# RESILIENCE FOR THE 2007 FLOOD EVENT, USING COMMUNITY KNOWLEDGE: A Case in Part of Sukoharjo Regency, Indonesia

Thesis submitted to the Double Degree M.Sc. Program,
Gadjah Mada University and International Institute for Geo-Information Science and Earth Observation
in partial fulfillment of the requirement for the degree of Master of Science
in Geo-Information for Spatial Planning and Risk Management


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**DOUBLE DEGREE M.Sc PROGRAMME**
**GEOGRAPHY FACULTY OF GADJAH MADA UNIVERSITY**
**FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION (ITC) OF THE UNIVERSITY OF TWENTE**
**2011**

**THESIS**

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# DISCLAIMER

This document describes work undertaken as part of a program of study at the Double Degree International Program of Geo-Information for Spatial Planning and Disaster Risk Management, a joint Education Program of ITC Faculty of Twente University, the Netherlands and Geography Faculty of Gadjah Mada University, Indonesia. All views and opinions expressed there in remain the sole responsibility of the author, and do not necessarily represent those of the institutes.

Damayanti, S.

## Abstract

Sukoharjo is one of the regencies in Central Java Province that has been frequently struck by flood in recent years. The location of this regency, in the middle of Bengawan Solo Basin, has made Sukoharjo prone to flood. The knowledge of the community affected by flood is important to be incorporated in flood risk assessment. Community resilience becomes an important factor in a disaster mitigation plan. Resilience relates to the ability to recover from a disaster and is for every person different. However, data and information related to community resilience is rare. For this reason, this research intends to assess community resilience for flood disaster. This research intends to assess local community resilience for flood disaster. It is also aimed to generate the 2007 flood event map based on the perception of the people.

Primary data was collected through interviews to 80 respondents and focus group discussion (FGD) as well as participatory mapping. The study area was in *desa* Laban and *desa* Kadokan, which was struck by the 2007 flood event. The respondents were choosing randomly on those villages. Factors for quantifying community resilience were asked to respondent by giving questionnaire and interviewing them. While FGD was done in order to gain flood map based on community knowledge. Based on FGD result, the flood depth in both villages varies from 0 until 300 cm, while the duration of inundation varies from 1-7 days. Flood also caused losses, which the distribution of losses was Rp. 0 - 100,000,000,0. However generally the losses was bellow than Rp. 2,000,000,-. Resilience value of the respondent based on weighting result is distributed from 0.113 until 0.700. The average resilience value is *desa* Laban is 0.403, while *desa* Kadokan is 0.368. Most of the resilience value was influenced by human capital.

Generally, people in both villages can continue their life normally although they are not completely recovered. Culture of Javanese people and religion factors influenced to community recovery in term of psychology. Moreover, in order to increase the community resilience, government has established flood control devices and rehabilitated the dike along Bengawan Solo and Samin river.



**Key words**: Sukoharjo Regency, interviews, focus group discussion, participatory mapping, flood characteristics, community resilience.

## Acknowledgement

Alhamdulillahirobil'alamin praise belong to Allah SWT, Lord of the world. With permission and guidance from Allah, I can finish this job.

I would like to give gratefully respect to Dr. rer. Nat. Muh Aris Marfai, S.Si., M. Sc. And Drs. Nanette for their excellent supervises. The advice, suggestion, discussion and supporting during writing process of my thesis were very helpful.

My gratitude also goes to Faculty of Geography, Gadjah Mada University, Prof. Dr. H. A. Sudibyakto, M. S., Prof. Dr. Junun Sartohadi, and all of staff in Geo-Information for Spatial Planning and Risk Management for helping me during the study. I also express the gratitude to ITC of The University of Twente, Drs. Robert Voskuil, and Drs. Tom Loran for giving me opportunity to study in the friendly environment.

The huge gratitude goes to Bappenas and The Netherlad Education Center that provides scholarship for me to pursue Master programme in Gadjah Mada University and ITC. So many experience and valuable knowledge I got during studying in both campus.

During the fieldwork, people in *desa* Laban and *desa* Kadokan helped me in obtaining data and information related to my research. Therefore I would like to say thank you for the people in both village, especially The head village of *desa* Laban and *desa* Kadokan that made it possible for me to do my research.

Especially thank also to all of my classmates in Geoinfo Batch 5. That was a wonderful opportunity being your classmate during studying in Yogyakarta and Enschede. Special thanks to Ali, my fieldwork partner, for companying me in fieldwork and the discussion.

My heartfelt thanks to my angels: Tonny Kurniawan and Soraya Alya Azzahra for your love and affection which could give me the extra strength to through these difficulties. There is no sacrifice will be in vain. Deep sincere thank also goes to my mother, father, brother, and sister for your praying and support.

Yogyakarta, February 2011

Sinta Damayanti

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## Abbreviations

| | |
|---|---|
| Antaranews | Official News Agency of Indonesia |
| APFM | Associated Programme on Flood Management |
| Bakornas PB | *Bada Koordinasi Nasional Penanggulangan Bencana*<br>National Coordinating Board for Disaster Management |
| Bakosurtanal | *Badan Koordinasi Survei dan Pemetaan Nasional*<br>National Coordinating Agency for Survey and Mapping |
| Balai Penelitian Kehutanan Solo | Solo Forestry Research Cemters |
| Baplan | *Badan Planologi Kehutanan*<br>Planology Forestry Agency |
| Bappeda | Regional Planning Agency |
| BBWS Bengawan Solo | *Balai Besar Wilayah Sungai Bengawan Solo*<br>The Main Bureau of Bengawan Solo River |
| BNPB | *Badan Nasional Penanggulangan Bencana*<br>The National Disaster Management Agency |
| BPDAS Solo | *Balai Pengelolaan Daerah Aliran Sungai Solo*<br>Solo Watershed Management |
| BPS | *Biro Pusat Statistik*<br>The Central Bureau of Statistics |
| Depkominfo | *Departemen Komunikasi dan Informatika*<br>Ministry of Communication and Informatics of Republic of Indonesia |
| Desa | Village in regency |
| Dukuh | Sub area of *dusun* or equal with *RW* |
| Dusun | Sub area of village consists of some *RW* |
| Eceng Gondok | *Eichornia crassipes,* water plants with a high 0,4-0,8 m, usually used as material handy craft. |
| EM-DAT | Emergency Events Database |
| FGD | Focus Group Discussion |
| FHCR | |
| Gamelan | A set of Javanese instrument |
| GIS | Geographic Information System |
| Gotong Royong | Community's activities to work together and to help each other |
| GPS | Global Positioning System |
| ICSU | International Council of Science |
| IFRC | International Federation of Red Cross |
| Kecamatan | Sub-district |
| Kelurahan | Village in municipality |
| Koperasi | Cooperative union |
| OSHA | Occupational Safety and Health Administration |
| Ranggon | place bellow the roof that is used for keeping goods during flooding, made from bamboo or wood |
| RBI | *Rupa Bumi Indonesia* |

| | |
|---|---|
| | Topographic Map of Indonesia |
| Rp. | Rupiah (Indonesia's currency) |
| RT | *Rukun Tetangga*<br>Sub area of *RW* |
| RW | *Rukun Warga*<br>Sub area of village |
| SCS method | Soil Conservation Service method |
| Tagana | *Taruna Siaga Bencana*<br>Youth Disaster Response. Team that focuses its activity on disaster emergency respond |
| UNDRO | United Nations Disaster Relief Organization |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |
| UN-ISDR | United Nations International Strategy for Disaster Reduction |
| WHO | World Health Organization |

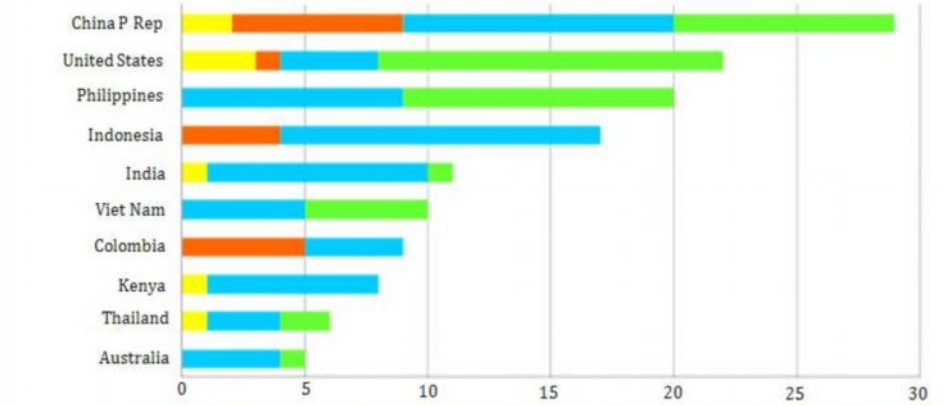
# 1. INTRODUCTION

*This chapter describes the general overview of research, consisting background of research, problem statement, objectives, research question, and benefit of the result.*

## 1.1. Background

One of the most common disasters that usually occur is flood. Flood has caused a big impact in terms of disruption and destruction to livelihood and the changes in the live of affected peoples. The characteristic of flood in each area is different in its duration, intensity, and frequency. The highest flood risk is area nearby the embankments or river. Therefore, people who live there will have bigger risk of flooding during the rainy season.

In terms of number of events, sixty percent of natural disaster that occurred in Indonesia throughout the year 2009-2010 is flood (Antaranews, 2010). The uncertainty of climate change and land use change as an impact of population growth are often suspected as the cause of flood. Moreover based on the characteristics of geographical and geological, Indonesia generally prone to flood. About 30% of 500 rivers in Indonesia cross densely populated areas (Bakornaspb, 2007). Most of the floods in Indonesia occur in the western part of Indonesia because this area has more rainfall than the eastern part. According to the Annual Disaster Statistical Review 2008, Indonesia is included in the top ten of countries experiencing disaster after China, United States of America, and Philippines. Most of the disasters that occurred in Indonesia are caused by geophysical and hydrological factor. Geophysical factors have caused disaster in Indonesia 4 times in 2008 while hydrological has caused disaster 13 times. The number of disasters of top ten most countries experiencing disaster can be shown in the Figure 1-1.




| | China P Rep | United States | Philippines | Indonesia | India | Viet Nam | Colombia | Kenya | Thailand | Australia | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Climatological | 2 | 3 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 8 |
| Geophysical | 7 | 1 | 0 | 4 | 0 | 0 | 5 | 0 | 0 | 0 | 17 |
| Hydrological | 11 | 4 | 9 | 13 | 9 | 5 | 4 | 7 | 3 | 4 | 69 |
| Meteorological | 9 | 14 | 11 | 0 | 1 | 5 | 0 | 0 | 2 | 1 | 43 |
| **Total** | **29** | **22** | **20** | **17** | **11** | **10** | **9** | **8** | **6** | **5** | **137** |

Figure 1-1. Top 10 countries by number of reported event in 2008
Source : Rodriguez et al., 2009

Sukoharjo is one of the regencies in Central Java Province that has been frequently struck by flood in recent years. The location of this regency, in the middle of Bengawan Solo Basin, has made Sukoharjo prone to flood. The Bengawan Solo river, as the main river in this watershed, crosses Sukoharjo and divides Sukoharjo into two parts. On the last three years, Sukoharjo experienced flood. The stream flow in Bengawan Solo river destroyed levee/ dike such as Kalan levee in *desa* Telukan in the year 2007 (Antaranews, 2007). This caused inundation in the village. The flood also let to evacuation of all the people of *desa* Kudu Grogol sub-district because the water depth reached 2 meter. Even some houses in the village were fully inundated. Sukoharjo also suffered losses about more than 500 million rupiah or more than 45 million euro in 2009 flooding (Kedaulatan rakyat, 2009). Furthermore, some figures of the 2007 flood event in Sukoharjo regency is shown at Figure 1-2

a b

Figure 1-2. Flooding in parts of Sukoharjo regency in the beginning of 2009.
a. Flooding in Kartasura Sub-district, b. Flooding in *Desa* Cemani, Grogol Sub-district.
Source : Public work agency

The knowledge of the community affected by flood is important to be incorporated in flood risk assessment (Wigati, 2008). The knowledge includes flood depth, duration, frequency, damage and their experiences in coping, preparing, and minimizing the damage. Their understanding of flood as a part of their environment is an important factor that should be considered by local government in establishing flood risk management (Febrianty, 2010).

Community resilience becomes an important factor in a disaster mitigation plan. Resilience relates to the ability to recover from a disaster and is for every person different. The level of recovery speed can be determined from experience, and internal/ external aid. Persons who have more experiences of certain disaster will be more resilient than person who does not. Also, external and internal aid in recovery process can increase the speed of recovery. Therefore, community resilience should be also considered in risk assessment that conducted by government in order to make mitigation plan.

Some researchers have used a participatory approach in generating information from local communities related to their behavior and perception of disaster. The information is different and unique between places/ areas since behavior and perception of disaster are related to culture and disaster characteristics. Therefore, the result of previous research can not be directly used in a risk assessment for other area. Febrianty (2010) has done research in flood risk perception and coping mechanism of people in Surakarta municipality. Although Sukoharjo

regency is nearby Surakarta municipality, which its culture is almost the same, the resilience between those areas may be different.

### 1.2. Problem Statement

As mentioned before, flood is the most frequent disaster that occurred in Indonesia. Local government has made plan and policy related to solve this problem. It includes disaster mitigation program. Risk assessment that is used by local government as a basis in disaster mitigation usually does not consider to community resilience yet. Recovery after disaster is an important factor that must be considered in disaster risk management. Each individual of community has different ability to recover. Therefore the speed of recovery will vary among the community.

However, recently some local governments in village level have made rules related to quick respond in disaster management. An example is the policy of the village head of *desa* Dalangan. Village head policy no. 360/01/IV/2009 mentions that it is needed to make an organization that consists of elements of the society that responsible to disaster management. One of the teams in the organization is responsible in recovery after disaster. The team is in charge of collecting data for recovery need and existing resources. However there is no specific data mentioned related to community resilience. Information related to resilience is rare. For this reason, this research intends to assess community resilience for flood disaster.

### 1.3. Objectives

The research intends to assess local community resilience for flood disaster. It is also aimed to generate the 2007 flood event map based on the perception of the people. The data usually can be collected by using a participatory approach. More specific objectives of this research are:

1. To generate the 2007 flood event map based on community knowledge.

   There are two villages that were used as case study area in this research. One of both villages is also a case study area of Achmadi's research (another student of this program that also doing his research in the same village with different focus). In this case researcher and

Achmadi used the same flood map that was generated by community but for different purposes.

2. To analyze community resilience for flood disasters.

## 1.4. Research Questions

Research questions have been formulated as shown in table 1.1

Table 1-1. Research Objective and Research Question

| No | Research Objective | Research Question |
|---|---|---|
| 1 | To generate flood map based on community knowledge | a What is flood distribution in the study area based on community knowledge<br>b What is water depth in the study area based on community knowledge<br>c What is flood duration in the study area based on community knowledge<br>d What is damage level in the study area based on community knowledge |
| 2 | To analyze community resilience for floods | a What defines community resilience<br>b How can community resilience be quantified<br>c How is community resilience in the study area<br>d What is the relation between flood severity and<br>e community resilience |

## 1.5. Benefit of the Research

This research provides information related to community resilience in risk assessment as a basis of disaster mitigation related to flood hazard.

