

Water supply in Opar, Sarawak

-a case study



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1. Abstract

This is a case study of the water supply in Kampong Opar, conducted by three students from the University of Copenhagen and from The Royal Veterinary and Agricultural university of Copenhagen. The Field study in Kampong Opar, Sarawak Malaysian Borneo took place over a period of ten days.

The aim of the project was to investigate factors influencing the water supply of Opar village. The investigation is of relevance because many rural communities in the developing world are dependent on a local and often unreliable source of water.

The main findings of our work are that the water in Opar is rendered undrinkable during the rainy season due to siltation of the water. There are indications that the siltation problems stem from commercial logging activities in the upper catchments of Opar. Here commercial logging took place until 1996, and the former logging sites and roads are still without vegetation. Furthermore, we found that the villagers experience shortage problems related to the actual design of the water supply system and its setting.

The last issue of interest is that the villagers - due to their water supply problems - have applied to get centralised water.

The field study is based on 19 household interviews, which has been supplemented with interviews with officials from the Health department in Bau, The Forest Department both in Bau and Lundu and the Public Works Department in Bau as well as observations and measurements of physical parameters.

2. Introduction

Objective

The objective of this project is to investigate: How the water is supplied to Opar and how precipitation, and the land use in the catchment area as well as the design of the supply system influence the water supply.

Sub-objectives

1. Identifying the influence the commercial logging activities in the Opar catchment areas has on the water supply in Opar,
2. Identifying other sources which can have an effect on the water supply,
3. Assessing the extent to which 1) and 2) constitute a problem at the point of consumption,
4. Examining how the villagers perceive the water supply and deal with the constraints imposed on the water supply,

Relevance

A good water supply (both quantitative and qualitative) is essential to every community but water supplies and its maintenance in small communities have been neglected in many developing countries. The World Health Organisation has estimated that 30 - 60 % of the existing water supply systems are not operational (Davis and Brikke, 1995; Tom, 1995). An untreated water supply may be affected by for instance the land-use practices in the catchments area. Logging in a catchment area can lead to a drastic lowering of water quality, due to the siltation of the rivers caused by erosion (Hurst, 1990). It also gives rise to a high turbidity level due to the fine soils being washed into the water courses by rainfall runoff (Davis and Brikke, 1995; Tom, 1993).

Assumptions

In the present case we assumed that the water supply for Opar village was affected by several factors:

1. The scars from previous logging in the catchment area will cause erosion and thereby siltation in the water.
2. The water supply is not reliable due to the design of the supply system
3. The supply is subject to precipitation and therefore unstable.

Hypothesis

We chose the following hypothesis for the project:

1. Previous commercial logging in the catchment area has an impact on the water supply,

because it causes siltation of the rivers.

2. Constraints within the water quality and the quantity are problems, because it is very detrimental for the villagers to depend on an unreliable source of water.
3. The villagers have probably have discussed the water situation and taken action accordingly.

Limitations

Due to the fact that we only spend ten days conducting our field work, the water quality measurements do only reflect the water situation one day in October 1998. As for the turbidity measurements they cannot reflect the siltation problem, because it only occurs during the rainy season which had not yet begun.

Definitions and terminology

Catchment area

The villagers in Opar understand a catchment as being the area bounded by the slopes in the immediate vicinity of the reservoir (dam) (intv. household & vil. log)

According to Jensen (1996) a catchment area refers to the land and water enclosed within a drainage divide, or in other words an area from which runoff resulting from precipitation converge in a single outlet point. It can be of varying size up to - and including - a whole river basin and it can be subdivided into macro-watersheds and micro-watersheds.

In this project we will use Jensen's definition of a catchment, because the villagers' definition does not encompass the whole area from where the water runs to the two rivers supplying Opar with water.

River

In our project we use the term river when referring to the Sijarak and Opar River. This is the terminology used by the villagers, but it should be noted that neither of these rivers were very large (approximately 150 cm. wide and 40 cm. deep).

Water supply system

The water supply system is used in this report to describe the physical system being responsible for transporting the water from the reservoirs to the households.

Duration of fieldwork

The data were collected from the 7th to the 18th of October 1998.

3. Project Design

This chapter describes the background for this project and the conditions under which it has developed.

3.1 Project design in Denmark

Project Group

The group dealing with this project consists of two geographers and one agricultural specialist. The group is not only interdisciplinary, it is also cross-cultural as one of the members is from Ghana and has different reference frame as how to conduct a field study. Even though we were interested in working with the same issues (water, shifting cultivation and perceptions of the local people), our different backgrounds and educational systems gave rise to both debates and conflicts in relation to the design of the project. We agreed upon integrating social- and natural science methods in the project, thus meeting the desires from each group member

Choice of topic and hypothesis

Our background information consisted of a 30-page general description of the upper catchment of the Sarawak River, its geography, population, land use etc. (notes from UNIMAS) and a general lecture-based introduction to Sarawak. It should be noted that we had no specific information on the Bau area but had to construct our project on the general description. We developed a picture of the area based on the limited information and designed the project accordingly.

We pictured a village as being situated next to the Sarawak River. And believed that the village was supplied with water from a reservoir, situated upstream from the village.

The river and reservoir and pipeline connected to the village, we imagined, was affected by siltation, due to land use practices taking place upstream from the point of water consumption. This led us to assume that there must be a problem with water supply.

Based on these assumptions we developed our objectives:

1. To identify the effects that land use practice upstream of the point of consumption has on the water supply
2. To ascertain to what extent these practices constitute a problem at the point of consumption
3. To explain how any water supply problems effect the daily lives of the people.
4. To examine any strategies the people have for dealing with these problems.

Methods to be used

As we were to conduct a case study we decided to collect the data by using qualitative methods as well as supplementing using quantitative methods.

The methods employed were expected to be: Measurements of physical parameters (erosion and water quality), direct observation, participatory mapping (PRA) and interviews among the inhabitants of the village of Opar.

The intention behind using direct observations (Andersen, 1990) was to get a visual picture of the whole setting of the water supply system and land use. Furthermore, it would give a frame of reference in relation to the interviews which we intended to carry out among the villagers and the farmers who cultivated the upstream area.

The idea was to select informants with different socio-economic backgrounds - mainly women. This was due to the assumption that the extent of the water problem was reflected in the socio-economic status of the villagers (that the poorer people had a less access in the sense that they lived at the village fringe where water pressure in the pipes was low),

and that it is mainly women who use water for their daily tasks.

