Master's Thesis (Academic Year 2013)

Assessment of Vulnerability to Flood: A Case Study in Sambas Regency, Indonesia.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Media and Governance.

Keio University

Graduate School of Media and Governance

MURIADI

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Summary

A method for assessment of vulnerability to flood is proposed in this research. It is an effort to contribute in finding solutions to the increasing damaging flood event around the world since last decades. Populations in floodplain area, that basically beneficiaries to natural inundation, now are becoming vulnerable to floods. In such condition, a need for vulnerability assessment to support policy making is increasingly significant.

The method consists of three stages of process: first, mapping the flood and its hazards to know areas under threat to flood; second, investigation of vulnerable populations and aspects in which they may be harmed by extreme floods; and the last, to locate where vulnerable populations exist and its potentiality of being exposed to floods.

Mapping the floods is carried out in two ways: using historical flooding events in administrative basis (sub districts) and trans-boundary inundated area by flood types. Investigation of vulnerable populations is carried out by in-depth interview and is aimed to find vulnerable groups within population. Aspects under investigation are food, housing, livelihood and health. Sambas Regency of West Kalimantan Province, Indonesia is the research site to test the applicability of the proposed method.

Results of this research include the identification of two types of flood commonly occurs in the research site; coastal flood and riverine slow-onset flood. It is also found that, even though almost all of sub districts in Sambas Regency experienced flooding events within period of 2007 until 2012, some sub districts tend to be more vulnerable than others. The other finding is that poor farmer households are more suffer to flood in longer period, while farm laborer households tend to be more vulnerable during flooding event. Some vulnerable sub districts are populated by many vulnerable households.

Key words: Vulnerability, flood, mapping, loss and damage, poverty

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CHAPTER I. INTRODUCTION

1.1 Climate variability and increasing flooding events

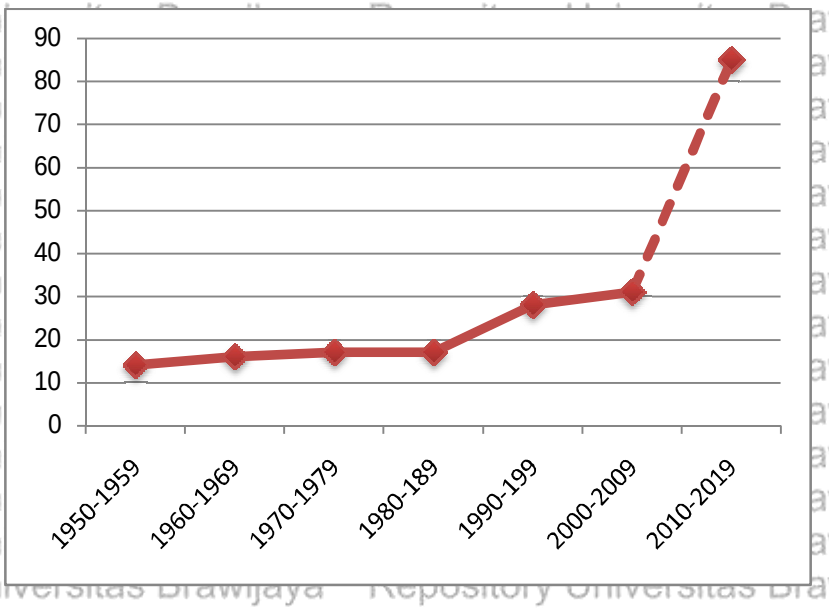
Within recent decades, damaging flood occurrence is increasing whole over the world. UN (Undated) stated that on a global basis, there is evidence that the number of people affected and economic damages resulting from flooding are on the rise at an alarming rate.

For instance, on early June 2013, risingwaters from several rivers in central Europe including the Danube, Ilz and Inn have inundated parts of Germany, Austria, Switzerland and the Czech Republic following days of heavy rainfall. Previously, on January 2013 several other parts of the world also experienced the same disaster. Jakarta and its surrounding areas are amongst cities that seriously hit by flood on the beginning of the year. The flood resulted in damage of properties, infrastructures and cost of lives in the capital city of Indonesia.

On the same month, water also flooded eastern part of Australia. The damages resulted from extreme weather and flooding in the country reach an amount of at least US$2.5 billion (Dayton 2013). In Africa, Mozambique is one country that hit by flood on January 2013. It was reported that flood have affected 19,646 persons throughout the country, causing total or partial damage to 2,979 houses, inundating 679 houses, and interrupting road infrastructures, as well as electricity and drainage systems (UN 2013). Few months later, exactly on April until May 2013, the NorthEastern section of Buenos Aires Province, Argentina, experienced several flash floods that cost many lives.

In historical records, Yangtze River Flood is one of the deadliest floods in modern history. It is expected around 3 million people were killed in the occasion which happened in 1931 (Coppola 2011 p.2). Wikipedia (2013) counts that from 1950 until 1989, there were averagely 16 deadly floods happened in the world on every 10 years. The number is almost doubled since 1990 until 2009. In 2010 and 2011, the site counts there have been 17 deadly floods in the world just in two years.

Table 1: Deadly Flood Occurrences in the World



Source: data processed from Wikipedia (2013)

Increasing climate warming and its variability is one of factors that contribute to increasing risk of flooding (Wetherald and Manabe, 2002). Factors such as precipitation intensity, volume, timing, antecedent conditions of rivers and their drainage basins, as well as human encroachment into flood plains and lack of flood response plans increase the damage potential (Kundzewicz et al 2007).

1.2 Human activities and flooding; a dilemma in pursuing social economic development

Flood happens not only related to climate variability but also influenced by human activities that changed the nature of living environment. Urbanization is one example of how human activity exacerbates the size and frequency of floods and may in turn expose communities to increasing flood hazards (Konrad 2013). Another example is deforestation in the headwaters. Various types of human activities such as land clearing for plantation or agricultural activity, mineral mining, and timber logging also much contribute to increasing flood events.

In many developing countries, dilemma is on the rise as pursuing economic prosperity still much depends on the extraction of natural resources. Reliance on mining activities, land use for large scale plantation and timber logging is common characteristic of developing countries. Therefore, it is often that the environmental problems accompanying resource depletion are exacerbated by development policy (Redclift 1991

p.20). In such condition, it is a challenging effort to preserve natural hydrological system while supporting economic growth and employment opportunities to millions of people.

Forest is one example of natural resources that economically valuable but also crucial for environment systems. Agrawal et al (2013) stated that historically, forests have played a major role to influence patterns of economic development, supporting livelihoods, helping structure economic change, and promoting sustainable growth. Destruction of forests not only means destroying economic opportunities, in many cases such action has led to severe and disastrous floods (ASEM 1999).

It is broadly acknowledged that forest mainly functions to hold rainfall water from runoff and gathering in one lower point. In some cases, forest canopy can block one third of rainfall water (Zhang et al 1994). Thus, destroying forests is like puncturing a wall of great dam. Unfortunately, it is happening in many floodplain areas. As consequence, the area that for a long time benefited from natural inundation, now are becoming disaster prone areas. For instance, coastal areas of Southeast Asian countries that basically agricultural rich floodplains such as in Bangladesh, Myanmar, Vietnam and archipelago of Indonesia now are frequently experiencing damaging floods. In such condition, people who for a long time beneficiaries of flooding are getting more and more vulnerable to the natural disaster.

1.3 Coping with flooding: importance of vulnerability assessment as basis for policy formulation

In such increasing magnitude and frequency of floods, assessing people vulnerability to flood is also increasingly important. The main purpose is to inform decision-makers or specific stakeholders about options foradapting to the impact of flooding hazards (Douben 2006). By studying vulnerability, it can be recognized correct actions that can be taken to reduce vulnerability before the possibleharm is realized (Balica 2007). Generally speaking, without vulnerability assessment, it is hard to formulate appropriate policies for coping with hazardous events and improving resilience of element at risks.

Vulnerability assessment is core of disaster risk management. IPCC (2012) in its summary for policy makers mentioned that disaster risk management and adaptation to climate change focus on reducing exposure and vulnerability and increasing resilience to the potential adverse impacts of climate extremes, even though risks cannot fully be eliminated. A vulnerability analysis and assessment can also be used to identify the

emergency responses that may be required, including the need for temporary shelters and evacuation requirements (UN undated)

While there is no doubt on the importance of vulnerability study and assessment, models and methods are vary. Many models have been developed and applied around the world. Broadness of vulnerability definition and complexity of vulnerability analysis makes a single model and method for general application is hardly applied. The most accepted way is development of models and methods for assessing vulnerability in regard of specificity of environmental hazards and specificity of area contexts without derailing from general accepted frameworks of vulnerability analysis.

CHAPTER II. FLOODS AND VULNERABILITY ANALYSIS: A LITERATURE REVIEW

2.1. Flood; types and hazards

Flood can be defined as the inundation of a normally dry area caused by rising water in an existing waterway, such as a river, stream, or drainage ditch (NOAA 2010). While, flooding is a term to emphasize on the effects of flood as a distinct from the flood itself, and briefly can be define as overflowing by water of the normal confines of a stream or other body of water, or accumulation of water by drainage over areas that are not normally submerged (WMO 2011).

Flood can be happened when rainfall exceeding the capacity of soil to evaporate incoming water, or because of surge of seawater.

