Towards sustainable forest management

Preliminary research for sustainable land use, forestry and nature conservation in Boltim, Sulawesi, Indonesia

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Forestry and nature management Major Tropical Forestry
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Abstract

The government of the communities Nuangan, Lowey and Matabulu in the East Bolaang Mongondow regency of North Sulawesi, Indonesia has requested Masarang foundation to develop a forest management plan in an area called Boltim forests. The forests of Boltim are located in the mountains of the Ratatombo forest in the East Bolaang Mongondow regency. This preliminary research was carried out to get an understanding of the ongoing developments in deforestation and forest degradation and to provide solutions related to these issues which are having a negative impact on the livelihood of the local population and the environment. This preliminary research investigated the influences of the forest to its surrounding area, the characteristics of the forest and its resources in form of commercial NTFPs. In addition, data were collected on policy formulation, farming practices and farmers motivation to adapt their techniques.

First, the characteristics of the landscape have been remote sensed by ArcMap. After that, the developments within and around the forest of Boltim were analyzed through satellite-based images. The diversity and structure of the forest have been inventoried with six measuring sites in the primary forest, each with three circle formed plots of 500m^2, 100m^2 and 4m^2. The abundance of sugar palms, rattans and durian fruit trees have been determined with twenty-six transects of 50m in primary and degraded forest. Moreover, one hundred and five transects of 10m long have been carried out on the riverbanks of the Matabulu river to investigate the presence of highly productive sugar palms. Furthermore, five key informants have been interviewed to indicate whether the policy contributes to the developments in the forest. In addition, twenty farmers from Matabulu have been interviewed to gain insight about their current agricultural practices, their motives and whether they are willing to adapt their techniques.

The elevation ascending from sea-level at the communities Matabulu, Loyow and Nuangan to 1235m in the forest at Boltim. The landscape between the forests at Boltim and the communities of Matabulu and Loyow is characterized by 40% steep slopes between the 24 and 40 degrees. The forests at Boltim are located on the higher elevation of five different watersheds areas which then flow into the areas of the communities of Matabulu, Loyow and Nuangan. This process is accelerating because the natural vegetation is disappearing on areas such as riverbanks and steep slopes. In the primary forests at Boltim there are 127 trees (>=30cm DBH) per Ha, a BA of 33.64m^2 per Ha and a total volume of 462m^3 per Ha. Moreover, there are 83 sugar palms and 721 rattans per Ha encountered in primary forest and there are 14 sugar palms and 204 rattans per Ha encountered in degraded forest. There are on average 133 highly productive sugar palms per Ha in secondary forest on the riverbanks of the Matabulu river and are within 3km range of the village Matabulu. The current policy contributes to the ongoing developments in deforestation and forest degradation within and around the forests at Boltim. It was found out that cloves are the most commonly planted crop to support the farmers in 95% of the households. Current agricultural practices are not sustainable. However, it seems that farmers are motivated to contribute to sustainable farming practices, but they do not have the expertise and resources to adapt their techniques.

The area between the forests at Boltim and the communities Matabulu, Loyow and Nuangan must be managed sustainable, likewise the proposed area. The abundance of sugar palms and rattans in and around the forests at Boltim has the potential to contribute to the development of the local population, when these NTFPs become industrialized in the East Bolaang Mongondow regency. A new agricultural system is required to protect the soil from erosion and contribute with the improvement of livelihood of the local population.

Preface

As a world traveler my fascination for nature and people is exceptional.

My attraction for nature and adventures in tropical forest has raised awareness about the importance of biodiversity and sustainable forest conservation.

My love for humanity and nature has brought me into contact with Willie Smits, the founder of Masarang Foundation. Masarang Foundation is committed to the conservation of biodiversity and the empowerment of the local population.

Thanks to Willie Smits, I have experienced the projects of the Masarang foundation in August 2017 and I was able to write my graduation report on behalf of the Masarang foundation about the management of a virgin rainforest. Towards sustainable forest management, was submitted as final thesis for the course Forestry and Nature Management Major Tropical Forestry at the University Van Hall Larenstein in Velp, The Netherlands.

I travelled again to the location in North Sulawesi, Indonesia in early June 2018 until the end of July 2018. The data submitted were collected in the forests at Boltim and in the community Matabulu. This primeval forest is home to a pristine environment and is situated in an unexplored area. My appreciations go to the Masarang foundation who provided me with guidance and accommodation. This includes the rangers who helped me with collecting field data, Stenley Keunang, Steven Wetik, Victor Allemay Windah, Youdy Windah and staff member Onna Risdianto Tijow-Senduk, who helped with the needed documents and guidance.

I would like to thank Willie Smits, my external supervisor, for his hospitality and sharing his knowledge. My supervisor from the university Erika van Duijl, for her outstanding guidance and feedback moments in all the processes of this report. To finish, I would like to thank William Smits and Wouter van den Berg for their grammatical corrections.

My gratefulness goes to Willy van Mensvoort and Henk Kaskens. Without their generous contributions, this report would not have been finalized.

The whole experience was a grand success thanks to these people.

I hope you enjoy reading the report.

Martijn Buskens,

Fenyuan, Taiwan December 19, 2018

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1 Introduction

This preliminary research for sustainable land use, forestry and nature conservation in Boltim was carried out on behalf of the Masarang foundation in Indonesia. The central government in the East Bolaang Mongondow regency of Sulawesi Utara (North Sulawesi) has, together with the local government of the communities Nuangan, Lowey and Matabulu, requested Masarang foundation to develop a forest management plan in an area called Boltim forests (Figure 1) (Masarang, 2017).

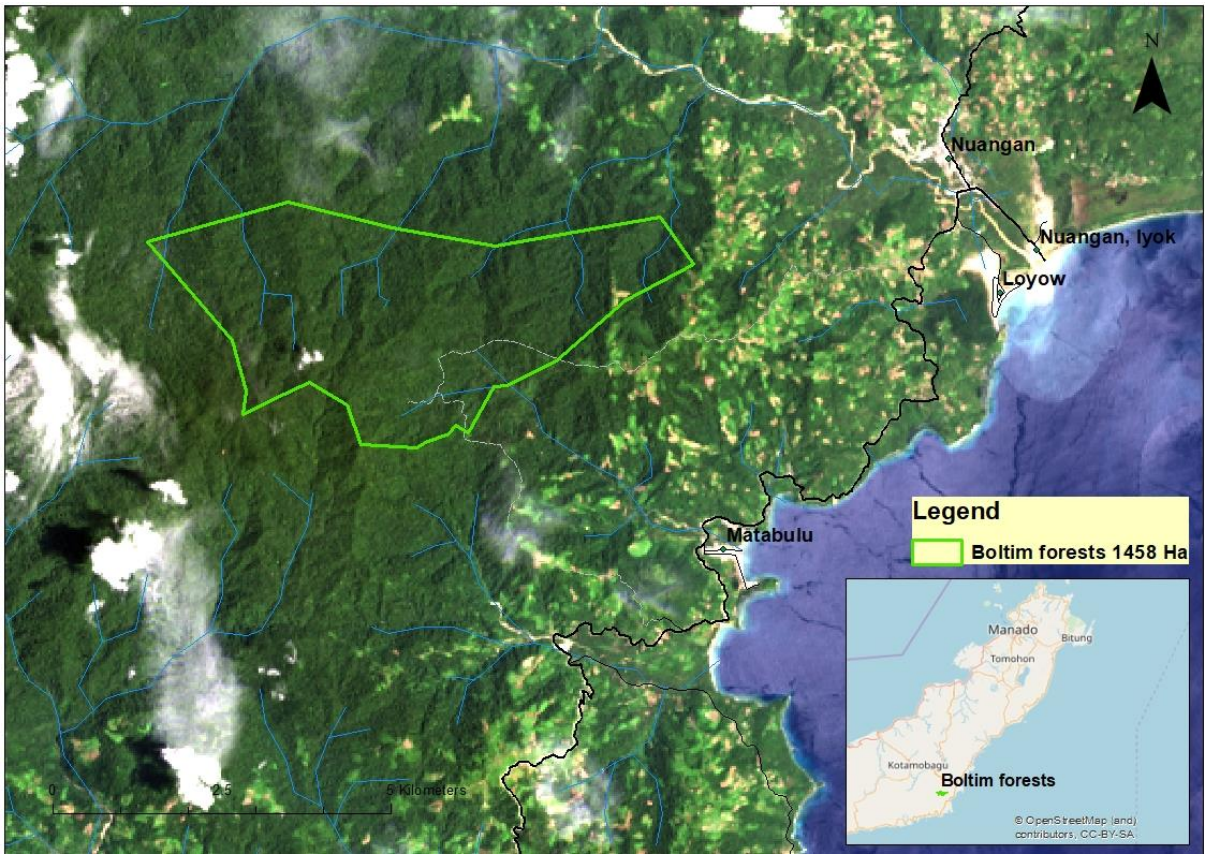


Figure 1: The location of the forests of Boltim.

The forests at Boltim have no conservation status and are not actively managed as the nature reserves like Tangkoko Batuangus Nature Reserve and Bogani Nani Wartabone National Park in North Sulawesi. Nevertheless, it would be better to conserve and actively manage these high-altitude forests at Boltim because they protect the low-lying areas from flooding and landslides. In 2015, landslides destroyed 7 houses in the communities Matabulu and Lowey. Thus, the governments in the East Bolaang Mongondow regency has many interests in preserving the forests at Boltim.

Boltim is an area of the Ratatombo forest and has the only entrée fee to that mountain range. The forests of Boltim contains over 1458 Ha of primary (Approx. 1000 Ha) and disturbed forests (Approx. 400 Ha) (Ering & Windah, 2016). The area between the forests at Boltim and the communities of Matabulu, Loyow and Nuangan contains agricultural land with disturbed lowland forest. The conservation of Boltim forests is needed to protect the area from deforestation and from further

forest degradation. It is desired to develop the local communities with sustainable forest resource management and the move to sustainable land use practices.

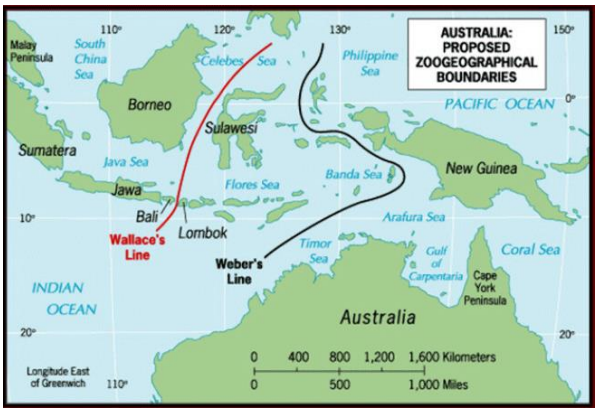


Figure 2: The Wallace Line (in red) and Weber line (in black) are the set lines what is dividing Asian and Austrasia biogeography. Sulawesi is between those lines.

Sulawesi is the biggest island within *Wallacea*. Wallace's line and Weber's line are separating the Asia and Australasia geographic flora and fauna species. Sulawesi is located between these two lines (Figure 2). Sulawesi's location, geologic history, and long geographic isolation have created Sulawesi's unique biodiversity and led to the evolution of many species endemic to the island (Whitten, Henderson, & Mustafa, 2002). Masarang foundation is interested in conserving the forests at Boltim because of its high biodiversity value and because no official management or conservation activities are carried out. In addition, it is the only place where the Celebes crested macaque, Anoa (a dwarf buffalo) and North Sulawesi Babirusa (a deer-pig) still coexist (Siwu, 2015).

Masarang foundation is devoted to forest restoration and the empowerment of local population (Yayasan Masarang, 2015). The Masarang foundation in Indonesia was established in 2001 by Willie Smits (Yayasan Masarang, 2015). Masarang Indonesia supports: reforestation, saving endangered animal species, biodiversity conservation, indigenous cultural preservation and environmental education.

Masarang foundation having as their mission "Nature conservation through collaboration and development of the local population" (Smits, 2001). They are specialized in sustainable management of such forest areas together with the development of the local communities and they would like to manage the designated area. Dutch investors approached Masarang foundation to express their interest in financing this project.

1.1 Problem analysis

The forest at Boltim was difficult to access, which slowed deforestation and agricultural development compared to other places in North Sulawesi. However, since 2011, a Kalimantan based logging company illegally exploited the forest at Boltim and opened the forest for further developments (Mamonto, 2018). These developments can be divided under two main problems: deforestation and forest degradation.

Deforestation

Forests are felled without a permit and are on land intended for forest production or forest conservation (Masarang, 2017). The area is characterized by large differences in elevation and its steep slopes. Frequently, the deforested areas are located on the steep slopes (Ering & Windah, 2016). When the usable tree species are felled, farmers preform slash and burning to clear the land and to use the land for agriculture practice (Laode, 2018). Agricultural expansion is one of the main drivers for deforestation at Boltim forests (Siwu, 2015). The land used for agriculture are often

conducted on these steep slopes without any measures to control erosion such as terracing, intercropping or contour hedges.

Forest degradation

In North Sulawesi the unemployment is much higher compared to other areas in Indonesia (Arifin, 2017). Forty percent of the inhabitants of northern Sulawesi do not receive a minimum salary to maintain their household (Smits, 2018). The farmers in the East Bolaang Mongondow regency do not generate enough food and income from their land to fulfil their need (Laode, 2018). This leads to more over exploitation of the forest and its resources such as land, timber and bushmeat.

The forest of Boltim is an area of the Ratatombo forest, Boltim forests has the only entrance fee to the Ratatombo forest in that mountain range. The Ratatombo forest in that mountain range has a conservation status. By conserving the proposed area, another, much bigger area of rainforest, will be preserved (Smits, 2016; Masarang, 2017).

In order to succeed in preserving the forests of Boltim, Masarang foundation needs to know what characteristics the forests have and what is needed to protect them. This is required to be able to make an appropriate conservation plan related the proposed area. Harvesting NTFPs (Not Timber Forest Products) such as sugar palm, rattan and forest fruit have shown to play an important role the conservation of forest in Sulawesi as these NTFPs provide an income for the population in and around forests (Hartman & Nijenhuis, 2013; Meijaard, Achdiawan, Wan, & Taber, 2014; Lawrence Greenwood, Thapan, Malik, Jamilur Rahman, & Taylor, 2008). Sugar palms, rattans and forest fruits, which are naturally present in the forests of North Sulawesi, could contribute to the development of the local population in the East Bolaang Mongondow regency. Especially highly productive sugar palms, which often stand along waterways and produce twice as much sugar-concentrated juice (Watulangow, 2018; Staaij, et al., 2011), could improve the livelihoods of the local population (Mokoginta, 2015). The abundance of these NTFPs could reduce the pressure on the forest and its resources such as land, timber and bushmeat.

Moreover, it is necessary to know what policy and legislation is being enforced and what the laws and regulations the community members have, to use the forest and its resources. There must also be transparency about the effects of this policy regarding the forests at Boltim. Also, it is important to know how farmers use their land and what their motives are. Involving farmers with this preliminary research and with the establishment of the management plan is necessary to develop sustainable agricultural practices and with the commercialization of NTFPs.

1.2 Purpose

Masarang Foundation would like to draw up a management plan for Boltim. The purpose is to do a preliminary research so that the management plan can be made.

The overall objective of this preliminary research is to examine the influences of the forest in Boltim to its surrounding area and to examine the forest characteristics with its forest resources in form of NTFPs. The abundancy of sugar palm, rattan and forest fruit such as durian could potentially lead to a reduction of deforestation and forest degradation and could contribute with the development of the local population. Also, it is essential to gather information about current agricultural practices,

whether the policy contributes to the developments in the forest and whether the local farmers are motivated to develop contribution to sustainable land use and sustainable forest resource management.

1.3 Research questions

The research questions are dived into the headings; area of influence, forest resources and social acceptability.

Area of influence

Research question 1:

1. *What influences do the forests of Boltim have on the surrounding lower elevated areas?*
    - **a.** *What are the characteristics of the area from the forests at Boltim to the communities next to the coast?*
    - **b.** *What are the developments within and around the forest at Boltim?*

Forest resources

Research question 2:

2. *What is the structure and diversity of the forest at Boltim in terms of trees and NTFPs?*
    - **a.** *What are the tree species in 1 Hectare of primary forest at Boltim?*
    - **b.** *What is the forest structure in 1 Hectare of primary forest at Boltim?*
    - **c.** *What are the NTFPs in and around the forests at Boltim?*
    - **d.** *Which NTFPs can be observed on 1 Hectare of primary forest at Boltim?*

Research question 3:

3. *What is the abundancy of the NTFPs rattan, sugar palm and forest fruit such as durian per hectare at Boltim's primary forest and at Boltim's degraded forest?*
    - **a.** *Which properties has the NTFPs; rattan, sugar palm and forest fruit in Sulawesi?*
    - **b.** *Could rattan, sugar palms and forest fruit such as durian present in the forests at Boltim contribute to the development of the local population?*

Research question 4:

4. *Are highly productive sugar palms present within accessible areas in Boltim?*
    - **a.** *How many highly productive sugar palms are present within and near the forests at Boltim?*
    - **b.** *Where are those highly productive sugar palms located?*

Social acceptability

Research question 5:

5. *Does the policy in Indonesia and in the East Bolaang Mongondow regency support the conservation of the forests at Boltim?*
    - **a.** *Does the policy contribute to the current developments in the forests at Boltim?*
    - **b.** *What is the current policy of land ownership and management in Indonesia and in that regency?*
    - **c.** *Who is enforcing this policy?*
    - **d.** *What laws and regulations the local population have, to make use of the forests and its resources?*

Research question 6:

6. *What are the agricultural practices of the farmers from the community Matabulu?*
    - **a.** *Which crops are characteristic of the area?*
    - **b.** *Which crops are the most important to maintain a household?*
    - **c.** *How do farmers maintain their land?*
    - **d.** *Why did they choose for these farming practices?*

Research question 7:

7. *Is it possible to implement sustainable farming methods with cooperation from the farmers?*
    - **a.** *Which factors are involved with the impact of adoption to farmers with the implementation of sustainable farming practices?*
    - **b.** *Are the farmers motivated to implement sustainable farming methods on their land?*
    - **c.** *What farmers need to adapt to sustainable agriculture?*

2 Methodology

This chapter describes the methodologies used to collect the required data. The methodologies are divided among the subjects: literature studies, area of influence, forest resources and social acceptability.

2.1 Literature studies

Literature studies have been undertaken to gain insight into previous studies on topics related to the research questions. This includes studies specifically aimed at the characteristics and developments in Sulawesi and Indonesia in its entirety. As well as global studies about forest conservation and sustainable forest resource management what leads to measures against deforestation and forest degradation.

2.2 Area of influence

Remote sensing has been carried out to display which areas are affected by the developments at Boltim forests. The characteristics of the landscape can influence the consequences of deforestation and forest degradation. The elements of the landscape such as water flow areas may be the cause of the current floods and landslides in the lower elevated areas. For these reasons, the forests at Boltim and the surrounding areas have been monitored by using ArcMap and satellite images retrieved from the United States Geological survey (USGS).

First, an elevation grid was created. This elevation grid is based on the data from the global topography adjusted into contour lines through Roy Watulangow, the GIS specialist of the Masarang foundation. Then, with the constructed elevation grid, a slope map and a direction of the slope map were created. After that, the grids with data about the flow accumulation and water basins were conducted by ArcMap. Temperatures and precipitations data of the last 40 years were then extracted from Global climate data to aggregate temperature and precipitation data, related to the designated area. Moreover, a satellite image from Landsat 8, made at the 28 of January of 2018, retrieved from USGS was used to indicate the landscape elements such as vegetation, land use and the status of forests in and around the forest at Boltim. Unfortunately, it was not possible to compare these data with previous satellite images due to the fact that the availability of spatial data is very limited.

2.3 Forest resources

Three methodologies have been carried out in the forest at Boltim to indicate the resources of the forest. The forest resources are divided into the headings; forest structure and diversity, NTFP abundancy and presence of sugar palms.

Forest structure and diversity

A forest inventory has been carried out to determine the forest structure and the diversity of trees and NTFPs. In total, 6 plots of 500m^2 (3000m^2 of monitored surface area) were carried out in the primary forest with 25m between each plot (Appendix 15 Plot location). A land marker in form of a pole have been set on the location. from this pole, a rope with marked distances of 12.63m, 5.64m and 1.128m was set that indicated 3 plots circle-formed (Figure 3).

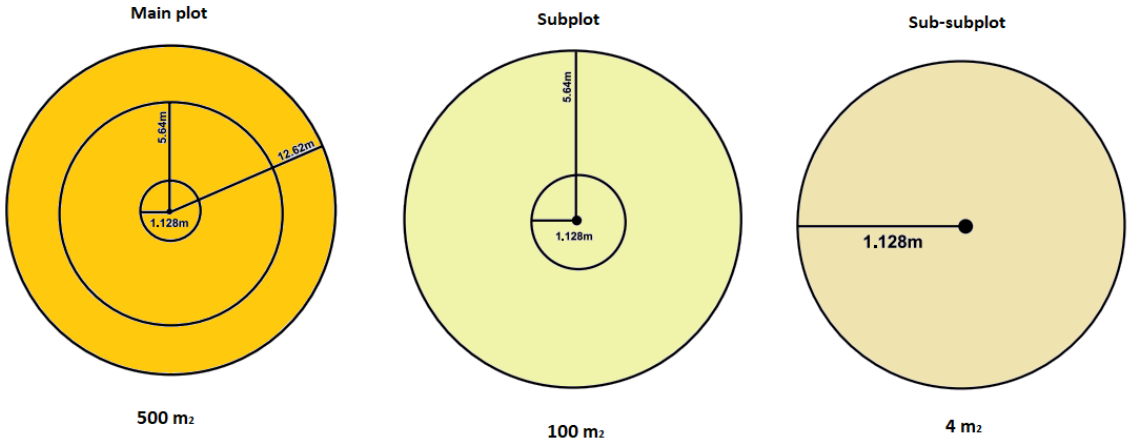


Figure 3: A model of the plots used for the forest inventory.