As a supplement - and to cross-check information gained through the household interviews - we would conduct participatorial mapping, hoping that by letting the villagers draw the map of the village (Jackson et. al., 1994) this then would indicate where the biggest problems concerning the water supply existed for the villagers.

Interviews among farmers were planned to reveal the land use in the upstream area and to reveal whether they gave any consideration to the nearby watercourse, specially in relation to erosion.

When having established the relations between water quality/quantity and the land use, and after mapping the different land uses in the area, we could decide how to carry out the second part of the project: I.e. to examine to what extent land use constitutes a problem in relation to the water supply and which land use practices have the biggest effects. For this task we were going to use Universal Soil Loss Equation (USLE)¹

3.2 Project design in Malaysia

Final definition of objective and hypothesis

On arrival in Opar we found that the village was not situated next to the Sarawak River. In fact there were no big rivers at all in the vicinity of the village. Instead there were two streams which supplied Opar with water. Another deviation from our initial assumptions was the fact that the land in the catchment area was not being used agriculturally. Instead we learned that commercial logging had taken place in the upper catchments of Opar during the first part of the 90's.

¹ The Universal Soil Equation (USLE) is a quantitative method of predicting soil erosion losses from rainfall, slope and other factors (Greenland D. J., 1994).

The change in the situation of the case area forced us to alter the project design. Instead of focusing on agriculture, we decided to investigate whether the commercial logging which had taken place had - or still has - an impact on the water supply. As our task was to investigate how land use affects the water supply, the overall theme could still be employed by modifying our objective, hypothesis and the methods applied so as to match the actual situation.

The overall objective was then defined as an investigation of the effects which the water supply system, land use (commercial logging) and precipitation in the catchment have on the water supply (quality and quantity) in Opar and how these effects are perceived and dealt with by the villagers.

Selection of methods

As a contrast to our previous project design, we were not going to make quantitative measures on soil erosion. As USLE is designed for measuring erosion from cultivated land it was not applicable, so we decided to include other factors affecting the water supply, such as precipitation and the actual design of the water supply system. The investigation was instead based on qualitative interviews at both local and administrative level, and quantitative measurements of the water quality.

The strategy was first of all to obtain a general picture of the village, its structure, water supply system and then conduct household interviews later. The general picture was important when selecting the respondents, both households and key informants. For the purpose of getting the general picture we interviewed the headman of Opar village, who supplied us with a guide for a tour of the catchment area and the water supply system.

Selection of household informants

Through the preliminary interviews we learned that the water shortage problem was related to the housing situation. Having this in mind, the selection of informants was based upon the use of a stratified sampling method (Casley & Kumar, 1993) where one considers both the location and the elevation of the houses in relation to the water supply

system. The selection was based on the assumption that these criteria were of bigger importance for the variation in water supply than the socio-economic status. This was a modification in comparison to our previous project design.

Selection of key informants

Key informants are especially knowledgeable people and are in the position to provide relevant information, ideas and insights on a particular subject (Casley & Kumar 1992).

Through the household interviews we realised that all personal wood consumption in the village came from the catchment area and was felled by three men. Therefore we picked these three as key informants at the local level (in Opar).

Through the interviews we learned that the Department of Health (D.O.H.) had carried out the calculations for the existing water supply system and that it has the overall responsibility for the maintenance of the water supply system. We, therefore, asked them for an interview.

The Forest Department administers the forest areas around Opar. We wanted to be informed of the plans for replanting the areas affected by logging and to clarify why and how it could be that commercial logging could take place in a water catchment area. Subsequently, we asked for an interview with one of their officials.

Finally, we interviewed The Publics Works Department (JKR) who are responsible for installing centralised, treated water. We choose JKR in order to get a insight in the plans for supplying Opar with treated water and to go into the aspects of payment for their services.

4. Results

The results described in this chapter are based on interviews with the Headman of Kampong Opar, 19 households in Opar, a group of three who conducted the village logging, the Department of Health in Bau (D.O.H.), the Forest Department in Bau and

Lundu (F.D.), the Public Works Department (JKR), our measurements of physical parameter and observations in the area.

(For a view of the village and the area consult app.1.2 & 3.2)

4.1 Description of the catchment area - the physical area, logging road, slopes, vegetation cover.

In Opar there are two catchment areas on the lime stone hill which is part of the Gunung Udan range. In each of two catchments the surface water runs into a river. These two rivers, Opar River and Sijarak River supplies Opar with water. The hillside facing Opar Village is covered by forest. At different places the forest is young which, according to our guide Mr. Pugin, is due to the fact that shifting cultivation took place up until the 1950 - 60's.

At the top of the hill there are several artefacts from previous logging activity including a disused logging road. This runs along the ridge, along the former logging sites, along side roads and skid tracks which ends just above the two catchment areas supplying Opar with water. (Sketch D.O.H. app. 3.3).

The yearly rainfall in the area (4 - 5000 mm/year) is concentrated in the rainy season (Nov- Jan). (erosion net info + precipitation measured at Kuching airport: Government of Sarawak, 1990).

4.2 Commercial logging

Due to the fact that commercial logging takes place on hillsides and that the erosion can damage the water supply in the area, it is prohibited to log in catchment areas. But the problem is, according to the D.O.H., that many of the small catchments have not been mapped, meaning in practice that licenses for commercial logging in catchment areas are given. It was only last year that the D.O.H. in Bau mapped the catchment areas in their district (intv. D.O.H.) Commercial logging took place in Opar during the period 1990 - 1996. Just above the reservoirs in the two catchment areas open scars can be seen in the vegetation cover, due to the barren logging tracks and erosion from these (app.3.3 + our

observation). It is difficult to place the responsibility for the negative effects that commercial logging has on, for instance, the water supply, because many different companies were involved (intv.headman).

In 1992 the villagers were given 50.000 Malaysian Ringit (Rm) (1 Rm. =1,7 kr.). from the company logging at that time. The size of compensation was negotiated between the village and the logging company and was given because of the inconvenience the logging posed for the village inhabitants (Interview. with D.O.H., the Headman and Households).

The main problem concerning the water supply in Opar does not stem from the actual logging sites but from the scars the machinery left in the forest (our observation). The reason is that the logging roads - as opposed to the logged areas - have not been re-vegetated, due to the compactation of the soil. Erosion was clearly visible in the undermining of the roads. We measured slopes that were 18 - 24 degrees and erosion gullies with depths from 0.4 to 1.5 meters.