There are many types of flood. World Meteorological Organization (WMO 2011) mentions ten types of flood, namely: flash flood, fluvial flood, urban flood, estuarine flood, single event flood, multi event flood, seasonal flood, coastal flood, snowmelt flood and ice- and debris- jam flood. Some of the mentioned types of flood are overlap each other in their characteristics. Therefore, to easily distinguish their characteristics and hazards for further analysis and assessment purposes, flood can be categorized into at least four main types: flash flood, riverine slow-onset flood (fluvial flood), urban flood and coastal flood.

Flash flood is one type than can be happened anywhere. It is also one of most dangerous types of floods. It is characterized by speed of water flow. Water in a higher place collected and gathering until suddenly flows in huge amount along flood way. It is how flash flood originally happened. It can be a natural caused flash flood and human-caused flash flood. Broken dam is one example of human-caused flash flood that extremely dangerous.

Riverine slow-onset flood is one type of floods. It is commonly happened in large floodplain areas. It is also one of the most common types of floods. It can be happened when rainfall extensively pours large area. Water collects to small rivers and streams to gather to larger river. This causes gradual increase of river's surface. As consequence, this type of flood can covers a very large area.

Another type of flood which also commonly found is urban flood. It is happened when rainfall water unable to flow smoothly because of lack of drainage system or hardly

infiltrate soil because of extensive concrete-covered land. Urban flood much related to human activities rather than natural phenomena like a coastal flood.

Costal flood is the increase of sea water level exceeding its normality. It can be happened due to storm or earth gravity. As its name, coastal flood is happened in coastal area. Tsunami can be also categorized as coastal flood as it happens in coastal area. Tsunami usually comes following earthquake under sea floor. One single tsunami can cause a very devastative disaster.

Different types of floods mean different types of hazards. Therefore the extent of vulnerability also will be different. It is important to consider this in the analysis of vulnerability. Alexander (1993 p.135) stated ten critical characteristics of floods that may influence the adaptation methods namely: depth, duration, area inundated, flow velocity, frequency and recurrence, lag time, seasonality, peak flow, shape of rising and recession limbs, and sediment load. Those characteristics are often different among types of flood.

Flash flood characterized by sudden happening. Some time it can be predicted, but often it comes without any sign. It can be resulted from heavy rain or storm, collapse of debris dam or man-made dam. Flash flood in Philippines 2011 is type of flash flood by heavy rainfall and storm. Flood in Wasior of Indonesian Papua in 2010 is related to collapse of debris dam. While, flash flood in Johnstown in 1889 is one example of flash flood due to collapse of man-mad dam.

Because of its characteristics, flash flood threats those who live along flood ways. Usually flash flood covers a smaller area compared to other types of flood. However, because it involves speed and huge amount of water, flash flood may very dangerous and harmful physically. It usually brings materials such as mud, stones and debris that multiply the hazard. Houses can be destroyed in just moments by this type of flood. It can also bring deaths while people take a rest or sleep at their houses. Properties and lives are more threaten by this type of flood. Therefore, almost all of people who live in flood ways and threaten by flash floods are vulnerable. Those with better economic status are not excluded in this case.

Hazards by riverine slow-onset flood little bit different from hazards by flash flood. It characterized by gradually increase of water level and large coverage area. People may have time to flee or be evacuated, but plantation and cattle also properties are hardly to be saved in occasions of riverine slow-onset floods. Therefore, people from different economic capacity will tend to have different vulnerability to this type of flooding.

Urban flooding may be very harmful to economic and social life, because it is happened in which human residences and economic activities are centralized. Inundated houses and economic centre can cause damage of properties and lost of economic resources. Infrastructures such roads, bridges, electricity systems and city watering systems can damage and require a huge amount of public fund to fix it. People can also be contracted to various diseases following urban flood.

Coastal floods characterized by surge of sea level. It may impact urban or rural area. In urban area it harmful to properties such as houses, vehicles and bridges and roads. In rural area it hazardous to crops as salted water may cause death to cultivations. Often this type of flood is followed by abrasions. Therefore, buildings and other facilities tend to be vulnerable to coastal floods.

Tsunami is disastrous flooding. One single tsunami may causes hundreds of thousand deaths. Indian Ocean tsunami in 2004 cost around 280.000 lives. While tsunami following Great East Japan earthquake on March 2011 cost around 16.000 deaths. Devastative characteristics of thisflood type make all people nearby coastal area vulnerable. Particularly those who live in low-lying area along coastal zone that is prone to earthquakes.

2.2. Floodplain and flood prone area

A floodplain is an area between two high elevations. A floodplaincan also be defined as an area of land adjacent to a stream or river that stretches from the banks of its channel to the base of the enclosing valley walls and experiences flooding during periods of high discharge (Goudie 2004)

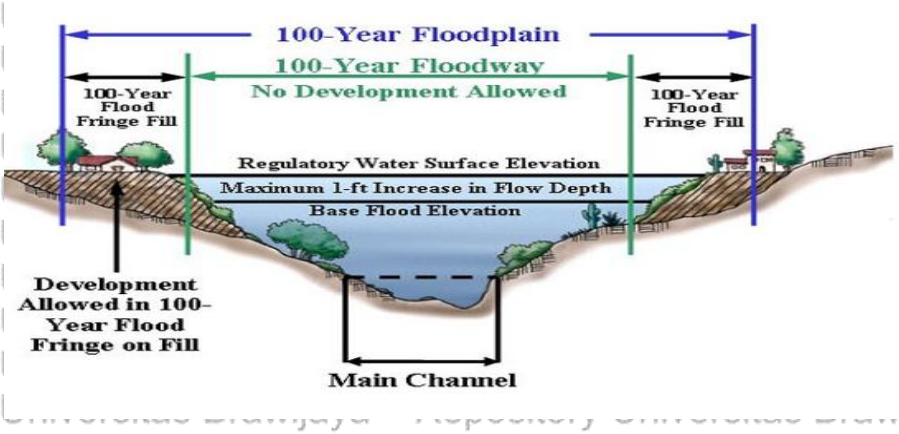
This area usually can be found along rivers. Floodplain area is mainly characterized by low and flat landscape. Regularly flooded and becomes gathering points of rich soils that brought by surface run-off water from higher places, floodplains are fertile and therefore inhabited by communities for the benefit of agricultural activities. It is not surprising that floodplain areas such as Mekong, Euphrates, Nile, and Mississippi have become centre of civilization since thousands years ago.

Floodplain can be a narrow area but also can be very large covering such as Vietnam's Mekong River delta, the flood plain of the Hau and Tien rivers that spread over more than 12,000 square kilometres (National Geographic 2013).

Flood prone area is an area having a 1 percent annual chance of flooding once every 100 year (www.investorwords.com). India is one example of a country with a huge area of

flood prone. According to the Ministry of Water Resources the country has 35.5 million ha flood liable areas (India Ministry of Water Resources).

Picture 1: Ilustration of 100 floodplain



Picture courtesy of Pinal County Government

2.3. Concepts and definitions of vulnerability

Defining vulnerability is helpful for finding the best ways to minimize it (Balica 2007). Unfortunately, there is no single acclamation of vulnerability definition. The term is used in broad area with different meanings (Barroca et al. 2006, Ballica 2007, Ballica 2012).

Turner et al (2003) define vulnerability as the degree to which a system, subsystem, or system componentis likely to experience harm due to exposure to a hazard, eithera perturbation or stress/stressor. Simpler definition is proposed by IPCC (2012) which describes vulnerability as the propensity or predisposition to be adversely affected. Blaike et al (1994) stated that vulnerability means the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard.

While, Balica (2007) defines vulnerability to flood as the extent towhich a system is susceptible to floods due to exposure, a perturbation, in conjunction with itsability (or inability) to cope, recover, or basically adapt.Previously, United Nations (1982) have already expressed flood vulnerability as the degree of loss to agiven element, or a set of such elements, at risk resulting from a flood of given magnitude andexpressed on a scale from 0 (no damage) to 1 (total damage).

Smit and Pilifosova (2003) formally express vulnerability in a formula as follow:

$$Vist = f\,(Eist, Aist)$$

Where *Vist*= vulnerability of community *i* to stimulus *s* in time *t; Eist, =* exposure of *i* to *s* in *t;* and *Aist*= adaptive capacity of *i* to deal with *s* in time *t*.

From above definitions, at least there area three components must be considered in any vulnerability analysis: exposure to hazards, susceptibility or sensitivity of elements at risks and adaptive or resilience capacity of the exposed elements.

Exposure is the probability of the element at risk to be present while the event occurs (EXCIMAP 2007). Susceptibility or sensitivity can be understood as the elements being exposed within a system, which influence the possibilities of being harmed in time of hazardous floods (Balica 2012). Resilience is capability of humans to endure hazardous effects of floods. Furthermore, Turner et al (2003) define hazard as threats to a system that comprised of perturbations and stress (and stressors), and the consequences they produce.

Generally, vulnerability can be divided into four different types that interconnected one another:

a) Physical vulnerability is how structures or built environment might impacted by hazards;
b) Social vulnerability is related to inability of population, whether in group or individual to withstand harms caused by hazardous events;
c) Economic vulnerability refers financial valuation of impacted elements
d) Environmental vulnerability is how environmental health affected by hazards

2.4. Factors influence vulnerability to flood

Perhaps, flood is one of the most destructive and deadliest disasters in modern history of human civilization. Tsunami following earthquake near Aceh of Indonesia in 2004 cost almost 280.000 lives. Flood of Thailand 2011 caused losses of hundreds lives and tens billions of economic loss.