Main plot

A 500m^2 plot with 12.62m radius is used to inventory all the trees and sugar palms with a DBH (Diameter Breast Height) greater than or equal to 30cm. Trees species were identified if possible, and the DBH and total height of the tree were measured. In addition, it was examined whether the tree has an NTFP function such as fruit, nut, spice, medicine or resin and whether the tree is used as timber.

Subplot

Within the main plot, a 100m^2 plot with 5.64m radius have been used to measure pole sized trees greater than and equal to 10cm DBH, and less than 30cm DBH. Trees species were identified if possible, and the DBH and total height of the tree were measured. In addition, it was examined whether the tree has an NTFP function such as fruit, nut, spice, medicine or resin and whether the tree is used as timber. Also, Sugar palms less than 30cm DBH and greater than 1 meter high, rattan greater than 2 meters long and other palm and/or shrub species which provide NTFPs such as fruit, nut, spice, medicine or resin were identified and reported.

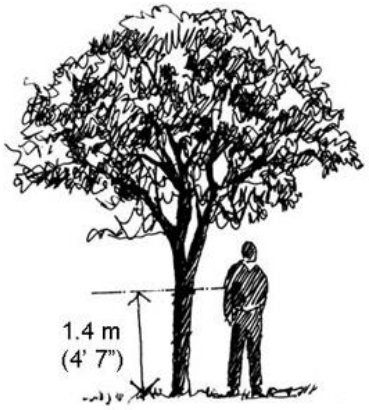
Sub-subplot

For seedlings less than 10cm DBH, a plot with a radius 1.128m have been used to count the seedlings present in the primary forest. Also, NTFPs in form of fungi, moss and herbs were determined and noted.

The tree and NTFP species within each plot (Table 1) were determined if it was possible and the DBH of the tree were measured with tree tape (Figure 4). The height of each individual tree was measured with the model visible in Figure 5. The field forms are visible Appendix 13 Field forms and the map used in the field is visible in Appendix 14 Field map.

Table 1: The sizes and conditions of each plot in the forest inventory.

Plot	Size of the plot in m^2	Radius in m	Remarks
Main plot	500	12.62	Trees >= 30cm DBH Sugar palms >=30cm DBH
Subplot	100	5.64	Trees >= 10 and <30 cm DBH Sugar palms >=1m high Rattans >=2m long NTFP palms NTFP shrubs
Sub-subplot	4	1.128	Trees < 10 cm DBH NTFPs such as fungi, moss and herb



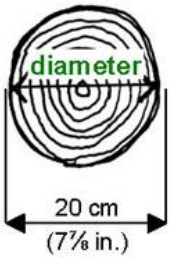


Figure 4: A model of how the DBH were measured (Richmond, 2007).

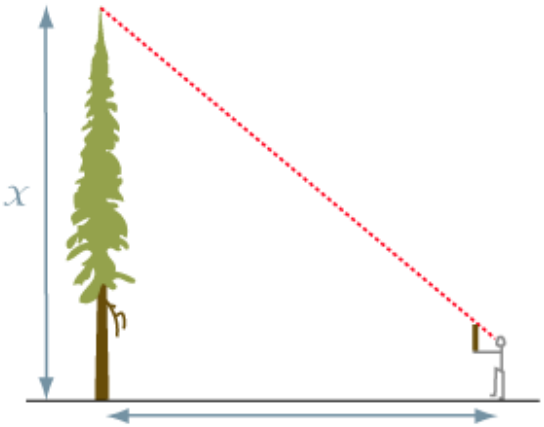


Figure 5: A model of the method what have been used to measure the total height of the trees.

NTFP Abundancy

To indicate the abundancy of Sugar palm (*Arenga piñata*), Rattan palm (*Calameae spec.*) and of Durian fruit tree (*Durio zibethinus*), systematic line transects of 50m long were set in a random direction (Appendix 15 Plot locations). Fourteen transects were carried out in degraded forests with a total surface of 14.000m^2 and twelve transects were carried out at Boltim's primary forest with a total surface of 12.000m^2.

Through following a set up rope with a fixed measurement in every 10m of the transect, with an estimated width of 10m of each side of the transect line, the selected NTFP species was noted (Figure 6). When the first plot was completed, the rope with fixed measurements have been used to indicate the 50m next, where no data was collected. Thus, one plot was set every 100m in the same direction. In its total 26 plots have been carried out to display significant information about the abundancy of the selected NTFPs at Boltim primary and degraded forest. The size of each plot is 1000m^2, and the selected NTFP has fulfilled conditions (Table 2).

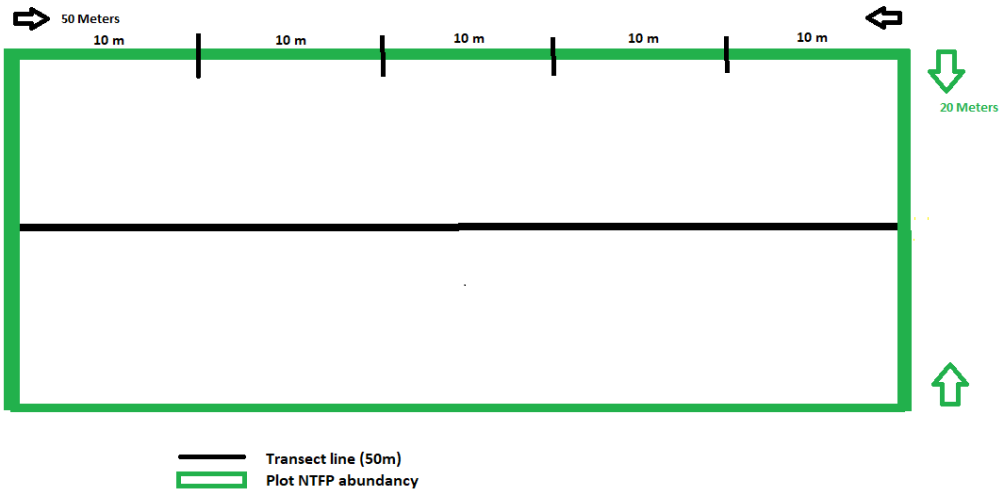


Figure 6: A model of transect what is used to indicate the abundance of sugar palms, rattan palms and durian fruit trees.

Table 2: The sizes and conditions of the transect used to measure the NTFP abundancy.

Plot	Size in m^2	Transect in m	Remarks
1	1000	50 x 20	- **Sugar palm** needed to be greater than 1m high - **Rattan** needed to be greater than 2m long - **Durian** fruit tree needed to have a DBH greater than 10cm

Presence of sugar palms

To indicate the presence of highly productive sugar palm within accessible areas from the community Matabulu, a transect line in the Matabulu river (Figure 7), has been carried out. The transect has started in the secondary forest of the Matabulu river, 1km inland from the village Matabulu. From this start point, the researches walked in the river against the stream to the higher elevated areas and the highly productive sugar palms were identified.

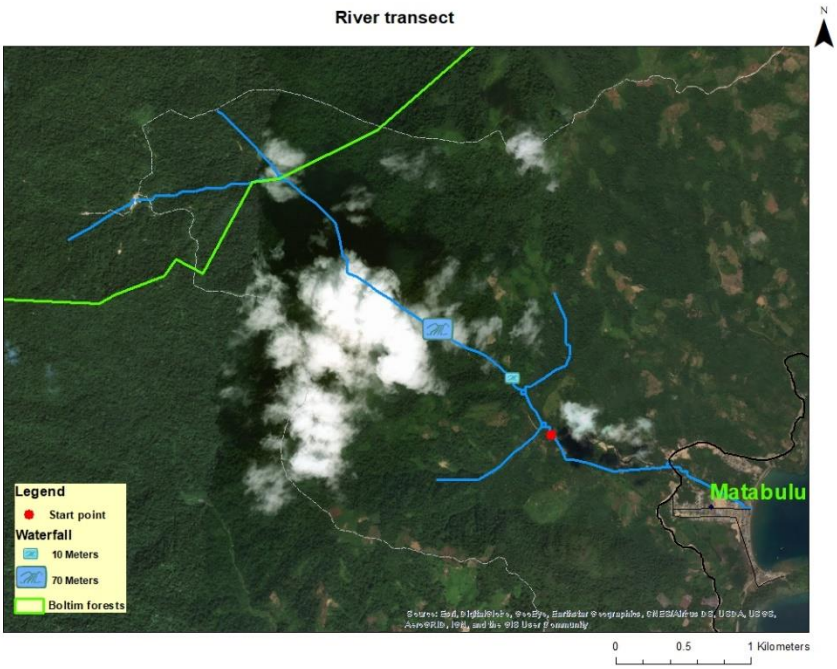


Figure 7: The Matabulu river (Sungai Matabulu).

In every 10m of the river, the sugar palms greater than 1m high was noted within 10m of the riverbank, on each side of the river. Immediately after the 10m transect, the next 10m transect was placed (Figure 8). A measuring tape was used to indicate every 10 meters transect. Not every part of the river has been observed because there were steep sections in the river and could not be reached in a safe way. Fifty-five measuring sites were carried out in secondary forest and fifty measuring sites were carried out in primary forest, of the total +-5km length of the Matabulu river.

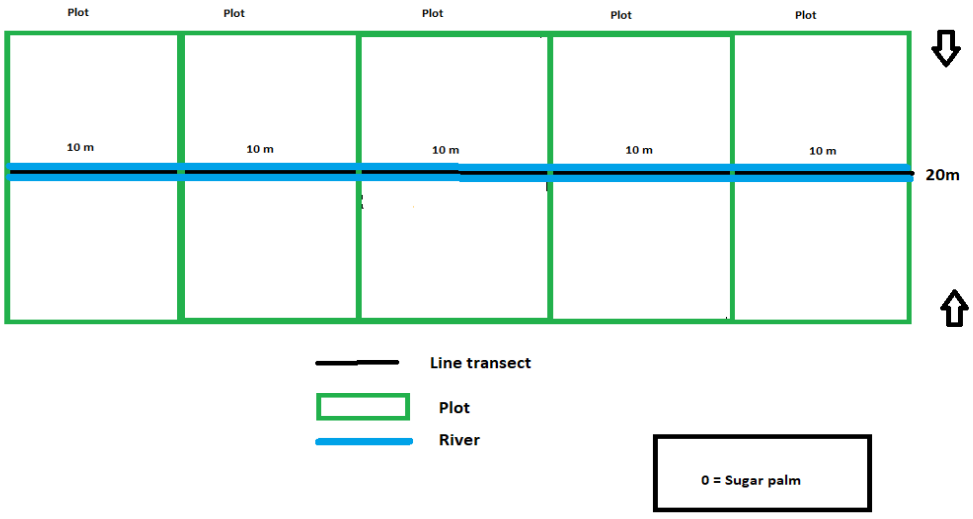


Figure 8: A model of the transect in the Matabulu river what is used to indicate the presence highly productive sugar palms.

2.4 Social acceptability

The methodologies of the social acceptability studies are divided into the headings; policy and law enforcement, agricultural practices and assessment farmers interest.

Policy and law enforcement

This social acceptability study about policy have been carried out to gain insight about Indonesian and local policy related to the current deforestation and forest degradation in and around the forests at Boltim.

Firstly, literature studies were conducted to gain insight into policy formulation and law enforcement in Indonesia and in the East Bolaang Mongondow regency. After that, five key informants were then personally interviewed in the months June and July 2018. They have been asked what the policy is within Indonesia and within the East Bolaang Mongondow regency regarding the right of the local population to use the land, the forest and its resources. It was asked which rights are derived by land tenure and which regulation are compiled by the local government. How is this monitored and what are the current developments regarding policy making. The five key informants were interviewed separately from each other at different locations. They are different in their background, interests, knowledge and authority.

The 5 key informants are:

1. Indra Kristiawan: Attorney at law, specialized in Indonesian real estate and land rights.
2. Willie Smits: President of Masarang and former official of the Indonesian Ministry of Forestry.
3. Alfian Mamonto: Head of the village of Matabulu in the East Bolaang Mongondow regency.
4. Yahya Laode: Environmental engineer and resident of Kotamobagu.
5. Dian Tijow: Entrepreneur of sewer systems and specialist in nature techniques.

Agricultural practices

Twenty farmers of a total of 170 farmers in Matubulu were interviewed individually to gain insight into the agricultural practices of these farmer which are living nearby the forest. These personal interviews took place at their home or at their farm in the months June and July 2018. The interviews covering the following topics: household features, farming land characteristics, land usage and their grounds. The interview questions with the form used are visible in Appendix 12 Interview questions.

Assessment farmers interest

To indicate the farmers interest to adopt to sustainable farming practices and their needs, extra questions are made covering the following topics: experiences, motivations and requirements. Also, the interview questions are visible in the used form in Appendix 12 Interview questions.

3 Area description

This chapter, area description, provides information about Sulawesi and the proposed area, its history, its characteristics, the biodiversity and the commercial NTFPs.

3.1 Background information

The surroundings of Sulawesi are one of the most complicated active margin in term of geology, structure and tectonic as well. The region represents a centre of triple junction plate: northward-moving Australian plate, the westward-moving Pacific plate, and the south-southeast-moving Eurasia plate (Whitten, Henderson, & Mustafa, 2002).

East and West Sulawesi collided approximately 13-19 million years ago, and ultrabasic rocks were exposed as East Sulawesi overrode the western portion (Bemmelen, 1949). The forces that caused the collision are still at work, and Sulawesi is being torn apart today (Simandjuntak & Barber, 2016).

Climate

Around an in the forests at Boltim, the climate is tropical with an average temperature of 24.7 °C (Appendix 5 Map of the annual mean temperature). At 800 meters above sea level the temperature it is 6 °C lower and the temperature differences from the areas next to the coast to the higher elevated areas in the forests at Boltim can be 15 °C (Appendix 6 Map of the annual minimum temperature and Appendix 7 Map of the annual maximum temperature).

There is 2038mm precipitation throughout the year (Appendix 8 Map of the annual precipitation). Even in the driest month, September, there is still 84mm of precipitation (Climate data, 2017). They highest amount of precipitation is in the month May, with an average of 234mm. This climate is considered to be an “Af” (rainforest), according to the Köppen-Geiger climate classification.

Soils

According to the major soils of the world published by the Food and Agriculture Organization (FAO), the common soils in North Sulawesi are acrisols, andosols and fluvisols. But various soils would be present in the study area (Whitten, Henderson, & Mustafa, 2002; Cannon, Harting, Salim, & Summers, 2015). There is no actual data presented in the study area at Boltim. However, it appears that ferralsols could be present at the higher elevated areas within the forest at Boltim and acrisols are most dominate on the slopes till the fluvisols at the lowest elevated areas (Buskens, 2018).

3.2 Biodiversity

According to WWF, Sulawesi's flora is most related to the floras of dry areas in the Philippines, Moluccas, Lesser Sunda islands, and Java (Wikramanayake, Dinerstein, Loucks, & Pimm, 2001). The lowland forests are similar to the lowland forest in New Guinea, whereas the upland areas are more related to Borneo (Whitten, Henderson, & Mustafa, 2002). Sulawesi is mainly a mountainous island with lowlands only occupying about 25% of the total area. Sulawesi has the typical coastal habitats found elsewhere in Indonesia. This includes mangroves, peat palm forests and wetlands (Hance, 2009).

There are between 100 and 200 tree species present in tropical lowland forest in Sulawesi (Whitten, Henderson, & Mustafa, 2002). The number of plant species in Sulawesi may be approximately 5,000 species (Whitten, Henderson, & Mustafa, 2002). The flora species diversity is estimated because the flora of the island is incompletely surveyed and poorly known.

A total of seventeen different forest ecosystems have been identified in Sulawesi (Table 3). The wide diversity of forests in Sulawesi is part of the reason for the islands high rate of endemism and biodiversity (Cannon, Summers, Harting, & Kessler, 2007).

Table 3: The types of forest in Sulawesi (Cannon, Summers, Harting, & Kessler, 2007).

Forest types Sulawesi:	
- Wetlands	- Upland intermediate
- Lowland alluvium	- Karst
- Mangrove	- Hill mafic
- Hill alluvium	- Upland limestone
- Lowland limestone	- Montane intermediate
- Lowland intermediate	- Tropical pine
- Lowland mafic	- Upland mafic
- Hill limestone	- Montane limestone
- Hill intermediate	- Montane mafic

Fauna

There are 127 known mammal species in Sulawesi (Hance, 2009). A large percentage of these mammals, 62% (79 species) are endemic. An exceptional 98% endemic land mammals would be present when bats are excluded of this percentage. Sulawesi contains the highest number of endemic mammals in Asia (Hance, 2009). Furthermore, 34% (478 species) of Sulawesi's 1450 birds are endemic (Brian, Coates, & Bishop, 1997).

Limited studies have been carried out to identify the other animal species: 25 species of amphibian are known (19 species are endemic) (Whitten, Henderson, & Mustafa, 2002), 40 lizards (13 species are endemic) (Rhee, et al., 2004), and at least 52 terrestrial snakes (Lang & Vogel, 2006). In addition, 557 butterflies are native to Sulawesi's region (Vane-Wright & Jong, 2003). Occasionally, new animal species are discovered. In 2017 researches discovered two tarsier species in Sulawesi (Velde, 2017).

Boltim houses Sulawesi's largest native endangered and protected mammals such as the Anoa, Babirusa, Crested black macaque, Bear cuscus (a marsupial), Maleo (Indigenous birth) and the

hornbill species; Sulawesi Hornbill and Red-knobbed Hornbill (Appendix 11 Animal species list) (Masarang field survey 2015, 2017 and 2018).

This appendix shows that there is uncertainty about the occurring rodent species, which have the forests at Boltim as their natural habitat. This is because there is a lack of data from existing rodents in Sulawesi. The lack of data, can also be seen from the conservation status of the Bear Cuscus (*Ailurops ursinus)* which has Data Deficient (DD) as conservation status.

3.3 Commercial NTFPs

Sulawesi's international NTFPs are honey, sugar palm, agarwood, rattan and the forest fruits such as durian, mango, salak and rambutan (FAO, 2017). Triggered by their cultural background the Minahasa (the biggest ethnical group in North Sulawesi), consume bushmeat (O'Brian & Kinnaird, 2000; Masarang, 2017). Seventeen different NTFP species are determined in and around the forest at Boltim (Table 4).

Table 4: The NTFP species at the forests of Boltim (Siwu, 2015; Mamonto, 2018; Laode, 2018; Ering & Windah, 2016).

NTFP Species local	**Species Indonesian**	**Name**	**Scientific**	**Function**
Aren	Arenga	Sugar palm	*Arenga pinata*	Juice
Rotan	Rotan	Rattan	*Calameae spec*	Furniture
Durian	Durian pohon	Durian fruit trees	*Durio zibethinus*	Fruit
Leechi	Leechi pohon	Rambutan tree	*Sapindaceae spec.*	Fruit
Mangga	Mangga	Mango tree	*Mangifera spec.*	Fruit
Langsa	Langsat	Langsat	*Lansium parasiticum*	Fruit
Pisang yaki	Pisang monyet	Monkey banana	*Musa spec*	Fruit
Jambu monyet	Jumbu monyet	Chestnuts	*Castanopsis spp.*	Nuts
Anggrek hutan	Anggrek hutan		*Coelogyne pandurata*	Decoration
Bambu	Bambu	Bamboos	*Bambusoideae spec*	Furniture
Apune	Jenis Pakis	Ferns		Decoration/ food
Pinang hutan	Pinang hutan	Ivory Cane Palm	*Pinanga kuhlii*	Fruit/flower
Beringin	Beringin	Fig	*Ficus spec.*	Fruit/rope
Damar	Damar	Conifers tree	*Agathis dammara*	Resin (elastic)
Kayu manis	Kayu manis	Cinnamon	*Cinnamomum spec.*	Spice
Gora hutan	Gora hutan	Crocodile agarwood	*Phaleria capitata*	Fruit/Spice
Lahusip		Fig	*Ficus spec*	Fruit

Sugar palm

Sugar Palm "*The champion of photosynthesis"* (Hartman & Nijenhuis, 2013) is a large palm with a single trunk. Through its crown what is consisting 15 to 20 huge leaves the palm receives a LAI of 6.5 (Smits & Djojohadikusumo, 2016). The main product is sap tapped from the inflorescence.