4.3 Village logging

During our household surveys we discovered that all the villagers, except 4 households who did not believe that it was allowed, obtained building materials for their houses from the hillside forest (within our definition of the catchment). The actual felling is conducted by three people (our guide Mr. Pogin being one of them) who are in possession of a chain saw and knowledge of the area. They fell approximately 15 -20 trees a year each. The three village loggers avoid felling trees on the slopes in the immediate vicinity of the reservoir, because this is inside their definition of a catchment area (int. house hold & vil. log). This procedure is in accordance with village rules. Theoretically, violation of this rule carries a fine of 300 Rm. (second int. with headman and the group int. with the loggers).

4.4 Description of the reservoirs (dams), tanks and the pipeline system

In both the Opar River and the Sijarak River the villagers have created a reservoir by building a approximately 60 cm. high wall across the rivers, thus creating a dam.

The pipelines supplying Opar are built into the walls of the dams. The pipe mouths are covered with netting to keep leaves etc. from clogging up the pipes. Further precautions have been made by surrounding the pipe mouths with rocks which also serve to stop leaves, branches etc. The pipeline from the Sijarak reservoir runs down into a tank (our observation). The tank serves both to relieve the water pressure and to allow sedimentation of silt and debris, resulting in less sediment transported down to the village (water supply design maps from D.O.H.).

The pipeline from Opar reservoir runs directly down to the main pipe in the village. The two pipes supplying Opar village with water are calculated to have a capacity to supply app. 1600 people each (design maps D.O.H.).

4.5 Finance, Reparation and maintenance

The Opar River pipeline was built in 1977 and the Sijarak River pipeline and tank were built and came into service in 1987. The design and finances for the water supply system were all provided by the D.O.H. The actual work, however, was carried out by the villagers of Opar, under the supervision of the D.O.H. The water supply system is considered simple, and as such is only built to last an estimated 15 -20 years (intv. D.O.H.). Nevertheless the villagers in Opar carry out reparation and maintenance, as their water supply comes exclusively via this system.

The villagers are organised in twelve groups, each group is responsible for a month each a year. The duties typically consist of cleaning leaves etc. away from the dams and pipe mouths whenever this causes a supply problem. The households all agreed that this theoretically should happen once a week. The groups contact the pipe committee if they themselves cannot repair a leakage on the pipe system (headman, households & Pipe committee). The pipe committee is responsible for collecting money from the households for reparation. Each household pay Rm1 per year (interv. with D.O.H., household & pipe committee).

Furthermore, the village has a big cleaning day twice a year. On this day the paths to the

dams are cleared, the tank is cleaned for sediments and any leakage on the pipes is fixed. We accompanied them on such a day, and we observed a major leakage on the pipe. The leakage was mended a few days later by surrounding the pipe with bamboo trunks. We were told that the same leakage reappears once a month and that a more permanent reparation would be done after the rainy season. The villagers explained that during the rainy season the pressure in the pipe is high and therefore difficult to repair. Furthermore, as there is no water shortage problem during the rainy season, a leakage, is considered to be of no significance in relation to their water supply.

4.6 Perception of water quantity and quality

The constraints within the water supply were related both to quantity and quality and there were several causes for these influences. The constraints on the water quantity were mainly related to the fact that there was a limited amount of water during the dry season (June - August). The limited amount of water was especially experienced by people living in the higher parts of the village.

Six of the nine households situated on the uphill areas in the village had supply problems 2-3 days a week in the dry season, whereas only 3 of 10 households situated down hill were in the same situation (household int.).

There is a discrepancy between the villagers' experience of the water shortage and the D.O.H. estimate of the river capacity. A partial explanation for this discrepancy lies in the fact that the calculation of the water capacity of the two rivers was based on the average yearly precipitation, the monthly differences have, therefore, not been taken into consideration (design maps D.O.H.). Furthermore, the pressure calculated to be sufficient to supply the villagers was based on the pressure in a full pipeline, and this varies due to the amount of water in the river, which again is due to precipitation (design maps D.O.H.). Another quantity constraint within the system supplying the Opar Village is - according to the villagers, the headman and the D.O.H. - that the reservoirs in the two rivers get clogged up with leaves, branches etc. and that the water supply was effected by siltation

All 19 households stated that the siltation problem depended on how often it rained, but 5 enlarged on the answer by saying that they experienced water quality problems every week during the rainy season.

(Households, Headman & D.O.H.). According to all the informants the siltation of the water is caused by erosion, which renders the water unsuitable for human consumption during periods of rain.

All the interviewed households agreed that the siltation problem became intensified after the commercial logging took place above the catchment. They informed us that there was a period of four months when the water could not be drunk. This statement is supported by the fact that the previous headman in Opar made complaints in 1990, 91 and 92 to D.O.H. about the siltation of the water (copy of letters from D.O.H.) The D.O.H. carried out surveys of the area and the water quality and stated that there was a siltation problem. On the basis of the surveys the D.O.H. recommended to the Ministry of Forest (as the ministry is responsible for issuing of logging license) that logging activities in the area should be stopped (ibid.). The D.O.H. based the recommendation on the visible signs of erosion in the area and on the quality measures taken of the water.

4.7 Measurements taken on water quality

The D.O.H. took measurements of the water quality in the Sijarak River and the Opar River in 1990, 1991, 1992 and again in April 1998. The parameters measured were: Turbidity, pH, temperature, conductivity, faecal Coliform, TDS, nitrate, iron, fluoride, and aluminium (copy of letters and measurements taken in 1998 D.O.H.).

One can use Turbidity measurements for stating the degree of siltation in the water. In 1990-1992 D.O.H. measured the turbidity. The results ranged from 2,6-5,2 NTU². New measurements from April 1998 showed that the turbidity were 1,11 - 1,79 NTU.

Our turbidity results from October 1998, were as follows:

² The value limit for human consumption is 10 mg/L = 10 NTU

Opar reservoir =15 NTU, Sijarak reservoir = 6-7 NTU, Sijarak tank 5 NTU, 5 selected households (selected in accordance to location in relation the pipeline) see app. 1.2) = 1-2 NTU:

According to the D.O.H the water quality in Opar is generally good, with the proviso that the amount of e-coli bacteria in the water is too high (40 - 60/ 100 ml. - the limit value being 0) and the siltation of the water is a problem during the rainy season (Intv, D.O.H.)

4.8 Household strategies in overcoming the water supply problem

Apart from the communal tasks of sorting out supply problems, the households themselves have ways of overcoming the water supply problems. In relation to quantity problems, the households use a storage tank which is filled up when there is sufficient pressure. Or alternatively the households collect water from their neighbours.

