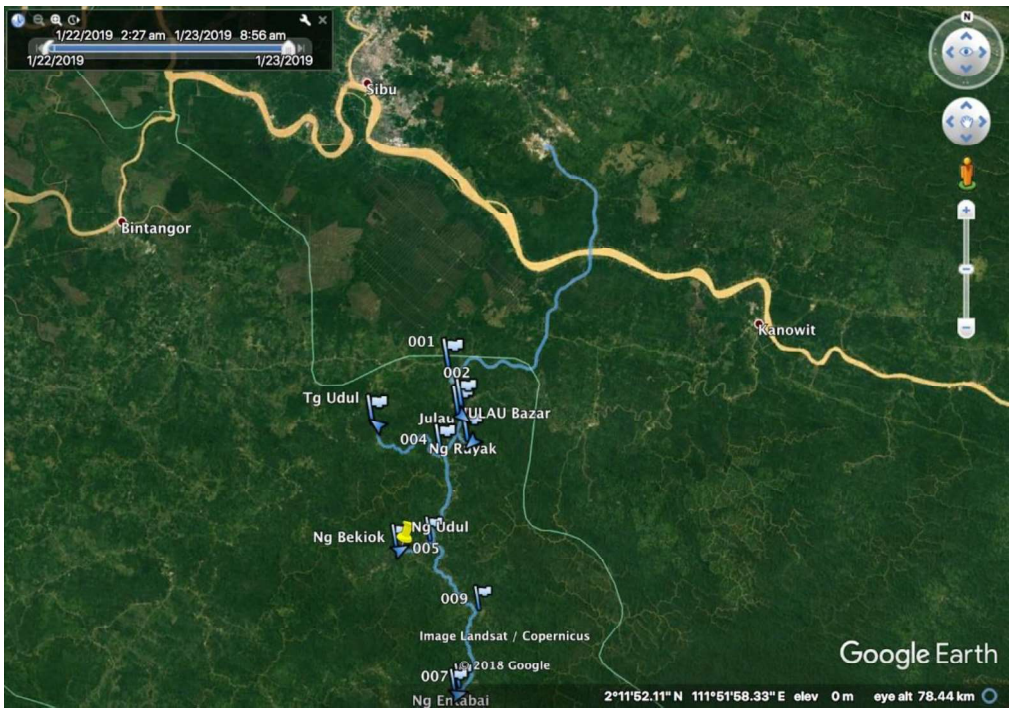
Fertilizer:
- Chalk (1 sack: 25 kg/ 24-26 RM)
- After harvesting the fruit
- Use alluminium ladder to climb the tree (300 RM)

<u>Forest sampling:</u>

Soil texture:
- Moisture: 4,5 out of 10 (=45%)
- Light: 100 lux
- pH: 7

Appendix 19 – Synopsis

Land Use Transitions among Rural Livelihoods in Nanga Bekiok
Final Synopsis



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20th February 2019
Word count: 2532

1. Introduction

This synopsis sets out to present the research questions of a study that is to be carried out in rural Sarawak. The study tries to explain how livelihood strategies have changed in rural settlements in Sarawak, Malaysia, with the construction and access to a road network. The purpose of the synopsis is to elaborate on the applied methods, the theoretical approach and the themes that have been found relevant in accordance to describe and answer the research questions as precisely as possible.

During the preliminary studies of the given case in the longhouse village Nanga Bekiok in southern Sarawak, it has been presumed that the construction and given access to the road network will have been likely to have created new patterns for the livelihood in the villages. This includes both the possibility of easier access to commuting possibilities, but also a change in the agricultural use of the areas in and around Nanga Bekiok. In our study, we aim to describe in which ways the access to the road network has changed both the social patterns in the village, but also the physical environment in and around the village.

2. Background

The thematic discourse for creating this synopsis is based on the introduction of road access in the village of Nanga Bekiok located in rural Sarawak. In accordance with this, there will be a brief description of the conditions and surroundings in the area.

2.1. The Region of Sarawak

Sarawak is placed on the island of Borneo, and along with the state of Sabah, it makes up the Malaysian part of Borneo. The state of Sarawak consists mostly of rural (secondary forest and cultivated areas) and remote primary rainforest, along with some urbanized areas, which are mainly located at the coastal line or along the rivers dissecting the island. The lack of a sufficient road network connecting the rural areas to the major cities has meant that most transport has had to be done by water or logging roads.