# 2. LITERATURE REVIEW

*This chapter reviews the related literatures used to support the research. This chapter consists of the general understanding of hazard and disaster, definition of flood hazard, disaster, coping capacity, vulnerability, resilience, and participatory GIS*

## 2.1. General Understanding of Hazard and Disaster

### 2.1.1. Flood Hazard

There are definitions of hazard. Hazard can be defined as "the potential of harm" (source :http://www.osha.gov). Moreover UNDRO, 1991 defined hazard as "the probability of occurrence within a specified period of time and within a given area of a potentially damaging phenomenon". Hazard also is defined as an extreme natural event with certain degree of probability of having adverse consequences (Garatwa and Bollin, 2002). Westen et. al., (2009) writes that a hazard is "a potentially damaging physical event, phenomenon or human activity that may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation". A similar understanding of hazard also states by Ericksen (2004). He defined hazard as "the relationship that can be seen between a potential natural event in a given area and the actual or potential human occupation or use of that area". Based on the cause, hazard can be distinguished into natural hazard and human-induced hazard (ICSU, 2005).

According to APFM (2008), flood is the combination result of meteorological and hydrological condition of an area. For some cases flood also caused by human induced factor. Therefore, flood hazards have to be seen as combination resulting from natural and man-made factors. Furthermore this organization groups/ classifies flood into local floods, river floods, flash floods, and coastal flood. Local flood is caused by bad drainage as the impact of urban development. This flood usually occurs during rainy season. The second type of flood, river floods, occurs as the impact of river run-off volume exceeds local flow capacities. This flood is triggered by heavy rainfall or snow melt in upstream or tidal influence. The third flood type, flash flood, is common in mountain and desert areas. This flood is the result of rapid accumulation and release of run-off water. Coastal flood is caused by high tides and storm. This flood usually occurs in city that is located in estuary.

### 2.1.2. Disaster

A hazard might lead to a disaster. Disaster usually defined as "an event that overwhelms the capacity to cope with it" (Europe. Spatial Planning Observ (2003) in Thywissen, (2006)). Furthermore according to IFRC (1993) in Thywissen (2006), a disaster is fundamentally a socio-economic phenomenon. United Nation in Garatwa and Bollin (2002) also defines disaster as "a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope using only its own resources". A disaster occurs when the live of individuals and communities are directly threatened by disaster agent. Furthermore McFarlane and Norris (2006) in Norris et al. (2007) defined disaster as "a potentially traumatic event that is collectively experienced, has an acute onset, and is time delimited; disaster may be attributed to natural, technological, or human causes. Disaster trend shows that most of disaster that occurred is caused by hydro meteorological (ICSU, 2005).

A worldwide database on disaster (EM-DAT) in Rodriguez et al., (2009) distinguishes disaster into two groups : natural and technological disaster. Furthermore the natural hazard is grouped into five sub-group : biological, geological, hydrological, meteorological, and climatology hazard. Based on the group, flood is a natural hazard that caused by hydrological factor.

## 2.2. Coping Capacity

Capacity is "combination of all strength and resources available within a community or organization that can reduce the level of risk, or the effect of a disaster. It may include physical, institutional, social or economic means as well as skilled personal or collective attributes such as leadership and management. Capacity may also be described as capability" (UN-ISDR, 2004 in Westen & Kingma, 2009). Related to flood, Rossi et al., (1994) in Wigati (2008) said that coping with flood is define as all those measures, with necessary policies and strategies of implementation, which a society may apply to alleviate the consequences of flood events. This may also include "doing nothing" except learning and adjusting to flood phenomena.

Coping capacity together with damage potential are measured in order to define overall regional vulnerability (Kumpulainen, 2006). Furthermore, he also mentions that ability of community or

region in preparing or responding toward hazard must be measured in coping capacity indicators. The indicators measure both on human properties or the existence of infrastructure.

Marschiavelli (2008) in Febrianti (2010), mentions that coping strategy within community is transmitted from generation to generation. Furthermore, WHO (1999) states that coping strategy is cultural. There are no standard about coping strategy. Therefore coping strategy is very depending on and is influenced by socio-cultural factors.

### 2.3. Vulnerability

There are some definitions about vulnerability. Birkman (2006) describes the extent of this word meaning. Every discipline group may have their own view of vulnerability, such as disaster management agencies, climate change organizations, academic staff, etc. Generally vulnerability can be distinguished into two; social vulnerability and in the context that related to climate change, for example, vulnerability describes the extent to which a system is susceptible to sustaining damage from climate change (Schneider and Sarukhan, 2001). EMA (1995) in Westen et al. (2009) defines vulnerability as the degree of susceptibility and resilience of the community and environment to hazards. Furthermore according UNDRO (1991) in Westen (2009), vulnerability is the degree f loss to a given element at risk or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude and expressed on a scale from 0 (no damage) to 1 (total damage). Wisner et al. (2004) defines social vulnerability as the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard.

### 2.4. Resilience

World Conference on Disaster Reduction has stressed in developing vulnerability indicators, both at national and sub-national scales, (Birkmann, 2006). Moreover UN (2005:9) in Birkmann (2006) states that these indicators will enable decision-makers in assessing the impact of disaster. According to UNESCO (2003) in Birkmann (2006), resilience is one of indicators that must be considered in risk assessment. Furthermore the resilience position in risk assessment framework can be shown as follows :

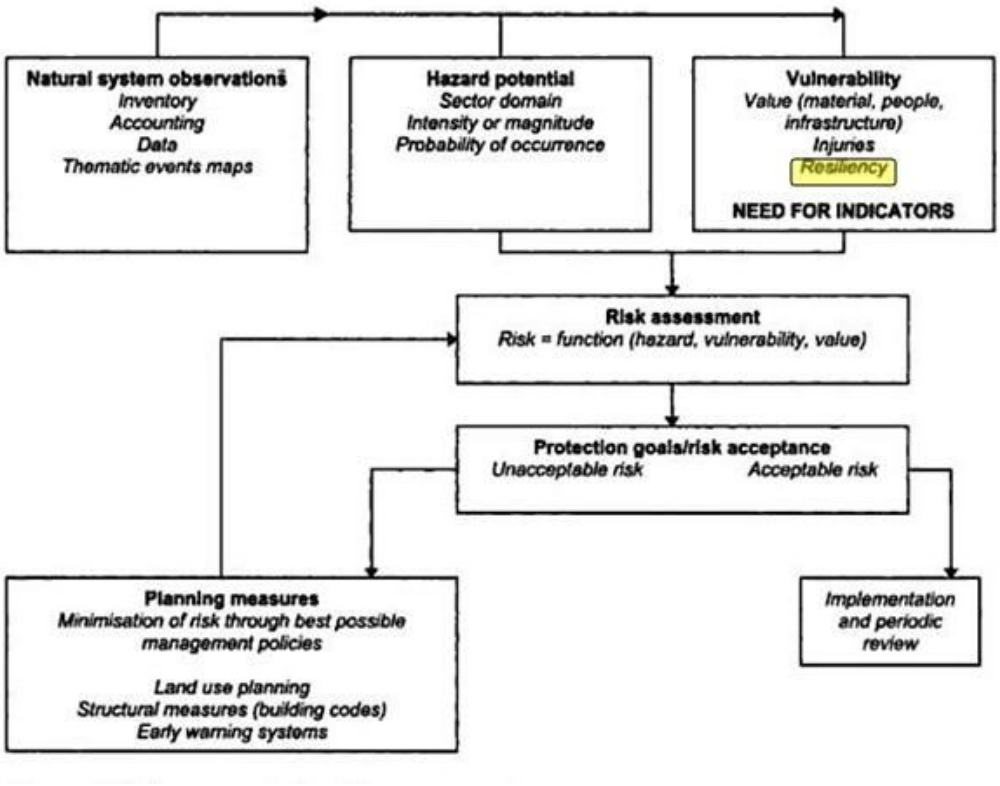



Figure 2-1. Resilience in risk assessment framework
Source : UNESCO (2003) in Birkmann (2006)

There are different definitions of resilience. The word "resilio" in Latin means "to jump back". Rose (2004) in Gwimbi (2009) defines resilience as a "process of, or capacity for, or the outcome of successful adaptation despite challenging and threatening circumstances". Schneider and Sarukhan (2001) define resilience as the flip side of vulnerability. Resilience is often considered to be the opposite of vulnerability (O' Brien at al., 2004). Moreover Buckle (1998) in Thywissen (2006) writes that resilience is the capacity that people or groups may possess to withstand or recover from emergencies and which can stand as counterbalance to vulnerability. Related to natural disaster, Ibarraran et al. (2009) stated that resilience is the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self organization, and the capacity to adapt to stress and change. Furthermore, in term of natural hazard, resilience is defined as the coping capacity related to recover ability from impacts of hazard (McEntire, 2001; Clark et al., 1998 in Islam et al., 2010). Some people may be better than others in recover ability after facing certain disaster. Therefore

everyone has different resilience. Vulnerability can affect to resilience. However resilience can increase or decrease independently (Antaranews, 2007). An example is insurance. Insurance cannot reduce the house damage, but it will help people to recover (financial support) after the occurrence of disaster. In this case resilience does not affect vulnerability in term of physical damage.

According to Islam et al. (2010), there are five major forms of capital in building community resilience. They are natural capital, economic capital, physical capital, social capital, and human capital. Saving, income, investments and credit are economic capital that describes financial resource for achieving people's livelihoods. Sulivan and Sheffrin, (2003) in Islam et al. (2010) also explain that human capital refers to skills and knowledge. Furthermore human capital can be associated with education, health, skills, knowledge, or information. It can increase people's understanding or perception of community risk and their ability in developing and implementing risk reduction strategies.

This research defined resilience as the ability of a community to recover from impact of flood. Variables that were investigated in order to define community resilience data are

1. Flood Experiences. Islam et al. (2010) states that human capital in community resilience can be associated with skills and knowledge which can be acquired trough experience. Therefore this research investigated flood experiences of respondents as variable in defining community resilience
2. Education. According to Tunstall, S. (2007), education as reflected in social grade is one of demographics factor that influence to resilience. People who have higher education level can be more articulate and more able to get help than people who have lower education. Therefore, the higher education level correlates to the more resilient of people. Islam et al. (2010) categories education in the human capital in community resilience since education also can increase community skills and knowledge.
3. Financial resources. There are elements in financial resource that were investigated. They are savings, family and/ or relation financial support, the sale of property, and loan. Islam et al. (2010) categories financial resources in economic capital that is very important in building disaster resilience. This is reasonable since financial resource can increase individual or

communities in absorbing disaster impacts and speed up process of recovery (Mayunga, 2007 in Islam et al., 2010).

4. Speed of recovery in term of cleaning up the house. McEntire (2001) in Islam et al. (2010) relates resilience with ability to recover quickly from impacts of hazard. Cleaning up the house from mud usually the first activity that people do after disaster in order to continue functioning of their life.

### 2.5. Participatory GIS

Participatory GIS (pGIS) has potential democratic in bottom-up decision making from and for community Moreover, pGIS is primary local stakeholders and community involvement. Marfai et al. (2008) mentioned that socio-economic characteristic of community is the key factor in flood mitigation. This is because local community provides important information related to causes, effect, and how community cope with the hazard.

Chapter V clause 26 (1:e) of Disaster management laws of Republic of Indonesia no 24 year 2007 mentions that every person has a right to participate in disaster mitigation decision making. Since result of risk assessment of certain disaster is used as consideration in making mitigation plan, community perception is important to be considered. This is because community is the one who experience with that hazard. Therefore every plan that related to them should be consider to their view.

This research used pGIS in the method. Participatory GIS was used in generating flood map which it included flood extent, flood depth, flood duration. Since there are some parameters that were measured in community resilience, pGIS also used in defining weighting value. The value is used to determine the resilience of some respondents that can describes community resilience in the study area.

# 3. STUDY AREA AND RESEARCH METHODS

*This chapter introduces the general overview of study area and method that used in this research. The discussion comprises the general overview of Sukoharjo regency, topography and climate, general description of Solo basin, general profile of surveyed desa, characteristics of the 2007 flood event in Sukoharj, flooding history in study area, data collection, questionnaire and interview, and Focus Group Discussin*

## 3.1. Study Area

### 3.1.1. General Information of Sukoharjo Regency

This research took location in two *kelurahan*/ villages in Sukoharjo that were affected by flood in 2007. Sukoharjo is one of some regencies in Surakarta ex residence, one of the most important residence in colonial time. Its location is in the south part of Surakarta municipality. More than half of its area is covered by paddy field. Therefore agricultural is the major sector that contributes significantly to its economical growth.

Total population of Sukoharjo regency in 2006 was 813.657 (BPS, 2006) which its density is 1.830 persons/ km2. Based on sex group, the population consists of 403.403 male and 410.254 female. Therefore the sex ratio in Sukoharjo is 98,33. Based on age, the population can be grouped into three age range; 0-14 year, 15-64 year, and up to 65 year which each group consist of 191.646, 552.435, and 69.576 people. The area of this regency is about 444,666 km2, which consists of 12 sub-district, 120 villages with the boundaries as follows :

- North boundary : Surakarta municipality and Karanganyar regency
- South boundary : Wonogiri regency and DIY Province
- East boundary : Karanganyar regency
- West boundary : Boyolali and Klaten regency

Administratively Sukoharjo is divided into twelve sub-districts (*kecamatan*). They are Kartasura, Gatak, Baki, Grogol, Mojolaban, Polokarto, Bendosari, Sukoharjo, Nguter, Tawangsari, Bulu, and Weru. Moreover the figure of Sukoharjo regency with its sub-district can be seen at Figure 3-1.

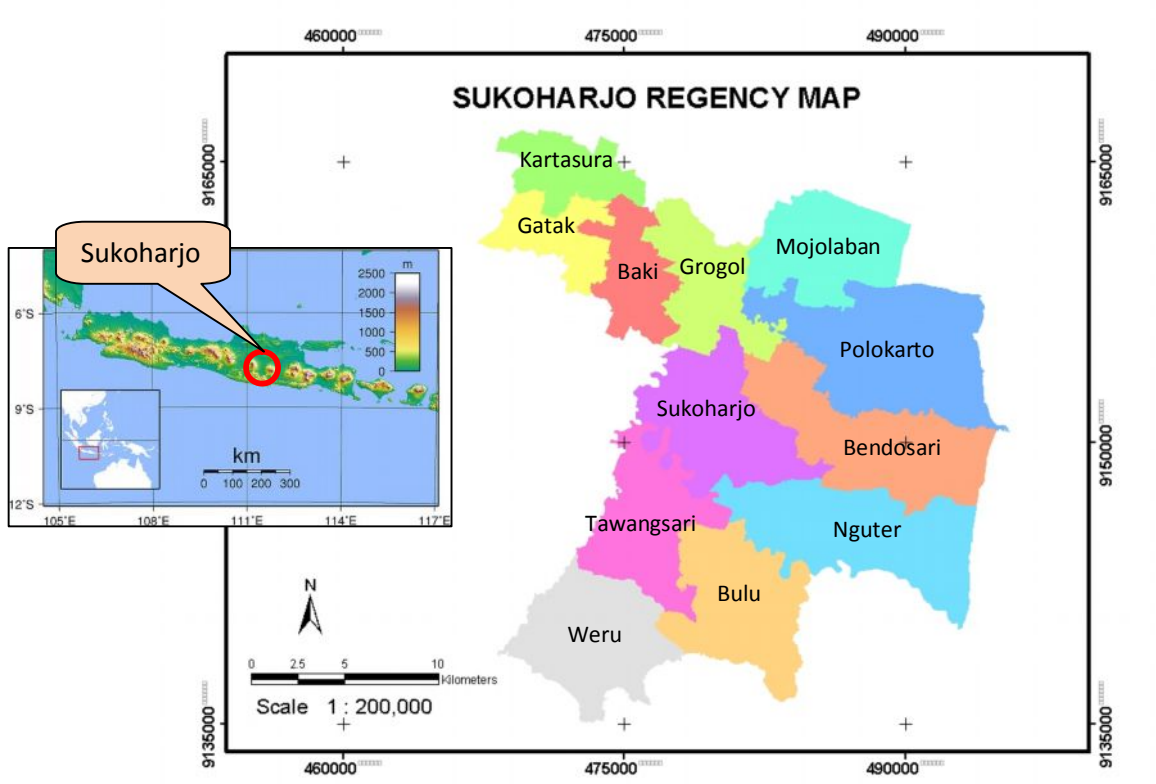



Figure 3-1. Sukoharjo Regency

### 3.1.2. Topography and Climate

Geographically Sukoharjo is located on 7° 42' S and 110° 50' E. The southern part of Sukoharjo is hillier than the northern part. Some part of this regency is crossed by Bengawan Solo river, the main river of Solo basin.