10 households had a storage tank (5 uphill & 5 downhill). The rest got water from their neighbours. Quality problems in the rainy season are overcome by either storing water on the days it did not rain, or by collecting rain water in outdoor tanks. 8 households had rain water tanks (5 uphill (of the 9) and 3 downhill (of the 10)) and 8 stored water on the days it did not rain (4 uphill and 4 downhill)(int. house-hold).

4.9 Centralised and treated water supply from The Public Works Department (JKR)

The public works department (JKR) in Bau district are implementing a centralised water distribution scheme. The water is taken from Sarawak River (surface water).

The water scheme is planned to be implemented in Opar in 1999. All the 19 households stated that they wanted the centralised water as a supplement to the existing water supply. JKR will provide the main pipe system whereas the households have to pay for their individual connection and use of water (int. JKR). According to the 19 households the benefits gained by using centralised water are that there is enough water all the year round and it is drinkable straight from the tap. The price for water was predicted to be 0.44 Rm./ 1000 l, when using under 15 000 l. From 15 000 l - 50. 000 l the price will be 0.64 Rm./

1000 l and from 50. 000 l and up the price will come to 0.69 Rm. /1000l. The prices were, according to all the respondents, reasonable³ (intv. households & JKR).

4.10 solutions to the water supply problems.

The headman and the 19 households asserted that the solution to both the water shortage problem and the siltation problem lies in the implementation of centralised water.

The idea of dealing with the problem at its source i.e. the erosion from the logging road, is considered by all the households of being too large a task. Even so, the village loggers expressed interest in doing something about the problem, if there was going to be a government sponsored rehabilitation scheme (int. vill. log.)

The representative from the Forest Department in Bau mentioned that there are rehabilitation plans for previously logged areas, especially catchment areas. A possible rehabilitation programme could conceivably follow the same pattern as used in the establishment of the present water supply system. Government agencies could provide technical assistance and finance, with labour coming from the villagers themselves (intv. F.D. Bau).

We learned that at the present time there are no plans a for rehabilitation scheme in the catchment areas of Opar (intv. F.D. Lundu).

5.0 Discussion:

In the cause of our fieldwork, looking into the water supply in Opar, many data have been obtained. Whilst some results stem from different measurements and observations, the majority of our results has been obtained through interviews. Therefore, it is important to look at the results in relation to the groups interviewed and the methods applied. Only this way can one get an idea of the biases involved in obtaining the results and thereby obtain a picture of the reliability, relevance and the representativity of the results.

³ The indcome span was from 250 1500 Rm/month

5.1 Discussion of selection of informants and methods applied.

Interviews with the headman.

The reason for interviewing the headman was partly to get some overall information about Opar and its water supply situation, but also a way of getting ourselves introduced to the village.

For the interview a semi-structured interview guide was used, since many of the questions were of formal character, such as "how many people are there in the village?" or "during what period did logging take place?" they were easily answered. Some of the questions were open-ended and served their purpose in the sense that Mr. Headman, on different issues expanded his answers. For instance, when talking about logging, he consulted the village book and told how the previous headman had made complaints about the logging.

The drawback of our questions were that they were very problem-orientated and thus did not leave very much room for the headman to contradict our presumptions concerning the type - and cause - of their problem with the water-supply. If we instead had used a topic focused interview guide, it would have allowed the Headman to express what he thought when asked about the water supply.

As it was, he understood English, so he preferred to read our questions, thus obtaining an overall view of the questions and he then replied to our interpreter in his own dialect. This caused a risk of his answers being influenced by the general trend of the questions and thereby making his answers match our presumptions. Another bias in preparing the questions was that we made them on the basis of what our interpreter had told us about the water supply problem in Opar. Our Interpreter, Mr. Lade, had already conducted his own field work in six different villages in the area.

The before mentioned biases compromise the reliability of the qualitative results obtained. The results cannot be used on their own, but have to be verified by gaining information from other sources. The relevance of the information gained can be discussed in the sense that the majority of the questions was factual, often only indirectly related to our objectives, but they

were relevant in order to get a picture of the village Structure when conducting the household interviews.

As for the questions related to the siltation of the water the answers were relevant in the sense that one had a comparable reference when interviewing the households.

Household interviews.

The main aims of the household interviews were to get the villagers' perception of the water-supply system, establish whether there was a problem and if so what did the problems entail. The interview guide used was semi-structured open-ended (Andersen, 1990). As the questions were very open-ended concerning the water, it allowed the respondent to answer in accordance with his/hers perception of the question. For instance, they all started out by telling about the yellow water during the rain when our intention was to ask about shortage. We did not use specific cross check questions but we had many follow-up questions to each topic, focusing on how the villagers specifically perceived a problem in relation to water quality and quantity.

Due to the fact that all the respondents answered "yellow water" when we tried to ask about shortage, we see this as an argument in favour of all the difficulties there would have been in obtaining the same information using, for instance, a handed out questionnaire. Other limitations in using a questionnaire were due to the time limit of ten days. There simply would not have been enough time to re-evaluate the questions when new information cropped up.

The translation of questions and answers was a bias in itself, because the interpreter would translate not just the question but also what he believed we meant. So it comes back to our perception of the situation. By simply using the word "problem" we could have guided the answers in a pre-ordained direction.

These biases reflect the fact that we were not in Opar long enough to eliminate the biases that occur when one does not have the time to adapt to a case area (Flyvbjerg, 1993). It is, therefore, difficult to establish whether the villagers looked upon us as someone who

could solve their "water supply problems" and therefore stressed the point that the "yellowwater" intensified after commercial logging activities started. But even so, the vivid way they explained the intensification of the siltation problems and their water shortage problems during the dry period, lead us to believe the basic validity of the answers given.

Group interview with village loggers.

The aim of interviewing the three people who carried out the logging for village consumption was to gain information about where and how logging was done. Furthermore as we wanted to clarify how big an influence this activity might have on erosion. The choice of the group interview method was arrived at with the objective of checking how much or little consensus there existed between the three on the different issues.

Conducting the group interview was satisfactory in the sense that they discussed issues like where they logged, what their definition of the catchment area was, what to do about the logging road - and thus minimise the siltation of the water.

We used the map of the area from D.O.H. to discuss boundaries of catchment areas. At this point they all three loggers were engaged in explaining their perception of the catchment area. A drawback was that one does not get the full context of the discussion, when using a interpreter. To make up for this we could have used a tape recorder, but as we in Denmark thought we were visiting a poor remote village, we thought such a thing to be too "Western" and could lead to an unnatural response (Casley & Kumar, 1992).

Another bias was that we did not see the actual logging carried out. Mr. Pogin only showed us where they logged. This again leads to a potential problem with reliability, because Mr. Pogin being our guide and key informant on the water supply problem and the role played by commercial logging, would probably not give us information that would lead to doubting the connection between commercial logging and the siltation problem in the water.