Huge of losses and damages caused by floods is influenced by many factors. Scope and magnitude of flooding is one main factor. Area impacted by flood may only as small as one hamlet but often reach whole country or even many countries. Flood in central Europe this June for example, reached almost half of European continent.

The other factors related to element exposed to floods its self. As it is commonly found, people are likely inhabited flood prone area due to richness of soil in flood plain areas and supportiveness of flooding to agriculture activities. Those people while become beneficiaries to flooding at the same time also vulnerable to it. Floods always have the two sides to people: beneficial and vulnerable.

Degradation of environment also influences vulnerability to floods. As the nature of flooding is influenced by environmental systems, changing in one component of the systems might also followed by the change of magnitude and intensity of the flooding. Further, people who live in flood prone area have to face the reality that negative side of flooding tends to increase.

While flood hazards are hardly eliminated, the way people respond to it much more flexible. Vulnerability to flood can be minimized or reduced according to the way people cope with it. Preparedness to upcoming hazardous flooding determines people vulnerability to flood. Even though in some cases floods can suddenly happened without alarming, but basically it can be anticipated. Regularity of flooding events for example should be perceived as a warning to do something.

However, it may also be happened that people do not prepare because they cannot. Limitation prevents people from doing so. In such case, policy from government also determines people vulnerability to flood. Correct policies are required to reduce people vulnerability to flood.

2.5. Approaches and frameworks for the assessment of vulnerability to flood

Ideally comprehensive vulnerability analysis is that one which considers the totality of the system (Turner et al 2003). However, consider totality of the system is almost impossible to be achieved. It is related to the fact that components linked to vulnerability are broad. The most reasonable way is that at least a vulnerability analysis considers the population and structures at risk within the flood-prone area (UN undated).

Basically, approaches to vulnerability analysis can be divided into two types: quantitative approaches and qualitative approaches. Quantitative approaches try to measure the degree of harms caused by potential hazards to the exposed elements. In this approaches, thus vulnerability is a hypothetical and predictive term, which can only be proven by observing the impact of the event when, and if, it occurs (Blaike et al. 1994 p58). Flood Vulnerability Indices by Balica (2012) is one example to quantitative approaches in vulnerability analysis.

In Qualitative Approaches, vulnerability is viewed as the quality of specific elements in coping with hazards. Therefore, in this approaches vulnerability is an evaluative and predictive.

Further, vulnerability analysis always related to broader purpose, such as risk management or mitigation and prevention programs. In term of that, vulnerability

analysis can also be viewed from two perspectives: structural and non-structural. Structural perspective focus on environment and physical aspects such as built structures, topography etc. Non-structural approaches emphasize on human behaviour including policy and administrative actions.

CHAPTER III. PROPOSED METHOD FOR THE ASSESSMENT OF VULNERABILITY TO FLOOD

Assessment of Vulnerabilities must always be related to a specified threat (or hazard), and the central questions are including which groupsof people are vulnerable to what and why (IFRC, 1996). However, it is important to realize thatvulnerability is not merely registered by exposure to hazards (perturbations and stresses), but also resides in the sensitivity and resilience of the system experiencing such hazards (Turner et al. 2003)

As vulnerability is not a stand-alone concept, the model of assessment used in this research combines two steps linked to different methods. The steps include:

1. Mapping the floods and its hazards
2. Investigation of vulnerable elements and aspects

3.1. Mapping the flood and its hazards

Flood maps are indispensable tools to provide information about hazards, vulnerabilities and risks, and to implement the necessary preventive and preparedness measures (EXCIMAP 2007).

In a complex analysis, a lot of efforts is needed to map a flood prone area. Particularly to consider environment systems such as topography of the area and the presence of structures such as irrigation and/or natural channels, roads, railways and so on, which are affect the nature of flooding considerably (Pagliara 2006).

However, simpler methods can also be used. One of the methods is what UN (undated) explains as a probability-based analysis wherein systematic records and historical information on past flooding are used to develop a relation of probability of occurrence versus magnitude. This study employs this method in which previous flooded villages and sub districts are collected to draw a map of potentially flooded sub districts (Flood Map). Data on flooded villages or sub district are collected whether from government's records and or local and national media reporting of flooded area in certain time. Media is important as in many area, data from governmental institution may hardly accessed or lack of availability.

Flood map shows potentially flooded areas according to groups (high, medium, and low). Grouping is made in sub districts basis and by looking at frequency of flooding

experiences within period of 2007-2012 (six years). Sub district with four to five times experience is grouped in high potentially flooded sub districts. Sub district with two to three times experience is medium potentially flooded sub district and the rest is in low potentially flooded sub district.

As flood is trans-boundary occurrence, flood hazard mapping is also important. It is aimed to draw trans-boundary flood map complemented with type of floods. This mapping will take into account not only historical data, but also topography, geomorphology, and catchment system.

3.2. Investigation of vulnerable elements and aspects

Investigation to know vulnerable people is carried out mainly but not limited by in-depth interview. Investigation is focused on knowing who is vulnerable to flood, where the people live and in what aspects are they more vulnerable.

Vulnerability is closely related to exposure to hazard. Those who have no possibility to be exposed to certain hazard would not be directly vulnerable. Therefore, vulnerability analysis should first identify who have probability to be exposed to hazards. This can be explained by mapping flood prone area. People who live in flood prone area basically are they who potentially vulnerable to flood. But of course it alone does not enough. Vulnerability is not only related to the exposure to hazard. Investigating characteristics of exposed population also must be done. Those who have more propensities to be adversely affected by flood hazard are those vulnerable. For example, damage of certain crops will directly influence those population groups that rely on the crops types as their daily livelihood.

In particular population, there might be certain groups exposed to the same hazard but has different vulnerability. People under poverty might be differently vulnerable to flood with those middle-income families, very young children might be more vulnerable than adults, female might also more vulnerable than male.

To know who and where do vulnerable people live, in-depth interviews are carried out to investigate how particular groups (elements) are vulnerable to flood. Result of the investigation can be used to identify groups of population that should be paid attention in the policy making. Knowing who and where, is not enough without understanding of in what aspects do they vulnerable. Therefore, in this assessment, four aspects of people life are investigated. Those are:

- **Food:**

The questions in the investigation of food vulnerability to flood are focused on following questions: first, how do people meals before, during and soon after flood? This question is aimed to know is there any changes in meal behaviour of people due to flood. By knowing the changes of meals behaviour, means knowing the effect of flood to food security of people. People who have to change their meal from normal to worse are those vulnerable. Both are in terms of adequacy and quality of the food.

Second question is on how do they get food supply? This question is aimed to know source of food supply of people. They who get supply from their normal sources are more resilience. People who rely on their own stocks also resilience. Some of them might rely on aid, help or owe to other people can be vulnerable

- **Housing.**

Investigation will be focused on whether their house can be used as shelter during flood. House that cannot be used as save shelter during flood is vulnerable. Shelter means not only for human but also to common properties such as furniture and appliances. The probability of the house to be damaged by flooding is also taken into account.

- **Livelihood**

The question for this type of investigation is focused on how dopeople's livelihood is potentiallydisturbed during flood? Disturbance of livelihood means disturbance to the source of income. Civil servants for example may not able to do their occupation during flood, but it does not mean they will lose their income as stopping from working for several days would not make their salary stopped or reduced. People who sources of livelihood are disturbed due to flood are those vulnerable. The other important things are about how long their livelihood will be disturbed by flood? What resources do they have to bounce back to normal livelihood? What do they do as source of income during flood?

- **Health**

The questions of investigation for this aspect include the impact of flooding to their people health. People who may be infected by serious diseases or fall into a serious illness are those vulnerable. How do they cure their illness during flood is also one of the indicators to know people vulnerability to flood. Those who depend on self-medicated and hard to reach health services are vulnerable.

3.3. General overview of Sambas Regency as research site

Sambas Regency is one of regencies in Indonesia. Located in relatively low and flat area, Sambas Regency experiences flood almost every year. Heavy rain in December and January usually results in large scale of inundation across the region. Geomorphology of the area is one of the factors behind regular flooding. 67,59 % of Sambas Regency's area lies on land with slope only 0-15%. Elevations from 0 to 7 meter above sea level covers area along several sub districts namely Sejangkung, Sambas, Tebas, Selakau, Jawai, Paloh and TelukKeramat, while elevation from 8-25 above sea level dispersed over Sejangkung, Sambas, Tebas, Selakau, Pemangkat, and TelukKeramat (Bappeda 2012). Therefore 49.5 percent of 6,395.70 km2 of Sambas Regency's area is flooding-area (BPS 2011). On the other side, the non flooding areas are non porous soil which is hardly infiltrated by water. Therefore surface run off tends to happened. This condition exacerbates flooding nature of the regency.

Table 2: Flooding Area and Soil Types in Sambas Regency

TOTAL AREA	FLOODING AREA	UNFLOODING AREA	
		Porous Soil	Non Porous Soil
639.570	317.221	116.559	205.790

Source: BPS 2012

Sambas Regency has many rivers. There are four main river catchments in the main land of Sambas Regency, namely: Paloh River Catchment, Sambas River Catchment, Sebangkau River Catchment and Selakau River Catchment. Sambas River Catchment is the main river catchment in which majority of population concentrated. 16 out of 19 sub districts of Sambas Regency are located along Sambas River Catchment area. With such geomorphology, Riverine Slow-Onset flooding is the most common happened floods in Sambas Regency. Continuous heavy rain for several weeks whether in coastal area and particularly in headwaters area will increase possibility of flooding along river catchments areas.