2.2. Dependence on Agriculture and Natural Resources

Given the circumstances of the geography in the area of Sarawak, most of its industry is based on the production and processing of agricultural products, including rice, rubber, pepper, palm oil and timber, which also is the case in the village of Nanga Bekiok, where the main source of production has been pepper and rubber. The connection to the road network, and thereby easier access to larger markets could possibly have changed the way in which crops are being produced, since the villagers to a lesser degree are dependent on a subsistence agricultural strategy, and instead are focusing on producing cash crops (Tanaka et al., 2014). This puts the agricultural production in Sarawak into a new perspective, where the farmers and villagers are to a higher degree dependent on world market prices, along with market fluctuations. This could both have a positive influence on the societies, in the sense that individuals have easier access to education- and job opportunities outside the villages, but on the other hand it could also mean that farmers are forced to exploit their fields in order to deliver the demanded supply of cash crops in order to get by.
It's the relation between these factors of the changing access to markets and the impact on the livelihoods in the villages this study sets out to examine through the problem statement.

3. Research Objectives

It is worth to mention that we are aware and opened for future development and changes to our research questions as the data will be collected and analyzed in the field, influenced by the knowledge and perception of local people. Based on the background information, preliminary research objective was defined as follows.

How has the use of natural resources in Nanga Bekiok changed with the improved accessibility and with what impacts on livelihoods and the environment?

In order to answer the overall research objective, we identify the following research questions (see Data Matrix in Appendix 1 for more subquestions):

RQ1. How has the use of natural resources changed?
RQ2. How have the environmental impacts of different land use practices changed?
RQ3. How are decisions about land use livelihood strategies made?
RQ4: What are the impacts of improved accessibility on rural-urban interaction and livelihood strategies?

4. Theoretical Framework

As a theoretical approach, a combination of The Sustainable Livelihood Framework (DFID) and the Theory of Access by Ribot and Peluso (2003) will allow us to understand different factors that influence people's lives in Nanga Bekiok, as well as the ways decisions about land use in the area, are made.

4.1. The Sustainable Livelihood Framework

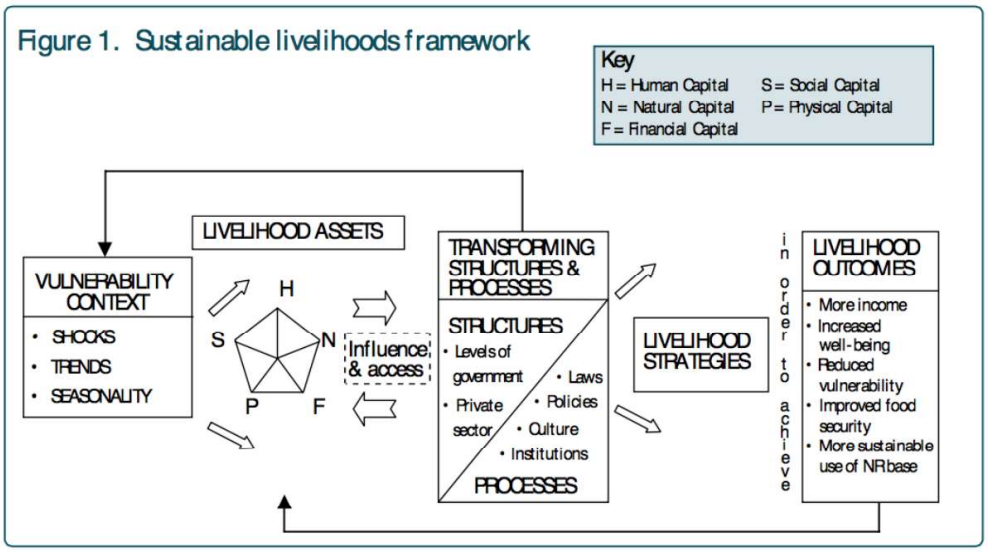

Figure 1 Sustainable Livelihood Framework (DFID 1999:1)

The Sustainable Livelihood Framework (Figure 1) provides a vocabulary to identify the many factors that affect livelihoods, the importance of these factors and the way they interact (DFID: 2.1). In relation to our research question, this framework will help us to analyse how the construction of the road (a transforming structure) has affected people's use of natural resources (livelihood strategies) and with what impact (livelihood outcomes).