We do not think that the same data could have been obtained by interviewing the 3 loggers separately. Questions like "*what could be a solution to the erosion problem?*" was not answered by any of the separate households, but because the 3 loggers discussed the questions amongst themselves they came to a consensus.

The Department of health.

Interviewing the D.O.H. was an opportunity of obtaining supporting information on the project design of the water supply system and the siltation problems in relation to logging. We went to the D.O.H. twice. The first time we collected maps and general information on the construction of the water supply system in Opar. Second time we went was in order to have more in depth information concerning the maps.

We conducted a topic focused interview (TFI), which was a good tool in this case because it kept us on the track and in control of the discussion, but the positive situation was dependent on the helpfulness we met with from the informants of D.O.H. An example of this is that when discussing where logging took place, the D.O.H. gave us maps from the time that commercial logging took place, showing the logging roads, skid tracks and logging sites in the upper catchments of Opar.

The drawback of the interview method was that in keeping it informal we took very few notes (Kumar & Casley, 1992), whereby some information may have been lost. Another problem with not taking notes is that information detrimental to our purpose was easily forgotten (Flyvbjerg, 1993). To make up for this we could have used a tape recorder, but apart from not having one, a tape recorder could have interrupted the informal atmosphere, which is very important when discussing sensitive issues. For example the following answers would probably not have been given if a tape recorder had been used: "Logging can legally take place because small catchments have not been mapped out and therefore the license is given."

The disadvantage of the D.O.H. wanting to be helpful by answering all the questions we

asked, was that he gave us information which we, when asking further, found that he was not in position to explain. Therefore, the reliability of the information can be questioned. An example of this concerned the turbidity measurements from the early nineties. We have the results but D.O.H. could not explain where in the water supply system they were taken (reservoir, tank or village) nor was he in possession of the dates when the measuring was conducted.

The Public Works Department (JKR).

The aim of interviewing JKR was to get the general information on the centralised water supply and its future implementation in Opar. As we only had a limited number of questions, we hoped to conduct a discussion about centralised water in general. As it turned out we did not speak with the engineer in charge, with the result that the person interviewed was not familiar with any of the discussions and arguments behind the decisions of implementing centralised water to the rural villages.

Another bias was that we were only interested in obtaining information on a minor part of the work of JKR. Therefore, we were not open for an overall introduction to JKR's work which could have revealed information not anticipated. So all in all only factual information about finances, consumer prices and quality of centralised water was obtained.

The Forest Department in Bau & Lundu.

We used the same semi-structured interview guide for both places, and the aim was to obtain information about rehabilitation schemes in logged areas and to discuss the problems relating to different interests in the catchment area. This information was of relevance since the inhabitants' foundation for obtaining water was affected and it seemed as if no one had any consideration of this.

In Bau we found that Opar was not under their department, but were told about other rehabilitation schemes taking place, especially in catchment areas and how they were conducted.

Lundu Forest Department which was in charge of the area around Opar, did not know of any schemes planned to take place in Opar. Actually they did not know whether such schemes existed, but referred to the fact that their chief was out of town.

This sums up the bias with both interviews, e.g. that we did not speak with a person in charge and the information gained was contrary to each other. The only issue they agreed on was that plans for rehabilitation was made in Kuching. Unfortunately, we did not get a chance make up for this controversy by conducting an interview in Kuching.

Observation.

On the tour of the catchment and the water supply system, guided by Mr. Pogin, (selected by the head-man) we used direct observation. This gave us the possibility of seeing the phenomena in a context and in its natural surroundings (Andersen, 1990). The obtained information/ knowledge gave us a frame of reference and probably a different understanding in relation to the subsequently interviews. A bias incorporated in the method is that our guide, Mr Pogin, led the way all the time, so there could have been places of interest we did not see.

Taking part in their cleaning day and the later repairing of the pipe was an opportunity to discover their strategies in situ. This, we believe, has given us a good understanding of their strategies. But one has to keep the short time of our stay in mind.

Measurements of physical parameters

Measurements (and descriptions) of physical parameters were conducted in order to estimate the extent of erosion in the catchment and to provide an indicator for the water quality.

The water measures were collected in both rivers during the dry season, and were taken just before the water went into the pipe system. Other measures were taken from six households located differently in relation to the pipe system. This was done in order to

decide whether any land activities taking place had an influence on the water quality.

The bias in our measurements on slopes and gullies are that we only took a few measurements which we used as representative for both catchments. When taking the water samples it should be noted that we completely relied on Professor Lauseng (UNIMAS) but also that the measurements taken only relate to the day in October it was taken.

One fact we did consider was the variation in different localities, which is why we took samples from both reservoirs, Sijarak tank and 5 households.

5.2 discussion of results

The answers given by the 19 households who were interviewed, revealed that there existed consensus on most topics in spite of difference in income, family size and social status. Consequently we believe the answers to be representative for the village.

It should be kept in mind that all our findings are subject to the biases related both to us as coming from outside as well as the described methods applied.

The villagers were not definite about to what extent they were affected by the different causes behind the supply problems. Anyhow, the inhabitants agreed that the different kinds of water supply problems all depended upon precipitation (and the intensity here of). From the answers we have obtained, it is only possible to make an estimate of the extent of the qualitative - respectively quantitative - supply problems. One indicator of the extent of the problems is the size of the tanks in the houses which have capacity of storing water for four days.

Storing water and using rain water tanks can be understood as symptoms of the factors affecting the water supply in Opar. One can also understand it as strategies incouncted in the supply system.

The applied strategies require an extra effort from the users of water, but none of the 19 households perceived it as a big problem. We understand that this is due to the fact that their strategies do not require that they spend much extra time obtaining water.

Even though they do not state that they have major water problems, they have decided that they do not want solely to depend on their local source of water. The application for centralised water as a supplementary water source can be seen or discussed as a new strategy for overcoming supply problems.

However, one can also look at it as a desired outcome for the government as logging is Malaysia's second most important export commodity (King, 1993), it is, therefore, desirable to solve both the water demand for the villagers and at the same time conduct a profitable business.

Logging is a profitable business, which could explain why logging was allowed to take place in the catchment area of Opar. Effects from logging imposed on the water supply causes siltation of the water, according to the Headman and the 19 households.