This NTFP produces:

- **Food:** The inner core (Sago), palm hearth and fruit are edible. Also, bees and larvae benefits from the sugar palm (Smits & Djojohadikusumo, 2016; Mokoginta, 2015).
- **Fibers:** Fibers, scent material, orchid media and packing material can be made of the sugar palm (Mokoginta, 2015).
- **Wood:** The trunk of the sugar palm van be used for timber and fuelwood as well (Smits & Djojohadikusumo, 2016).
- **Medicines:** Sugar palm is used in traditional medicines and it has little impact on blood sugar level. Thus, it is suitable for diabetics (Smits, 2017).
- **Biofuels:** The Dutch government has been searching for new raw materials for biofuels released into sugar palm (Elbersen & Oyen, 2009). The analyses of Ecofys, one of the largest consultancy firms in Europe in the field of energy saving, renewable energy and climate issues, concludes that sugar palm has the possibility to a sustainable and profitable source of bio ethanol (Staaij, et al., 2011). These studies display the potential of Sugar Palm as biofuel products.

Sugar palm is C4 classed in which the plant undergoes photosynthesis and grows naturally in Sulawesi's forests (Smits & Djojohadikusumo, 2016). In Sulawesi it is commonly grown on a small scale up to several hectares of trees.

Naturally, the palm matures after 7 to 10 years. Then the tapping of the palm sap can start because the inflorescence is developing (Elbersen & Oyen, 2009). The process of maturing can be accelerated by custom seed production of up 5-6 years (Smits, 2017). To tap the juice the inflorescence is cut off and the sugar-rich juice that is flowing from the stem is collected twice a day. In good conditions, the sugar palm can be tapped during a period of 5 - 12 months a year for 3 till 15 years (Staaij, et al., 2011). The juice ferments due to its high sugar content. So, processing is required to avoid this fermentation. The village hub, a "zero waste" sugar palm processing's factory in Tomohon, North Sulawesi, cooperates with local small holders to process sugar from the sugar palm (Hartman & Nijenhuis, 2013).

The sugar palms in Tomohon produces average 22.5 liters of juice per day. In this juice is 12-15% sugar (Vrancken, 2014). The production of sugar palms is dependent on land characteristics and water, light and nutrient availability (Watulangow, 2018). Sugar palm is inefficient in monoculture, the palm can withstand drought and flooding and sugar palm is ecologically resilient (Smits & Djojohadikusumo, 2016).

Wolter Elbersen and Leo Oyen mention that the full potential of sugar palm is difficult to estimate (Elbersen & Oyen, 2009). The Faculty of Forestry at the University of Dumoga Kotamobagu in Bolaang Mongondow in Indonesia is mentioned in its findings that the cultivation of sugar-palm trees can be used to meet economic needs of households, particularly for education, health, and social life (Mokoginta, 2015). Funds from the United Nations, the World Bank and the Norway Pension fund are invested to investigate the possibilities with sugar palm production on large scale and sugar palm in global reforestation projects (Rasmussen, 2011).

Rattan

Rattan is a very important NTFP because to its versatility. Rattan palm is used for (WWF, 2010):

- **Food:** The inner core and some fruit is edible. Also, the shoot of some of the rattan species are edible as well.
- **Furniture:** Furniture is the main product of rattan.
- **Shelter:** Rattan is used as material to build housing in rural areas.
- **Handicraft:** Handicraft provides besides furniture the main income supply for the rattan industries.

Rattan is an attractive forest product because it is easier to harvest than timber. Also, rattan is much easier to transport, and it grows faster than most trees (Meijaard, Achdiawan, Wan, & Taber, 2014).

Rattan canes are cut and harvested in the forest when the climber is 7 years old, then after every 4 years the palm can be harvest again (Meijaard, Achdiawan, Wan, & Taber, 2014). Rattan (*Calamus zollingeri*) is the large-diameter rattan in Central Sulawesi. This species must be at least 10m in length before it can be used for furniture framing (W.A. Franke College of Forestry & Conservation, 2010). It is often necessary to climb into the canopy to free large canes or canes entangled in the trees.

Large canes are boiled in oil to make them dry and to protect them from insects. Canes with small diameters are dried in the sun and before they are sold the processers often smoke the canes using Sulphur (Meijaard, Achdiawan, Wan, & Taber, 2014). Furniture canes are cut to 4m lengths and straightened for shipment.

Eighty percent of the rattan world market is produced in Indonesia (Caroko, 2006). The annual export value of rattan produced in Indonesia is between 300 and 350 million US dollars (Meijaard, Achdiawan, Wan, & Taber, 2014). The availability of rattan palm decreases because overexploitation in its natural habitat and because there are too few rattan palm plantations (Cannon, Summers, Harting, & Kessler, 2007). In the forests at Boltim there are several types of rattan such as; tohiti (*Calamus inops Becc. ex. celebicus Becc*.), stem (*Calamus zollingerii Becc., Calamus minahassae, Calamus koordersianus Becc*) (Siwu, 2015).

Forest fruit

The most known international tradable Indonesian forest fruit are rambutan, mango, salak and durian. Forest fruits such as durian are extremely popular in all the countries of south east Asia. Durian is trade international and has a high economical value (Langford, 2014). These forest fruits are exotics in the forest of Sulawesi, but there are native species that are related to these forest fruits and therefore very similar (Smits, 2018). The forest fruits from the forests at Boltim are used locally and are sold at the local market (Mamonto, 2018). Forest fruit trees play an important role in the nutrition-sensitivity of the food system of the local inhabitants (Termote, et al., 2013).

Bushmeat

Regardless of economic developments and declining wildlife populations, the people of northern Sulawesi continue to use wild animals as a food source (O'Brian & Kinnaird, 2000). Hunting for subsistence and commercial markets is still practiced today. Rapid transformation of forest to agricultural developments has reduced the habitat availability for wildlife populations (Whitten,

Henderson, & Mustafa, 2002). The human population is increased and has caused additional hunting pressure in the remaining forest (O'Brian & Kinnaird, 2000).

In Tangkoko Batuangus Nature Reserve, a national park in North Sulawesi, the population of mammals (except Sulawesi pig) declined with 75% between 1979 and 1994 (15 years) (O'Brian & Kinnaird, 2000). This population decline was caused by hunting. The Tomohon market traders travel to Bolaang Mongondow Regencies to buy wild meat from local hunters (O'Brian & Kinnaird, 2000). Illegal hunting occurs within the forest at Boltim. Ten percent of the farmers in Matabulu admit that he hunts. The number of hunting is causing problems to the local wildlife populations (Siwu, 2015).

4 Results

This chapter displays the gathered results. In the first section, the area of influence is surveyed by satellite-based images and compared with the developments inside and around the proposed area. In the second paragraph the results according, the methods related to the forest resources are presented. The third paragraph displays the results achieved according the social acceptability studies.

4.1 Area of influence

The elevation differences are characteristic of the area ranging from the lowest point below sea level in the communities of Matabulu, Loyow and Nuangan and thereafter, ascending to the highest elevated point of 1235m, at the forest of Boltim (Appendix 1 Map of the elevation). The landscape between the forests at Boltim and the communities of Matabulu and Loyow is characterized by 40% steep slopes between the 24 and 40 degrees (Appendix 2 Map of the slopes). These steep slopes are directed to the communities located next to the coast (Appendix 3 Map of the direction of slopes). The higher elevated areas have on average 350 mm more rain per year than the lowest elevated areas (Appendix 8 Map of the annual precipitation). It appears that the forest at Boltim feed the rivers that flow to the coast. In addition, the forests at Boltim support five different water flow areas (Appendix 4 Map of the boundaries of the watersheds).

There are at least four different vegetation types between the forest at Boltim and the communities Matabulu, Loyow and Nuangan (Appendix 10 Satellite image of the vegetation types). Next to the village Loyow, an area with a dark green color indicates an untouched mangrove forests. In addition, the forests of Boltim are located between two areas classified as protected forests. Thus, the forests of Boltim act as a buffer zone between these two areas (Appendix 9 Map of the forests classification).

Developments

In 2015, Boltim forests consisted mainly of primary dryland forest (85%), and some areas with secondary dryland forest (10%) and dry land farming with mixed shrubs (5%). This data is according to the land use map (Figure 9), retrieved from the Ministry of Environment and Forestry (2015) in Indonesia.

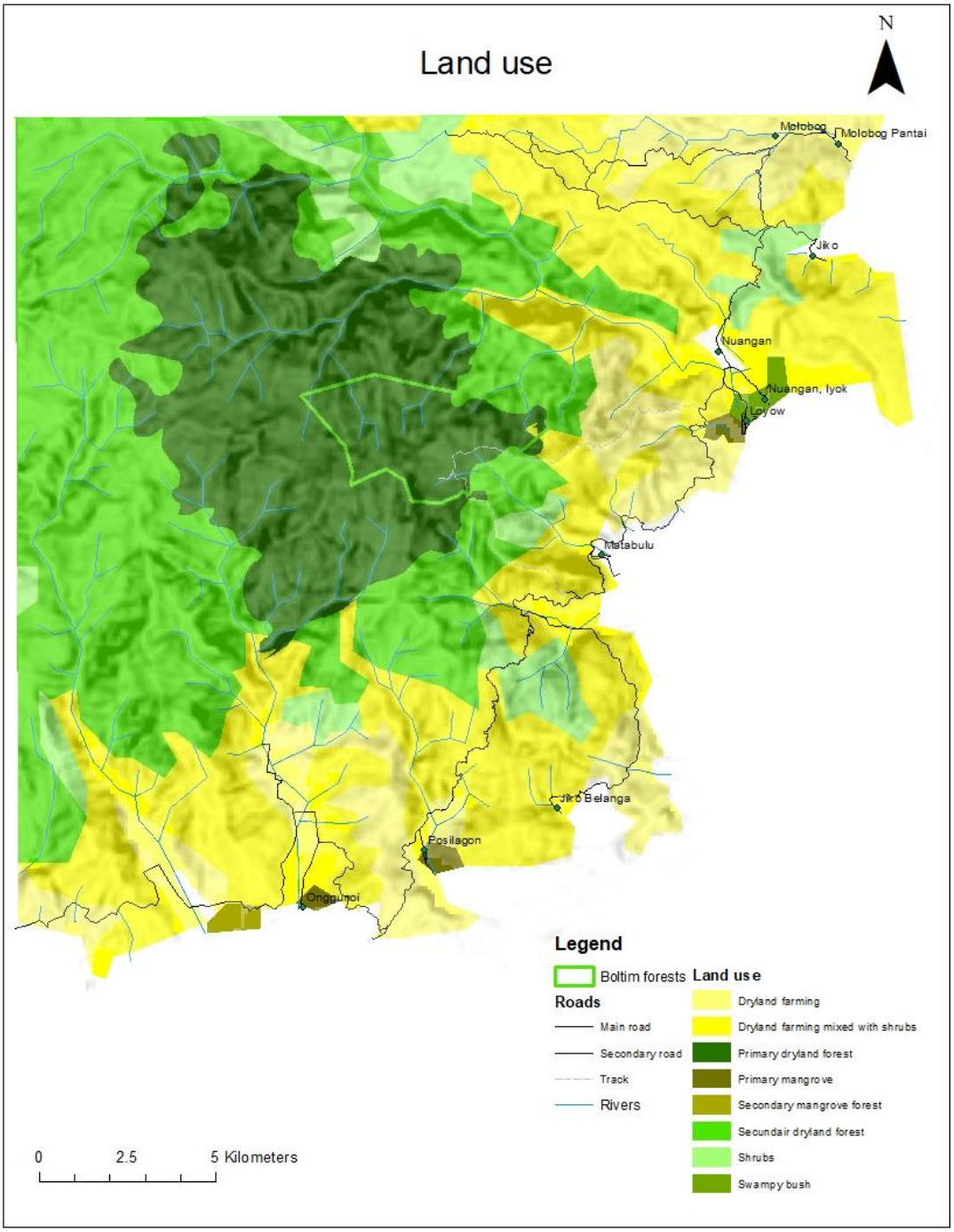


Figure 9: A land use map of the studied area.

Nowadays, the expansion of agricultural developments continues into the forests at Boltim (Figure 10). The arrows indicate the developments in the proposed area. The primary dryland forest decreased to 65%. The areas with secondary dryland forest (25%) and dry land farming with mixed shrubs (10%) increased. In Figure 10, it is noticeable that the expansion of agriculture is reaching into forest classified as limited production forest (HPT) and even into forest classified as protected area (Appendix 9 Map of the forests classification). The agricultural expansion continues to areas susceptible to erosion such as; steep slopes, riverbanks and the sources of rivers.

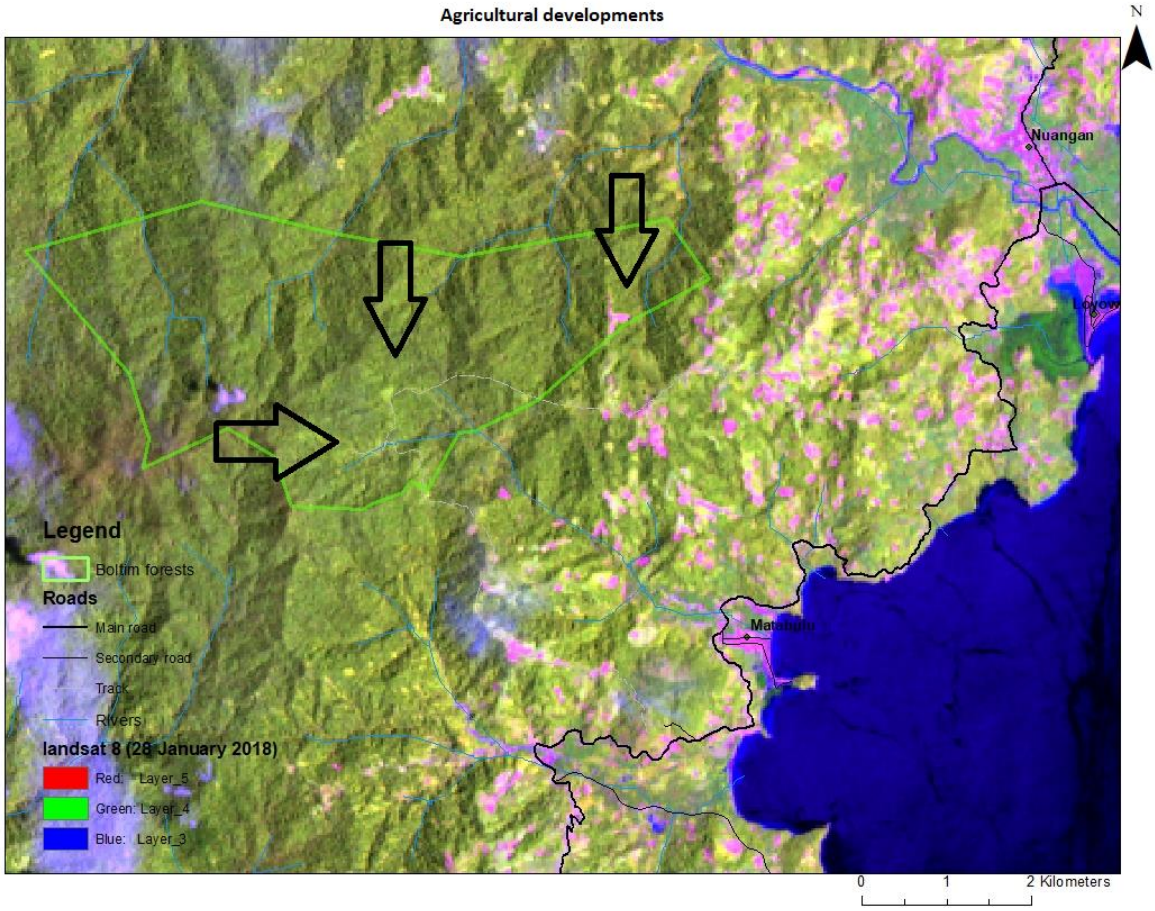


Figure 10: A satellite image what is displaying the agricultural developments within and around the forest of Boltim. This satellite image is recorded at the 28th of January 2018 with Landsat 8 satellite. This picture displays the agriculture developments within and around the forests at Boltim. The bands used to display the wavelengths to the resolution of the satellite image are 5,4, and 3.

The forests at Boltim are located on the higher elevation of different watersheds areas and are therefore important for regulating the water flow downstream (Appendix 4 Map of the boundaries of the watersheds). This map displays that the water flows downwards into the area of the communities Nuangan, Loyow and Matabulu. This process is accelerating because the forests are disappearing on areas sensitive to erosion such as the riverbanks and the steep slopes.

4.2 Forest resources

The results are divided into the headings forest structure and diversity, NTFP abundancy and presence of sugar palms.

Forest structure and diversity

There are 127 trees per Ha greater than and equal to 30cm DBH. The trees greater than and equal to 30cm DBH, and less than and equal to 200cm DBH, has a BA (Basal Area) of 33.64m^2 per Ha and a total volume of 462m^3 per Ha (Kershaw: V = 0.42 * BA * H). The most common species (25%) is Tayupu (*Trema orientaris*), 15% of all the detected trees per Ha are timber tree species and 257 of

the 493 trees per Ha were unknown tree species (Table 5). There are 367 trees per Ha greater than and equal to 10cm DBH and less than 30cm DBH. In addition, there are 42500 seedlings and saplings per Ha (102 trees with a diameter of less than 10cm on an operable surface of 24m^2).

Table 5: The number of the determined tree species per Ha (N=6; plot size DBH >=10 and <30cm: 100m^2, plot size DBH >=30cm: 500m^2).

Number of trees per species						
Species local	**Scientific**	**Timber**	**N/Ha DBH >= 10cm and <30cm**	**N/Ha DBH >= 30cm**	**N/Ha DBH >=10cm**	**Appearance in % per Ha**
Tayupu	*Trema orientaris*		100	23	123	25%
Pulutan	*Palaquium abovatum*	Yes		10	10	2%
Kayuroda	*Aglaia sp.*	Yes	17	3	20	4%
Yabon	*Antocephalus macrophila*	Yes		7	7	1%
Beringin	*Ficus spec.*			7	7	1%
Mawehang	*Terminalia catappa*		17	3	20	4%
Palang		Yes		3	3	1%
Kapuraca	*Calophyllum soulattri*	Yes		3	3	1%
Kayu Kambing	*Garuga floribunda*	Yes	17		17	3%
Wakan	*Litsea albayana Vid*		17		17	3%
Binuang	*Tetrameles nudiflora R.Br*	Yes		3	3	1%
Gopassa	*Vitex glabrata R.Br or Vitex quinata F.N.Will*	Yes		3	3	1%
Kayu batu		Yes		3	3	1%
Unknown			200	57	257	52%
Total			**367**	**127**	**493**	**100%**

The forest structure can be interpreted in a reverse J shape formation (Figure 11). There are 493 trees per Ha greater than and equal to 10cm DBH, in which the number of trees declining when the DBH class increasing till 13 trees per Ha with a DBH greater than 110cm (Figure 11). The R-squared of 0.9371 tells the coefficient of multiple determination and means that the data is significant by 93.7%.

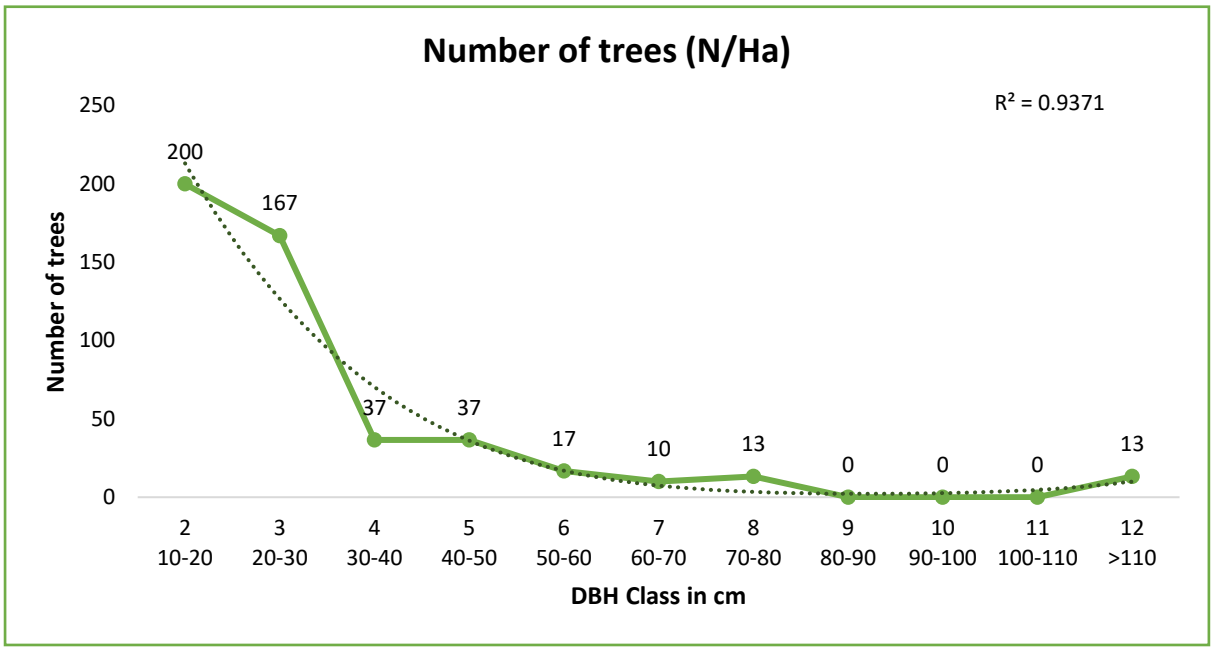


Figure 11: The number of trees in DBH class per Ha (N=6; plot size DBH >=10 and <30cm: 100m², plot size DBH >=30cm: 500m²).