The framework contributes with a more holistic account of livelihoods since it does not only look at economic capital but likewise other forms of assets (human, natural, social, physical, financial) that decide whether or not people are able to improve their livelihoods (Scoones 1998; in Hidayat 2015:28). In relation

to our field, an asset can thus be a social network, land right or natural resource that makes it possible for the villagers to benefit from the land use changes in the area.

4.2. Theory of Access

To understand people's access to natural resources in Nanga Bekiok as well as decision-making processes about land use transition, it is relevant to look deeper into the word 'access'. Ribot and Peluso define the term access as the *ability* to derive benefits from things (Ribot and Peluso 2003:153). To get better infrastructure in a community is thus not the same as being able to benefit from this. In a Theory of Access, Ribot and Peluso look at different mechanisms (technology, capital, markets, labour, knowledge, authority, social identities and negotiation of social relations) that either exclude or enable people's access to benefit from resources (Ribot and Peluso 2003: 161-172). In our fieldwork, the 'access mechanisms' will contribute with theoretical terms to analyse who are able to benefit from the land use transitions in Nanga Bekiok. Likewise, the theory will allow us to map different actors and power relations that influence how decisions about land use are made and help us to understand potential conflicts that arise from this.

5. Methods

In order to fulfil the objectives of our research, a combination of social- and natural science methods will be used. This interdisciplinary approach should help us to gain an understanding of the problem from a wide perspective and will allow us to analyse the problem in a complex manner. This section aims to introduce different methods.

5.1. Social Science Methods

5.1.1. Semi-structured Interviews

Semistructured, open-ended interviews are the most structured form of qualitative interviewing (Casley & Kumar 1988: 13-14). Since questions are open-ended and without a strict order, informants are encouraged to express themselves in detail. The interviewer is likewise allowed to pursue interesting leads by posing additional questions to the things mentioned by the informant (ibid.).

5.1.2. Questionnaires

Surveys are designed to generate quantitative data through standardized and structured questions (Casley & Kumar 1988: 54). Through household surveys, we can learn about different demographic characteristics such as types of activities undertaken by the household, sources of income, data on social and ethnic status as well as access to resources (water, education, fertilizers etc.). Since surveys force informants to answer according to predefined categories, caution is necessary to avoid leading questions embedded with prior assumptions.

5.1.3. Participatory Observation

The purpose of participatory observation is to engage in the daily activities carried out by the informants in order to get an understanding of their everyday life and values. In this way, data is gained through the experience of the researcher.

5.1.4. Participatory Rural Appraisal

Transect walks:

The purpose of this method is to walk through the study site in order to look at resource uses and specific features and practices in the area (Brockington and Sullivan 2003:61). This can be carried out with an informant as a guide to get an overview of area-specific endowments and problems (Mikkelsen 2005:90).

Ranking and Scoring:

Ranking and scoring reflect different interests between people and can be used to assess people's expectations, beliefs, judgements, attitudes, preferences and opinions (Mikkelsen 2005: 89-90). In this way, the method can be used to understand how people classify and attach value to different things.

5.2. Natural Science Methods

5.2.1. Soil Sampling

A soil analysis will be applied in order to understand the impacts of different land-use practices on soil quality and soil fertility. Auger samples will be taken at different crops sites (e.g. paddy rice, rubber, pepper, fruit and vegetable gardens) of different age. The composite sample will be collected and soil texture with colour will be identified. Subsequently, the soil samples will be air dried and analysed for pH, phosphorus and nitrogen concentrations, total C% and N% from which C: N ratio will be calculated. A reference sample will be collected in secondary forest. The specific sampling location will be identified after getting introduced into the local environment via transect walks and the history of agricultural practices with the help of interviews, seasonal calendars and historical timeline of cropping and agriculture management.