All the 19 households stated that the siltation of the water increased during and after commercial logging activities had taken place. The turbidity measurements taken by D.O.H. can neither confirm or contradict this statement since no turbidity measurements had been taken prior to logging (1990). Furthermore, we do not know at what time of the year they were carried out. Therefore, one cannot compare these turbidity results with the situation the villagers experience. The results of the turbidity measurements carried out by D.O.H. in the early 90's do not exceed the permit limit of suspended material in the water. This could lead one to believe that there are no siltation problems in Opar, but there definitely are indicators for the opposite

The description of the effects commercial logging had on the catchment, based on visual impression from D.O.H. our observations and the villagers statements are indicators that commercial logging actually has caused an increased siltation of the water.

Whether the logging performed by the villagers has an effect in relation to the siltation of

the water, demands a better understanding of how and where the logging is carried out. On the other hand to fell trees from the hill area has been done a long time before commercial logging activities took place. Even though we only have the three village loggers' statements concerning where they log and how many trees they fell, it does not appear crucial in relation to whether the village rules have been enforced or not because not that many trees were felled per year. Therefore, the fact that Mr. Pogin is a logger and also the one who enforces the rules does not seem so crucial. As we have seen above, there exist several indicators that the siltation problem has increased perceptibly after commercial logging has been carried out.

As we have seen in relation to the commercial logging it is not the actual felling of the trees which constitutes a problem but the machinery associated with it.

All the interviewed household believe the mountain water to have a better taste than the centralised water when it is not effected by siltation. Therefore one cannot expect that one water resource can be replaced by another.

6. Conclusion

The village of Opar, which has been the focus of attention in this case study, is supplied by surface water from the nearby catchment areas. Our investigations have shown that several factors affect the water supply of the village. Most of these factors have been taken into consideration in the design of the water supply system but more recently a new factor: commercial logging, has begun to influence the supply.

Commercial logging was carried out in the water catchments of Opar in the first half of the 90's. Since the slopes in the catchments are very steep (between 18 and 24 degrees) and due to the amount and intensity of the precipitation in the area - but also the susceptibility of the soil these slopes are very susceptible to erosion when left without vegetation. Therefore, the open areas, which were left barren under - and after logging has been exposed to erosion, which has caused siltation of the water. As it was worst the water

was not consumable for several months. For this, the village was compensated by a logging company but logging continued until 1996. Even though commercial logging has stopped; the logging roads and skid tracks are still left without vegetation. Due to this the barren areas has in many places become even more bare. Evidence of this are shown by the undermined sites of the logging roads and gully erosion also within these roads. Areas like these are still contributing to the siltation of the water during heavy rain, which is thus not drinkable for the villagers. As we found, there do not exist any plans for rehabilitating the catchment after the logging activities.

There are other factors which causes the water supply is not to be relied upon. The water supply system has a capacity of supplying a bigger population than the one which at present is living in Opar, this of course entails having full pipelines. Full pipes are not always present during dryer periods of the year. For households situated elevated in relation to the main water supply line and to other households, the experience of supply problems is even more severe. For overcoming periods with low water supply most households has a water tank installed which for the most part can store water up to four days.

Another problem which effect the water quantity are leaves and twigs which clog up the pipes in the supply system. The village is organised in teams who takes turns in manually taking away these leaves and twigs.

We have found that Opar village has strategies to overcome most of the limitations related to the water supply and that the villagers in general did not consider problems with the water supply to be big. However the villagers have experienced more severe problems with siltation of the water since commercial logging has been carried out in the catchment. The village is now going to have treated centralized water supply implemented as a supplement to their present supply. The reasons for that are that treated water is clean and is to be relied upon. The costs in getting centralized water did not seem to be of importance to the villagers (local water is free) because the costs were low.

7. Perspective

The conflict between the commercial logging and the water resources in Opar is not a unique case (Peng, K. K., 1986). It is, therefore, of importance for the rural communities that strategies for combining different land use interests are implemented.

The fact is that there already are restrictions against logging in catchments areas, on steep slopes etc., and re-forestation and rehabilitation of logged areas are issues of discussion in Malaysia. This could be taken as an indication that consideration is given to the water resources in rural areas, and that in future the economic gain from logging activities will be weighted against the costs of rehabilitation. Therefore, only the really profitable areas will be logged.

Villages whose water resource is sacrificed for economic interests will then have to be supplied with water from other sources, this could be e.g. centralised water. In spite of the fact that some villages in future continue to rely on local water supply, we believe that the probable outcome will be that more and more villages will get connected to a centralised water supply system in the future.

This trend is also observed in Western countries for instance in Denmark. Even though we in Denmark rely on ground water, many bore holes become contaminated due to farming activities. This is why small water supply systems are closed down and people instead get connected to centralised systems. Both for Denmark and Malaysia it is unlikely that economic input is sacrificed as long as there are other solutions to the water demand. One solution in Malaysia is the centralised water supply.

7. References

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Summery of interviews conducted of households, Forest Department in Bau & Lundu, The Department of Health (D.O.H.) + design maps of the supply system + copy of letters stating siltation. The Public Works Department (JKR), Headman, village loggers can be ordered from us.

Appendix 1.

- App. 1.0 Household interview guide
- App. 1.2 Village map

Appendix 2.

- App. 2.0 First interview guide for the headman
- App. 2.1 Follow up Interview guide for the headman

Appendix 3.

- App. 3.0 First interview guide for D.O.H.
- App. 3.1 Second interview guide for D.O.H
- App. 3.2 Map of the catchment.
- App. 3.3 Map of logging sites and roads

Appendix 4.

- App. 4.0 Interview guide for JKR

Appendix 5.

- App. 5.0 Interview guide for F.D.

Appendix 6.

- App. 6.0 Interview guide for village loggers

Interview guide for the people in Kampong Opar. 12 october 1998.

Household:

Man

Woman

Occupation

Were they live in the village (map from library) and maybe identify their luxurious goods as ex. car nice house.

1, How many people are living here ?

2, How much is the income of the household (rain-/dry season)?

3, How much water do your household use on average ?

Quantity:

4, Do you have problems with water supply?

5, How often do you have a problem with water supply?

6, Has there been a change in water supply the last 5-10 years?

7, Why has there been this change?

4, Do Kampong Opar do anything to improve the water supply?

Quality:

9, Do you have problems with yellow water?

10, How often do you have a problem with "yellow" water?

11, Has there been a change in the amount of times with "yellow" water the last 5-10 years?

12, Why has there been this change?

13, Do Kampong Opar do anything to overcome the problem with yellow water?

14, Where do you get water from when you cant get it from the tap? Or the water is yellow?

15, Do you think the water situation is a problem?

Logging:

16, Do you use trees from the water catchment area? or others you know?