### 3.1.3. General Description of Solo Basin

Bengawan Solo river is the biggest and longest river in Java island. Total area of the basin reaches 12% of Java island area or 1,581,672 ha (TIM-Balai Penelitian Kehutanan Solo, 2007). Administratively Solo basin covers 17 regencies and 3 municipalities. They are Boyolali, Klaten, Sukoharjo, Wonogiri, Karanganyar, Sragen, Blora, Rembang, Ponorogo, Madiun, Magetan, Ngawi, Bojonegoro, Tuban, Lamongan, Gresik, and Pacitan regency. Some municipalities that include in this basin are Solo, Madiun, and Surabaya municipality. Those

regencies and municipalities are distributed in two provinces, Central Java and East Java province.

Based on land utilization map that is issued by *Badan Planologi Kehutanan* (Baplan), total area that is covered by forest in Solo basin is 374,136 ha or 23.99% of total area. The forested area is distributed into three main sub-watersheds. They are Solo Hilir sub-watershed (197,336 ha), Madiun sub-watershed (102,763 ha), and Solo Hulu sub-watershed (74,037 ha). Forested area distribution in Solo Basin can be shown at Figure 3-2. Asdak (2002) states that the existence of forest in a basin can be supporting effort in reducing the occurrence of floods. Landuse change, especially in forested area, will give significant influence to flooding with time period 5-20 years. Furthermore Asdak (2002) explains that forest can reduce the concentration of runoff for rainfall with low until medium intensity. Forest also can release the water to river more controllable. However, the forest influence will be not significant for heavy rainfall with high intensity. Forested area distribution in Solo basin is presented at Figure 3-2.

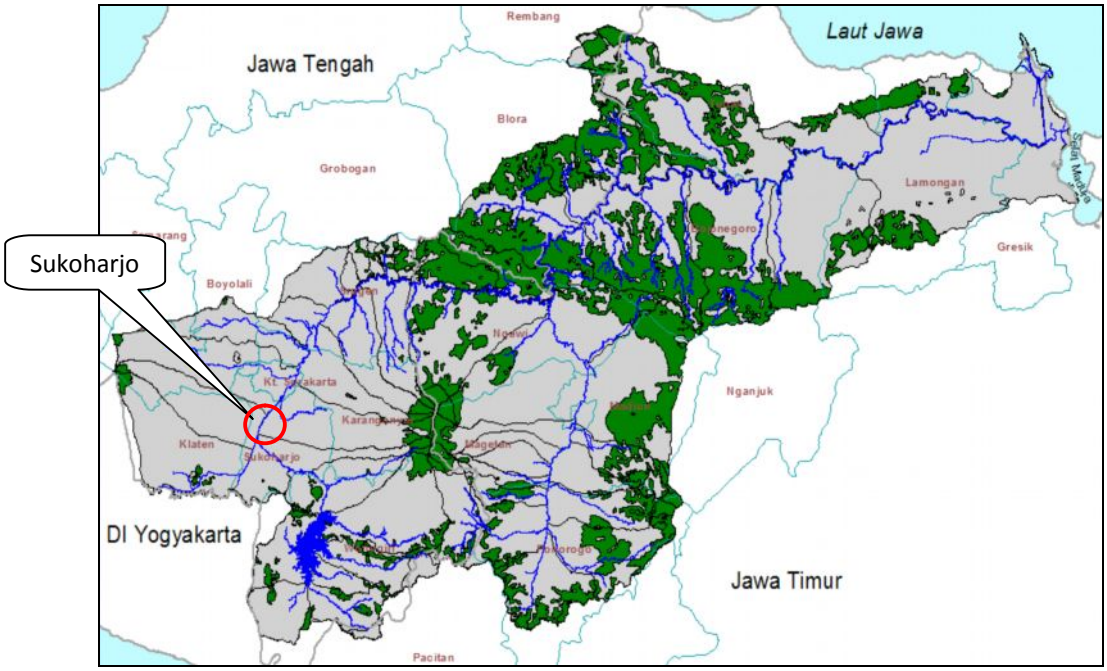
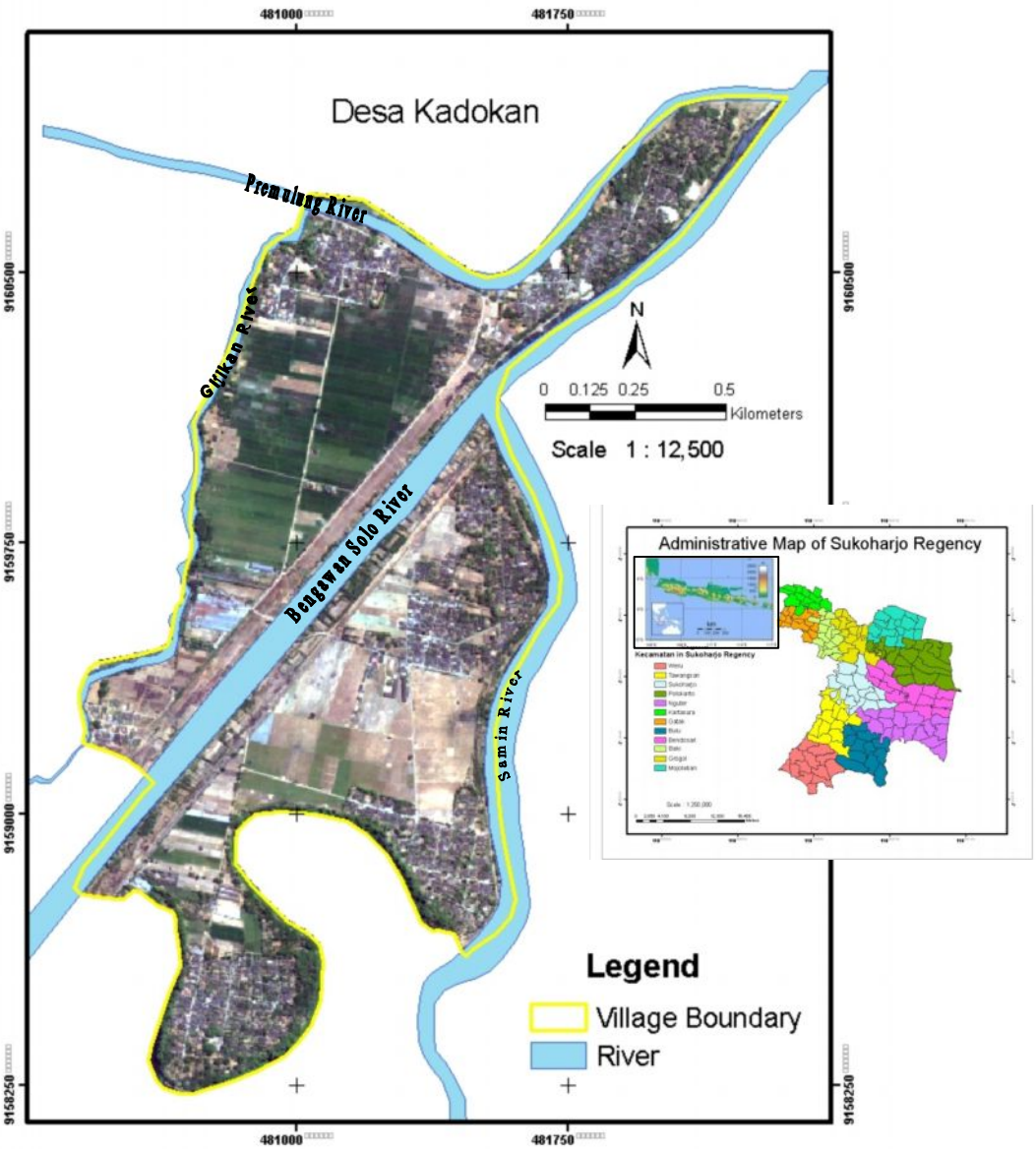



Figure 3-2. Forested area distribution in Solo Basin

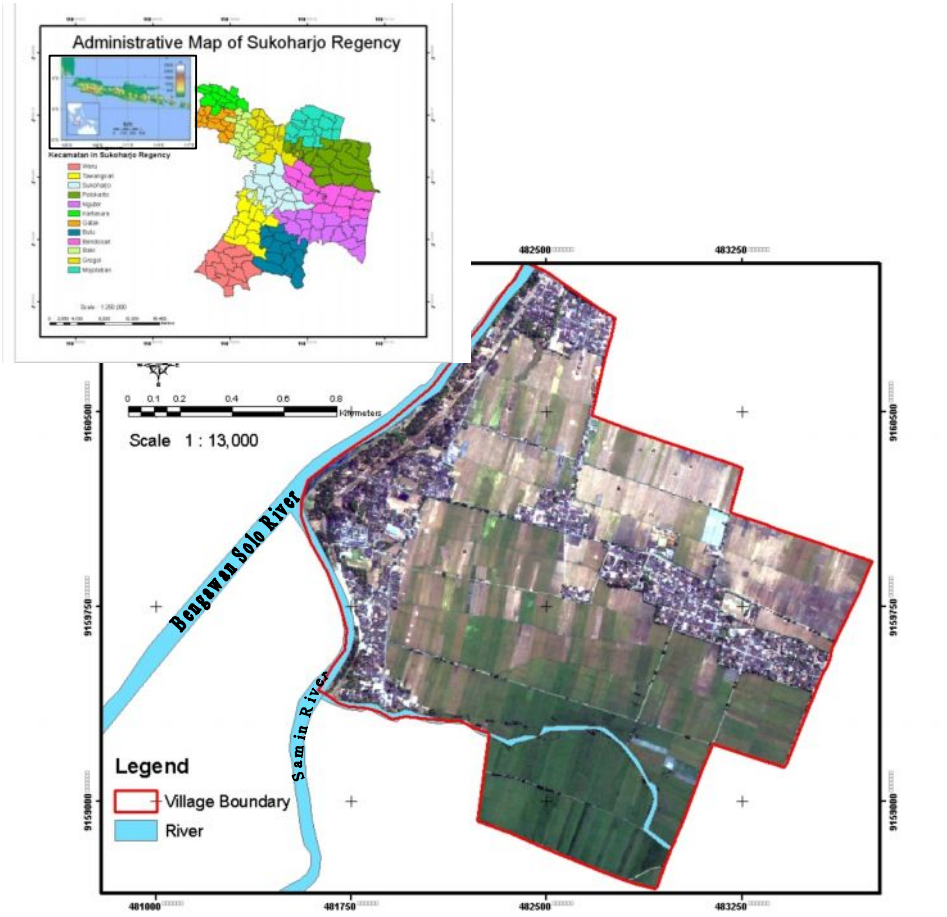
Source : Solo Watershed Management

### 3.1.4. General Profile of Surveyed *Desa*

Two of the villages in Sukoharjo regency that were inundated in 2007 are *desa* Laban (www.tempointeraktif.com, 2007) and *desa* Kadokan (www.antaranews.com, 2007). Although both villages are located in the different sub-district, however geographically their location are close each other. Naturally both villages are prone to flood. The overflow of Bengawan Solo river and Samin river had caused flooding in those villages in the end of 2007. *Desa* Laban is bounded by Bengawan Solo and Samin river on the west part, while *Desa* Kadokan is bounded some rivers. Even Bengawan Solo river crosses this village and divides it into two parts. Some rivers that usually cause flood in Kadokan are Gijikan river, Premulung river, Samin river, and Bengawan Solo river. Therefore, naturally *desa* Kadokan is more prone to flood than *desa* Laban. Figure 3-3 shows both villages as study area.


481000
481750
Desa Kadokan
Premulung River
Glijkan River
Bengawan Solo River
Samin River
N
0 0.125 0.25 0.5
Kilometers
Scale 1 : 12,500
Administrative Map of Sukoharjo Regency
Legend
Village Boundary
River
9160500
9159750
9159000
9158250

(a)




(b)

Figure 3-3. Study area location
Top. Desa Kadokan; Bellow. Desa Laban

### 3.1.4.1. *Desa* Laban

*Desa* Laban is one of villages in Mojolaban sub-district that was inundated in 2007 flood event. Total area of *desa* Laban is 280,467 ha. Figure 3-3 shows that most of the area is paddy field. Some settlements areas are located nearby Bengawan Solo and Samin river. Bengawan Solo and Samin river limit this village on the west side. The boundaries of this village are :

- North boundary : *desa* Plumbon and *desa* Wirun, Mojolaban sub-district
- East boundary : *desa* Wirun and *desa* Tegalmade, Mojolaban sub-district
- South boundary : *desa* Tegalmade, Mojolaban sub-district
- West boundary : *desa* Kadokan, Grogol sub-district

Administratively *desa* Laban consists of 3 *dusun*. *Dusun* is a group of RW and RT that usually exist in village in a regency. Every *dusun* has its representative/ head of *dusun* that works in village office. There are 6 RW and 25 RT in *desa* Laban. Total population of *desa* Laban is 4,228 or 1,542 families. The sex ratio of this village is 1 : 1.02. Most of the people work as a

laborer. The others work as civil servant, trader, teacher, and so on. Livelihood of people in Laban can be seen at table 3-1 and figure 3-4. Some people depend on their economical life by working in textile industry as a labor. Based on Desa Laban (2009), livelihood in this village has been seen in Table 3-1. Unfortunately, since the textile production is a home industry and using very simple technology, the waste is being thrown directly in Bengawan Solo river. Therefore the quality of water in Bengawan Solo river is bad. Moreover this condition is being worse by domestic waste.

Table 3-1. Livelihood in *Desa* Laban

| Occupation | Frequency | Percent (%) |
|---|---|---|
| laborer | 556 | 31.95 |
| farm worker | 462 | 26.55 |
| farmer | 446 | 25.63 |
| civil servants | 120 | 6.90 |
| merchant | 96 | 5.52 |
| breeder | 35 | 2.01 |
| craftsman | 16 | 0.92 |
| other | 9 | 0.52 |

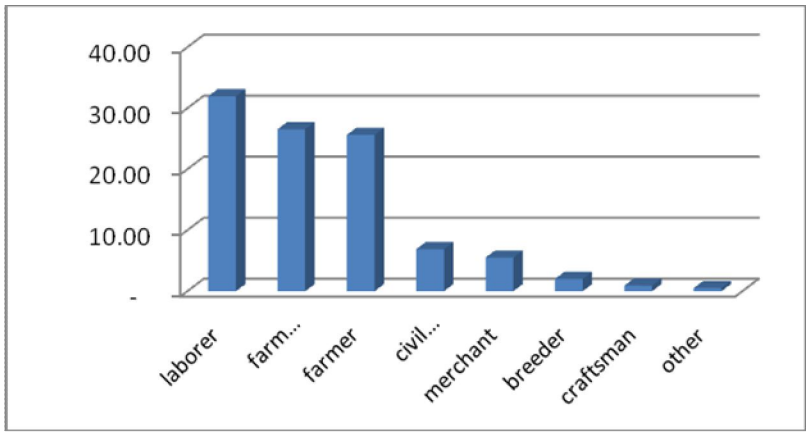



Figure 3-4. Livelihood in *Desa* Laban

Only 1 of 3 *dusun* in this village was not inundated in the 2007 flood event. Located far from river, *dusun* 1 was free from flood. The 2007 flood event at least had inundated some houses in 2 *dusun*. According to Solo Forestry Research Bureau Team, flooding in this village was caused by the broken dike in *dukuh* Nawut that is located in *desa* Tegalmade. Furthermore the team also explains that water from Samin river could not enter Bengawan Solo river. Unmaintained levee along Samin river has been suspected as the cause of the broken of the levee. Furthermore, general overview of *desa* Laban can be seen in Figure 3-5.