The diversity of NTFPs indicated that there were 7 sugar palms greater than and equal to 30cm DBH per Ha and 33 sugar palms less than 30cm DBH and greater than 1m high per Ha. Furthermore, there were 600 rattans per Ha detected that were greater than 2m long. In addition, there are 7 Fig (Beringin) greater than 30cm DBH per Ha and 17 Fig (Lahusip) per Ha observed in the primary forest at Boltim (Table 6).

Table 6: The number of monitored NTFPs per Ha in primary forest (N=6; plot size main plot: 500m², plot size subplot: 100m²).

NTFPs N/Ha	Main plot N/Ha	Subplot N/Ha	Total N/Ha
Sugar palm	7	33	40
Rattan	x	600	600
Fig (Beringin)	7		7
Fig (Lahusip)	x	17	17

NTFP abundancy

The NTFP inventory indicated that there are 83 sugar palms and 721 rattans per Ha, encountered in primary forests and there are 14 sugar palms and 204 rattans per Ha, encountered in degraded forests. Durian appeared to be not common, as it was not found in any of the plots (Figure 12).

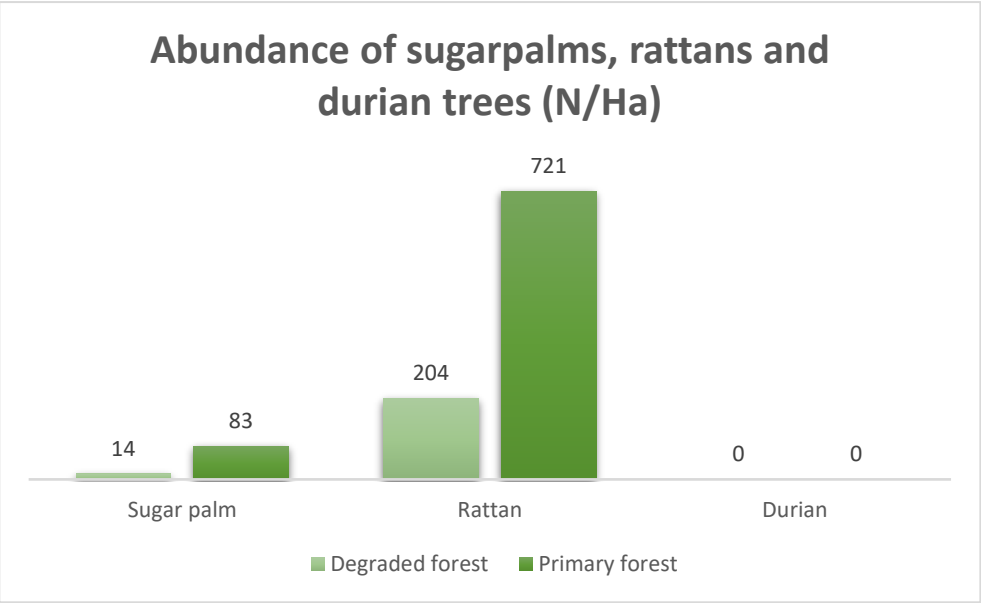


Figure 12: The abundancy of sugar palm, rattan and durian per Ha in primary and degraded forest (N=26; plot size: 1000m²).

The abundancy of sugar palms appeared to be higher in primary forest (*M* = 7,818; *SD* = 3,576) then, in degraded forest (*M* =1,4615; *SD* = 2,205). This difference was significant: *t* (17) = -5,465, *p* = 0,00004. Also, the abundancy of rattans seemed to be higher in primary forest (*M* = 69; *SD* = 14,63) compared to degraded forest (*M* = 21,76; *SD* = 13,76). Likewise, this difference was significant: *t* (22) = -9,753, *p* = 0.000000002.

Presence of sugar palms

The transect line in the Matabulu river indicated that there are 133 highly productive sugar palms per Ha within 10m range on the riverbanks of the Matabulu river in secondary forests and 46 sugar palms per Ha within 10m range on the riverbanks of the Matabulu river in primary forests (Table 7). The number of sugar palms per Ha in secondary forest (*M* = 2,2037; *SD* = 2,076) is almost three times as large, as the number of sugar palms per Ha in primary forest (*M* = 0,7959; *SD* = 1,299). This difference was significant: *t* (89) = -4,1608, *p* = 0,00007. The highest numbers of highly productive sugar palms were within 3km range of the village Matabulu, on the riverbanks of the Matabulu river (Figure 13). The highest number of 210 sugar palms per Ha was located before the first waterfalls in secondary forest. The number of sugar palms in primary forest, visible in the north of the map, had at least 10 sugar palms per Ha.

Table 7: Sugar palm per Ha in secondary and primary forest within 10m range of the Matabulu river (N=105; plot size: 200m²).

Forest type	Sugar palm per Ha
Secondary forest	133
Primary forest	46

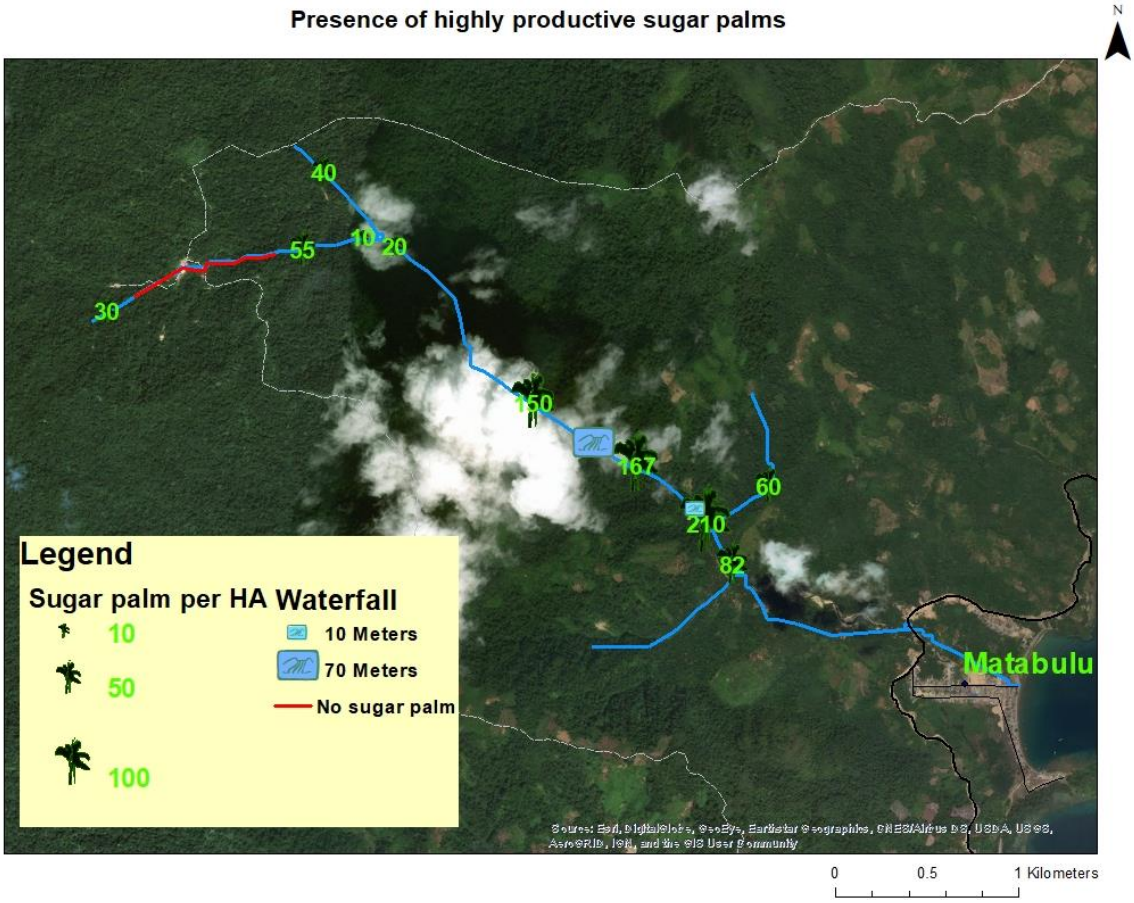


Figure 13: A map what indicate the presence of sugar palm per Ha in those specific areas.

The red line in Figure 13 displays an area of over 1km long where no sugar palms were determined. The vegetation in that area was different than primary or secondary forest. Instead of a forest, grass and shrubs vegetation dominated the landscape. This could be caused by natural flood, landslide or human intervention for example logging.

4.3 Social acceptability

The results that were gathered through the social acceptability studies are divided into the headings policy and law enforcement, farming practices and assessment farmers interests.

Policy and law enforcement

In 1967 the government of Indonesia introduced a law, the Foreign Investment Act, that allowed foreign capital investment in all economic sectors including the forestry sector (Rimbawato, 2006). It marked the beginning of a period with very high timber extraction. In the 1990s the Indonesian government took steps towards forest conservation by introducing laws for logging regulations or establishing projects. Projects such as the National Park development worked out very well because in 20 years the number of National Parks increased from three to forty (Wardojo & Masripatin, 2002). In 2011, the government started a forest moratorium to prevent new clearing of primary

forests and peat lands (Austin, Stolle, & Alisjahbana, 2013). In 2015, Indonesian president Joko Widodo banned clearance and conversion of carbon-dense peatlands (Mongabay, 2015).

Still, it is difficult to implement sustainable forestry and agriculture practices within Indonesia. This is caused by the fact that there are two different legal acts within Indonesia. Indonesia have a governmental law system were the lawmaking is centrally organized from Jakarta, and Indonesia have a traditional law system were the lawmaking is set by each tribe within each district (Kristiawan, 2018). The many districts and indigenous groups within Indonesia, with each its own tradition, laws and regulation makes it difficult to organize and implement a regulated and justified policy system what is counting for everyone within Indonesia.

Indonesian individuals can have an owner ship right on land called “Eigendom or Hak Milik” and it is continuing endlessly. Companies and Institutes can have the right of ownership on land through HGB (Hak Guna Bangunan) for buildings and HGU (Hak Guna Usaha) for plantations. Foreigner can have ownership through Hak Pakai or Right to Use which are valid for a limitation of time and depending on the law and regulations within that regency. The House of Representatives called DPRD (Dewan Perwakilan Rakyat Daerah) and the Provincial government has the highest authority to laws and regulations related to land and management rights. Every regency has different policy and regulations related to setbacks from rivers, sea, cliff and slopes called PERDA (Peraturan Daerah). In every district the land use plan is made by the RTRW (Rencana Tata Ruang Wilayah) and the local Bupati (district manager). They can reform and implement changes in this policy making at any time.

The policy making within the regency or province comes from the institute called Peraturan Daerah or Local Law Enforcement (DPRD). The Bupati or the governor needs to execute the policy conducted by DPRD. The DPRD controlling the Bupati and the governor.

Important laws related to forest conservation and sustainable land use are:

- Protection of endangered species.
- Logging and agriculture needs a permit and is related to land use plan and forest classification (Figure 14).
- 50-meter buffer zone besides a river, creek or cliff.
- No agriculture on slopes of more than 14 degrees.

Once again, in every regency there are different policies and regulation related to forest conservation and agriculture. The Indonesian law has a higher level than the traditional law, but it is still difficult to implement forest conservation, sustainable agriculture and the protection of endangered species. The government needs to synchronize with the traditional law and the communities itself to implement law enforcement. The traditional laws are important because there are many different tribes with each its own culture, policy and regulation within Indonesia.

Policy East Bolaang Mongondow regency

Each household within the East Bolaang Mongondow regency has between 3 and 5 hectares of land (Laode, 2018). However, every community member has the right to go in to the forest, which are not classified as a conservation or production forest, to use the land (Figure 14).

The classifications of forests and there use within the study area are:

- Non-forest: Agriculture permit within the laws and regulations.

- Production forest (HP): Reduced allowance on using the forest resources such as harvesting trees.
- Limited production forest (HPT): Very limited allowance on using the forest resources such as harvesting trees.
- Protected area: Forest protected, no permit to use forest resources.

When a community member wants to use land, they need to go to the head of the village (Lurah or Kepala Desa). He or she will provide permission after the land is measured. Then the community member need to contact the district area office called the Camat. When the district area office approved the land use plan with the delivered documents, they will provide a letter of approval.

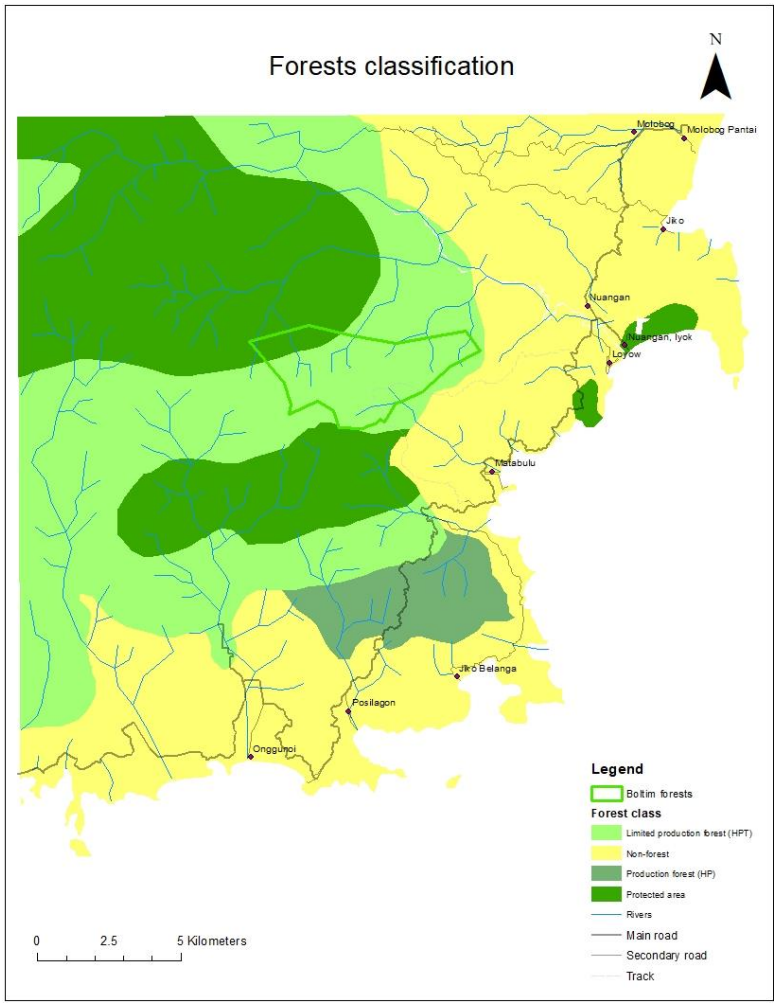


Figure 14: The map displays the four forest classifications and its related land use. The data is retrieved from Global Forest Watch and comes from the Indonesian Ministry of Forestry (2014).

With that letter of approval, the community member need to contact the Ministry of Agrarian Affair called BPN (Badan Pertanahan National). The BPN will contact the Bupati to delivers the wished legal owner ship documents to the community member who want to use that land. When the community members have that certificate, they are the legal owner and have rights to sell the claimed land. On the community grounds of Matabulu, Loyow and Nuangan many farmers are active who come from another regency and have claimed their land without permission from the Lurah, Camat or Bupati.

Areas which are classified as HP, HPT or as Protected, needs to be maintained by the Ministry of conservation of natural resource called BKSDA (Badang Konservati Sumber Daya Alam). This is a central forestry institute that have an office in each province. The office of BKSDA in North Sulawesi is located in Manado (Figure 1 on p.1). BKSDA are concerned in the conservation of natural resources. They have the power to impose fines and to bring offenders to justice. The management rights of Boltim's forest, the proposed area, are within the "The Directorate General of Forest Protection and Nature Conservation" or called locally the PHKA (Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam). This PHKA is a management license what is conducted under the Ministry of Environment and Forestry of Indonesia. The PHKA together with the Bupati are planning to give this management right to the Masarang Foundation. Already, 100 families in the East Bolaang Mongondow regency have signed the documents containing statements regarding support related to the nature conservation program (Siwu, 2015).

Agricultural practices

It was found that farmers from Matabulu have an average land size of 2.3 Ha. Most farmers (75%) receive their land from family members. Fifteen percent of the farmers bought the land and ten percent of the farmers admitted that they took the land without a permit (Table 9).

Table 9: How farmers receive their farming land, N=20, "N" is the number of interview participants.

How farmers received the farmer land	% of the farmers
Family land	75%
Bought	15%
Just took	10%

All farmers interviewed planted cloves, 60% of the farmers planted banana and 45% of the farmers planted coconut (Table 8). Other crops planted are fruit trees such as; mango, lemon and durian.

Table 8: Crops planted by the farmers (N=20).

Crops planted	% of the farmers
Cloves	100%
Banana	60%
Coconut	45%
Cacao	30%
Chili pepper	25%
Nutmeg	25%
Other	15%

Economic reasons appeared to be the main driver for farmers in their crop selection (80%). Ten percent of the farmers indicated that they choose these crops because they are the most productive in that area. One farmer (5%) indicated to choose these crops because family reason and one farmer (5%) said that he chooses these crops because of the abundant wildlife population which are feeding on other crops (Table 10).

Table 10: The reasons why farmers choose these crops (N=20).

Crop selection reasons	% of the farmers
Economical returns	80%
Highly suitable productivity	10%
Family reasons	5%
Abundant wildlife	5%

It was found out that cloves are the most commonly planted crop to support the farmers in 95% of the households. Coconut is in 30% of the farmers households an important crop. Chili pepper is for 20% of the farmers household an important crop. Banana and nutmeg support for 10% of the farmers household (Table 11).

Table 11: The most important crops to support the farmers household (N=20).

Most important crops	% of the most important crops
Cloves	95%
Coconut	30%
Chili pepper	20%
Nutmeg	10%
Banana	10%

It has been determined that all the interviewed farmers are planting crops in a monoculture and no measures against soil loss or nutrient depletion are taken. These farmers practice slash and burn methods to clear the land. The interviewed farmers maintain their farm through "keeping the land clean". Through a brush cutter they cut all the natural vegetation constantly, with no natural germination allowed. When farmers prune or thin, they use the wood as fuel wood. The farmers do not use any inputs (chemical fertilizers or manure).

Seventy percent of the farmers interviewed indicated that they did not have the knowledge to prevent erosion and to protect nutrient cycles. Thirty percent of the farmers said that they are planting trees like lemon, mango and durian to reduce erosion. But according to the Lurah (head of the villages) of Matabulu, the erosion destroys many of the planted durian trees (Mamonto, 2018).

Thirty percent of the farmers interviewed, maintain their land by themselves, seventy percent of the farmers uses workforces. Those workforces are family members (93%), other farmers or friends (29%) or hired employees (14%) (Table 12). The two farmers told in the interview that they were hiring workers from another district (Minahasa).

Table 12: The workforces of the farmers (N=14).

Labour	*N=14*
Family members	93%
Friends/Other farmers	29%
Hired employees	14%

Assessment farmers interests

All the farmers interviewed showed interest in moving to sustainable agricultural practices. Eighty percent of the farmers interviewed agree to design a new sustainable agricultural system on all their land. Twenty percent of the farmers interviewed agree to place a new agricultural system partly on their land. (Figure 16).

Almost all interviewed farmers (95%) have indicated that they need trainee to convert to sustainable agricultural practices. In addition to education, interviewed farmers indicated that they need tools (50%), crops (40%) and workforce (20%) to implement sustainable agriculture practices (Figure 15).

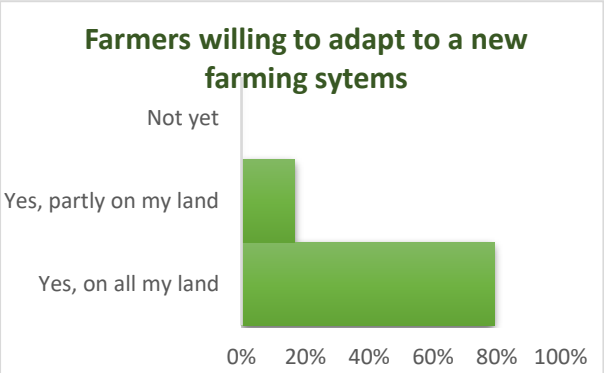


Figure 16: Farmers willing to adapt to a sustainable new farming system (N=20).

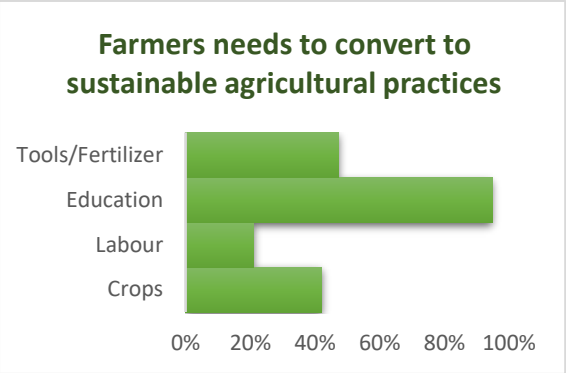


Figure 15: Farmers need to convert to a sustainable farming system (N=20).

5 Discussion

This chapter evaluates the validity of this preliminary investigation, discusses the expectations, notes errors in this research and gives possible suggestions for further studies.