Map 1: Sambas Regency by Sub Districts

Originally, people of Sambas Regency are benefitted by regular flood. Increased water level in rainy season is useful for irrigating paddy fields and transporting various forestry products. From 65.335 ha of paddy field in Sambas Regency, 63.442 ha (97.10 %) still depend on natural inundation as irrigation system (Bappeda 2012). Rise of rivers' water also beneficial for bringing timber, rattan and various other forestry products since the area still lacking of paved roads. The problem is that some new developed agricultural products are not really durable to inundation. Meanwhile, the nature of flooding also gradually changed.

In the past, flooding happened during rainy season which begins from September and reaches its peak on the beginning of February every year. Water level would not exceed 50 cm which is good for cultivating rice. Nowadays, flooding might happened on any month with extreme intensity. Sometimes, water level increases until 2 or 3 meter from ground. This kind of flooding is not only harmful to plantation, but also hazardous to properties and human life.

Collected data from various sources indicate that from 2003 until September 2012 there had been more than 10 times of flooding that causes huge damages whether to crops as well as properties and human condition. The problem is that the nature of flooding may have been being changed due to both natural and developmental factors.

Since long time ago, farmers in Sambas Regency depend on annual flooding for irrigating their paddy field. Naturally inundated areas are suitable for cultivating rice, main staple food of most Indonesian people. Therefore, mainly population is concentrated around low and flat area in which annual inundation happened. They cultivate paddy once a year by taking advantage of annual inundation. Besides paddy, people also cultivate other products such as coconut tree and rubber tree. By early 80's development of agricultural sector has brought about various commodities to people lives. Citrus, pepper, cocoa and various other crops were being introduced. Many people change their commodities to such plantation.

4.1. Human activities and flood problems in Sambas Regency

Intensity of deforestation contributes much to the magnitude of flooding in Sambas Regency. Rivers as water collector is experiencing rapid decrease in its capacity due to sedimentation resulted from various activities in the head waters and surface run off (Bappeda 2012). Lack of drainage system and inability of existing ones to channel waters also contributes to the occurrence of damaging floods (Nirmala 2008).

Fostering economic growth to create employment opportunities, Local government aggressively attracts investment into the area. Plantation is prior sector offered to investors that soon flocked to the area as well as other regencies in West Kalimantan. Within several years, thousands of hectares of forest have been changed to be palm oil plantation. This looks to be effectively fostering economy. Sambas Regencyis rapidly developing. It can be seen from the establishment of several banks' branch offices and other financial institutions in the Sambas City and other sub districts.

Local statistics (2012) mentioned that land-use for plantation in the area is increasing rapidly year to year. Palm oil plantation area is increasing 10,770 ha in 2011 alone. Totally from 2007 until 2011 palm oil plantation increased from 18.646 hectares to 60.261 hectares. Much of area consumed by the plantation is in headwaters.

The problem of flood and human activities in Sambas Regency is not limited on what has happened in the area. River catchment systems in the regency are far beyond governmental borders. For instance, streams of Sambas River Catchment collect water

from a very huge area including from Bengkayang Regency and parts of Sarawak-Malaysia. Deforestation is also massively happening in that areas that at the end exacerbates flooding in Sambas Regency.

Table 3: Palm Oil Plantation in Sambas Regency Year 2007 - 2011

Year	Planted Area (Ha)	Production (Ton)
2007	**18.645**	**23.797**
2008	**19.095**	**24.795**
2009	**25.316**	**26.529**
2010	**54.401**	**33.415**
2011	**60.621**	**41.147**

Source: BPS 2012

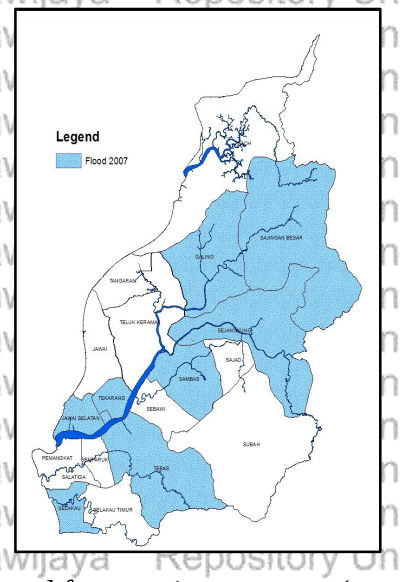
CHAPTER IV. RESULTS AND DISCUSSION

4.1. Damaging flood events in Sambas Regency from 2007-2012

Sambas regency experiences regular flood during 2007-2012. Generally, two types of flood are happened in Sambas Regency, Riverine slow-onset flood is the most common. While coastal flood some times happened in coastal villages. January, April and October are months in which floods tend to happened.

In January 2007 floods inundated eight sub districts namely Sambas, Sejangkung, Galing, Selakau, Sajingan Besar, Tebas, Tekarang and Jawai Selatan. Water height reached 2-3 meter from the ground. Indonesian Ministry of Public Work stated that 1940 houses, 3000 ha paddy fields and 6000 ha citrus plantation were damaged in the occasion (see appendix 1). In this flood, heavy rain in the headwater of two catchments area (Sambas River and Selakau River) probably the cause of the flood.

Map 2: Flooded Sub Districts in 2007



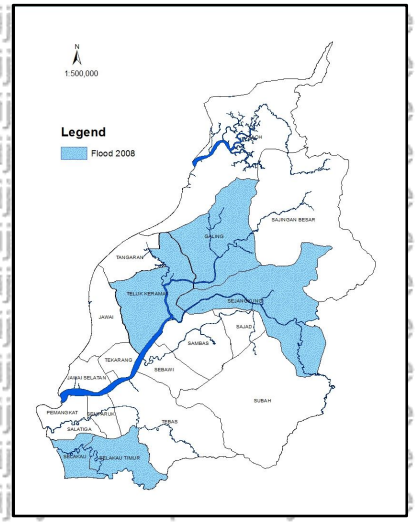
Source: collected from various sources (see Appendix 1)

Just months later, exactly in June 2007, flood again happened in Sambas Regency. Laboratorium Pengendalian Hama dan Penyakit (Laboratory of Pest and Plantation Disease Control) of West Kalimantan Province, Sambas Office reported that flood inundated 11.160 ha area and caused damage to 288 ha of cultivation. It is not identified which sub districts were flooded in this occasion.

Flood again happened in Sambas Regency in early January 2008. It is reported that 20 villages of 8 sub districts were flooded including Selakau, Selakau Timur and

Teluk Keramat. Depth of inundation reached 175 centimeter from the ground. Flood also happened on April of the same year. 733 hectares were inundated but there is no damage was reported in this occasion.

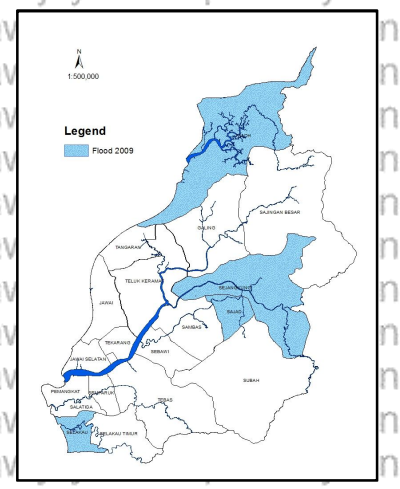
Map 3: Flooded Sub Districts 2008



Source: collected from various sources (see Appendix 1)

In 2009, flood happened twice. From January to early February, flood inundated Paloh, Sejangkung and Sajad. While on November of the same year, flood inundated Selakau Sub Districts. Flood in Paloh and Selakau was a combination of increase in sea water level and heavy rain. In Paloh Sub District it was happened in village named Kalimantan. This village lies in relatively low elevation as it is in Selakau. While flood in Sejangkung and Sajad was related to heavy rain in the headwaters of Sambas River.

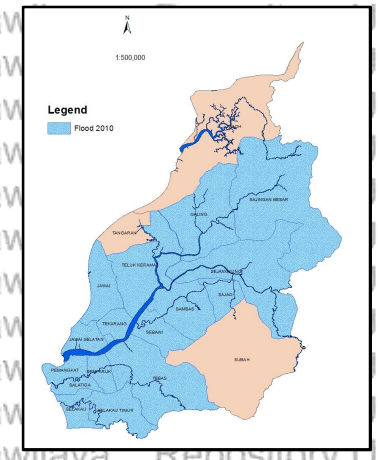
Map 4: Flooded Sub District in 2009



Source: collected from various sources (see Appendix 1)

On January and February 2010, flood inundated majority of Sub District in Sambas Regency. Villages along Sambas River Catchment, Sebangkau River Catchment and Selakau River Catchment are flooded. The flood sent sorrow to farmers as inundation remained longer. People are not only lost their crops, but also unable to re-cultivate their lands for a longer period. The sorrow even worse when on October 2010, flood came again and caused damage to at least 2431 ha of crops.