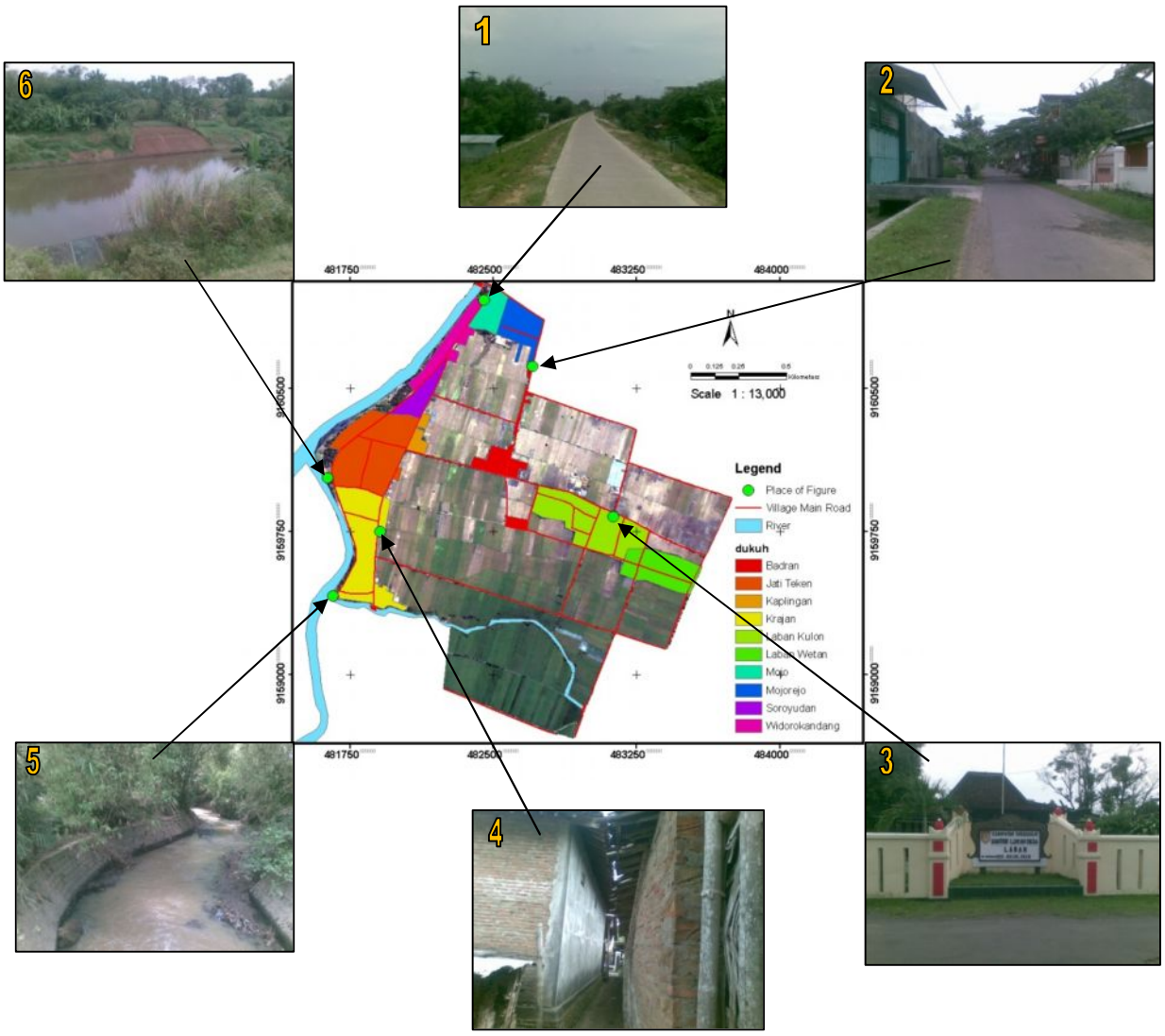



Figure 3-5. General Overview of *Desa* Laban

Detail information about Figure 3.5 can be described as follow :

1. Road along top dike. As one of main road in this village, the top of this dike has been strengthened. The dike has been increased about 1.8 meter after flood event 2007. This road connects people who stay in *desa* Laban and *desa* Tegalmade from and to Surakarta municipality. This road is about 2 meter wide.
2. Daily situation in *desa* Laban. This area was inundated by flood in 2007. The main cause of flooding in this area is the broken dike in *dukuh* Nawut in *desa* Tegalmade.
3. Village Head office. During flood in 2007, this office was free from inundation. This building became center of assistance for people in this village during the disaster. Some people also had been evacuated in this office.
4. The bandy wall. The wall of respondent's house is bandy because of flood in 2007. Garbage from paddy field entered this house and pushed the wall of the kitchen. The owner of this house doesn't have enough money to repair it.
5. This canal flows water from some village nearby *desa* Laban into Bengawan Solo river. This canal is also become the boundary of *desa* Laban with *desa* Tegalmade. In 2007 flooding, water in this canal was overflow because the water can not enter Bengawan Solo river. The automatic door that connects this canal and Bengawan Solo river was closed automatically since the water level in Bengawan Solo river was high. The overflow water from this canal inundated its surrounding and then this condition had been worse by the broken dike in *desa* Tegalmade.
6. Bengawan Solo river. As the main river in Solo basin, this river accepted water from Sewu hill and Lawu mountain in the huge volume because of extreme rainfall on those areas in the end of 2007. The huge volume of water caused dike along this river were broken in some areas.

#### 3.1.4.2. *Desa* Kadokan

Total area of *desa* Kadokan is 192,1605 ha, which more than half is paddy field. Bengawan Solo river divides the village into two parts, west and east part. *Desa* Kadokan lies in lowlands. The average elevation of Kadokan is 500 m above sea level. This village receive rainfall 2,000-3,500 mm/ year with average temperature 23-32 $^{o}$C.

Naturally this village was not divided by river into two parts. Government has cut Bengawan Solo river and made it more straight and wider in order to avoid flooding that often occur along this river. The straightening was conducted by government in 1988. This condition makes people who stay in west or east part of the river difficult to communicate each other. There is only one bridge that connects people in the village. The location of the bridge is in another village. They have to turn around other village when they want to communicate. *Desa* Kadokan is also bounded by Samin river on the east and Premulung river on the north. The administrative boundaries of the village are:

- North boundary : *desa* Semaggi, Pasar Kliwon sub-district, Surakarta municipality
- East boundary : *desa* Laban, Grogol sub-district and *desa* Tegalmade, Mojolaban sub-district
- South boundary : *desa* Telukan, Grogol sub-district
- West boundary : *desa* Grogol, Grogol sub-district

Administratively *desa* Kadokan consists of 2 *dusun, 24 RT* and *6 RW*. Total population of this village is 4,763 or 1,266 families. Most of the people depend on their economical life to industrial sector as a labor/ worker. The livelihood type in *desa* Kadokan can be seen in the Figure 3-7 while flood mark of the 2007 flood event that left in part of houses is shown in Figure 3-6.

Figure 3-6. Flood marks in *desa* Kadokan
Left : Flood mark in *dukuh* Nusupan; Right Flood mark in *dukuh* Kadokan. (Source : Fieldwork 2010).

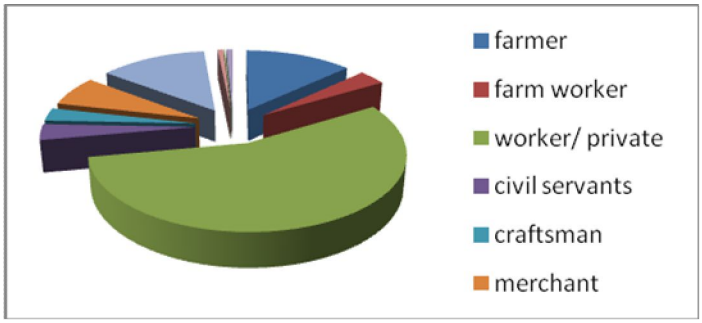



Figure 3-7. Livelihood in *desa* Kadokan
Source : Monograph of *Desa* Kadokan , 2009

Technically, settlement along big river must be protected by dike. But there is one *dukuh,* Nusupan, in this village that is unprotected by dike. Even, this *dukuh* is bounded by two rivers, Bengawan Solo and Premulung river. This condition makes Nusupan more prone to flooding than other *dukuh* in this village. Before straightening of Bengawan Solo, this *dukuh* is close to other *dukuh* in this village. However, this *dukuh* is isolated since 1988. There is only 1 road that connects this *dukuh* to other places outside it. The general overview of *desa* Kadokan can be seen in Figure 3-8.

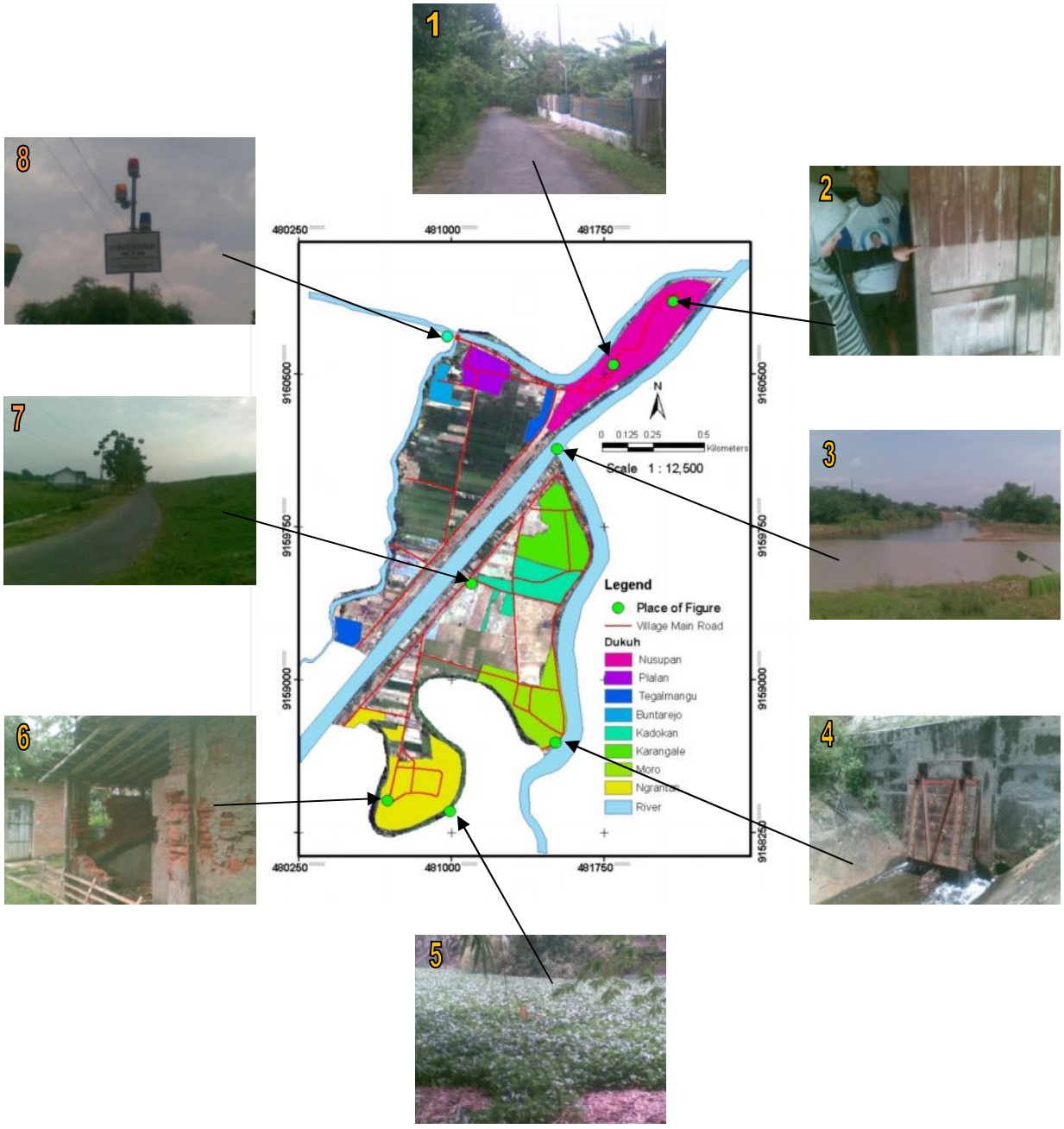



Figure 3-8. General Overview of *Desa* Kadokan

Detail information about Figure 3-8 can be described as follow :

1. Daily situation in Nusupan. Nusupan is one of some *dukuh* in this village that is unprotected by dike. This condition makes this area is more prone to flood than other *dukuh* in this village. Every rainy season, some area of this *dukuh* are always inundated as the impact of water overflow from Bengawan Solo river.
2. House of one respondent in Nusupan that still has water mark of the 2007 flood. The height of water that entered this house was 1 meter. But since the owner of this house has increased the floor, the depth of water outside this house was deeper.
3. The river intersection between Samin river and Bengawan Solo river. People who stay in this village states that the water velocity of Samin river is faster than Bengawan Solo river. That is why people feel that Samin river is more dangerous that Bengawan Solo river.
4. Automatic door of canal that flows its water into Bengawan Solo river. This door will be automatically closed when the water level of Bengawan Solo is high. This will cause some area nearby this door will be inundated. Although the closing door cause inundation, but the door can avoid the worse situation. If it is opened it will cause the worse inundation because water with the bigger volume from Bengawan Solo river enter the village
5. Eceng Gondok vegetation. This vegetation grows in the ex-river of Bengawan Solo river. People in this area use this vegetation as the base material of handy craft. The existence of this vegetation has been pro and contra among the people. Beside this situation can increase mosquito population in this area, eceng gondok has contributed to some people's income.
6. Broken house as the impact of flood 2007. Family who stayed in this house has moved to her father's house that is located nearby this house. The flood destroyed the wall of the old house.
7. Dike along Bengawana Solo river in *desa* Kadokan. After flood in 2007, government increased its height and width. Although the increasing of dike height has made some people feel more save, but other people still feel worry since the quality of this dike is bad.
8. Flood early warning system. This device is located in *kelurahan* Joyotakan in Surakarta. However since the impact of flooding also in *desa* Kadokan, this device is important for people in this area. The early warning system was built after big flood in 2007. This device will give information about critical level of water in the river.