5.1 Area of influence

It appears that the higher elevated forests at Boltim, influence the surrounding, lower elevated areas. The slopes between the forests at Boltim and the communities Matabulu, Loyow and Nuangan are steep and the flow is directed towards the areas of the communities of Matabulu, Loyow and Nuangan. In addition, it was found that the forests at Boltim are feeding the rivers that are home to five different watersheds. However, all these data are based on one custom contour lines map from the global topography and it seems that the elevation data is not accurate because there are pixels with no data visible in the lower elevated areas. It would have been better to use multiple sources.

It would also have been better to use multiple sources for the satellite images which have been used to determine the development within the landscape. Unfortunately, only one satellite image could be used because clouds influence other Landsat 8 and Sentinel satellite images of 2016, 2017 and of 2018. In addition, none of the satellite images from Landsat 7 could be used because they were of poor quality. This means that the details in the results to indicate the developments in the landscape are missing. Hopefully better satellite images can be used in the near future.

5.2 Forest resources

The exact coordinates of the plot locations were not accurately set because there was no GPS available and a mobile phone was used. The data collected by the forest inventory to find out the forest structure and diversity displays that 52% of determined trees per Ha were unknown tree species. To draw up an appropriate management plan, it is desirable to know which tree species are represented in the forests at Boltim. However, with almost no tree species information on over half of the current tree species, it can be considered whether it is possible to map every forest type with its dominate tree species. The forests in Sulawesi have much less commercial timber species than in the forest at Borneo and Sumatra (Ashton, 1982). As a result, less research has been carried out into tree diversity and forest structure in the forests of Sulawesi (Cannon, Summers, Harting, & Kessler, 2007). Possibly, the lack of information about vegetation in Sulawesi and the shortage of local expertise about tree determining is underestimated. On the other hand, detailed data of the present NTFPs can be collected by using this method when more plots are being carried out.

Moreover, at Boltim there are 493 stems (>10cm DBH) per Ha detected. This number is less than the 587 (>10cm DBH) stems per Ha in Borneo and compered to the 589 (>10cm DBH) stems per Ha in the Amazon region (Banin, et al., 2014). Also, the BA is in Boltim (33.64m^2 Ha) lower, compared to the BA in Borneo (37.5 m^2 Ha). However, the BA is substantially higher at Boltim than in the Amazon region (28.1 m^2 Ha) (Banin, et al., 2014). It appears that there are more trees in Boltim that have a

higher DBH compared to the trees in the Amazon. But, it is not possible to draw definite conclusions because of the small number of inventoried plots in the forests at Boltim, more research is required.

The data collected to understand the NTFP abundancy displays a much higher number of sugar palms and rattans per Ha in primary forests compared to the abundance of sugar palms and rattans in degraded forest. The observed rattan density per Ha is common in Sulawesi and it could be that the abundancy of rattan is related to the elevation (Stiegel, Kessler, Getto, Thonhofer, & Siebert, 2011). However, only a limited number of plots have been carried out to indicate the rattan abundancy. More research is required to indicate the exact number of rattan per Ha.

According the president of Masarang, sugar palm and rattan are indicators of degraded forest (Smits, 2018). This is confirmed by the data indicating the presence of sugar palms on the river banks of the Matabulu river. The higher abundance of sugar palms and rattans inside the monitored plots in the primary forest than in the monitored plots in the degraded forest could be related to:

1. Reduced impact by human development: The fact that the area in the primary forest is difficult to access means that there is less influence from the local population. The local population do not attach value to sugar palm and rattan because they do not know how to harvest or do not see the financial benefits of harvesting the NTFP. So, they remove these NTFPs in the areas they go to.
2. Abundant wildlife population: The abundancy of wildlife in the primary forest like the Sulawesi palm civet (*Macrogalidia musschenbroekii*), they are very important for spreading seeds of the sugar palm (Subrata & Syahbudin, 2015).
3. Natural processes: There are many natural processes such as fluvial, tectonic and hillslope processes in the monitored plots at the primary forest (Figure 17). These processes may have contributed to the reproduction and development of sugar palm and rattan. This could have influent the results of the data collected in the forest.

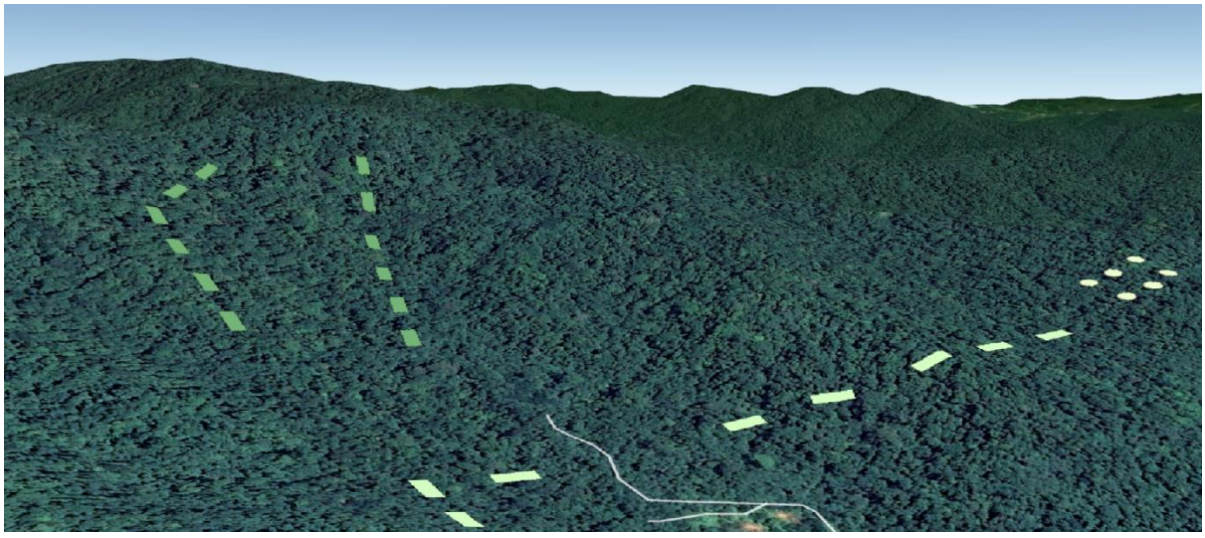


Figure 17: The location of the transects. The dark green plots are made in primary forest but specific on that slope. The results are promising but it could be influent by that specific land characteristics.

Therefore, additional plots are needed to be able to show which forest classification contains the highest number of sugar palms and rattans. Also, more forest classifications are needed than primary and disturbed forest. Because the forest classifications of primary and disturbed forest could

be subdivided into at least three classifications for primary forest (virgin/lightly degraded/medium degraded) and three classifications for degraded forest (lightly degraded/medium degraded/heavy degraded).

The used methodology worked well but in occasions, it could be discussed if the NTFP fulfill the requirements and if the detection was inside or outside the plot. This likewise can be discussed in the methodology used to calculate the presence of highly productive sugar palms within accessible areas. The sugar palm inventoried at the riverbanks of the Matabulu river, displays only data about that river. The data can be different in other rivers in and around the forests at Boltim.

To succeed in the conservation of the forest and reduce pressure on the forest resources such as land, timber and bushmeat, harvesting NTFPs could be the solution. Nonetheless, the NTFPs, sugar palm and rattan, need to be industrialized to make the most profit from it (Mokoginta, 2015; Lawrence Greenwood, Thapan, Malik, Jamilur Rahman, & Taylor, 2008).

5.3 Social acceptability

The data collected to determine whether current policy supports forests conservation at Boltim suggests that a complex, bureaucratic political system is partly responsible for the current deforestation and forest degradation in and around the forest at Boltim. This contrary to what the same government claims, by giving the management rights to the Masarang foundation, it seems that they are motivated to preserve those forests. Nevertheless, the inaccuracy of policy makers can be reduced by developing local economies that support sustainable forest resource management (Roberts, 2012).

The twenty farmers interviews of the total 170 farmers in Matabulu tell significant data about the current land use, how they maintain their land and tells which crops are important to support the household. However, it is not clear how much money farmers receive from their current crop production. Farmers must be financial compensated to change their agricultural practices; economic reasons seem to be the main motive of the current land use.

Furthermore, the held interviews with farmers suggest that the farmers in Matabulu are motivated with implementing sustainable land use practices. Awareness or recognition of soil problems often appears to correlate positively with the adoption of farmers' practices (Stonehouse, 1991). The farmers interviewed have indicated that they need trainee to move to sustainable farming practices. Education, generally correlates positively with the adoption of farming practices (Knowler, et al., 2001). However, no agreements have been made on how this will be paid. It may be that the farmers have thought that they will get something for free and that could be the reason why they are so positive about the move to sustainable land use practices and with the participating on an educational program.

In order to apply sustainable farming methods in cooperation with farmers, it is important that other farmers who do not live in Matabulu and are active in the region are also involved in the investigation. The conservation of forest and the protection of soil will only succeed when the majority of farmers participate and are guaranteed to have at least the same income. A new developed farming system could compete with the current agricultural practices.

6 Conclusion

This preliminary research has revealed that the healthy primary forest at Boltim is home to a complex diversity where sustainable forest resources such as sugar palms and rattans are obtainable. The abundancy of those NTFPs in the forests at Boltim and the presence of highly productive sugar palms within accessible range of the community Matabulu, could potentially lead with the development of local population and with the conservation of the forests, when those NTFPs are commercialized.

The forests in Boltim are important to capture the rain water and to provide water into the lower elevated areas. These forests safeguard the surrounding lower elevated areas and its inhabitants because they provide directly water to five different watersheds. High priority should be given to halt the developments, deforestation and forest degradation in the areas between the communities next to the coast and the forests at Boltim as well as in the proposed area. Because the area between the forest of Boltim and the communities Matabulu, Loyow and Nuangan is very vulnerable to erosion. The current unsustainable agricultural practices contribute to the ongoing developments, deforestation and forest degradation. Local policies, poverty and underdevelopment are a key factor to these ongoing developments within and around the forests at Boltim. Fortunately, the interested parties are motivated to contribute with implementing forest conservation and sustainable forest resource management.

6.1 Inference

The forests at Boltim capture the rain and ensure that the rivers flow towards the lower elevated areas. The results also display that the areas outside the proposed area are very important to protect because the steepest slopes are between the forests at Boltim and the communities Matabulu, Loyow and Nuangan. The current floods and landslides that occur in the area will not reduce if the present developments, deforestation and forest degradation, continues in that area. Not even when the forests at Boltim are protected. Also, in the area between the forest at Boltim and the communities next to the coast there are different types of vegetation visible, which are too threatened by the current developments. The area between the forests at Boltim and the communities Matabulu, Loyow and Nuangan must be managed sustainable, likewise the proposed area. This is required to conserve its biodiversity and to reduce erosion, landslides and floods.

The structure and diversity of the forests shows a healthy forest where primeval trees are still present. The collected data displayed that more research is needed to determine which vegetation types, forest structures and dominant tree species are in the landscape. There is a lack of knowledge to identify tree species within the population of the local communities and within the expertise of the rangers of Masarang. It is absolutely essential to hire a qualified tree and landscape determinist when another forest inventory is carried out. The researches indicated that there are abundant commercial NTFPs, sugar palm and rattan, inside the forests at Boltim and that there are abundant highly productive sugar palms present within 3km range of the village Matabulu. Now, these NTFPs must be commercialized and distributed in order to contribute to the development of the local population and with reducing pressure on the forest resources such as timber, land and bushmeat.

The current policy and land use contributes to the developments within and around the forests at Boltim. The legislation is there, but there is a lack of control and policy-making to implement a sustainable policy. It seems that the policy makers do not have enough expertise and funds to manage the area in a sustainable way. Also, farmers do not have enough funds to support their households and pay for the desired developments such as agricultural machinery and training. It seems that they are motivated to contribute to sustainable farming practices, but they do not have the expertise and resources to adapt their techniques.

6.2 Requirements

In order to reduce deforestation and forest degradation and to succeed in the conservation of the forests at Boltim, the proposed management plan needs to fulfill the requirements of the stakeholders (Table 13).

Table 13: An overview of the stakeholders and his interests.

Stakeholder group	Interests				
	Environmental importance Forest and land conservation with protection of endangered animal species and biodiversity	**Social importance** Rural developments and improvement of livelihoods	**Policy formulation** Implementing and monitoring legislation and regulations	**Financial security** The certainty of financial independence and financial security
Masarang Foundation	✓	✓		
Investors	✓	✓		
Indonesian central government	✓		✓	
Government of the East Bolaang Mongondow regency			✓	✓
Local farmers		✓		✓
Local inhabitants		✓		✓

Preventing deforestation

The main cause for the current deforestation is the agricultural expansion. The policy of the East Bolaang Mongondow regency contributes to these developments. To prevent deforestation, close cooperation with the policy makers is required so that Indonesian laws and regulations can be implemented and monitored. Also, the farmers who are active around and in the forests of Boltim

need to be informed about the effects of unsustainable land usage for example erosion. These farmers need to be trained in sustainable agricultural methods for instance agroforestry.

Reducing forest degradation

Poverty and local traditions contribute to the degradation of forests. It is therefore necessary to explore together with the local population what can be done to reduce forest degradation, such as less natural regeneration of timber seedlings and fewer NTFPs. The local population should be benefit financial from conserving the forest, its biodiversity and its resources. One way could be the industrialization of the NTFPs, sugar palm and rattan.

Improvement of livelihoods

The farmers in Matabulu prefer crops that produce money rather than food crops. To generate more income, more land is used. However, it would be better to generate more income from the current land that the farmers have. This can be achieved by the development of a new agricultural system. The developed farming system need to generate more income and need to protect the soil to reduce erosion, landslides and floods.

Protection of endangered animal species and biodiversity

The preliminary study has shown that the biodiversity of forests is complex, and that endangered species are present. However, to protect the endangered animal species and the biodiversity more research is needed to map the vegetation types and its biodiversity. This is required to make an appropriate conservation plan what will protect the endangered animal species and the biodiversity. Also, it is desired to educate the inhabitants of the East Bolaang Mongondow regency about the importance of forest and its biodiversity conservation.

Transparency policy formulation and social acceptability

The management plan should clarify how Boltim forests are managed sustainable and what the role of local authorities such as the PHKA (Direktorat Jenderal Perlindungan Hutan dan Konservasi Alam) and the BKSDA (Badang Konservati Sumber Daya Alam) will be. It is important to cooperate against illegal practices. In addition, high priority should be given to cooperation with farmers active in the area, local population and policymakers to justify land tenure and to ensure that the proposed plan is socially acceptable to all parties involved.

Financial security

The local government and its people attach great importance to financial security and development. Therefore, the proposed management plan by Masarang foundation must attach high values to financial resources that result in independence and development. The commercialization of the NTFPs present can contribute to financial security. In addition, the local population must attach financial value to the prevention of damage caused by erosion, floods and landslides.

7 Recommendations

This chapter describes the recommendations to develop successful a sustainable management plan for the conservation of the forests in and around Boltim, with the improvement of livelihood of the local population. These recommendations are based on the results and conclusion from the conducted preliminary research and the requirements of the involved stakeholders.

7.1 Forest conservation

The forests of Boltim and the area between the forests of Boltim and the communities Matabulu, Loyow and Nuangan need to be conserved and managed sustainable. Therefore, Masarang should have influence in the land use plan related to the forest of Boltim and Masarang should have influence on the land use plan related to the area between the forest of Boltim and the communities Matabulu, Loyow and Nuangan as well. This means that both areas need be managed by Masarang. This is required to reduce erosion, to prevent landslides and floods and to conserve its unique biodiversity. Agreements must be made with community members from Matabulu, Loyow and Nuangan about who can use the land classified as non-forest. This is necessary to jointly end the irresponsible agriculture of people who are come from another regency and do not have a permit to use the land. There must be close cooperation with the BKSDA, based in Manado, because they have the power to ensure that Indonesian legislation can be applied within that area and Masarang does not have that power. To make this possible, Masarang must arrange the facilities so that the inspectors can be welcomed. In addition, patrols must be organized to combat hunting and other illegal practices for instance logging.

To understand the characteristics of the forests and to discuss what the forest need to remain a healthy primary diverse forest, more research is needed about the vegetation types, forests structures and its biodiversity. To protect the endangered and rare animal species it is required to do research about the population density of the well-known animal species such as the Anoa, Babirusa and Celebes crested macaque and investigate the presence of rare species such as rodents and marsupials. Masarang need to be able to identify their breeding ground to not interrupt these sparsely populated animal species because, harvesting NTFPs such as sugar palm needs to be done daily and can affect the natural behaviour of these animals.

In addition, a training programme should be designed by Masarang to provide information on the importance of preserving forests and biodiversity to the inhabitants of the East Bolaang Mongondow regency. The financial value of the EGS (Ecosystem Goods and Services) such as the prevention of damage from erosion, landslides and floods could contribute to the interests of protecting the forests in that regency (Wu, Hou, & Yuan, 2010; European commission, 2009; TD Economics & Nature Conservancy of Canada, 2017).

7.2 NTFP industrialization

The industrialization of the available NTFPs, sugar palm and rattan, will be leading to succeed with nature conservation through collaboration and development of the local population. To determine

whether and how a sustainable sugar palm and rattan industry can be made in the area, more research is required about the species of rattan, quality of rattan and sugar contents of the juice from the sugar palms. In order to design a sustainable harvest method, more research is needed to display data about productivity, growth and reproductivity of those NTFPs within and around the forests at Boltim. So far, the results indicated that these commercial NTFPs are available within the forest of Boltim and within accessible range of the community Matabulu. However, both NTFPs need to be processed before they are marketable. The juice tapped from sugar palm need to be distributed to the sugar palm factory in Tomohon, and rattan must be distributed to Gorontalo, another province in Sulawesi (Mamonto, 2018).

To industrialize sugar palm new tappers from the communities, Matabulu, Loyow and Nuangan need to be educated before tapping of sugar palm can start. Moreover, a zipping line or a network of tubes is required to transport the juice, from the higher elevated areas to an intended processing's factory. The small processing factory is required to convert the juice to a syrup to avoid the fermentation due to its high sugar content. After that, a water tank truck must transport the syrup from its location in East Bolaang Mongondow regency to the sugar palm factory in Tomohon.

Up to now, the rattan determined in the fields is *Calamus spec*. and is considered high quality rattan (Wan, Wan, Hamdan, & Salleh, 2001). Rattan is a climber and can overgrown tree species. By harvesting rattan, other flora species like the sugar palm benefits (Windah, 2018). A research need to be carried out to indicate the abundancy of commercial rattan within and around the forest at Boltim. This research need to include that rattan, sized between 30 -34 mm, with no black or brownish spots, is considered the most valuable as it is the most popular used for furniture (Wan, Wan, Hamdan, & Salleh, 2001). When more sufficient data has been collected, and there is abundant rattan available, a sustainable harvest method must be developed. After that, a sustainable processing factory with responsible use of Sulphur must be designed and implemented in the East Bolaang Mongondow regency. All the inhabitants of East Bolaang Mongondow will benefit from the development and financing of processing factories of sugar palm and rattan. Masarang must ensure that a profit margin from these factories is donated to the Masarang foundation so that the entire project in Boltim, is financially self-sufficient.

7.3 Improvement of agricultural practices

A new agricultural system is required to protect the soil from erosion and contribute with the improvement of livelihood of the local population. Masarang need to design a training program for the farmers to train the farmers about; the consequences of unsustainable agriculture, the solutions to unsustainable agriculture and the positive impacts of sustainable agriculture. Also, Masarang must do a study about current crop productivity and their financial revenues of the farmers located in the area between the forest of Boltim and the communities Matabulu, Loyow and Nuangan. In order to demonstrate a sustainable farming system to farmers, demonstration farming plots could be made on the farmers land or a plot of land must be bought to use as demonstration farm. The implemented farming system could be an agroforestry system with a total ground cover. The trees in agroforestry systems includes productive function, such as food and fuelwood production, and protective function, such as soil and nutrient cycle protection. Trees in agroforestry systems contributes significantly to the diversification and sustainability of the crop production (Atangana, Khasa, Chang, & Degrande, 2014; Smith, Williams , Plucknett, & Talbor, 1992; Tomich, et al., 1998). The proposed farming system should have the crops: Sugar palm; this multi propose, cash crop is

easy to grow on any gentle slope land (Mokoginta, 2015) and the sugar palms will protect the soil from erosion and conserves its nutrient cycle (Smits & Djojohadikusumo, 2016; Staaij, et al., 2011). Moreover, sugar palm alone will provide 4 daily jobs per hectare (Elbersen & Oyen, 2009). Through, reintroduce coffee arabica (Dutch colonization times), within the Bolaang Mongondow Regency (Tijow, 2018), it is hoped that coffee production in the proposed agroforestry system, will improve the livelihoods of the inhabitants the East Bolaang Mongondow regency as in South Sulawesi (Neilson, 2013). Coffee arabica can grow in a shady environment and it seems that it produces better quality coffee beans in a shaded environment (Wintgens, 2009; Lambot, et al., 2017). In addition, forest birds benefit from shadow coffee farms (Buechley, et al., 2015) and the farmers benefits from the birds because they control pests (Johnson, Kellermann, & Stercho, 2010). Furthermore, cassava and ginger seems to be good recommendations to plant in the advised agroforestry system because cassava has been demonstrated to be a soil improver (Tengnäs, 1994) and ginger appears to grow ideal in an agroforestry system (Pandey, Pandey, Jadeja, Tandel, & Nayak, 2017). It is also desirable to plant a legume tree (*Fabaceae*), for instance jengkol (*Archidendron spec*.). This tree is required to increase income, to spread risk when other crops do not produce and to conserve the soil which is sensitive to erosion. The nuts of this 20m high tree species are edible, used as medicine, and do have a high nutrition value (Nielsen, Fern, Fern, & Morris, 2018). Jenkol (*Archidendron pauciflorum*) is a native species in the forest of Sulawesi, so this tree species must be ecologically important (Steenis & Steenis-Kruseman, 1992).