5.2.2. Water Sampling

Analysis of water quality of Kanowit and Merurun River will help us to assess possible adverse environmental impacts of agricultural practices such as leaching of fertilizers and pesticides. Following parameters of water quality will be measured: temperature; dissolved oxygen; chemical oxygen demand; biological oxygen demand, pH; total suspended solids; turbidity; ammonium, phosphate and nitrate concentration; total coliform and faecal coliform count (TCC). As for soil sampling, specific location sites will be identified after the first assessment of the local environment through transect walks and interviews.

5.2.3. Use of Global Positioning System (GPS)

GPS registration will be used throughout the fieldwork in order to get a visual overview and spatial understanding of the study area. Specific points of interests, sampling sites, the routes of transect walks etc. will be marked. Subsequently, maps will be created by uploading the recorded data into Google Earth and will be used in the final stage of our analysis as supportive material.

6. Description of Research Questions

6.1. Research Question 1: How has the use of natural resources changed?

We decided to divide natural resources into land use and ecosystem services. Regarding land use, we will focus on how the land is cultivated depending on the type of crop and the different agricultural techniques that have been used. We differentiate crops between food crops, cultivated for self-consumption, and cash crops, grown for sale to return a profit.

First, we will collect information about the location of the fields, cultivation techniques and main crops cultivated through interviews with the local community and participatory observation. During the interviews, it will also be asked, especially to the elderly members of the community, to reconstruct the history of Nanga Bekiok and its agricultural shift. This will help us to construct a historical timeline of land use. Transect walks will be used to identify and locate the household fields. Once arrived on site, by using GPS measurement, we can geolocalize its position in order to build a digital map. From the collection of these data and information, we will have an overview of the land use pattern.

Ecosystem services, on the other hand, include a series of services that the ecosystem offers to the local population. Through interviews and participatory observations, we will obtain an overview of the use and importance given to the ecosystem by the local community.

Based on the data obtained, through the transect walk we will have a geographical and spatial location (where possible) of these services and using forest and faunal inventory survey method, we will obtain data

on the abundance of species diversity of flora and fauna. The presence of certain aquatic species can be important to address water quality.

6.2. Research question 2: How have the environmental impacts of different land use practices changed?

Agriculture changes such as shifts towards cash crops cultivation and intensification of shifting cultivation can have negative environmental impacts, depending on the management practices, and for instance, lead to soil degradation (Tanaka et al. 2014). Smallholder rubber farming in Sarawak can be characterized by low-intensive management in contrast to pepper farming, often characterized by the application of excessive fertilizer amount. Excessive use of fertilizers can lead to leaching of nutrients into the surrounding water systems and cause river pollution. In order to assess potential environmental impacts of the land-use changes in Nanga Bekiok, soil and water sampling will be used to obtain characteristic physical and chemical parameters. Additionally, semi-structured interviews with farmers will be performed in order to get an understanding of their perception of land use changes.

6.3. Research question 3: How are decisions about land use livelihood strategies made?

When examining how people's use of natural resources has changed, it is relevant to understand the decision-making process behind these land use transitions. Who participates in the decisions about agricultural development, which factors influence the decisions and who benefits from the changes? Does the outcome of the decisions lead to conflicts between villagers? To answer this we need data about land ownership, different actors engaged in the decision-making process as well as their interests. The Theory of Access (Ribot & Peluso 2003) as a theoretical framework will help us identify the actors and power relations between them. Methods to examine this could be semi-structured interviews, informal conservations and focus group interviews. It is, however, important to note, that since decision-making processes related to power relations and potential conflicts between the villagers, ethical considerations should be taken into account in relation to how people are asked about this topic. Transect walks will provide information about land ownership, while a historic timeline will contribute to an understanding of how decision-making about land use has changed over time.

6.4. Research Question 4: What are the impacts of improved accessibility on rural-urban interaction and livelihood strategies?

The recent access to the road, along with a better connection with the market, has impacted the interaction between the village and the nearby urban area and thus also the livelihood strategies. This has potentially led to a reduction of the labour force in Nanga Bekiok. What is the consequence of this and how are these changes related to the development projects introduced by the government in Sarawak? To investigate this, we need to collect data on the economic effect of road access and market availability, as well as the connected changes in trade habits of the local populations. To do so, we are going to use a range of social science methods from SSI and questionnaires to focus group discussions and community mapping. We are aware that the access to the road can lead to both an export of resources and goods as well as an import, in the form of increased remittances or a "mobile market" coming to the village.

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