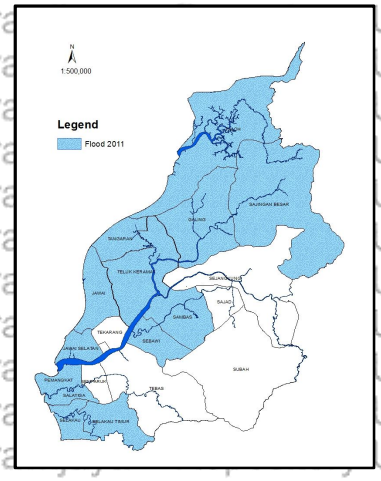
Map 5: Flooded Sub Districts in 2010



Source: collected from various sources (see Appendix 1)

While on January 2011 great flooding caused 64 households evacuated. More than 1581 ha agricultural area and 4.173 plantations were damage. This time, type of flood included both coastal and riverine slow-onset floods. Indonesian National Disaster Management Agency mapping the flooded area as shown by below map. Again in October 2011 flood inundated 90 hectares area and caused damage to 18.5 hectares crops.

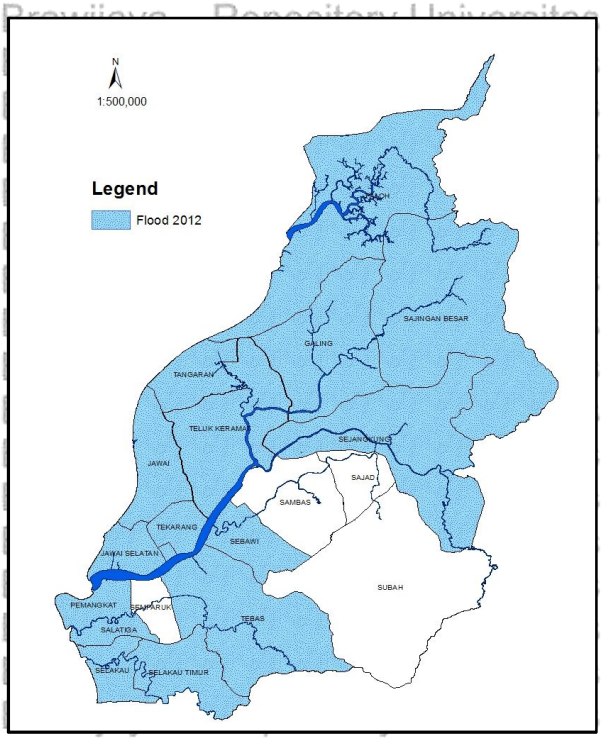
Map 6: Flooded Sub Districts in 2011



Source: collected from various sources (see Appendix 1)

Then, in January 2012 almost all sub districts of Sambas Regency were flooded by 2-3 meter of water height. Firstly five coastal sub districts were flooded on early of the year. Heavy rainfall later inundated catchment areas. Tweleve sub districts namely Selakau, Selakau Timur, Salatiga, Pemangkat, Galing, Jawai, Jawai Selatan, Sejangkung, Sajingan Besar, Teluk Keramat, Tebas, Sebawi were severely flooded in the occasion. The depth of inundation was reported 3 meters in some places. Surge of seawater and continuous heavy rainfall were behind the huge flooding.

Map 7: Flooded Sub Districts in 2012



Source: collected from various sources (see Appendix 1)

4.2. Potentially flooded Sub Districts in Sambas Regency

From obtained data of historical events of flooding in Sambas Regency 2007 until 2012, it is found that some sub districts experiences more frequent flooding than others. For instance, Selakau Sub Districts experienced flooding every year during that period, while Subah Sub Districts relatively free from the disaster. However, it is important to consider that in fact, the data might not cover all the reality on field. Subah Sub District for example, may also experience flood in the period,but missed by media and government attention. However, the absence of attention at least indicates that there is no significant flooding event in the area in which crops or the population was impacted.

Table 4: Flooded Sub Districts by Year

No	Sub Districts	Year						Count
		2007	2008	2009	2010	2011	2012	
1	Paloh			x		x	x	3
2	Galing	x	x		x	x	x	5
3	Sajingan Besar	x			x	x	x	4
4	Teluk Keramat		x		x	x	x	4
5	Sejangkung	x	x	x	x		x	5
6	Sambas	x			x	x		3
7	Sajad			x	x			2
8	Subah							0
9	Sebawi					x	x	2
10	Tebas	x			x		x	3
11	Tekarang	x					x	2
12	Tangaran					x	x	2
13	Jawai				x	x	x	3
14	Jawai Selatan	x			x	x	x	4
15	Semparuk				x			1
16	Pemangkat				x	x	x	3
17	Salatiga				x	x	x	3
18	Selakau	x	x	x	x	x	x	6
19	Selakau Timur		x		x	x	x	4

Source: processed from various sources (see Appendix 1)

Regarding number of flooding experiences, sub district in Sambas Regency can be grouped into several categories. The grouping can be helpful in the formulation of flood risk management.

Table 5: Sub Districts by Group of Risk to Flood Hazards

Sub Districts	Group	Descriptions
Selakau, Selakau Timur, Sejangkung, Sajingan Besar, Jawai Selatan, Teluk Keramat and Galing	High	Flooded almost every year; depth of water may reach 2-3 m;
Paloh, Pemangkat, Tangaran, Jawai, Salatiga, Sebawi, Sajad, Sambas, Tekarang and Tebas.	Medium	Flood may happened because of combination between heavy rainfall and surge of seawater;
Semparuk and Subah	Low	Flood may happened but with short time and less depth of inundation.

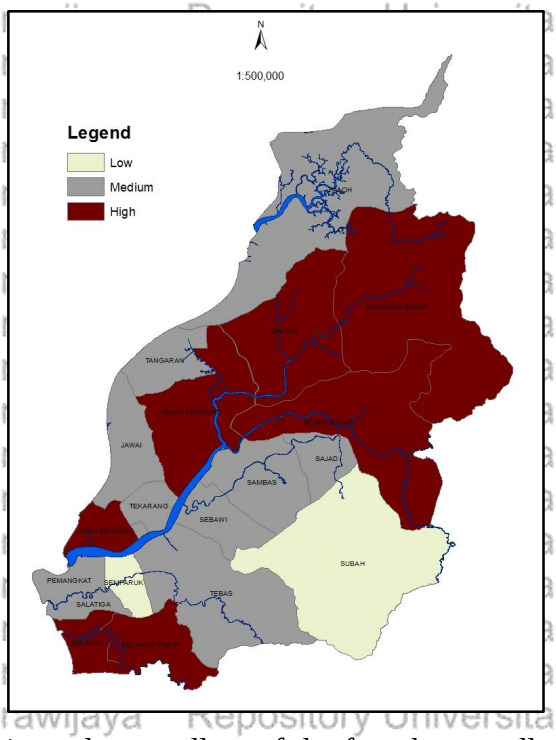
Selakau, Sejangkung and Galing are sub districts on the first group (Highly potential flooded sub district). Those sub districts experienced flood disaster almost every year. Magnitude of floods is also more severe in those sub districts compare to others. Selakau, due to its position is one of most vulnerable sub district to flood hazards. Both coastal flood and riverine slow-onset flood are potentially happened in this sub district. In Sejangkung, flood is potentially happened in Sepantai Village and Semanga Village. Narrow and swirling river is hardly accommodating waters from huge catchment area of Sambas River. Deforestation in the headwaters of the catchment area exacerbates the potential. Similar thing is also happened to Galing Sub District.

Selakau Timur, Jawai Selatan, Teluk Keramat and Sajingan Besar are three sub districts that also can be categorized as the first group. Those sub districts just slightly less flooded than those in the first group. Riverine slow-onset floods are most common happened in the sub districts. In Sajingan Besar, flood potentially occurs particularly in Santaban Village which is located in Sambas River Catchment, and Sungai Bening Village which is located in Paloh River Catchment.

The second group (Medium potential flooded sub district) includes sub districts namely: Paloh, Pemangkat, Tangaran, Jawai, Salatiga, Sebawi, Sajad, Sambas and Tebas. Paloh, Tangaran, and Pemangkat are coastal sub districts. Surge of seawater may influence the flood occurrence in the sub districts. Salatiga, Sebawi, Sambas, and Sajad are influence by riverine systems. Overall, flood happened in the third group of sub districts is mainly related to combination of heavy rainfall and surge of seawater level.

The third group (Low potential flooded sub district) is including Semparuk and Subah. This group of sub districts is relatively save from flood risk. Flood in Subah usually occurs in a very limited area, and mainly in non-populated area. Some roads may be blocked by inundation in the sub district but usually will discharge in relatively short time. Semparuk Sub District is also similar. Flood tends to be happened just in shorter time and with less significant depth of inundation in the sub district.

Map 8: Flood Map by Classified Sub Districts



The analysis above is made regardless of the fact that usually not all parts of the sub districts were flooded. Often, flood happened only in one or several villages within the sub districts. Sajingan Besar Sub Districts for example, mainly only inundated in two villages of its five villages. To draw more accurate maps, aerial images can be very helpful. Since the data is not obtained, the above data can be combined with other topographical data such as of elevation points and catchment systems.