Finally, a well-structured organization needs to be established in collaboration with all the involved stakeholders to accomplish sustainable forestry and nature management, so that people of the East Bolaang Mongondow regency and the environment can coexist in harmony.

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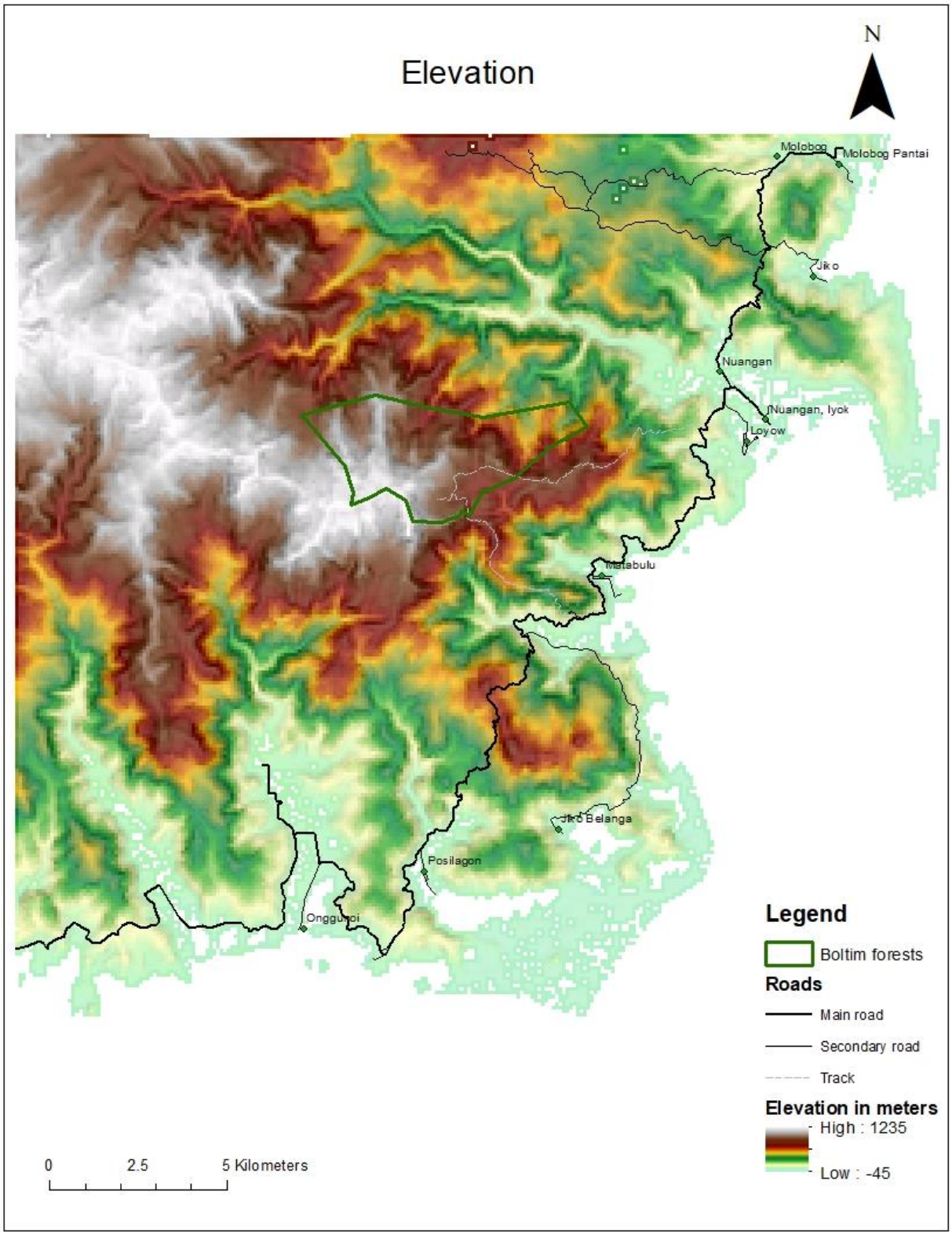
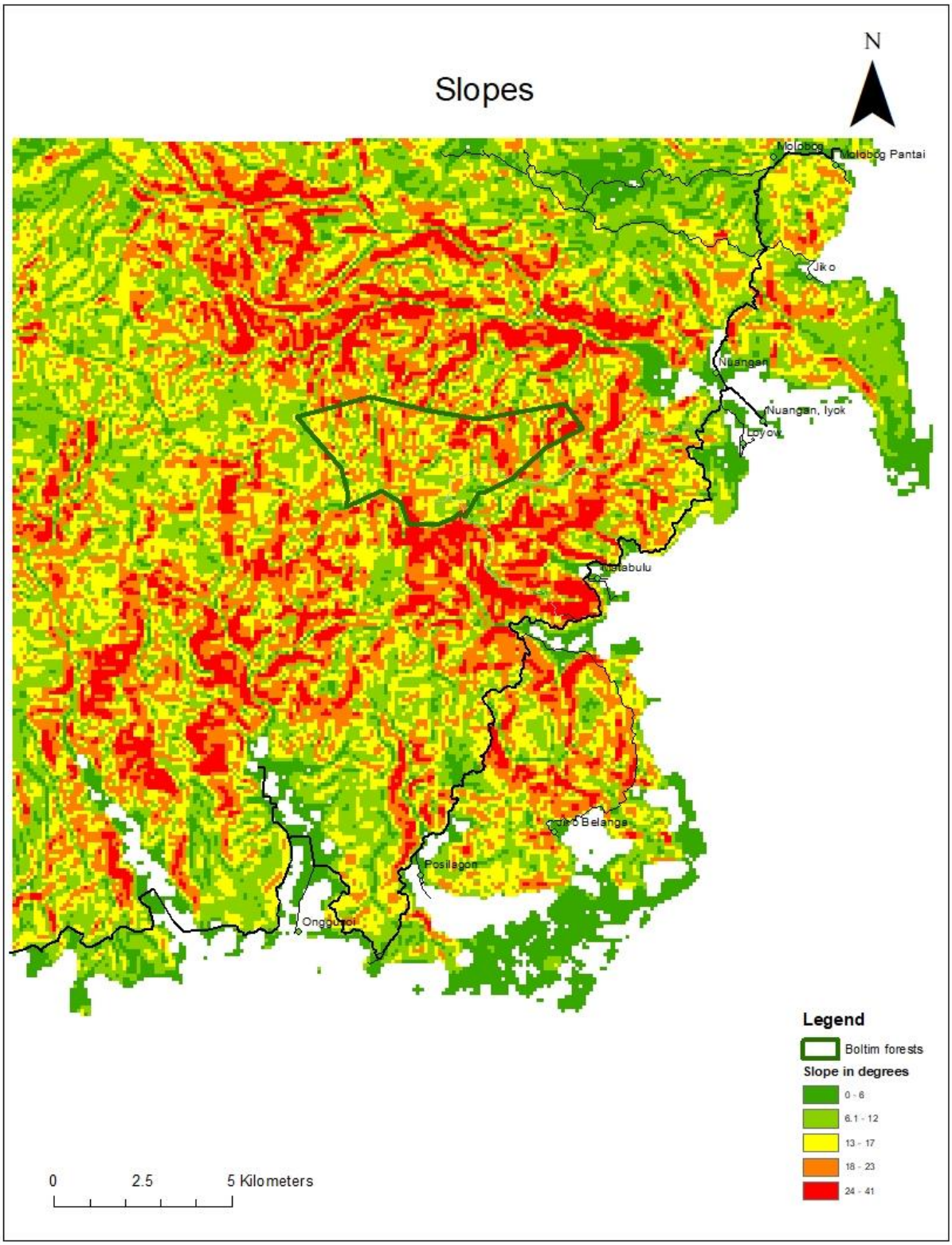
Appendixes