### 3.1.4.3. Landuse

According to Wigati (2008), geographic aspect and social economic condition of community in certain area influences to type of landuse. *Desa* Laban and *desa* Kadokan are located in alluvial plain. This condition can be determined by the existence of big river near the village. Therefore naturally both villages are prone to area. The detail type of landuse can be shown at the Figures 3-9 and 3-10

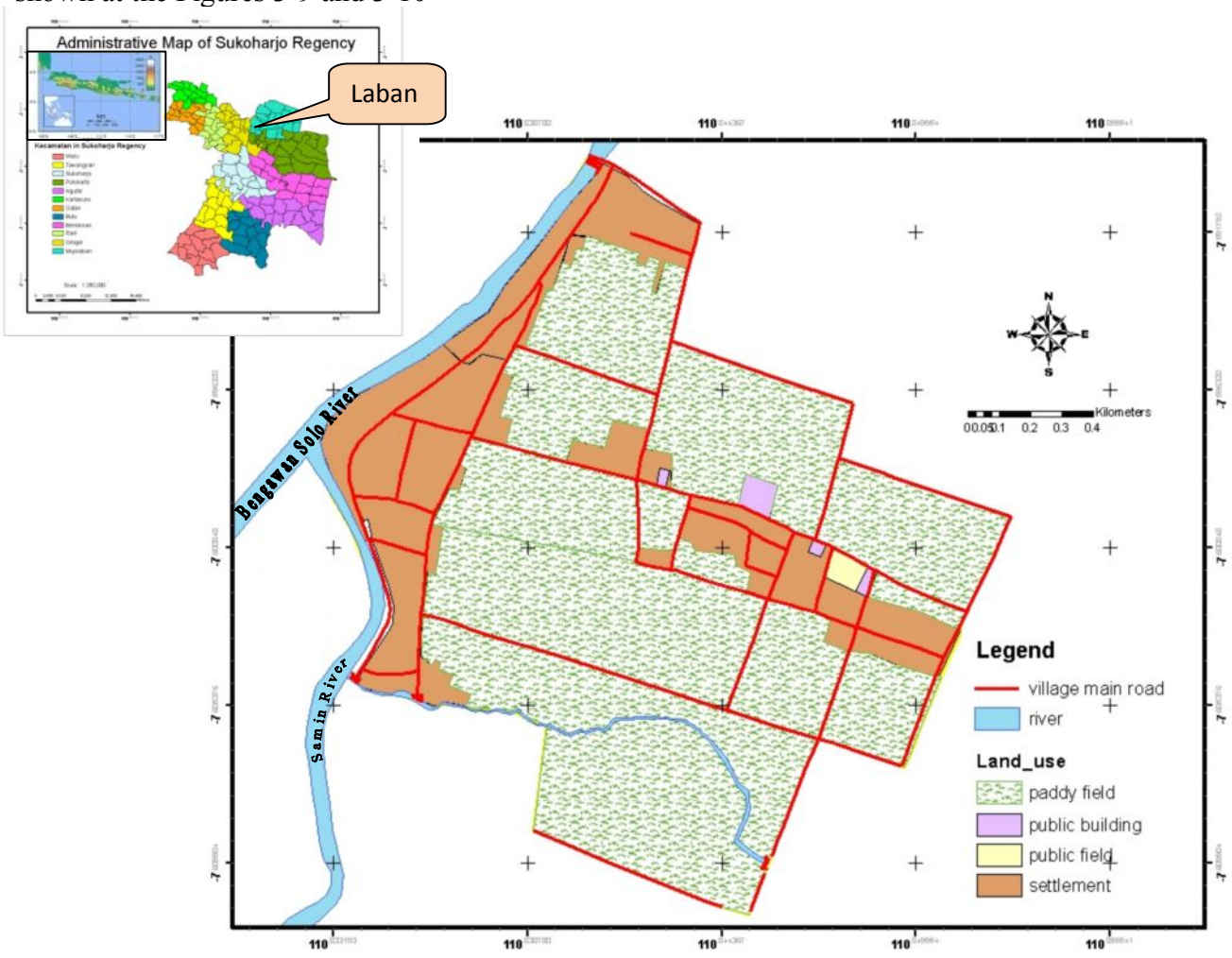



Figure 3-9. Land Use in *Desa* Laban

There are four land use type in *desa* Laban; paddy field, public building, settlement, and public field. Figure 3-9 shows that *desa* Laban area is dominated by paddy field. Another landuse type in this village is public building. There are four public building; 1 junior high school, 2 elementary schools, and 1 village office. The west part of this village is dominated by

settlement. This type of land use also distributed on the north and middle part of the village. *Desa* Laban also has 1 public field that is located nearby village office. The field usually is used as the center of village activity such as independence-day festival.

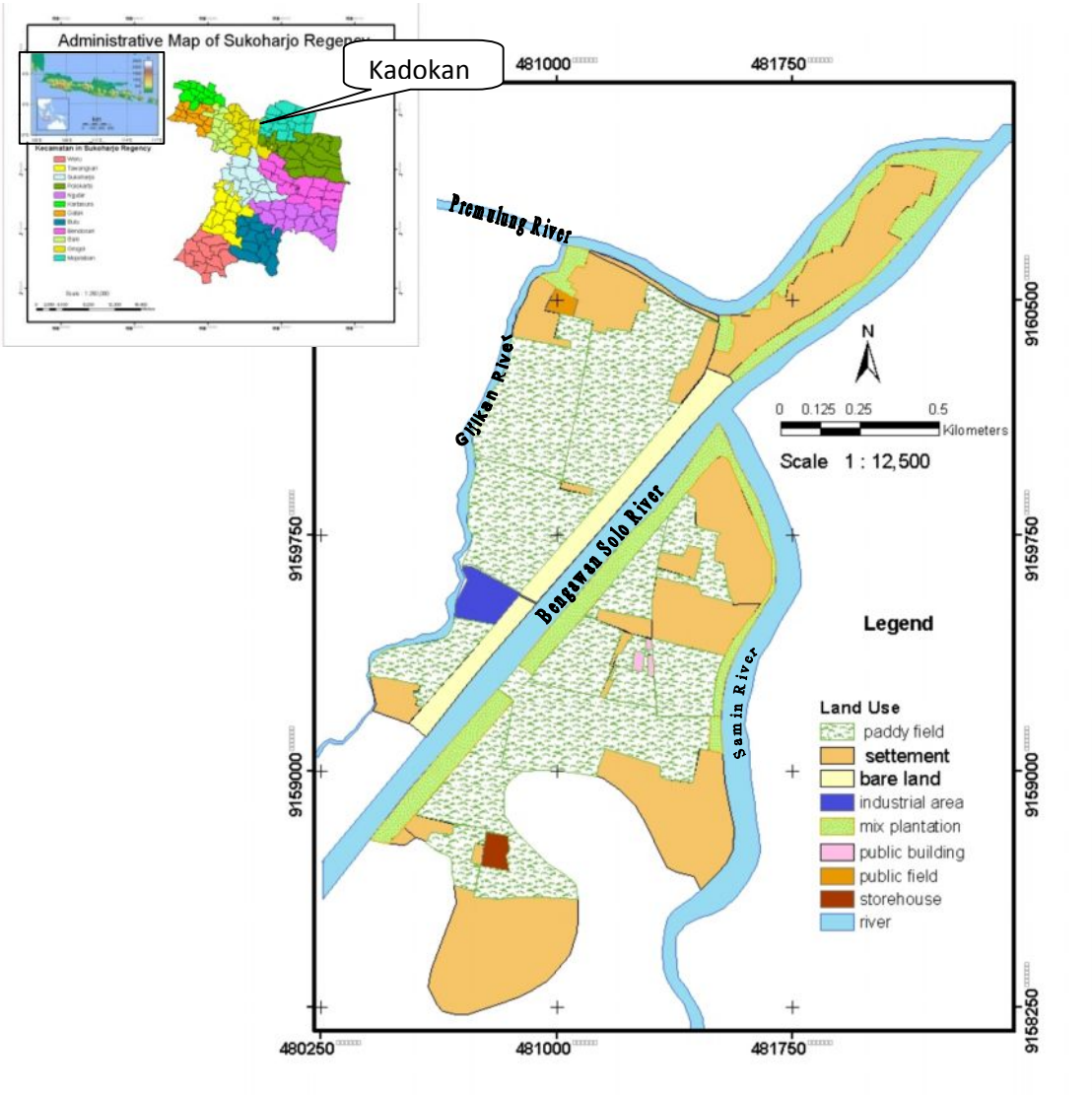



Figure 3-10. Land Use in *Desa* Kadokan

*Desa* Kadokan has eight landuse types. They are paddy field, settlement, bare land, industrial area, mixed plantation, public building, public field, and storehouse. Industrial area is distributed in some parts of this village. Economic policy of local government has caused the growing up of some industries in this village. Another landuse type is settlement, which is located nearby some rivers (includes the original Bengawan Solo river). The growing of

settlement is usually started from area nearby river. This is reasonable since river can give living to human life. The fertile land nearby river also used as mixed plantation area.

### 3.1.5. Characteristics of the Floods in 2007 in Sukoharjo Regency

During rainy season in the end of 2007 until the beginning of 2008, parts of Surakarta and surrounding areas were inundated by flooding. This was the largest flood in this area after the big one in 1966. Although it was not as big as the 1966 flood, losses that caused by the 2007 flood was also very large. Sukoharjo as a regency nearby Surakarta was also inundated. Based on public work agency, the flood distribution is displayed in Figure 3-11. The flooding was caused by broken dike and back water of rivers that could not flow into Bengawan Solo river.


Figure 3-11. The 2007 Flood Event Distribution in Sukoharjo Regency
Source : Public Work Agency (2008)

Based on Solo Watershed Management Disaster Report, since December 20$^{th}$ 2007, Solo Hulu sub-watershed had been 100% saturated. Interception after that day was done slow, even some area could not intercept water anymore. This means that rainfall after December 20$^{th}$ becomes a runoff. Runoff that could not received by water body such as river, dam, had caused flooding. Figure 3-12 describes saturation level in Solo Hulu basin in December 2007

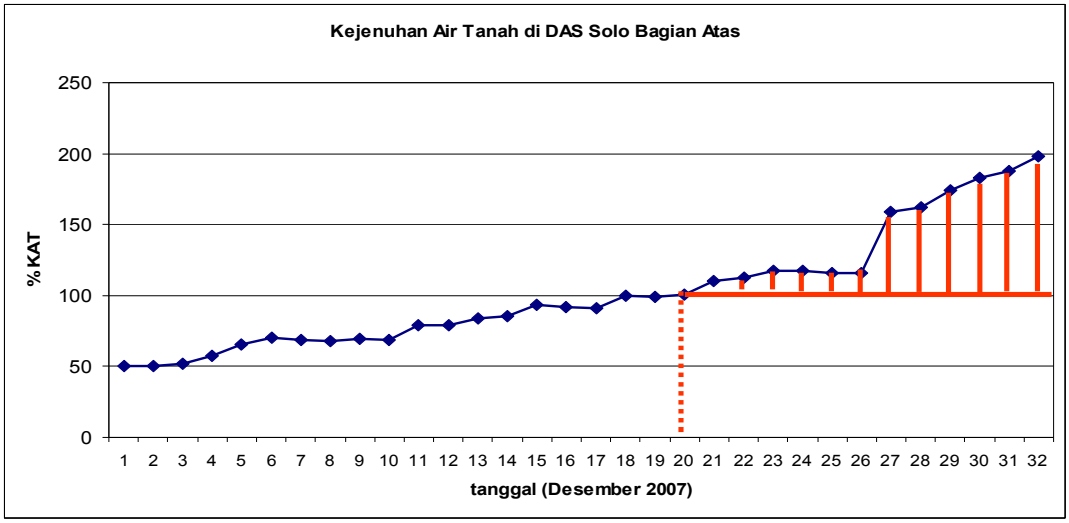



Figure 3-12. Saturation level in Solo Hulu basin in December 2007
Source : Solo Watershed Management (2008)

Moreover based on this report analysis, rainfall factor became the main cause in 2007 flooding in Solo basin, especially rainfall that occurred in December 26$^{th}$ 2007. The rainfall reached its peak on that day and being concentrated in Solo Hulu sub-watershed. Figure 3-13 describes rainfall in Solo basin from December 24$^{th}$ until 27$^{th}$ 2007.

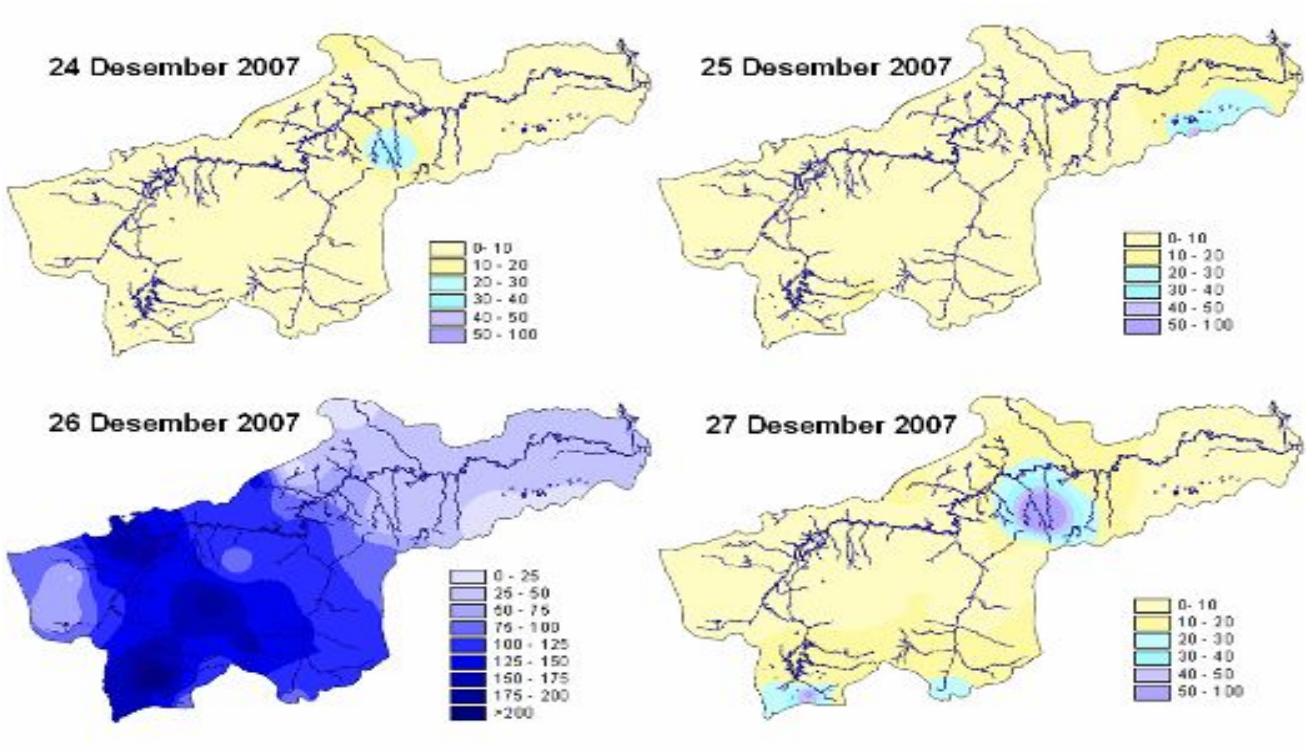



Figure 3-13. Daily Rainfall (mm/day) in Solo Basin
Source : Solo Watershed Management (2008)

This report also mentions that total runoff in Solo Hulu sub-watershed on December 26$^{th}$ 2007 is 418,972,710 m3. The runoff calculation is done by using SCS method. The calculation result shows that Sub-watersheds on Lawu mountain-slope gave more contribution to total runoff in Solo basin than other sub watersheds. Among the sub watersheds in Solo basin, Keduang sub watershed gave the highest contribution which its total runoff is 37,536,749 $m^3$. Runoff distribution in Solo basin is shown in Figure 3-14 and appendix 2.