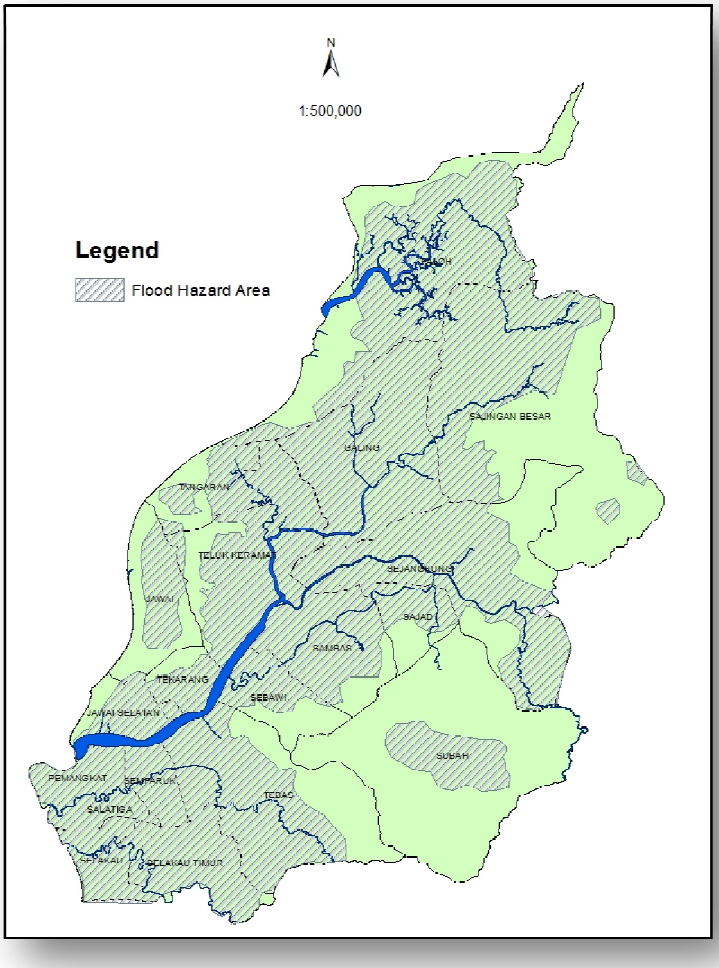
Data collected from Bappeda (Local Development Planning Agency) indicates that there are 271 low elevation points dispersed over Sambas Regency. Those elevations points are areas in which water potentially collect. Map of flooded area in 2011 indicates that flood happened in which low elevation points are located.

From the low elevation points, catchment systems and historical flooding events, a map of potential riverine slow-onset flooding area is drawn as can be seen from Map 9 below.

Sambas River Catchment is large floodplain. In fact, this river catchment area is very broad. It spans beyond borders. Some of its streams connects water system in Bengkayang Regency and even reach parts of Malaysian territory. Therefore, this river catchment collects water from a very large area and transports it through channeling system that end to Natuna Sea (South China Sea). Critical point of this catchment system is in Sejangkung Sub District in which all waters from upper streams have to meet and

flow through narrow and swirling channel. Historical records show that floods usually happened in the area.

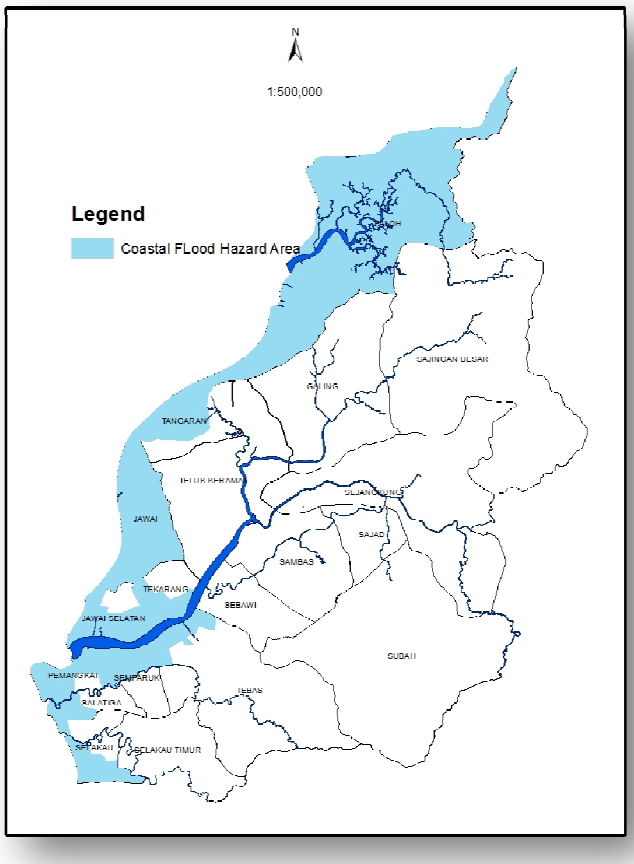
Map 9: Riverine Slow-Onset Flood Hazard Map



Selakau River Catchment is unique. Like Sambas River Catchment, it also collects water from large area. The streams reach Bengkayang Regency and Singawang City. It is a swirling and narrow river. The river catchment is sitting on a very low and flat area. That is why villages along this river easily flooded during heavy rain.

Selakau Sub District, as the mouth of Selakau River Catchment area also threatened by surge of seawater. During stormy season on December and January, seawater usually surge into several villages of the sub districts. Surge of seawater also may inundate several villages in Pemangkat, Jawai Selatan, Jawai, Tangaran, Paloh and sometimes may also surges deeper into Sambas River until Tekarang and Tebas.

Map 10: Coastal Flood Hazard Map



4.3.Live with flood hazards, poor household and the vulnerability

Generally, poor farmer households are suffer a lot due to floods. Extreme inundation not only destroys their crops but also disrupts their livelihood. Often, they are unable to cultivate on their lands for month after flood that makes their recovery even longer. Coastal floods for example, surge of salted seawater need several months before the inundated land can be re-cultivated. In some inner land area, similar case can also happen.

> Often, flood brings bad water. It stinks and harmful to crops. Usually it takes three month after flooding before we can cultivate crops like cassava or corn. (Mr. Hadi 42, Gayung Bersambut Villages)

Crop failure may lead to prolonged burden to poor farmers' household. However, short effects of floods are more sorrowful to farm laborer. Below is explanation of results of in-depth interviews to investigate people vulnerability to flood.

- **Food:**

In Sambas Regency, majority of poor farmers use their harvests for domestic consumption. For other purposes such as for electricity, school and health costs, they usually work as laborers beside their activities on their own land. It is also often for them to divide their jobs among family members. Women usually work on paddy field or tapping rubber trees, while men become laborers for cash.

Damage of crops such as paddy means shortage of food stocks for farmer households. Three months are the time to grow paddy and totally five to six months from the preparation (land clearing) to harvest. People cultivate paddy on their land for twice a year. Therefore, once fail of harvesting crops means lost six months staple food supply. In such condition, farmer households depend on other source of livelihood to fulfill their daily need of food. As consequence, they have to sacrifice other budgets such as for education and health.

On the other side, not all of farmer households have land for cultivating crops for staple food. Some of them work for other farmers. In term of short time impact, such households are more vulnerable to flood. Their daily food is obtained from wage as laborers. The wage is used for supporting daily need of food. Once they lose income, they will soon involve in shortage of food supply.

Mr Hadi (42 years old), a labor farmer from Buduk Sempadang Hamlet of Gayung Bersambut Village in Selakau Sub Districts told that sometimes his family experience starvation during flood because they have no enough food stock and unable to buy rice, the staple food of most Indonesian.

> During flood we eat what ever left at home. We do not cultivate rice. We usually do fishing (during flood). If we lucky, we can get 1 to 2 kg fish that we can change to 1-2 kg rice. If we do not get the fish, then we are dependently live by support from aid or help from relatives who lives not here. One month (duration of flood) is not a short time. Sometime, we have nothing to eat. (Mr. Hadi, 42)

However, in term of food supply, not all farmers so suffer as Mr. Hadi did. Mr Aspia (55 year old) from Sei Daun Village for example, the owner of coconut tree and rubber tree gardens mention that he still able to fulfill his daily need of food during one-month period of flood. Even though it is not really the same as it does in normal life. Similar answer is also stated by Jamani (37 years old) and Marjini (49 years old), both also live in Sei Daun Village. Jamani is truck driver and Marjini is timber collector.

> Usually flood remains for one month. Our daily meals are not the same as in normal, but we still eat everyday. (Aspia 62)

> We hardly get food during flood. But at least we are still able to eat every day. Usually we get food aid during floods. (Marjini 49)

> During flood we consume instant noodle and rice. Usually we got food aid from local government and students. It does not enough but very helpful. (Jamani 37)

- **Housing:**

Often, main focus of flood effects is on housing aspect rather than other aspects. In fact, people are more resilience to flood in this aspect, at least in comparison to other aspects such as food and livelihood.

Basically people have adapted their housing with flood since a very long time. In Sambas Regency, people usually make 'Parak', a leveled space inside their houses. They use the space as shelter during inundation. Valuable properties are brought there. It can be done because flood comes gradually that enable them to prepare.

Picture 2: a house with 'Parak' as anticipation to flood

In some cases, the magnitude of flood may have been increase but still not so much influence people's houses. Usually, minor damages are sometime happened but they will soon able to fix it, one thing that they hardly do with damaged crops. Besides, people also usually have prepared their houses for flooding event.