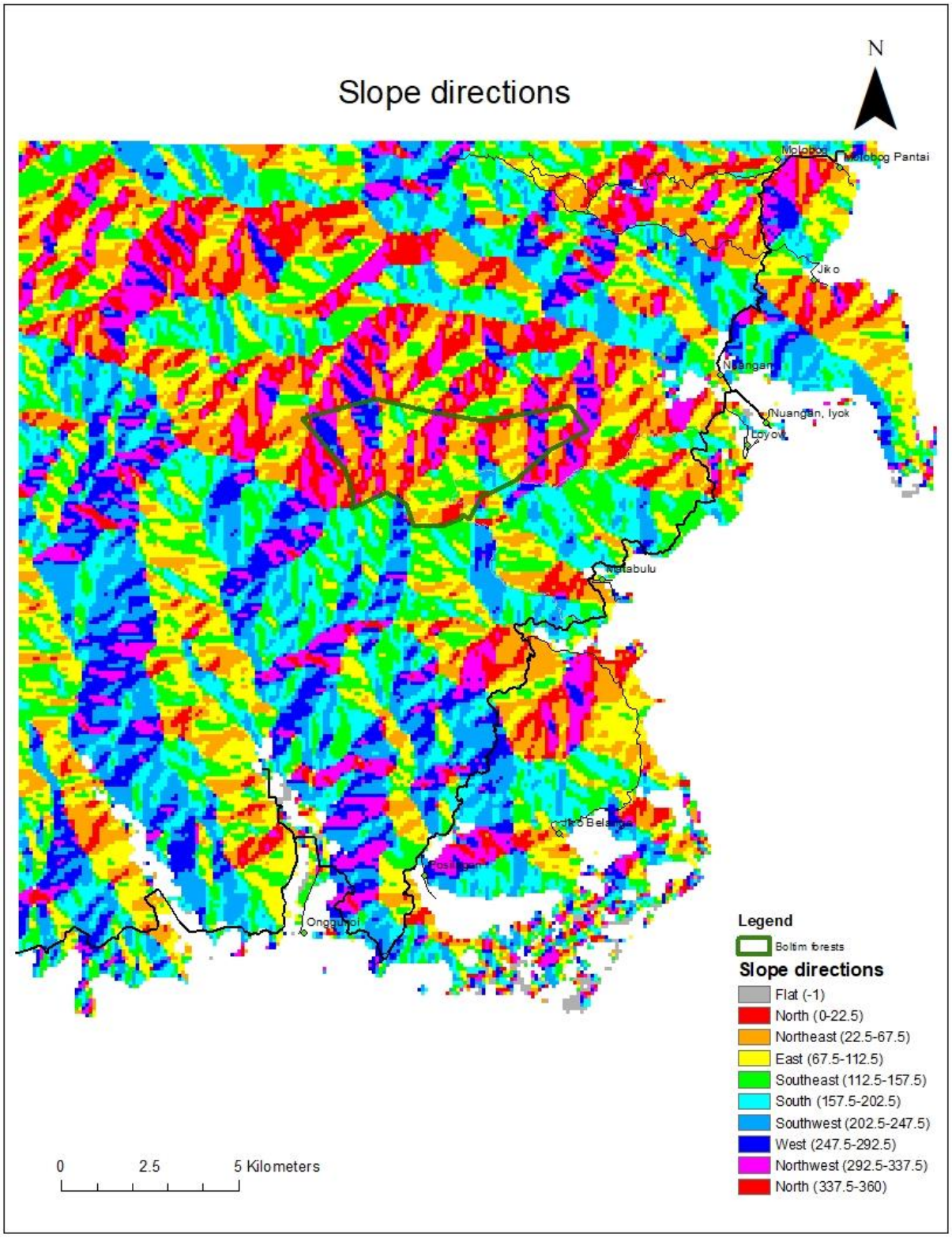
1. Map of the elevation



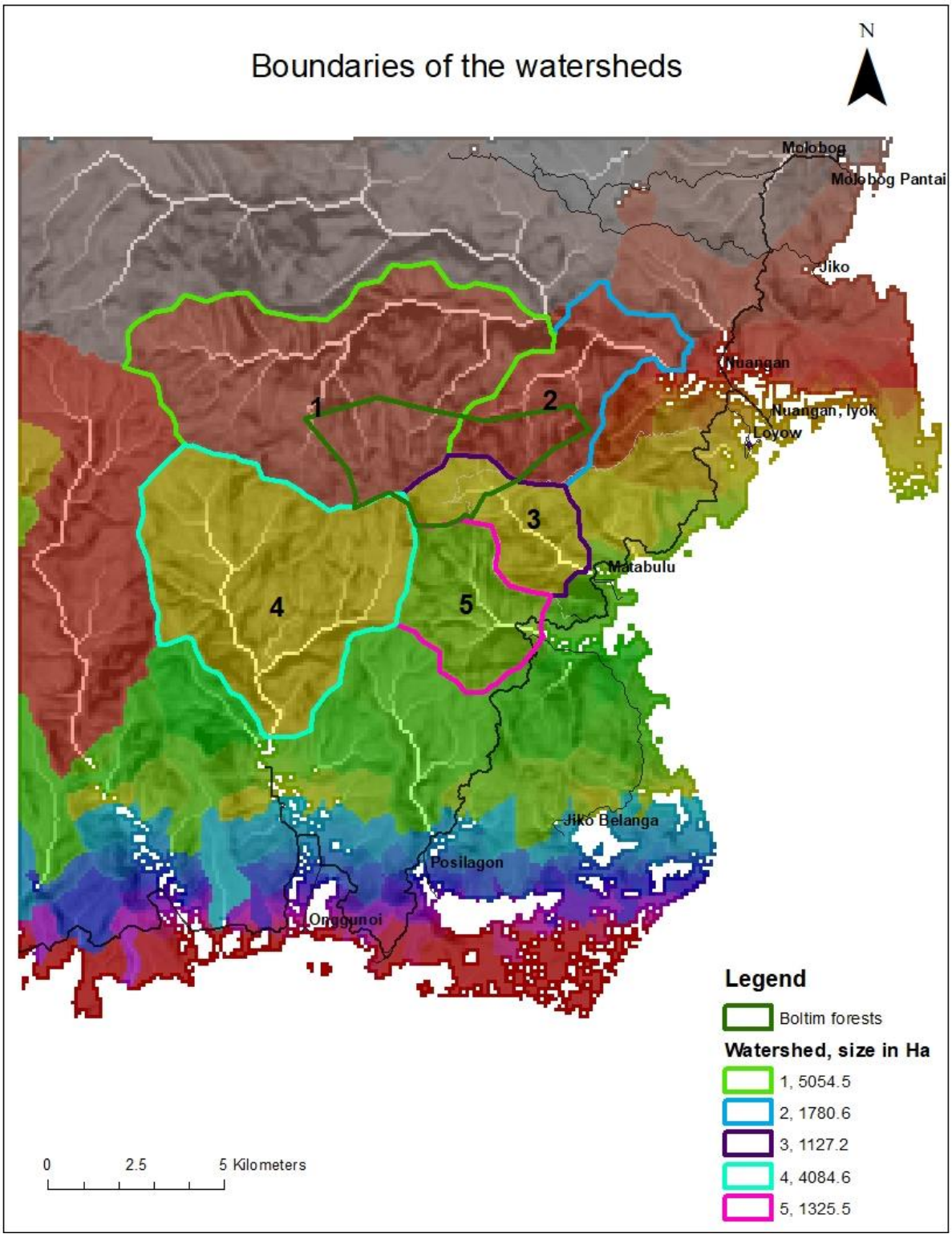
2. Map of the slopes



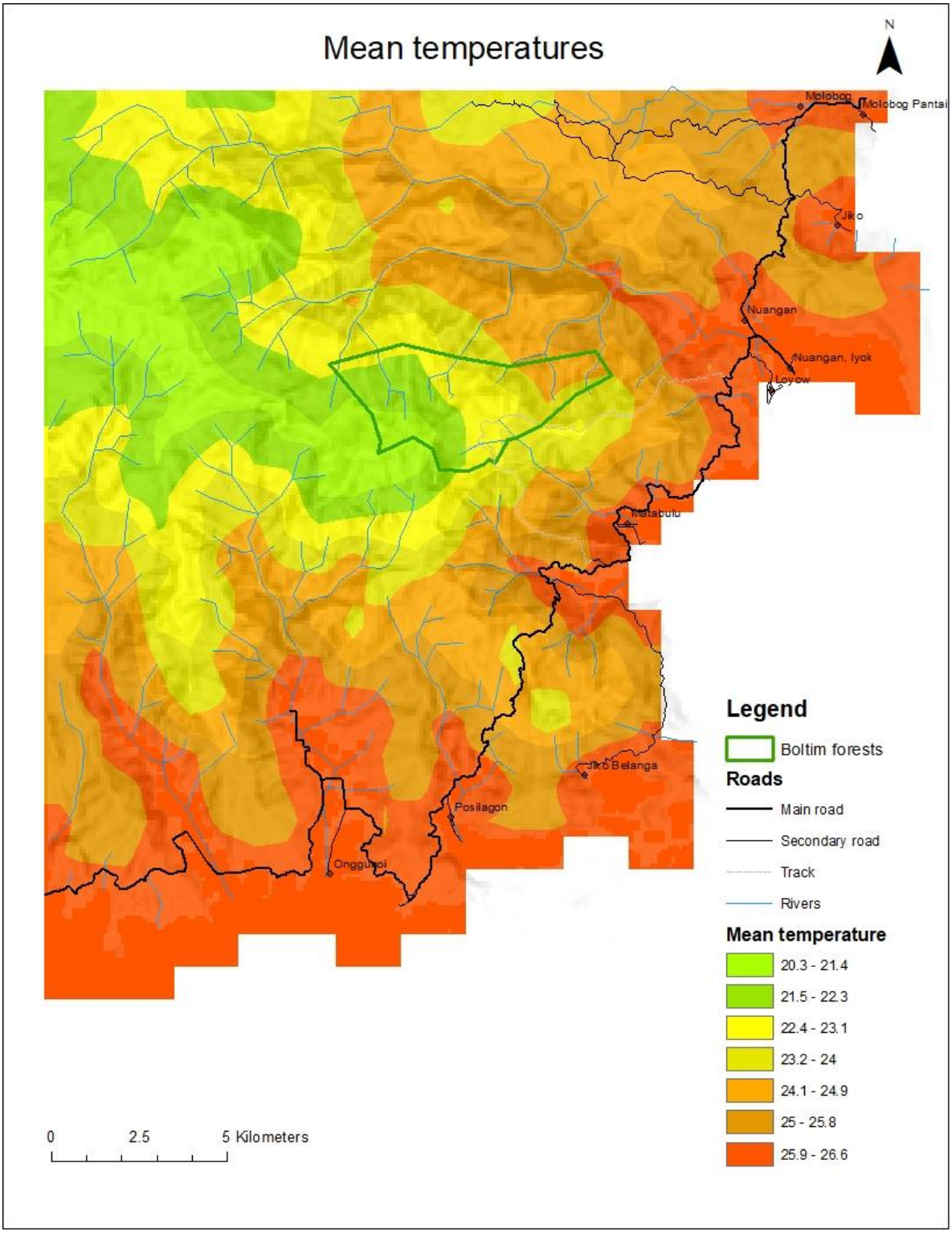
3. Map of the direction of slopes



4. Map of the boundaries of the watersheds

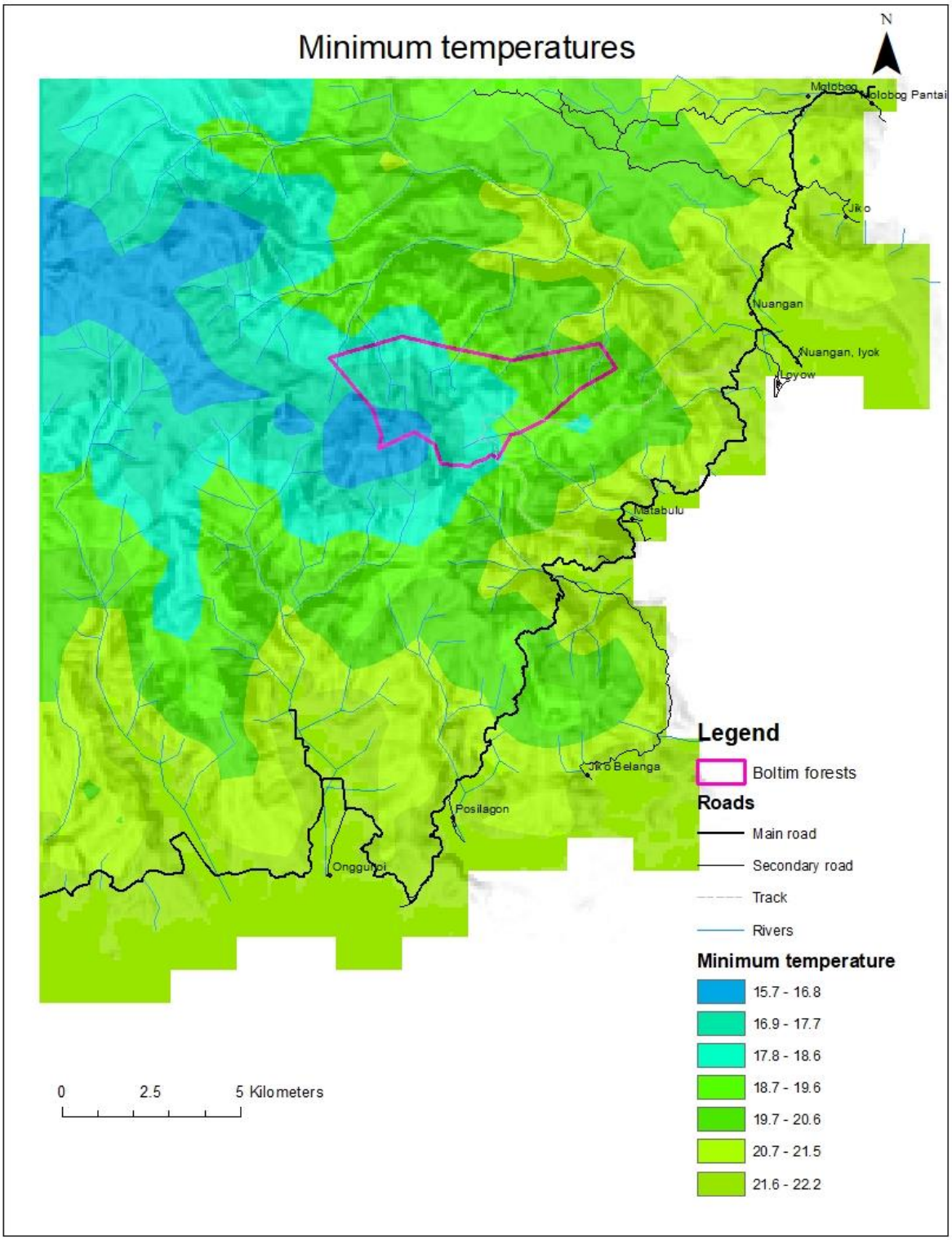


5. Map of the annual mean temperature



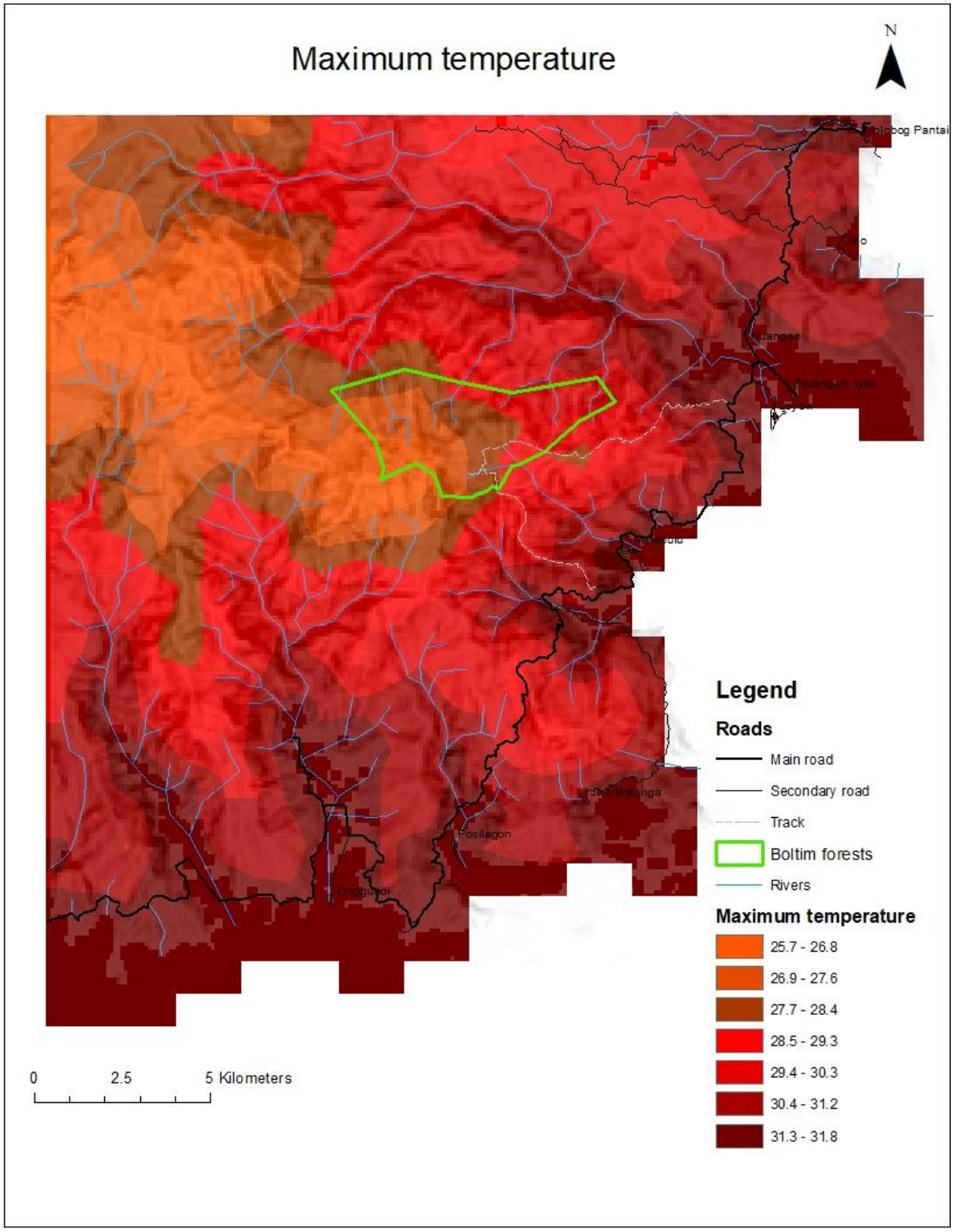
WorldClim.- Global Climate Data (1970-2000) Retrieved March 23, 2018.

6. Map of the annual minimum temperature



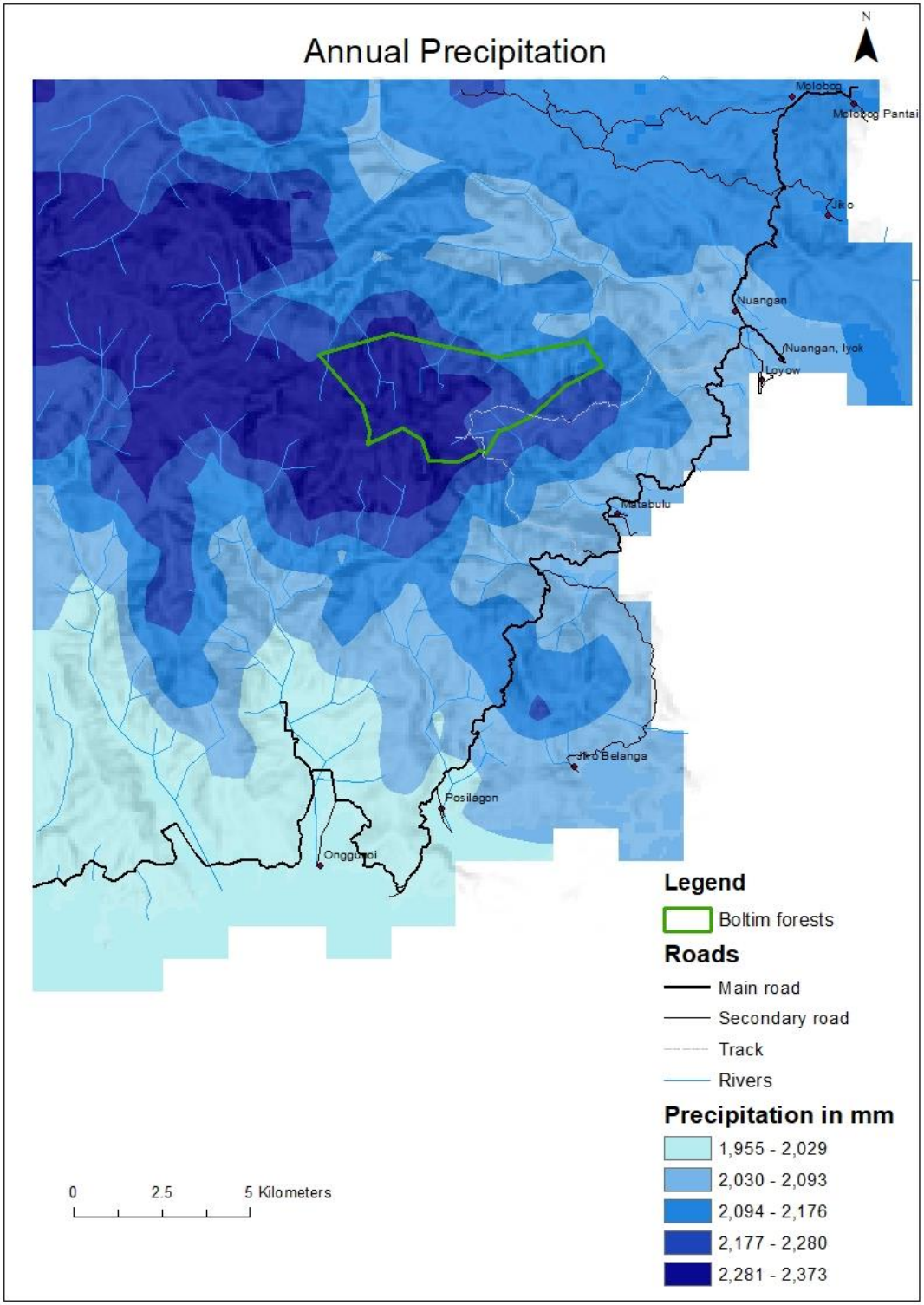
WorldClim.- Global Climate Data (1970-2000) Retrieved March 23, 2018.

7. Map of the annual maximum temperature



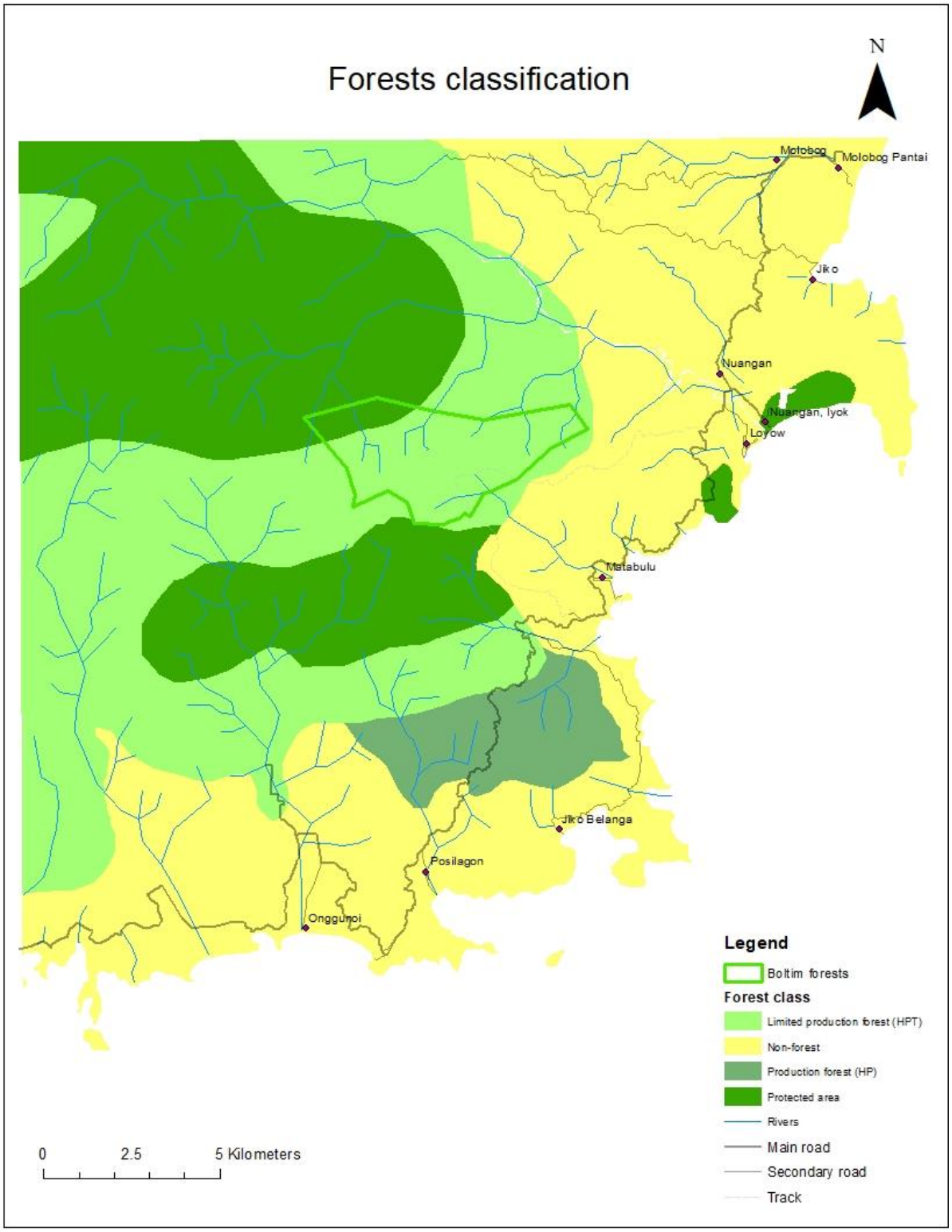
WorldClim.- Global Climate Data (1970-2000) Retrieved March 23, 2018.

8. Map of the annual precipitation



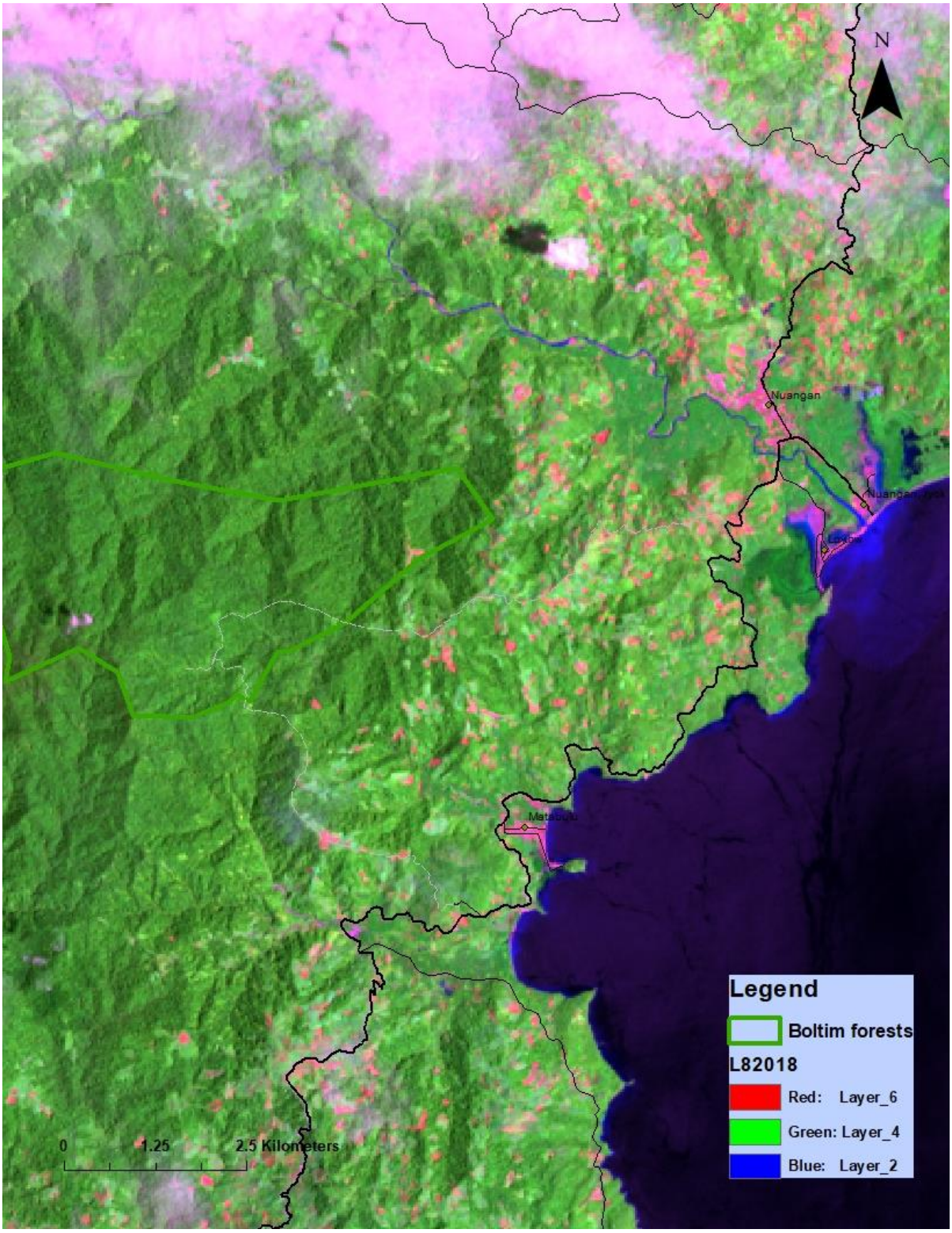
WorldClim.- Global Climate Data (1970-2000) Retrieved March 23, 2018.

9. Map of the forests classification



Retrieved from the Ministry of Environment and Forestry in Indonesia (2014).

10. Satellite image of the vegetation types



Retrieved from the United States Geological survey (USGS) Landsat 8, made at the 28 of January of 2018.

11. Animal species list

IUCN	International Union for Conservation of Nature
DD	Data deficient
LC	Least concern
NT	Near threatened
VU	Vulnerable
EN	Endangered
CR	Critically endangered

Mammals		
English Name	**Scientific Name**	**IUCN**
Sulawesi Rousette	*Rousettus celebensis*	LC
Swift Fruit Bat	*Thoopterus nigrescens*	NT
Lesser Dog-faced Fruit Bat	*Cynopterus brachyotis*	LC
Bear Cuscus	*Ailurops ursinus*	DD
Spectral Tarsier	*Tarsius spectrum*	VU
Black Crested Macaque	*Macaca nigra*	CR
Sulawesi Wild Boar	*Sus celebesis*	LC
Lowland/Mountain Anoa	*Bubalus sp.*	EN
Sulawesi Babirusa	*Babyrousa celebensis*	VU
Sunda Sambar	*Rusa timorensis macassaricus*	VU
Celebes rat	*Taeromys celebensis*	LC
Rodents sp.	*Muridae*	DD

Birds		
English Name	**Scientific Name**	**IUCN**
Sulawesi Serpent-eagle	*Spilornis rufipectus*	LC
Brahminy Kite	*Haliastur indus*	LC
Black Eagle	*Ictinaetus malayensis*	LC
Philippine Scrubfowl	*Megapodius cumingii*	LC
Maleo	*Macrocephalon maleo*	EN
Slender-billed Cuckoo-dove	*Macropygia amboinensis*	LC
Spotted Dove	*Streptopelia chinensis*	
Black-naped Fruit-dove	*Ptilinopus melanospila*	LC

White-bellied Imperial Pigeon	*Ducula forsteni*	LC
Ornate Lorikeet	*Trichoglossus ornatus*	LC
Golden-mantled Racquet-tail	*Prioniturus platurus*	LC
Blue-backed Parrot	*Tanygnathus sumatranus*	LC
Sulawesi Hanging-parrot	*Loriculus stigmatus*	LC
Red-bellied Hanging-parrot	*Loriculus exilis*	NT
Black-billed Koel	*Eudynamys melanorhyncha*	
Bay Coucal	*Centropus celebensis*	LC
Sulawesi Scopsowl	*Otus manadensis*	LC
Glossy Swiftlet	*Collocalia esculenta*	LC
Edible-nest Swiftlet	*Collocalia fuciphaga*	
Asian Palm-Swift	*Cypsiurus balasiensis*	LC
Sulawesi Dwarf Kingfisher	*Ceyx fallax*	NT
Sulawesi Hornbill	*Penelopides exarhatus*	VU
Red-knobed Hornbill	*Rhyticeros cassidix*	VU
Ashy Woodpecker	*Mulleripicus fulvus*	LC
Red-bellied Pitta	*Pitta erythrogaster*	LC
Yellow Wagtail	*Motacilla flava*	LC
White-rumped Cuckoo-shrike	*Coracina leucopygia*	LC
Sulawesi Cicadabird	*Coracina morio*	LC
Sooty-headed Bulbul	*Pycnonotus aurigaster*	LC
Hair-crested Drongo	*Dicrurus hottentottus*	LC
Black-naped Oriole	*Oriolus chinensis*	LC
Slender-billed Crow	*Corvus enca*	LC
Sulawesi Babbler	*Tricahastoma celebense*	
Black-fronted White-eye	*Zosterops atrifrons*	LC
White-necked Myna	*Streptocitta albicollis*	LC
Grey-streaked Flycatcher	*Muscicapa griseisticta*	LC
Finch-bellied Myna	*Scissirostrum dubium*	LC
Brown-throated Sunbird	*Anthreptes malacensis*	LC
Black Sunbird	*Nectarinia aspasia*	LC
Olive-backed Sunbird	*Nectarinia jugularis*	LC
Yellow-sided Flowerpecker	*Dicaeum aureolimbatum*	LC
Grey-sided Flowerpecker	*Dicaeum celebicum*	LC