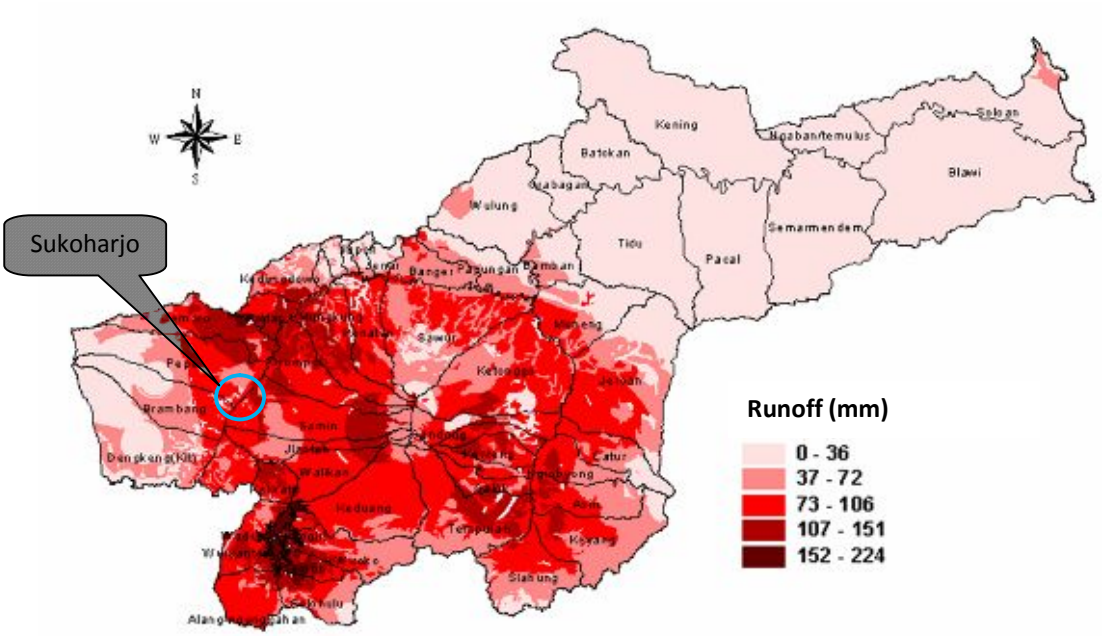



Figure 3-14. Runoff Distribution in Solo Basin in December 26th 2007
Source : Solo Watershed Management (2008)

### 3.1.6. Flooding History in Study Area

Flooding in *desa* Laban and *desa* Kadokan was caused by broken dike. The high rainfall and dike condition was blamed as the cause of flooding in both villages. Parts of dike were broken and let water with huge volume from Samin river flow into the villages. According to interview with local people, the velocity of water in Samin river was faster than Bengawan Solo river although Bengawan Solo river is bigger than it. Figure 3-15 and 3-16 shows some points along dike that were broken.

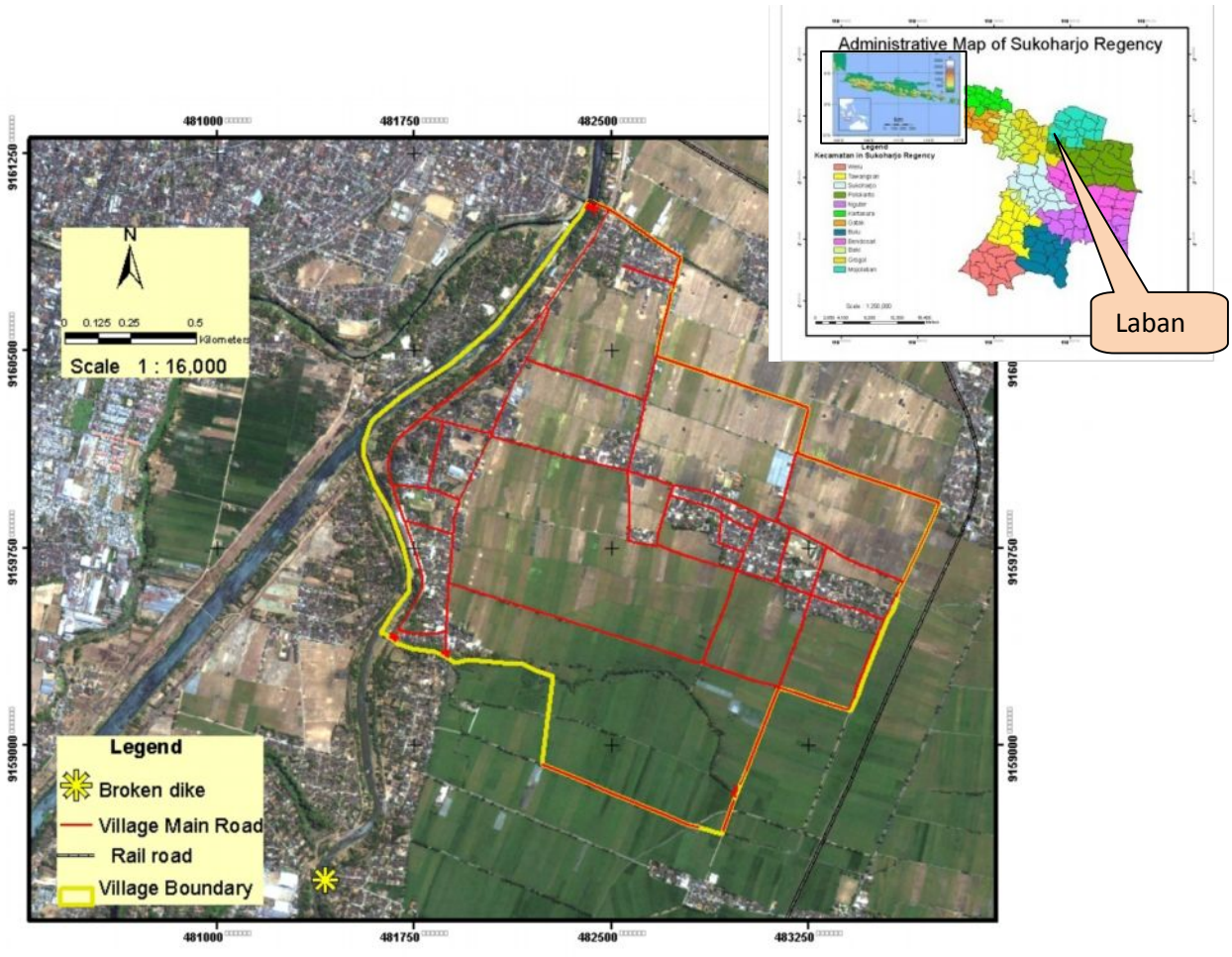



Figure 3-15. Broken Dike Location that Caused Flooding in *desa* Laban

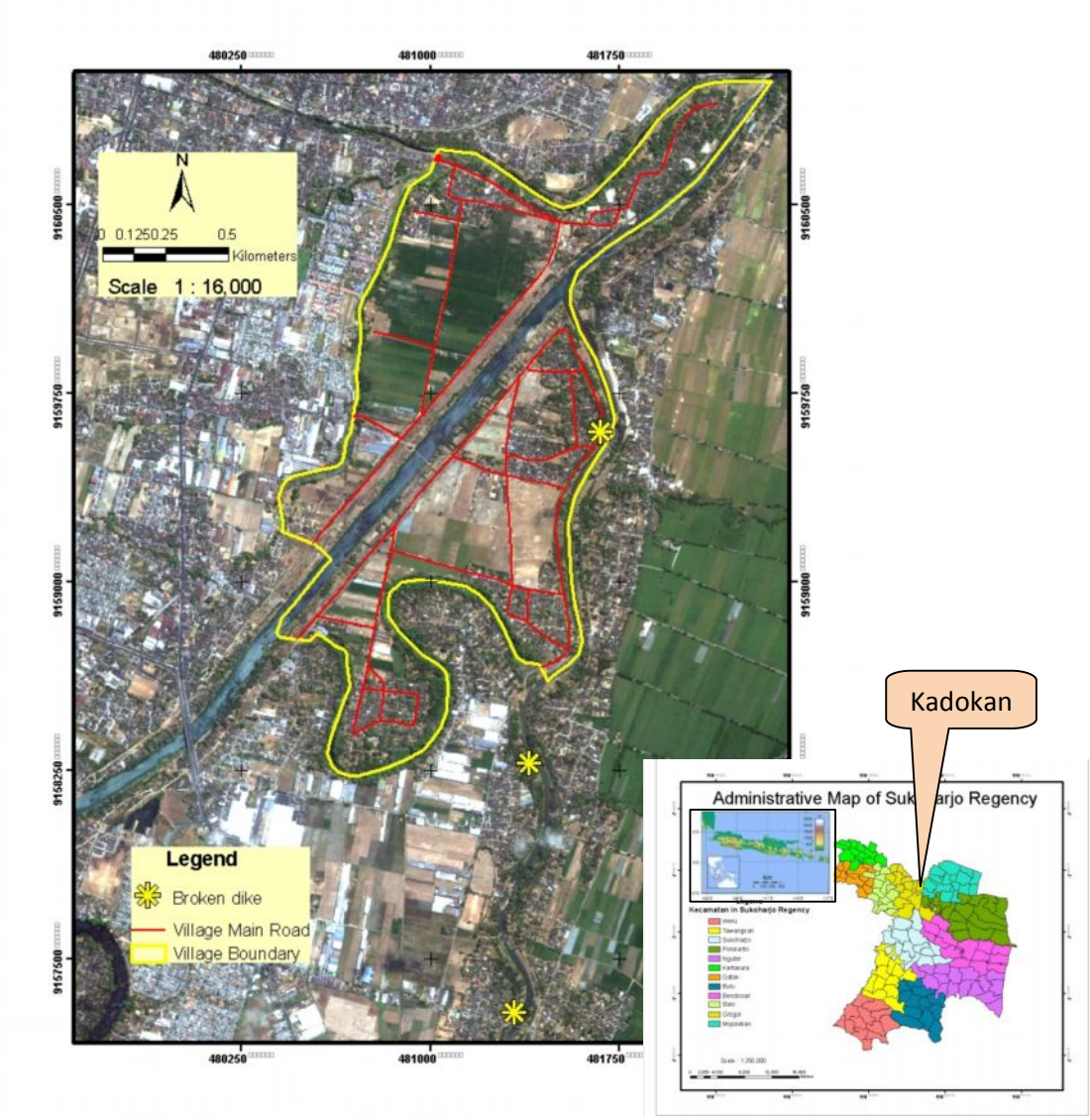



Figure 3-16. Broken Dike Location that Caused Flooding in *desa* Kadokan

There was one location of broken dike that caused flooding in *desa* Laban. The location was outside the village, in *desa* Tegalmade. General elevation of *desa* Tegalmade is higher than *desa* Laban. Therefore, although there was no broken dike in *desa* Laban, this village was inundated as the impact of broken dike in *desa* Tegalmade. The sudden flooding that occurred in the morning of December 26$^{th}$ 2007 had shocked people in *desa* Laban.

The inundation had been worse by railroad that lies on the north part of the village. Actually there was culvert beneath the railroad that was built by Dutch government. However the

culvert has been closed by the people. This reason made water was stuck in *desa* Laban, especially on the west part which has lower elevation than on the east part. There are only two automatic water door in *desa* Laban. However, since the water elevation in Bengawan Solo river was high, the doors were closed to avoid the worse inundation. The doors then released the water slowly after the height of water elevation in Bengawan Solo river was decreased.

The second flooding occurred at December 27$^{th}$ 2007. Rainfall still became the cause of the flooding. On that time, broken dike had not been repaired yet by government. Therefore water from Samin river flowed into the village again. However the volume of water was not as huge as the first one.

On the other hand, there were three location along dike of Samin river that were broken and made *desa* Kadokan was inundated. Two of them were located in *desa* Telukan, which is located on the south part of *desa* Kadokan. As well as *desa* Tegalmade, the broken dike in *desa* Telukan also occurred in the morning. Water from Samin river flowed through the broken dikes and inundated *desa* Telukan. The water then moved to the north and filled the ex-Bengawan Solo river. After the water had filled the canal, it moved to the north and started to inundate *dusun* Ngrantan and *dusun* Moro in *desa* Kadokan.

The other broken dike that caused flooding in *desa* Kadokan was broken dike that was located in the village. As well as the other two broken points, this point also located along the dike of Samin river. In this place, the dike broke sooner after the broken dike in *desa* Telukan.

The cause of flooding on the west part of Bengawan Solo river was different. Overflow of Gijikan and Premulung/ Wingko river inundated *dusun* Buntarejo and *dusun* Plalan in *desa* Kadokan. While inundation in *dusun* Nusupan, which is unprotected by dike was caused by overflow of Bengawan Solo river and Premulung/ Wingko river.

There was three time of inundation. As well as in *desa* Laban, this village was inundated on December 26$^{th}$ and 27$^{th}$ 2007. However, the opening of water door in Gajahmungkur/ Wonogiri dam on December 27$^{th}$ 2007 night, caused this village inundated again on the morning of the day after it. The water door of the dam was opened by government with the permission of minister of Public Work in order to avoid the worse condition. However the policy caused people in the village was inundated longer.

### 3.2. Research Method

This research focused on two activities: generating of a flood map based on community knowledge, and determining and analyzing variables of community resilience. The main methods in this research are doing Focus Group Discussion (FGD), giving questionnaire and interviewing respondents. Some people are involved in FGD in order to describe the flood event in their village. Beside describe the flood, they are also being involved in weighting the resilience factors. The questionnaire was used for defining the community resilience data. For further information, interview is also being done.

*Desa* Kadokan and *desa* Laban are two of villages in Sukoharjo regency that were chosen as the study area. Both of those villages were inundated during the 2007 flood event. Geographically Kadokan is more prone toward flood than Laban since the new Bengawan Solo river divides this village into two parts. Furthermore this village also bounded by another rivers, Premulung/ Wingko, Gijikan and Samin river. Laban is also bounded by rivers, Samin and Bengawan Solo river, but only on its west side. For obtaining resilience data, 80 households were selected and interview was done. The respondent selection was done randomly on the area which was inundated during the 2007 flood event. The respondent spatial distribution can be seen in Figures 3-17 and 3-18.