17, where do you log?

18, How do you log?

19, How often?

20, For what use?

21, How do you get the trees down (the logging road) ?

22, Have you ever considered the consequences?

23, Is it legal to log?

24, Who owns the land?

25, Does the kampong have any restrictions/rules?

Future:

26, What do you think about the future plans of getting water from The Ministry of Health

(D.O.H)?

27 ,Are you willing to pay for it ?

28, What do you think is good water ?

Centralised water or mountain water?

Appendix 2.0

Main questions for Headman of Kampong Opar. October. 7. 1998.

- 1, How many households?
- 2, How many people? men, women
- 3, For how long has there been running water in the village?
- 4, Where are you getting the water from?
- 5, How many water intakes are in use?
- 6, How did the village finance and construct the water supply system?
- 7, How do you maintain the system?
- 8, Are all the households involved in the maintenance? how do they contribute?
- 9, Do you receive any aid for maintenance?
- 10, What are the water supply problems? quantity and quality
- 11, How does the problem show?
- 12, Are all households equally effected?
- 13, What land use have and are taking place above or close to the water intake?

Appendix 2.1

Interview the Headman 13 October 1998

Logging

- Who owns the area up there?
- When did logging take place?
 - In Opar catchment?
 - In Sijarak ?
- Did helicopters fly up every day during logging period ?
- How did the water quality change during logging:-
 - More muddy ?
 - More often muddy ?
- How long did you deal with it before you made complaints ?
- Did the logging stop because of your complaints or because they had taken what they wanted ?
- Did Opar get any compensation from the logging company ? How much ?
- How is the water quality now compared to during logging ?
- Do you have the article ?

Centralised water supply

- Why apply for centralized water supply ?
- Has the whole Kampong agreed about getting centralized water supply ?
- Is it going to be supplement supply ?
- Why don't you improve the present supply ?

Local logging

- When the villages take timber from the area, from where do they take it ?
- How much / many ?
- Do they use the logging roads (to get down) ?
- To what extend are you allowed to take timber from up there ?
- Do you know anyone :-
 - Logging company worker ?
 - Who log up there now ?

Appendix 3.0

Interview with Department of health, Bau. October 12. 1998.

The main reason for contacting D.O.H was to get the general information on the project design for the water supply system in Opar. Furthermore we hoped to get a good topographical map, so we could point out the catchment area.

Questions:

- 1, What are the general planes for the water supply in Opar?
- 2, How was the planing and constructions carried out on building the two water supply systems?
(Opar and Sijarak river).
- 3, How were they financed?
- 4, How are plans for water supply generally financed?
- 5, How are they maintenance?

- 6, What kind of water is used in the centralised water system?
- 7, What are the intentions of the centralised system?
- 8, How does the villagers perceive the option and how much are they going to pay?

- 9, The surveys you made in the catchments during logging what did they show?
- 10, What happened after you made the surveys.

Appendix 3.1

Follow up Questions for Anthony from Department of health, Bau. October. 13.98

We went back to Anthony because there was some of our questions that we had not asked and the we did not understand all the information on the pipe line, water supply, demand map.

Our main questions were as follows

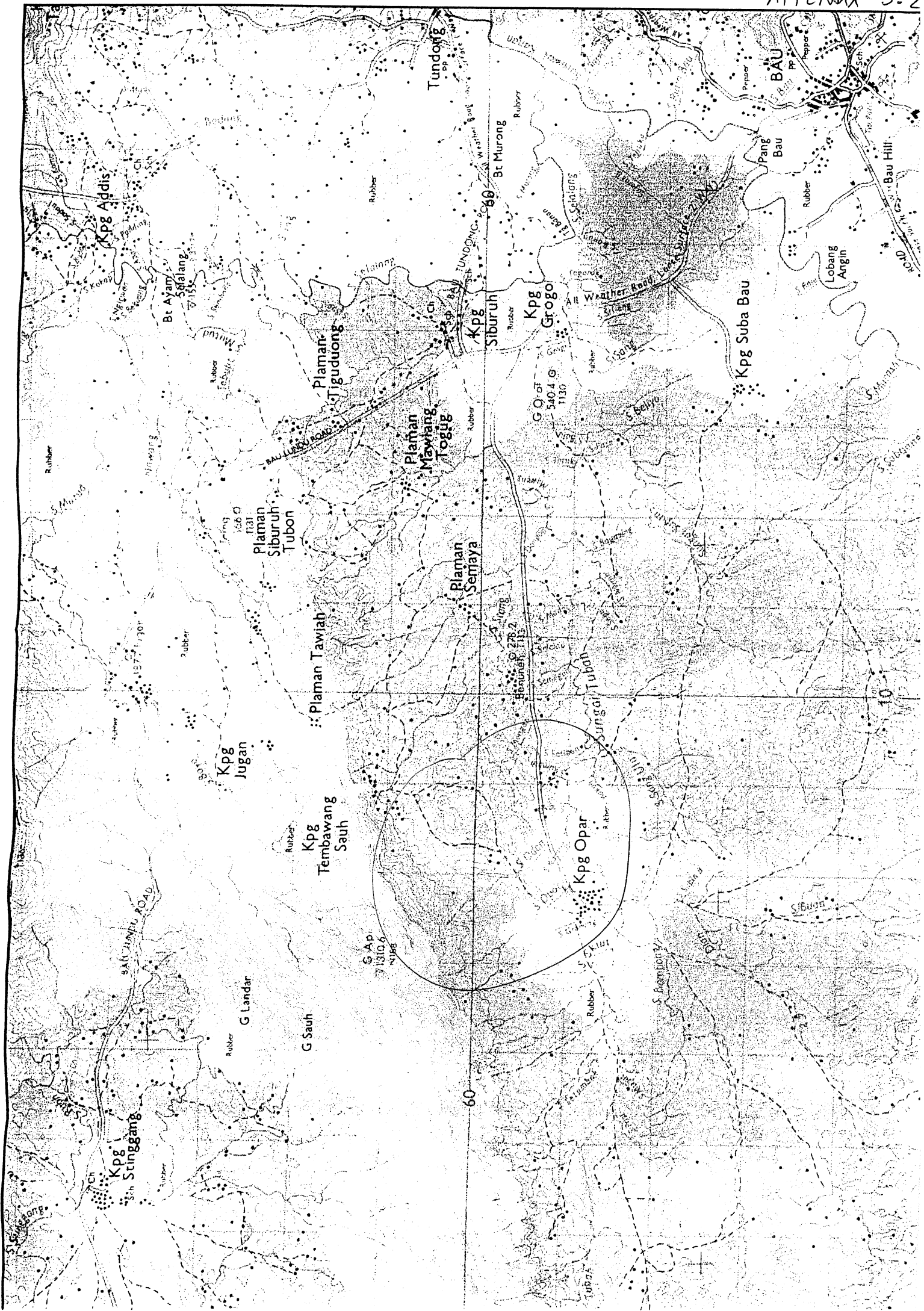
- The water samples you took during the logging period, can you tell some more of the results.
- Were they part of the reason logging stopped