12. Interview questions

Farmers Interview (Wawancara petani)

Nama:

1. **Berapa banyak orang yang tinggal bersama anda?** *(How many people are living with you?)*

2. **Apa profesi Anda?** *(What is your profession?)*
    - Petani *(Farmer)*
    - Nelayan *(Fisherman)*
    - Penambang *(Miner)*
    - Pekerjaan lain *(Other profession)*

3. **Apakah Anda pemilik tanah?** *(Do you own land?)*
    - Ya
    - Tidak

4. **Bagaimana cara Anda mendapatkan tanah itu?** *(How did you receive that land?)*
    - Tanah keluarga (Warisan) *(Family land)*
    - Dibeli *(Bought)*
    - Diperoleh dari komunitas masyarakat *(Retrieved from community ground)*
    - Hanya mengambil *(Just took)*

5. **Berapa luas lahan Anda?** *(How big is your land?)*

6. **Apa yang Anda lakukan dengan tanah Anda?** *(What are you doing with your land?)*
    - Bertani (*Farming)*
    - Berburu *(Hunting)*
    - Logging (Sumber kayu) *(Logging)*

- Tidak ada *(Nothing)*

7. **Apakah Anda menggunakan lahan yang bukan milik Anda?** *(Do you use land what you not own?)*
    - Dimana? (tunjukan di peta) *(Which/Where)*

8. **Untuk tujuan apa?** *(for which purpose)*
    - Bertani *(Farming)*
    - Berburu *(Hunting)*
    - logging
    - Memanen NTFP (Sumber daya hutan diluar/bukan kayu) *(Harvest NTFP)*
    - Lainnya *(Other)*

9. **Tanaman apa yang telah Anda tanam?** *(Which crops have you planted?)*
    - Cengkih *(Cloves)*
    - Pala *(Nutmeg)*
    - Kelapa *(Coconut)*
    - Pisang *(Banana)*
    - Kakao *(Cacao)*
    - Lainnya *(Other)*

10. **Mengapa Anda memilih untuk menanam tanaman ini?** *(Why you have chosen for these crops?)*

11. **Tanaman apa yang paling penting untuk mendukung rumah tangga Anda?** *(Which crop is the most important to support your household?)*
    - Cengkih *(Cloves)*
    - Pala *(Nutmeg)*
    - Kelapa *(Coconut)*
    - Lainnya *(Other)*

12. **Tanaman apa yang Anda tanam sebelumnya?** *(Which crops did you plant previously?)*
    - Tidak ada *(Nothing)*
    - Jahe *(Ginger)*
    - Singkong *(Cassava)*
    - Kopi *(Coffee)*
    - Aren *(Sugar palm)*
    - Rotan *(Rattan)*
    - Kayu *(Timber)*
    - Lainnya *(Other)*

13. **Bagaimana tanaman Anda ditanam?** *(How are your crops planted?)*
    - Monokultur (Seragam/satu jenis tanaman) *(Monoculture)*
    - Contour Line plant *(Contour line planting)*
    - Tanaman multi (ada banyak jenis tanaman) *(Multicrop)*
    - Lainnya *(Other)*

14. **Bagaimana Anda mempertahankan (merawat) tanaman Anda?** *(How do you maintain your crops?)*
    - Penyiangan *(Weeding)*
    - Memangkas *(Pruning)*
    - Menipis *(Thinning)*
    - Pupuk (Kimia / Mulsa) *(Fertilizer Chemical or Mulch)*
    - Lainnya *(Other)*

15. **Mengapa Anda memilih metode pertanian ini?** *(Why did you choose this farming method?)*

16. **Siapa yang membantu Anda bertani?** *(Who is helping you with farming?)*

- Keluarga *(Family members)*
- Karyawan (pekerja) *(Employees)*
- Teman (petani lain) *(Friends or other farmers)*
- Sendirian *(Alone)*

17. **Apa pengalaman Anda dalam menggabungkan tanaman?** *(What are your experiences with combining crops?)*
    - Tidak pernah (*Never)*
    - Positif:
    - Negatif:

18. **Apakah Anda pernah mencoba sistem pertanian yang berbeda?** *(Did you ever try a different farming system?)*
    - Tidak,
    - Ya
    - Mengapa? (Why)

19. **Apa yang Anda lakukan untuk mengendalikan erosi atau mengurangi penipisan nutrisi?** *(What are you doing to control erosion or reduce nutrient depletion?)*
    - Tidak ada: *(Nothing)*
    - Contour hedges: *(Countour hedges)*
    - Total penutup tanah: *(Total ground cover)*
    - Terracing:
    - Lainnya: *(Other)*

20. **Apakah Anda tahu langkah-langkah terhadap erosi dan penipisan nutrisi?** *(Do you know measures against erosion and nutrient depletion?)*
    - Ya, suka
    - Tidak

21. **Apa pendapat Anda tentang penerapan sistem pertanian yang dikembangkan di daerah tersebut?** *(What are your thoughts of implementing a developed farming system within the area?)*

    - Positif:
    - Negatif:

22. **Apa yang Anda butuhkan untuk mendukung dan menerapkan sistem pertanian baru di tanah Anda?** *(What do you need to support and to implement a new farming system on your land?)*

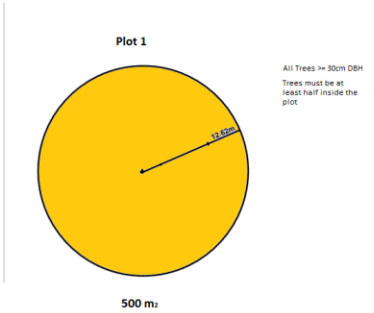
    - Tanaman: *(Crops)*
    - Buruh: *(Labour)*
    - Pendidikan: *(Education)*
    - Lainnya *(Other)*

23. **Apakah anda berharap agar sistem pertanian inovatif ini diterapkan di lahan Anda?** *(May this innovative agricultural system be implemented on your land?)*

    - Ya, di seluruh tanah saya *(Yes, on all my farm land)*
    - Ya, sebagian di tanah saya *(Yes, partly on my farm land)*
    - Belum *(Not yet)*

13. Field forms forest resources

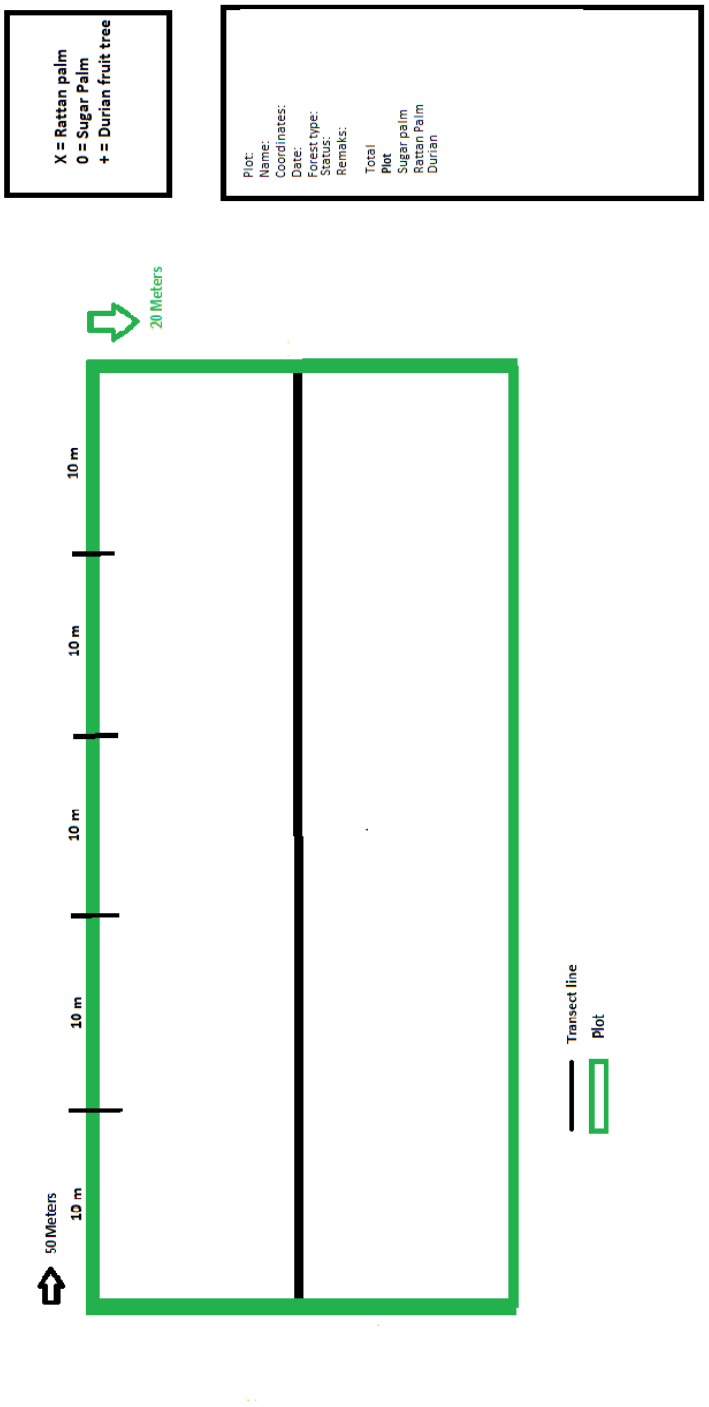
Forest inventory



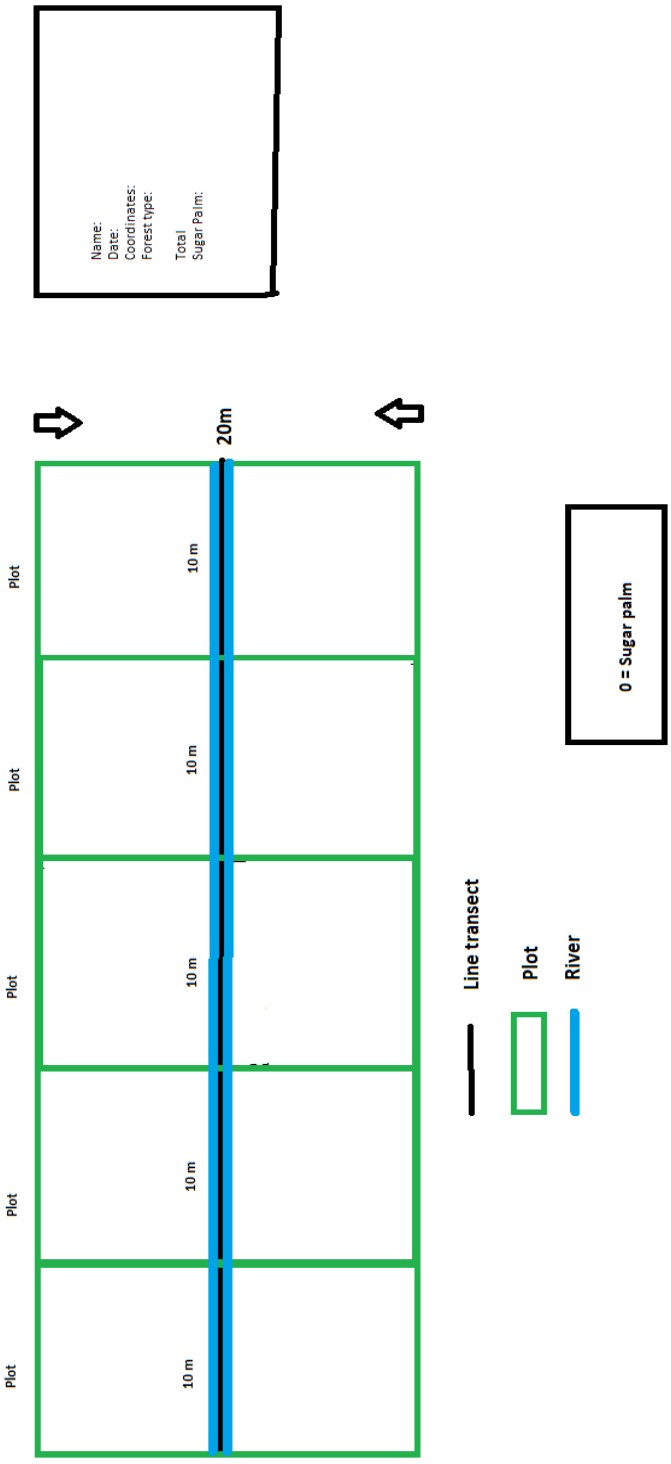
Plot:		**Coordinate:**						
Name:			**Hight**	=	**Total hight estimated**			
Date:			**Timber**	=	**YES, NO or Fuelwood**			
Guide name:			**NTFP**	=	**YES or NO**			
Vegetation type:			**Status**	=	**Common, Uncommen or Rare**			
Status:			**Remaks**	=	**Think of ecology importance and NTFP use**			
Canopy closer:								
Closed canopy in %								

Plot:	Species (Local name)	Species (Indonesian name)	DBH	Hight	Timber	NTFP	Status	Remaks

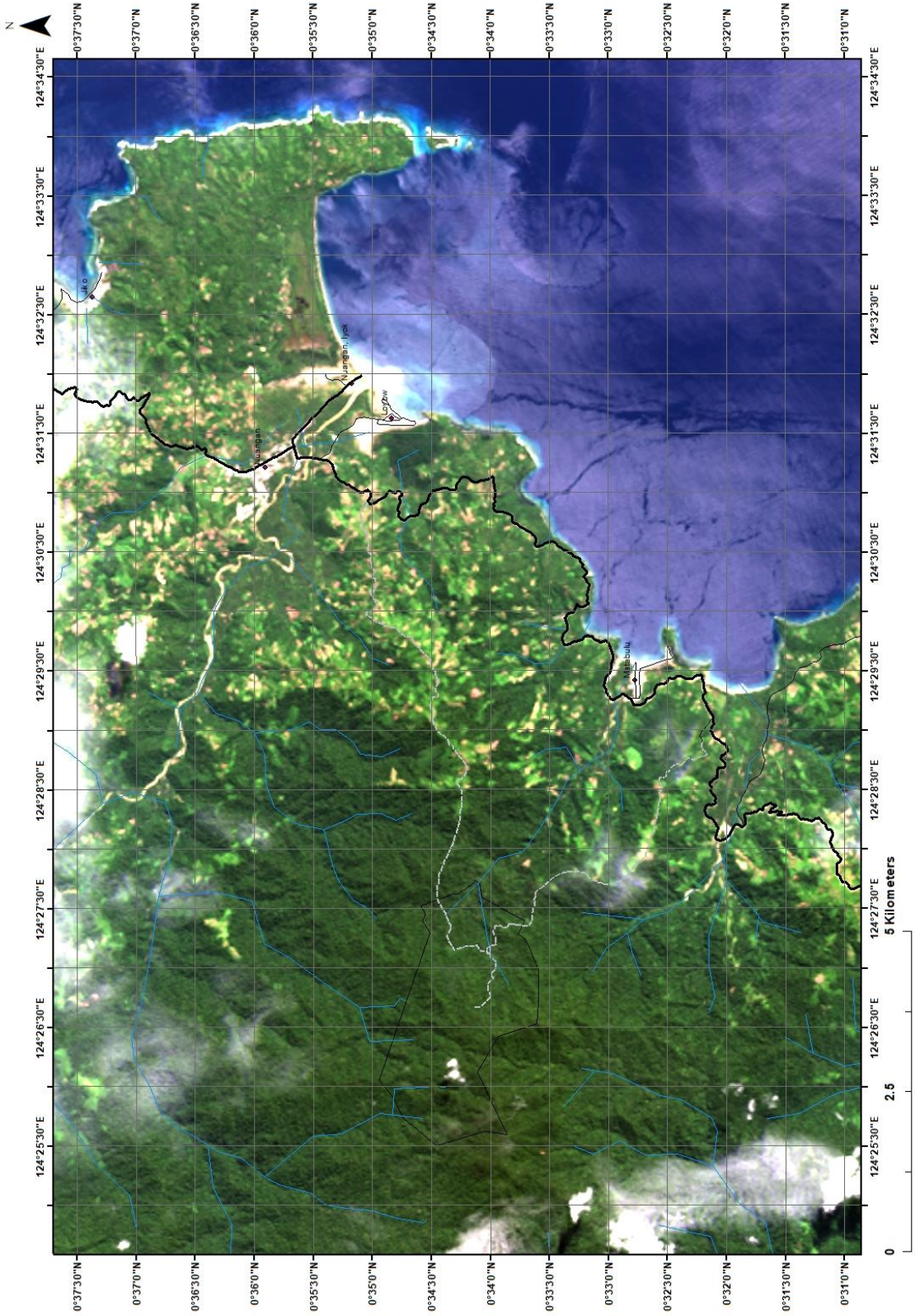
NTFP abundancy



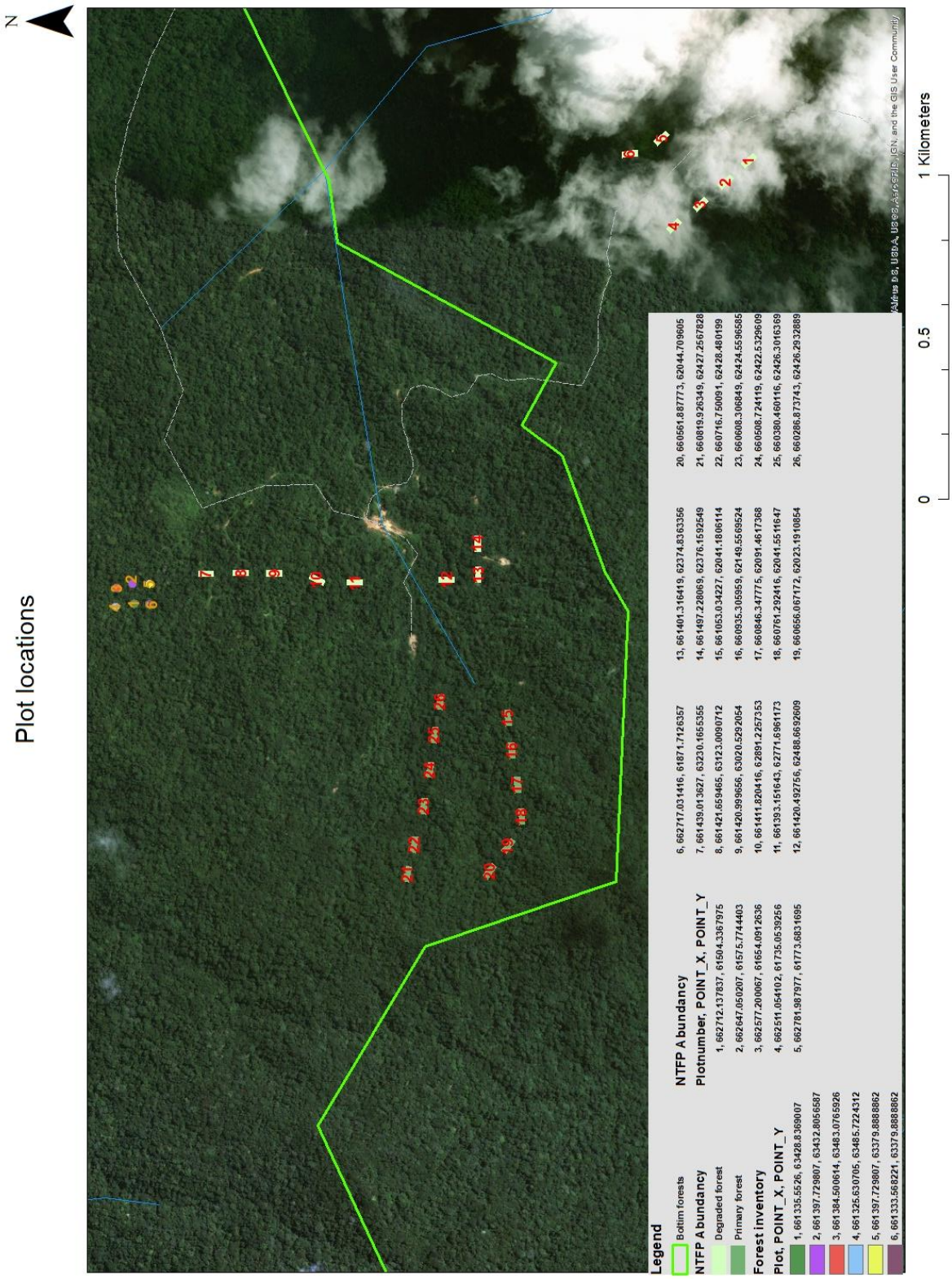
Presence of sugar palms



14. Field map


N
0°37'30"N
0°37'0"N
0°36'30"N
0°36'0"N
0°35'30"N
0°35'0"N
0°34'30"N
0°34'0"N
0°33'30"N
0°33'0"N
0°32'30"N
0°32'0"N
0°31'30"N
0°31'0"N
124°34'30"E
124°33'30"E
124°32'30"E
124°31'30"E
124°30'30"E
124°29'30"E
124°28'30"E
124°27'30"E
124°26'30"E
124°25'30"E
Jiko
Nusahan, Ipat
Loyow
Nusahan
Mas Bulu
0
2.5
5 Kilometers

15. Plot locations

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