In Buduk Sepadang Hamlet of Gayung Bersambut Village, Selakau Sub District, Local Government established a residential area consists of several houses for local people. The houses are designed to be 2 meter single-leveled which makes people not so

comfort. The highness of elevation is accused to cause many accidents for children. It is also not suitable for old people who need a lot of effort to get in the house. Many of the houses then abandoned.

> Once I lived there but I feel not comfort with the design and situation. I built my own house here. My house is designed for two seasons. In dry season children can easily get in the house, during flood we move to higher level (Mr. Hadi 42)

Picture 3: Mr. Hadi and his two-levelled house

- **Livelihood:**

Disruption of livelihood during flood is sorrowful to people, particularly the poor who depends on daily income basis for fulfilling daily need such as food, electricity bill, or education and health costs.

Disruption of livelihood caused by flood can be in many forms. For farmers, damage of crops is one example. They also cannot do their activity in farming land. For labor farmer, they are also unable to do activities during flood. Rubber tappers are also almost impossible to tap the tree during flood, even though the main cause is not always the flood but rain that wet the trees.

As aforementioned, mainly households in Sambas Regency have two livelihoods. The women work on paddy field and the men as laborers. The paddy field is prepared for food stock and wage from labor work for other daily costs. The two sources of income model is useful in case flood may disrupt one but not the other. However, if the magnitude of flood reaches extreme level, both livelihoods may also be disrupted.

> In this village (Gayung Bersambut), women usually work on paddy fields and the men go to other cities like Singkawang for cash. Usually the men work as carpenters or do other works, the women cultivate paddy for their own consumption, not for commercial. (Mr. Tri Hardiyanto 36 years old)

> Daily we (majority of Village population) work as labor farmers or rubber tappers. But during flood none of that work can be done. Me myself work for other farmers while I do cultivate palm oil plantation of my own. I usually work three days for others and one or two days in my own land. (Mr. Hadi 42)

In coastal area, besides damaging crops, floods also disrupt livelihood by damaging fishponds. Damages to fishponds may cause a huge amount of economic losses. For instance, in 2012, surge of seawater in Sambas Regency has caused losses to fishpond farmers at amount that can reach hundred thousands US Dollar (See Appendix1). Fortunately, fishpond farmers are usually able to recover sooner because they can cultivate their ponds just after inundation. Besides, usually not all of their products damaged during flood and economically they are better.

In some extent, flood also beneficial to certain population. Timber gatherers/wood gatherers are those who take advantage from flooding. They can easily transport their products during flood.

- **Health:**

In term of health, children are more vulnerable to flood. Diarrhea is one disease that spreads easily during flood. Almost all flooded area in Sambas Regency is vulnerable to diarrhea spread. In some cases, diarrhea can spread and reach area that is not directly inundated by flood. It is related to water consumption that still relies on wells and river's water.

Expecting mothers and sick people are actually more vulnerable to flood. Transportation obstacles during flood may become hindrance for such people to reach health services. Pepen (33), a paramedic, said that expecting mothers are those that may in trouble due to transportation obstacles as resulted from flood occurrence.

Below is the summarization of all information perceived from key informants in the in-depth interviews. Answers from informants are cross-checked with other informants to ensure the consistency.

Table 6: Vulnerability during flood

Household	Food	Housing	Livelihood	Health	Coping Strategy
Farm laborer	Suffer	Troubled	Suffer	Suffer	Aid
Farmer	Troubled	Troubled	Suffer	Suffer	Owe /Aid
Woodgatherer	Troubled	Troubled	Benefited in moderate flood	Suffer	Owe/Aid
Truck Driver	Troubled	Troubled	Disrupted	Suffer	Owe/Aid
Rubber Tapper	Troubled	Troubled	Suffer	Suffer	Owe/Aid

Table 7: Vulnerability One to three month after flood

Household	Food	Housing	Livelihood	Health	Coping Strategy
Farm laborer	Normal	Normal	Normal	Normal	-
Farmer	Troubled	Normal	Suffer	Normal	Aid
Woodgatherer	Normal	Normal	Normal	Normal	-
Truck Driver	Normal	Normal	Normal	Normal	-
Rubber Tapper	Normal	Normal	Normal	Normal	-

Note:

- Key informants that represent each household:

Farm Laborer:

Mr. Hadi (42 years) is living in Buduk Sempadang Hamlet of Gayung Bersambut Village, Selakau Sub District; family members 5.

Wood gatherer:

Marjini (49) is living in Sei Daun Village of Selakau Sub District; Familiy members 4.

Truck Driver:

Jamani (37) is living in Sei Daun Sub District; Familiy members 4

Rubber Tapper:

- Abdul Muis (46) is living in Lubuk Lagak Hamlet of Kampung Dagang Village, Sambas Sub District
- Sunardi (35) is living in Senabah of Subah Sub District; family members 3.

o Darmaji (51) is living in Lubuk Lagak Hamlet of Kampung Dagang Village, Sambas Sub District

Farmer (land owner):

Aspia 62 is living in Sei Daun Village, Selakau Sub District; family members 3

- Second opinion/cross checkers (for the detail see appendix 2):

a) Minhad
b) Tri Hardiyanto
c) Budi
d) Uci Triatna
e) Totok
f) Efizar
g) Eko Susanto
h) Pepen
i) Rudi
j) Agus Supardan

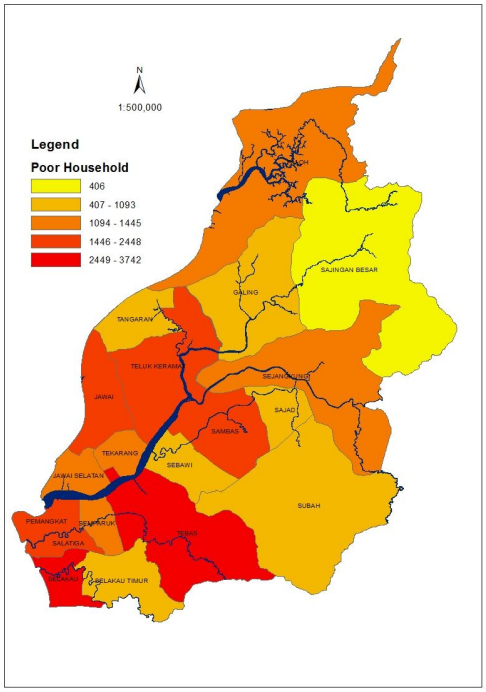
4.4.Vulnerable households in vulnerable sub districts

Selakau Sub District is area with high vulnerability to flood. This sub districts is the area in which two types of flood hazards potentially happened. While, population of poor households is also higher in this sub districts. The worse thing is that majority of the poor population is farmer households.

The other sub districts with high vulnerability are Selakau Timur, Jawai Selatan and Teluk Keramat. Here, flood hazards are potentially happened and number of poor population is relatively high, even though number of poor farmer household not as many as in Selakau Sub District.

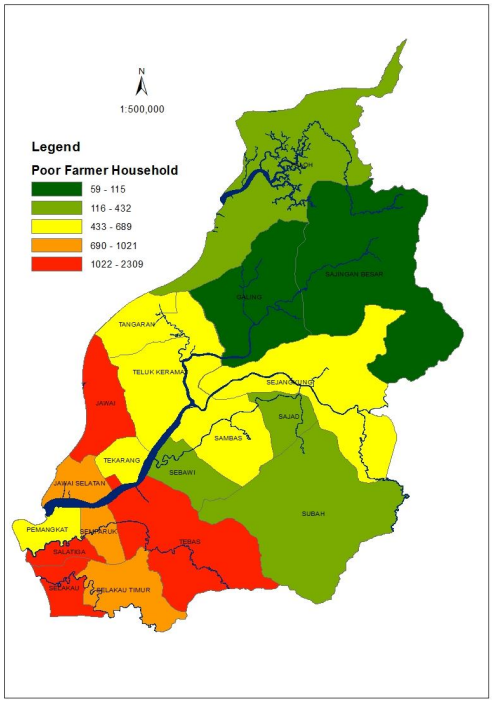
Tebas, Jawai, Pemangkat, Sambas and Salatiga, even though categorized into medium flood hazards area, are vulnerable because populated with many poor households. Particularly Tebas and Jawai that has many poor farmers household population. Meanwhile, Sajingan Besar, Galing, and Sejangkung are aggregately less vulnerable to flood as few poor populations can be found in the area. Even though the sub districts are potentially flooded.

Map 11: Number of poor household in Sambas Regency year 2012 by Sub District



Source: Processed data obtained from Bappeda

Map 12: Number of poor farmer household in Sambas Regency year 2012 by sub district



Source: Processed data obtained from Bappeda

CHAPTER V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

There is an increasing tendency of flood events in Sambas Regency. Within period of 2007 until 2012, almost all of sub districts in the area experienced flood events at least in some of its villages. Number of sub districts flooded tends to grow from year to year. Data shows that at least 10 damaging floods have been occurred and caused a lot of losses.

Basically, there are two types of flood hazards in Sambas Regency. Coastal floods are commonly happened in coastal villages including some villages in the mouth of Sambas River. While, riverine slow-onset flood covers a greater area that includes almost all sub districts in Sambas Regency.