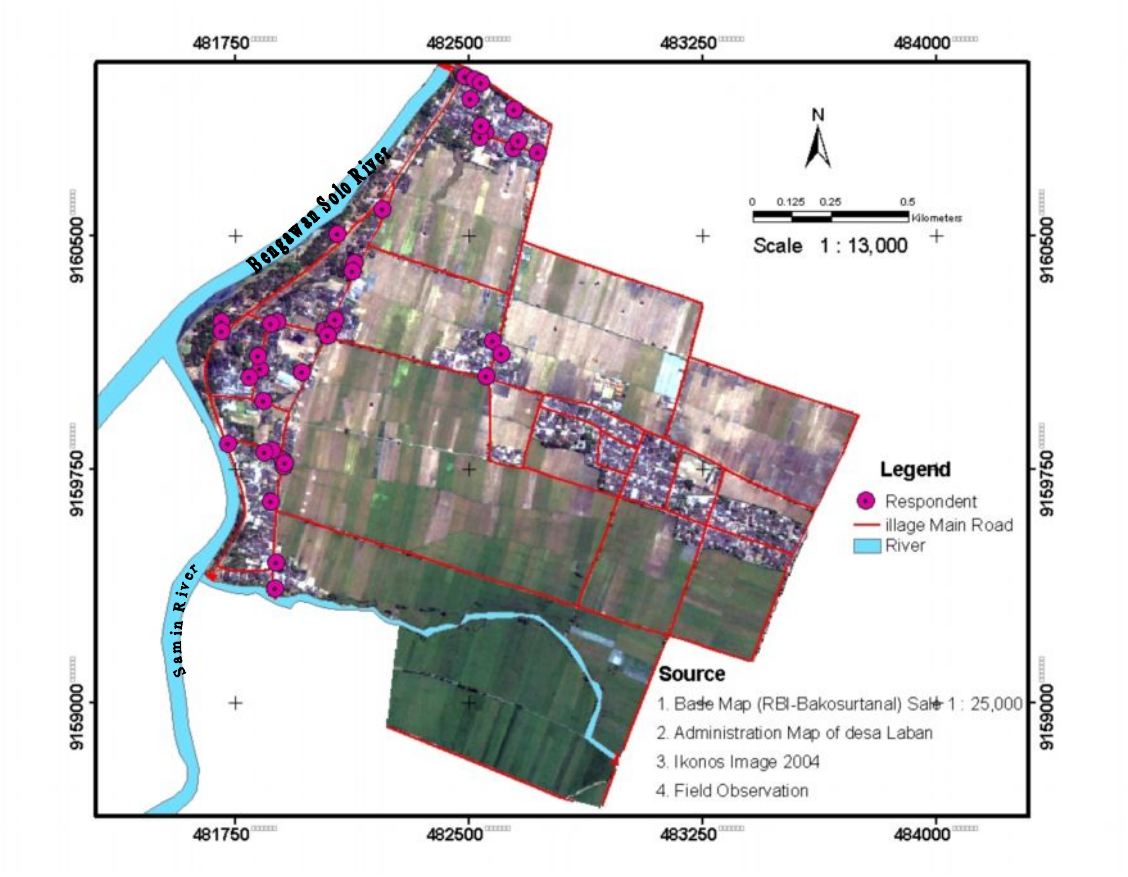



Figure 3-17. Spatial Distribution of Respondents in *desa* Laban

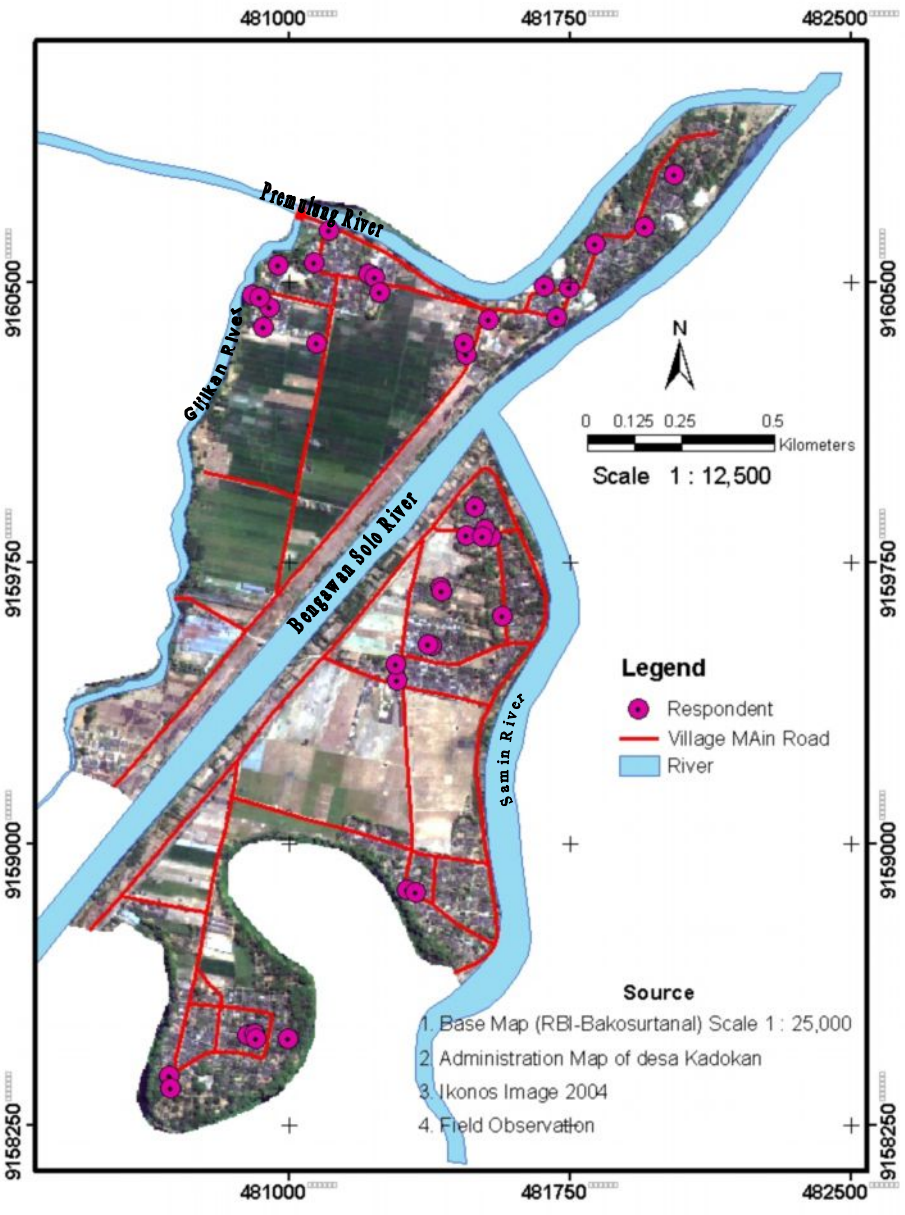



Figure 3-18. Spatial Distribution of Respondents in *desa* Kadokan

In order to gain objectives, the research questions and its method had been constructed as shown in Table 3-2.

Table 3-2. Research Question and Methodes

| No | Research Question | Method |
|---|---|---|
| 1 | What is flood distribution in the study area based on community knowledge | - Participatory GIS & Questionnaire |
| | What is water depth in the study area based on community knowledge | - Participatory GIS & Questionnaire |
| | What is flood duration in the study area based on community knowledge | - Participatory GIS & Questionnaire |
| | What is damage level in the study area based on community knowledge | - Questionnaire and interview |
| 2 | What defines community resilience | - Literature Review |
| | How can community resilience be quantified | - Questionnaire and interview, |
| | How is community resilience in the study area | - Questionnaire and interview, weighting |
| | What is the relation between flood severity and community resilience | - Questionnaire and interview |

The framework of this research is shown in Figure 3-19

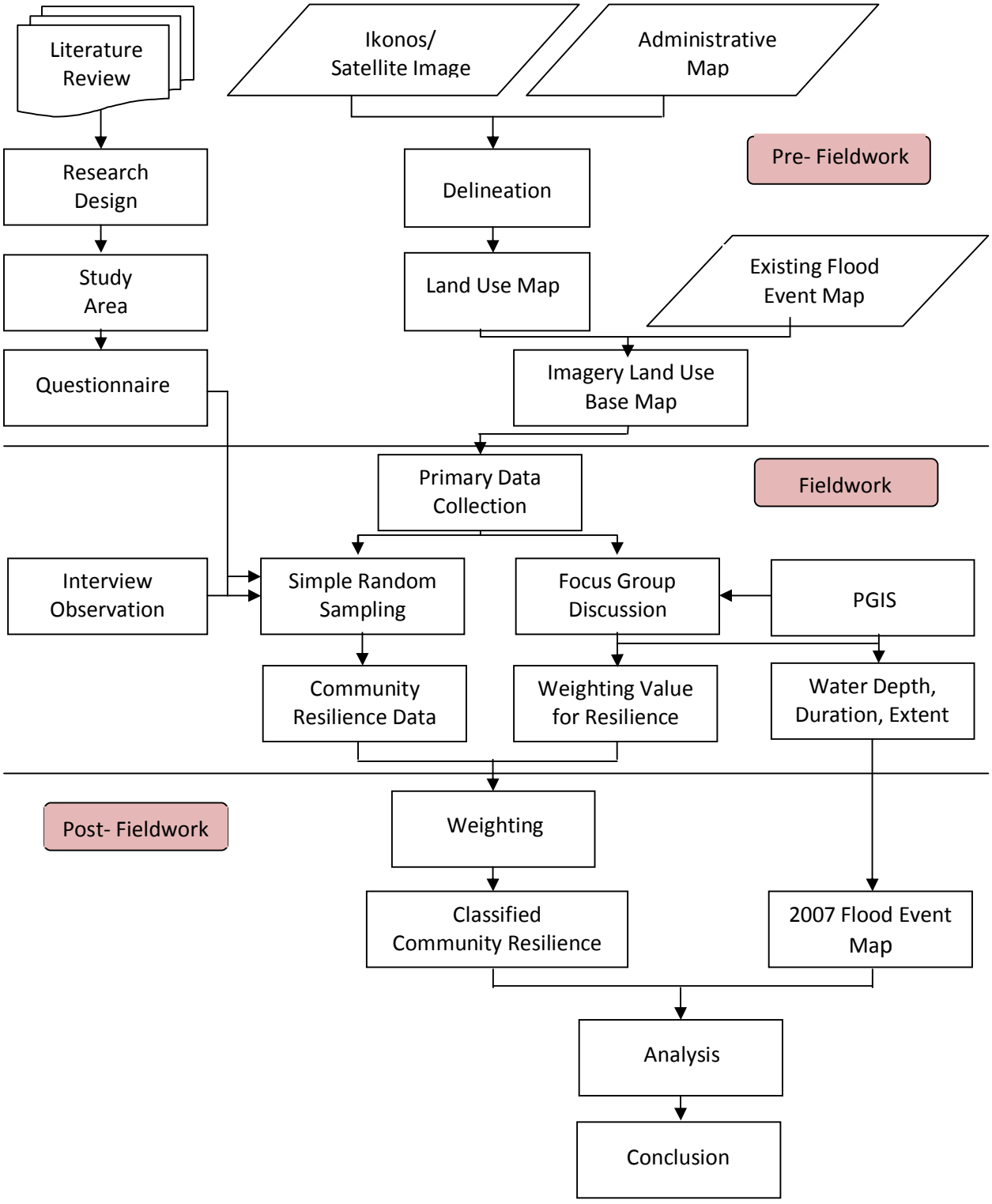



Figure 3-19. Outline of the Research

### 3.2.1. Material

This research needs some data requirements for achieving the objectives. Some data requirements and its sources can be shown at Table 3-3:

Table 3-3. Data Requirement and Data Source

| No | Data Requirement | Data Source |
|---|---|---|
| 1 | Administrative map | Local government |
| 2 | Demography data | Local government |
| 3 | Existing Hazard Map | Public Work Agency |
| 4 | Landuse | Ikonos/ Satellite image |
| 5 | RBI | Bakosurtanal |
| 6 | Flood 2007 report | Solo Watershed Management<br>Public Work Agency |
| 7 | Flood extent and depth | PGIS Interview |
| 8 | Community resilience | Fieldwork & interview |

## 3.3. Data Collection

### 3.3.1. Data Availability

Part of the data were available from *Bakosurtanal* (Base Map, RBI), and village office for village map and general information about the village. Other data that had to be collected during fieldwork were community flood risk perception, losses as the impact of flood, and community resilience toward flood. Duration for recovery, flood experience, aid, and source of recovery fund were some resilience data that were collected from the respondent.

### 3.3.2. Fieldwork Equipment

Several equipments were used to collect primary data. They are GPS, tape measurement, and digital camera. GPS is used to get geographic information of household building position and some important places and objects. Tape measurement is used for measuring the water level inside the house of respondents. Digital camera is used to capture some important places or object and wall print of flood mark inside the house.

### 3.3.3. Data Sampling

This research was using simple random sampling in choosing respondent in order to get resilience data. The sampling was done in the area which was inundated in flood 2007. In *desa* Kadokan, the 2 *dusun* were inundated. Therefore samples were taken from both areas. Some samples on *desa* Laban were only taken in two of three *dusun.* This is because *dusun* 1 was not inundated in 2007 flood event, while *dusun* 2 and 3 were inundated.

## 3.4. Questionnaire and Interview

Questionnaire was implemented in order to collect resilience data from respondents. Indepth interview was also done to get community view of both flood risk perception and resilience. The total number of respondent of *desa* Laban and *desa* Kadokan is 80 persons. They have different social economic background. Detailed information of respondents' social economic condition is explained in the following chapter.

Meeting local authorities such as RT head and village head was done before going to the field. This activity was done in order to get permission for collecting data in the community. Moreover, this was also aimed for getting overview of the 2007 flood event in the village. Generally the interview was good. Javanese culture that friendly to guest was helping researcher in doing interview.

A questionnaire was designed by adapting from literature reviews that are related to resilience. The questionnaire was written in bahasa Indonesia in order to help respondent in understanding and filling it. Data that were asked in the questionnaire were socio-economic background, flood characteristics (flood duration and extent), flood damage, flood experiences, flood perception, recovery fund of flood impact, speed of recovery in term of cleaning up the house, psychology disruption, and institutional respond of flood mitigation. More valuable and deeper information related to 2007 flood event also explored by doing interview. The interview was done in bahasa Indonesia and Javanese language. There was no translator during the interview since the researcher can speak in those languages.

### 3.5. Focus Group Discussion

Focus Group Discussion has been conducted in order to define the 2007 flood map based on community knowledge. Moreover this discussion resulted in weighting value/ score for resilience variables. FGD in *desa* Kadokan and *desa* Laban were attended by community representatives. FGD in *desa* Kadokan was attended by head of RTs and RWs while in *desa* Laban was attended by head of *dusun* and other community representatives. In this discussion, the researcher used village map from high resolution imagery (IKONOS). Participants were asked to draw the flood in the village based on their knowledge. The flood characteristics that were described by the participants are flood depth, flood distribution, and flood duration. In order to make it easier for them to describe flood characteristics, every element has been categorized into 3 levels. They are low/ quick; moderate; and deep/ long. The FGD and its result can be displayed in Figure 3-20.

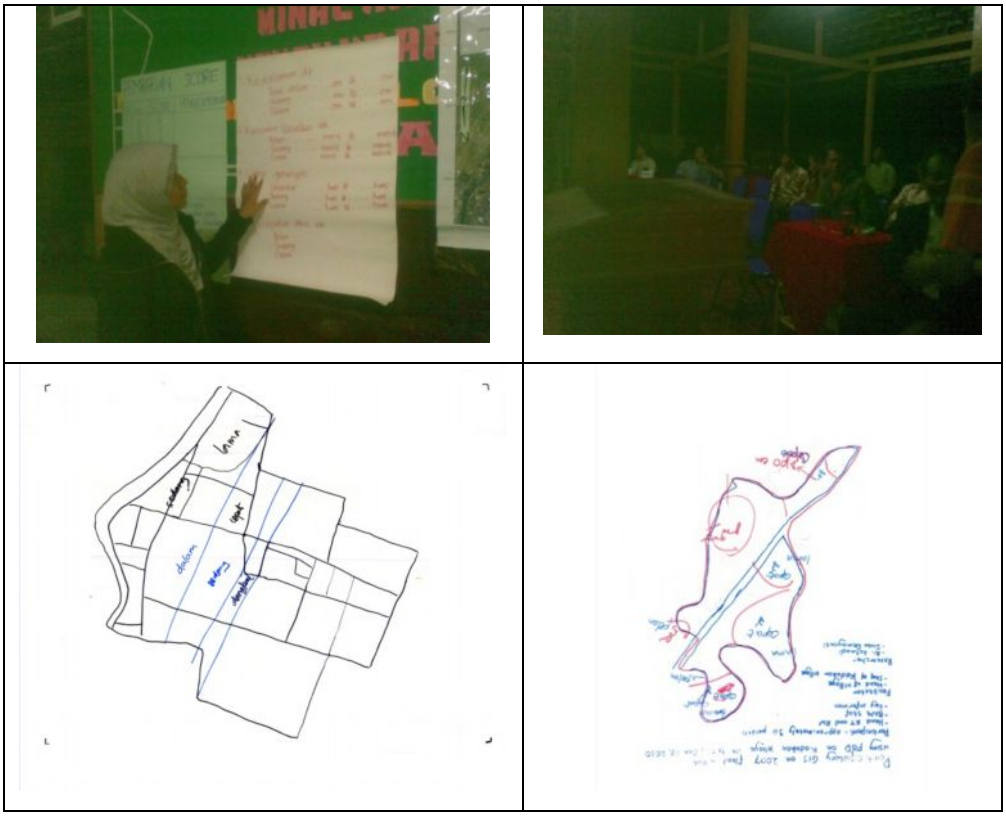


Figure 3-20. Focus Group Discussion and the 2007 flood event sketch map
(Source : Fieldwork 2010)

# 4. SOCIAL ECONOMIC PROFILE AND FLOOD RISK PERCEPTION OF RESPONDENTS

*This chapter describes the social economic profile of 80 respondents in selected villages so called-desa, the impact of the 2007 flood even that was occurred on December 200, which is considered as the second greatest flood on its history, to respondents' life, and respondents' perception of flooding.*

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## 4.1. Introduction

This research was using respondents for identifying community resilience toward flood hazard. The respondents in the study area have different social economic condition, which it was assumed would influence the community recovery ability after flood among them.