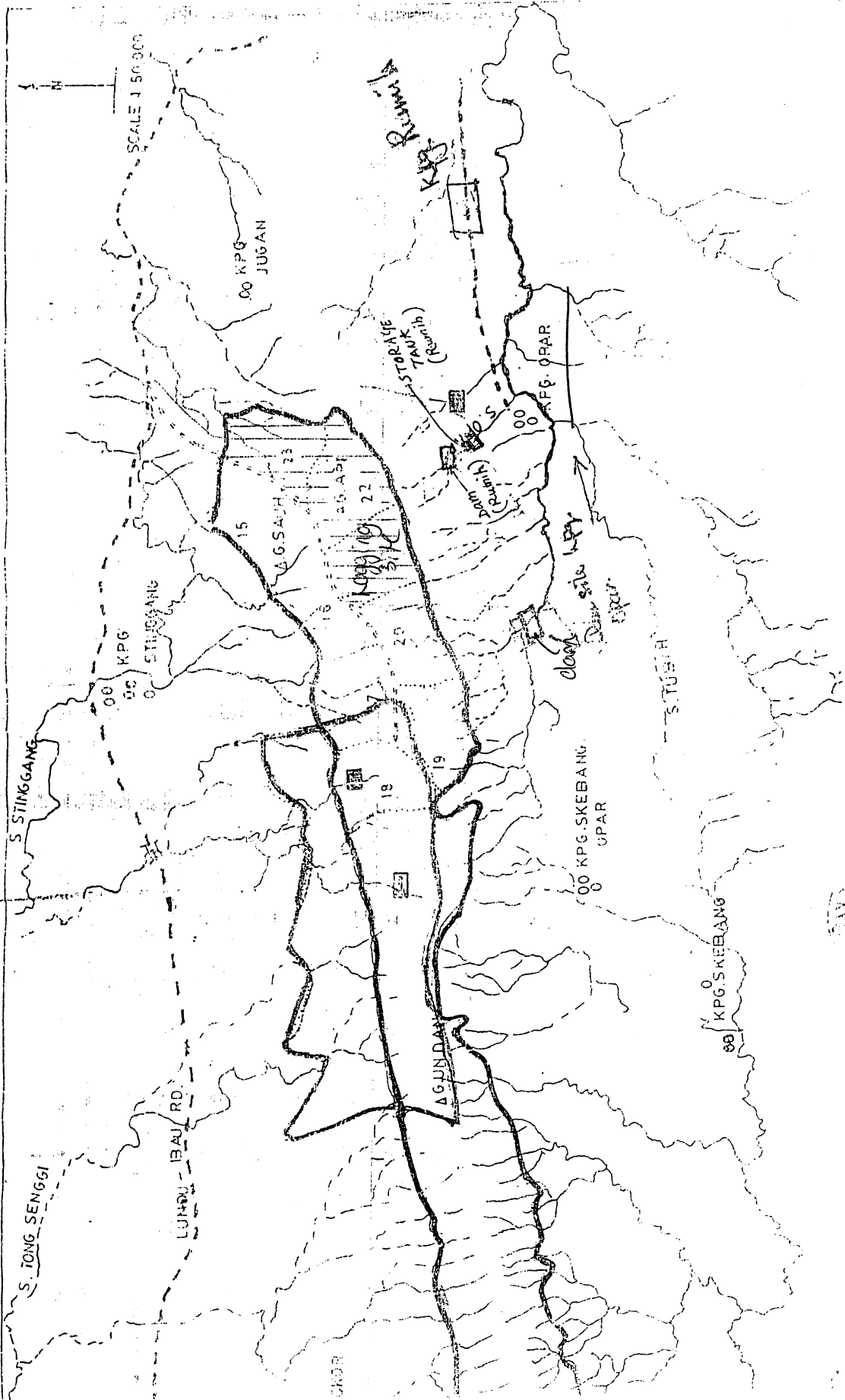
What kind of classification does the Opar and Sijarak catchment have

- How could logging take place in a water catchment
- Who was logging
- Who gives the permission

Where can we get information about the catchment area, precipitation, evaporation and so forth.

Appendix 4.0





Interview with JKR (public works department)

As everyone in the village mentioned the future plan supply as a solution to their supply and quality problem, we visited to get the overall information about the overall distribution.

Our main questions were as follows.

Future plans for supplying Opar and other villages

- Time schedule on the project
- Supply source
- supplementary or as only source
- costs
- village needs or government wants

Why supplying Opar with centralised water

- What is wrong with existing system
- are the problems similar in the other villages

Appendix 5.0

Interview guide for the forest department October

Facts question:

- Definition of a catchment area
- Map of Opar area
- Land classification

Rules:

- What rules are applied to the villagers use of the forest?
- Rules concerning commercial logging - What are they?
- What about the different land use interests logging - who deals with these problems?
- Does the villagers have rights to complain?

Rehabilitation:

- What do you do in relation to logged areas and reforestation?
- How do you do it?
- What have you done?
- Supervision of the villagers
- Wild life
- Water quality problems - are you aware?
- Replanting - would you employ the villagers?
- Does logging companies have responsibilities ? reforestation?

Appendix 6.0

Group interview: logging men Oct. 10. 1998.

Interview guide:

History:

- Have the villagers always taken timber from the hill?
- How is the logging now compared to earlier?

Who are logging:

- How many in the village
- Does people from other villages log here?

From where: (Point out on the logging site map from D.O.H).

- Close to the logging road
- Same spot every time
- Where commercial logging took place

For what use:

- Private
- Selling
- What kind of trees

How is logging carried out:

- How much did you log last year
- How much in the whole village
- How do you select the trees
- What kind of trees
- How do you get the trees down
- How much time do you use

Precautions:

- Away from catchment
- Same spot
- Any rules in the village about logging
- How do you define the catchment

Logging effect:

- Change in possibilities of getting timber because of commercial logging
- Did the commercial logging take place in an unsatisfied manner
- Are you satisfied with the compensation
- When did logging take place
- When did the village complain
- Why did D.O.H only make surveys in the early nineties