The intensity and magnitude of flood hazards vary among sub districts. Generally, in terms of potentiality to be flooded, the sub districts can be grouped into three categories: first, Selakau, SelakauTimur, Sejangkung, SajinganBesar, Jawai Selatan, TelukKeramat and Galing are highly potential flooded sub districts; second, Paloh, Pemangkat, Tangaran, Jawai, Salatiga, Sebawi, Sajad, Sambas, Tekarang and Tebas are medium potentially flooded sub districts; and the third, Semparuk and Subah that are low potential to be flooded.

There are two types of people vulnerability to flood, during flood vulnerability and after flood vulnerability. During flood vulnerability is inability to withstand flood hazards while it is happening. After flood vulnerability is effects caused by flood hazards that makes people suffer for longer period even though the hazards have already gone.

Generally, poor farmer households are more vulnerable to floods. Damaged crops and disruption of livelihood are two main causes of why they more vulnerable to flood. For poor farmer household, time required to recover following damaged crops is longer.

In term of during flood vulnerability, farm labourer households are more vulnerable to flood. This type of households relies on daily income for fulfilling their need of food supply. Disruption of livelihood caused by flood will soon result in shortage of food for the households.

Combining potentiality of being exposed to flood hazard and concentration of vulnerable population, Selakau Sub District is the area with high vulnerability to flood, because it is highly potential to be exposed to flood hazards and populated by many

vulnerable households. The other sub districts with high vulnerability are SelakauTimur, Jawai Selatan and TelukKeramat. Here, flood hazards are potentially happened and number of poor population is relatively high, even though number of poor farmer household not as many as in Selakau Sub District.

Tebas, Jawai, Pemangkat, Sambas and Salatiga, even though categorized into medium flood hazards area, are vulnerable because populated with many poor households. Particularly Tebas and Jawai that has many poor farmers household population. Meanwhile, SajinganBesar, Galing, and Sejangkung are aggregately less vulnerable to flood as few poor populations can be found in the area. Even though the sub districts are potentially flooded.

5.2 Recommendations

From the above assessment of vulnerability to flood, it can be found that some sub districts are more vulnerable to flood then others. Selakau Sub District, in term of flood hazards and characteristics of its population is the most vulnerable sub district in Sambas Regency. Policy makers should pay more attention to the vulnerable sub districts and their vulnerable population.

The focus of attention should also be paid towardstwo dimensions of vulnerability to flood: during flood vulnerability and after flood vulnerability. During flood vulnerability is related to emergency response, while after flood vulnerability is related to post disaster relieve programs. This research suggests that different population atributes should be approached in regard to their specificity. Farm labourers for example, are more vulnerable during flood than farmers, but farmers are much suffering after flood as they need to re-cultivate their land which often must sarifice other aspects of their lives.

The other important thing that should be considered is that the increase in the damaging flood events much influenced by human activities in the headwaters, it is also important to strengthen prevention actions, particularly by managing forests utilization in the headwater of river catchments. Forest is not only prevention tools in flood risk management system, but also source of livelihood to people as a choice of coping with flood. For instance, timber gathrers/wood gatherers are those beneficiarry to flooding as long as they can appropriate forestry products. Many people around forest also depend on forestry products as a coping strategy during flood events. Therefore, lost of forest will exacerbate not only the magnitude of flooding but also vulnerability of people.

Acknowledgements

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Appendices

Appendix 1*:*

Period	Location	Depth	Flooded Area	Damages	Source
2 - 5 jan 2007	Sub districts: Sejangkung, Sambas, Selakau, Tebas, Sajingan, Tekarang, Galing, Jawai Selatan (Villages; Bukit Sekuler, Samalagi, Selakau Tua, Sei Daun, Semanga, Senuju, Sendoyan, Sijang)	2 - 3 m		1940 houses, 3000 ha paddy fields and 6000 ha citrus plantation	*Source: http://www.pu.go.id/publik/ind/produk/info_peta/rwnbanjir/bencana2007/61indexbanjirsambas.htm retrieved on 4/20/2013 at 14:16*
June-07	Sambas Regency		11,160 ha of cultivated area	268 hectares of cultivation	*Source: Laboratory of Pest and Plantation Disease Control of West Kalimantan Province, Sambas Office.*
First week of January 2008	8 sub districts including Selakau, Selakau Timur and TelukKeramat (20 villages)	175 cm		1.000 houses in (2.138 households/ 12.185 people)	*Source: http://otomotif.kompas.com/read/2008/01/07/17415449/direktori.html Retrieved at 12;28 on 4/20/13*
First week of January 2008	Selakau (Gayung Bersambut), SelakauTimur (Buduk Sempadang, Seranggam) Galing (Sijang, Trigadu, Semayong and Tempapan Hulu) Sejangkung (Semangak and Sajingan kecil)				http://www.wartaterkini.com/89/69/44/banjir-masih-genangi-1-253-rumah-warga-di-sambas.htm retrieved at 14.00 on 6/26/2013
Apr-08	Sambas Regency		733 ha cultivated area	No damaged was reported	*Source: Laboratory of Pest and Plantation Disease Control of West Kalimantan Province, Sambas Office.*
January to Februar y 2009	Paloh (Kalimantan) Sejangkung, Sajad			Crops uncounted	*Local Government of Sambas*
Novemb er 2009	Selakau (Semelagi Besar, Pangkalan Bemban, Sei Daun and Bentunai			120 ha crops	*Local Government of Sambas*
January 2010	Selakau, Semparuk, Sajad, Teluk Keramat, Sejangkung, Tebas, Salatiga, Jawai Selatan, Pemangkat, Galing, Sajingan Besar, Selakau Timur, Sambas, dan Jawai.				http://istanaborneo.blogspot.jp/2010/04/banjir-sambas-bukan-takdir.html retrieved at 18:21 on 6/26/2013

Oct-10	Sambas Regency		12,192	2431 hectares of cultivation	*Source: Laboratory of Pest and Plantation Disease Control of West Kalimantan Province, Sambas Office.*
Jan-11	Sambas Regency			64 households evacuated, 1581 horticulture plantation, 4173 hectares plantation	*http://geospasial.bnpb.go.id/2011/01/26/peta-kejadian-bencana-banjir-di-kab-sambas Retrieved at 12;25 on 4/20/13*
Oct-11	Sambas Regency		90	18.5 hectares of cultivation	*Source: Laboratory of Pest and Plantation Disease Control of West Kalimantan Province, Sambas Office.*
Jan-12	Sejangkung (sepantai) Selakau (twimentibar, gayung bersambut)bentunai	2-3 m		Losses more than Rp. 2 billion	*http://pontianak.tribunnews.com/m/index.php/2012/01/20/banjir-sambas-rugi-2-miliar Retrieved at 13;33 on 4/20/13*
Jan 12	Selakau, Pemangkat, Jawai, Tangaran and Paloh			443 tons of fish and shrimp	*http://m.equator-news.com/sambas/20120202/banjir-443-ton-ikan-dan-udang-lepas?device=mobile retrieved at 17:13 on 6/26/2013*
January 2012	Selakau, Selakau Timur, Salatiga, Pemangkat, Galing, Jawai, Jawai Selatan, Sejangkung, Sajingan Besar, Teluk Keramat, Tebas, Sebawi.	2-3			*http://equator-news.com/utama/20120114/sambas-dikepung-banjir retrieved at 07:25 on 6/27/2013*

Appendix 2

Key Informants					
NO	**TITLE**	**NAME**	**AGE**	**ADDRESS**	**OCCUPATION**
1	Mr	Agus Supardan	50	Sambas City	Head of Social and Workforce Department of Sambas Regency
2	Mr	Eko Susanto	45	Sambas City	Officer at Health Department
3	Mr	Totok	36	Sambas City	Officer at Bappeda Sambas
4	Mr	Efizar	43	Sambas City	Officer at Local People Protection Office
5	Mrs	Pepen	33	Sabung	Paramedic
6	Mr	Budi	32	Gayung Bersambut	Citizen/Staf of Pest and Disease Controling Laboratory of West Kalimantan Province, Sambas Office
7	Mr	Trihardiyanto	36	Gayung Bersambut	Citizen/Staf of Pest and Disease Controling Laboratory of West Kalimantan Province, Sambas Office
8	Mr	Jamani	37	Sei Daun	Citizen/Truck Driver
9	Mr	Hadi	42	Buduk Sempadang	Citizen/Farm Laborer
10	Mr	Aspia	51	Sei Daun	Citizen/Farmer
11	Mr	Marjini	49	Sei Daun	Citizen/Wood gatherer
12	Mr	Asnan	52	Senabah	Citizen/Fomer Sub Village Chief
13	Mr	Suhardi	35	Senabah	Citizen/Rubber tapper
14	Mr	Abdul Muis	53	Lubuk Lagak	Citizen/Sub Village Chief/Rubber Tapper
15	Mr	Darmaji	51	Lubuk Lagak	Citizen/Rubber Tapper
16	Mrs	Sittam	60	Lubuk Lagak	Citizen/female headed household/Rubber Tapper
17	Mr	Minhad	36	Sekabau	Citizen/Current Village Secretary/civil servant
18	Mrs	UciTriatna	33	Gayung Bersambut	Citizen/Staf of Pest and Disease Controling Laboratory of West Kalimantan Province, Sambas Office

Appendix 3

Note: Picture shows timber gatherer transporting his products by small boat. (Insert: Family of Wood gatherers preparing their products); both pictures are taken during fieldwork in Sei Daun Village, Selakau Sub District