Moreover, according to Febrianti (2010), socio economic condition of respondent influenced the respondent's perception related to flood. The social economic characteristics includes gender, age, and education, and occupation

## 4.2. Social Economic Profile of Respondent

### 4.2.1. Gender

Most of respondent that were selected are male. From Table 4-1, it can be shown that about 55 percent of the respondents are male and about 36 women participated in this research as respondent. They are representing 45% of total respondents.

Table 4.1. Respondents distribution based on gender

| Gender | Frequency | Percent (%) |
|---|---|---|
| Female | 36 | 45 |
| Male | 44 | 55 |
| Total | 80 | 100 |

Most of the male respondent could give more detailed information related to flood event than female respondent. They stayed at their house during the flooding for keeping their goods and monitoring the flood condition, while their other family members such as wife and children

were being evacuated to a safe place. Therefore, the information given by the male respondent is more detail.

### 4.2.2. Age

The youngest age of respondent in this research is 20 years old, while the oldest one is 74 years old. Based on the range, researcher classified age of respondent into 5 classes. For further information related to respondent's age can be shown in Table 4-2 as follow. Most of the respondent is in the age range 31-40 years. There are 28,75% or 23 respondents in this range.

Table 4.2. Respondents distribution based on age

| Age Range | Frequency | Percent (%) |
|---|---|---|
| 20-30 | 3 | 3.75 |
| 31-40 | 19 | 23.75 |
| 41-50 | 23 | 28.75 |
| 51-60 | 21 | 26.25 |
| >60 | 14 | 17.5 |
| Total | 80 | 100 |

Some respondents who have age more than 50 years old and have stayed in that area more than 50 years can give information related to the 1966 flood event. They can compare and contrast the depth, duration between both flood event, also flood frequency before the construction of dike along Bengawan Solo river and Wonogiri dam. According to these respondents' perception, the 2007 flood event was more dangerous than the 1966 flood event. Although the 1966 flood event was deeper than the 2007 flood event, the velocity of the 2007 flood event was faster than the 1966 flood event. Moreover, after construction of the dike and the Wonogiri dam, people on the both village never experience big flood until 2007 flood event. Therefore, socially and technically the 2007 flood event was more dangerous than the 1966 flood event.

### 4.2.3. Education

The interview has been conducted to 80 persons, which 40% of them received the elementary school as the last education level in their life. Although most of respondents are educated, there are also 12 persons or 15% of respondent are not educated. The education level of respondents can be shown in Table 4-3 and Figure 4-1 :

Table 4.3 Education Level of Respondent Based on Age Range

| Education Level | Frequency | Age (Percent) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 20-30 | 31-40 | 41-50 | 51-60 | >60 | Total |
| No Education | 12 | - | - | 2.50 | 6.25 | 6.25 | 15.00 |
| Elementary School | 32 | - | 3.75 | 13.75 | 16.25 | 6.25 | 40.00 |
| Junior High School | 13 | - | 6.25 | 7.50 | - | 2.50 | 16.25 |
| Senior High School | 18 | 2.50 | 12.50 | 2.50 | 2.50 | 2.50 | 22.50 |
| College | 5 | 1.25 | 1.25 | 2.50 | 1.25 | - | 6.25 |

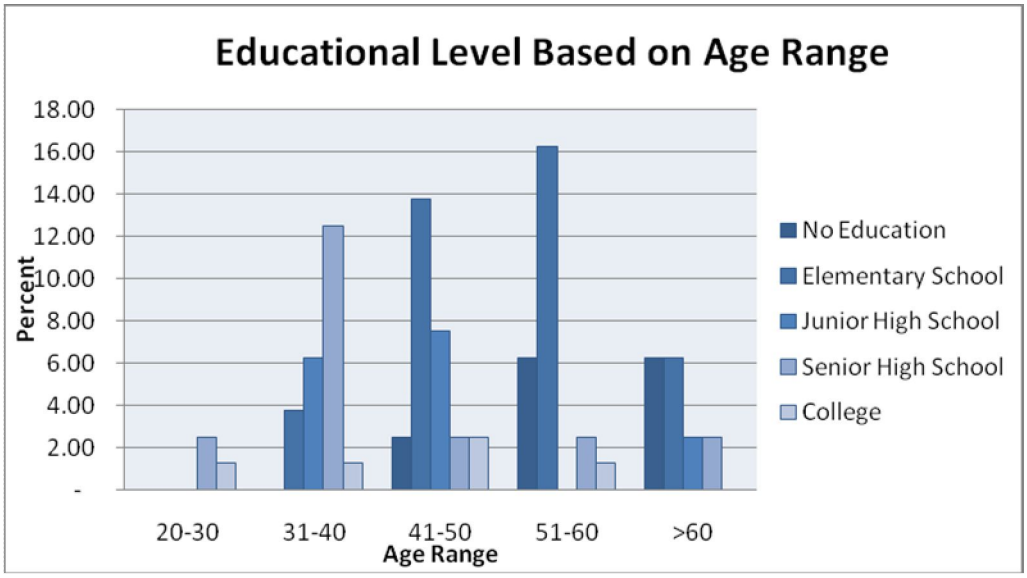



Figure 4-1. Educational Level Based on Age Range Graph

### 4.2.4. Occupation

There are some occupation types that are found during interview. Most of the respondents work as laborer. They are dominated occupation type of respondent about 31.3%. This

occupation type has correlation with education level of respondent. From respondent occupation distribution in Table 4-4 can be seen that most of them work in non formal sector. There are also 13 respondents are housewife. The housewife is easier to meet during the primary data collection since the interview is conducted in the day time. Although the housewife is unemployment, she also helps the family finances by working odd jobs such as washerwoman or raising livestock at home.

Table 4-4. Distribution of Respondent Based on Occupation

| Occupation | Frequency | Percent (%) |
|---|---|---|
| Housewife | 13 | 16.3 |
| Trader | 20 | 25.0 |
| Laborer | 25 | 31.3 |
| Civil Servants | 1 | 1.3 |
| Teacher | 2 | 2.5 |
| Retired | 2 | 2.5 |
| Other | 17 | 21.3 |
| Total | 80 | 100 |

## 4.3. Respondent's Perception of Flooding

### 4.3.1. Duration of Inundation Inside The House

Based on interview result, most of houses of respondent were inundated for 3 days. The percentage is 36.3%. Duration of inundation in respondent's house varies from 1 day until 7 days. Also there is 1 house of respondent that was not inundated during the 2007 flood event. The house is located in *dukuh* Nusupan, the only *dukuh* in the study area that is unprotected by dike. The owner has already increased the floor of the house. Moreover the house is also located on the highest elevation on that area. The spatial distribution of duration of inundation in respondent's house can be shown in Table 4-5 and Figure 4-2 and 4-3.

Table 4-5. Duration of Inundation Inside Respondent's House

| Duration | Frequency | Percent (%) |
|---|---|---|
| No Flood | 1 | 1.3 |
| 1 day | 7 | 8.8 |
| 2 days | 21 | 26.3 |
| 3 days | 29 | 36.3 |
| 4 days | 13 | 16.3 |
| 5 days | 6 | 7.5 |
| 6 days | 1 | 1.3 |
| 7 days | 2 | 2.5 |

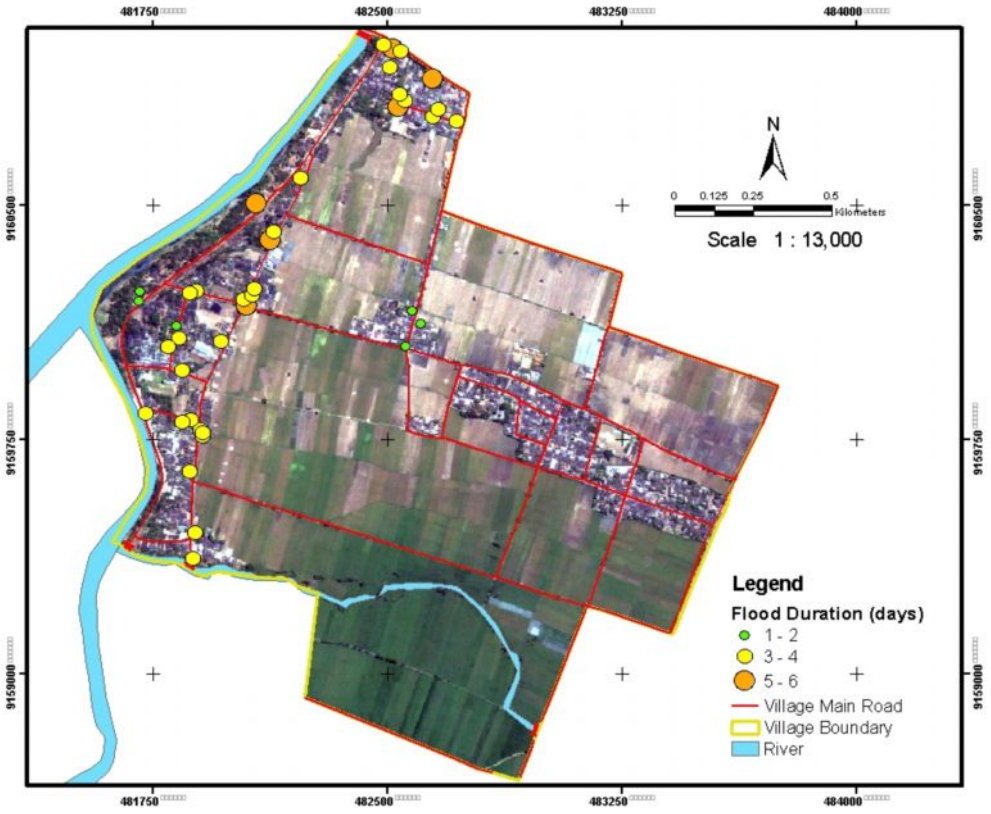



Figure 4-2. Duration of Inundation Inside the House of Respondent in *desa* Laban

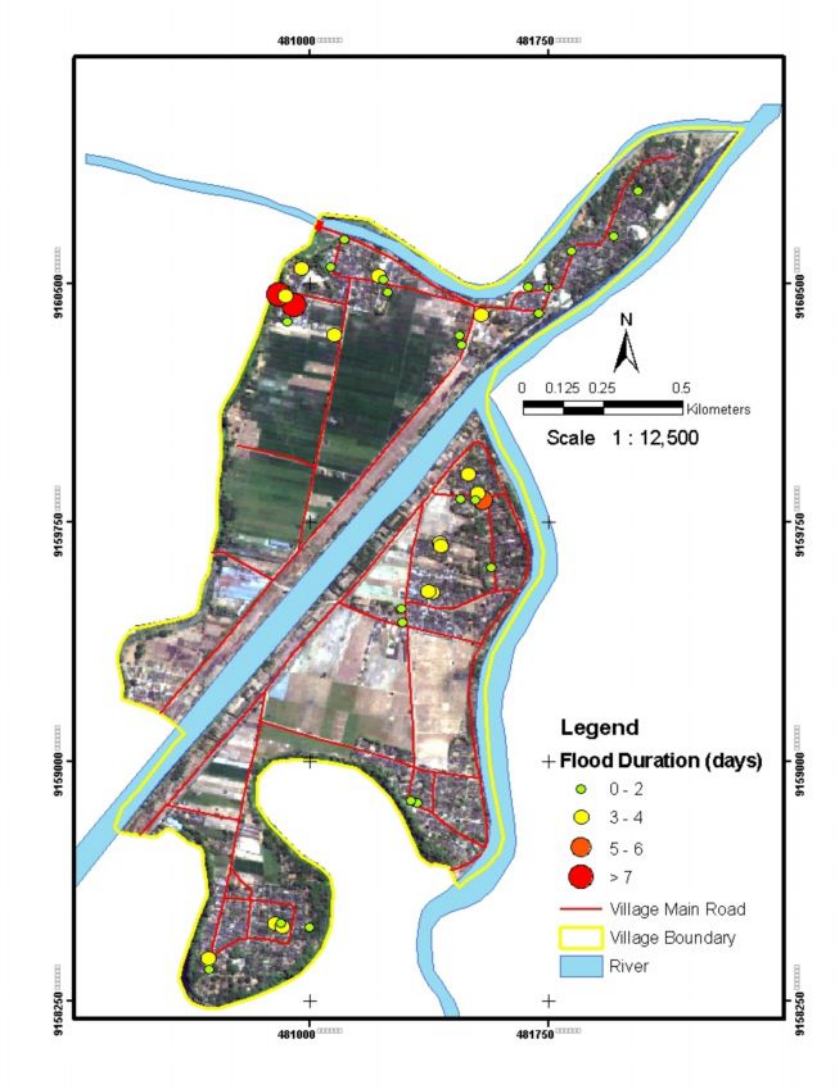



Figure 4-3. Duration of Inundation Inside the House of Respondent in *desa* Kadokan

The variation duration of inundation inside respondent's house is caused by some factors. They are elevation, floor height of the house, total automatic door that let water flow into river, barrier factor such as dike and railway that act like a dike. Generally duration of inundation in respondent's houses in *desa* Laban is 3 days or more. The length of inundation time in this village was being worse by the existence of railway on the north part of this village. Moreover, there are only two automatic doors in this village that made water flowed into Bengawan Solo river slowly.

The duration of inundation is more vary in *desa* Kadokan. Even there were two respondent's houses that were inundated for 7 days during the 2007 flood event. The houses are located nearby Gijikan river that is located on the west part of this village. There was not water pump on the river intersection between Wingko river and Premulung river on that time. There was only automatic door that regulated the water flowing from Gijikan river into Premulung river. On the other hand water level on Premulung river was also high. Since water level of Bengawan Solo river was still high, water in Premulung river could not flow into Bengawan Solo river. Therefore, duration of inundation for some areas nearby Wingko river was long.

### 4.3.2. Flood Depth Inside The House

The 2007 Flood inundated houses in both villages with different depth. The depth varies from 0 cm until 300 cm inside the house. The depth variation depends on the general elevation of the area and the raised floor level. The water depth inside the respondent's houses can be shown in table 4-6, figure 4-4 and 4-5.

Table 4-6. Flood Depth Inside The Respondent's House

| Flood Depth | Frequency | Percent |
|---|---|---|
| 0-50 | 10 | 12.5 |
| 51-100 | 33 | 41.25 |
| 101-150 | 17 | 21.25 |
| 151-200 | 14 | 17.5 |
| 201-250 | 2 | 2.5 |
| 251-300 | 4 | 5 |

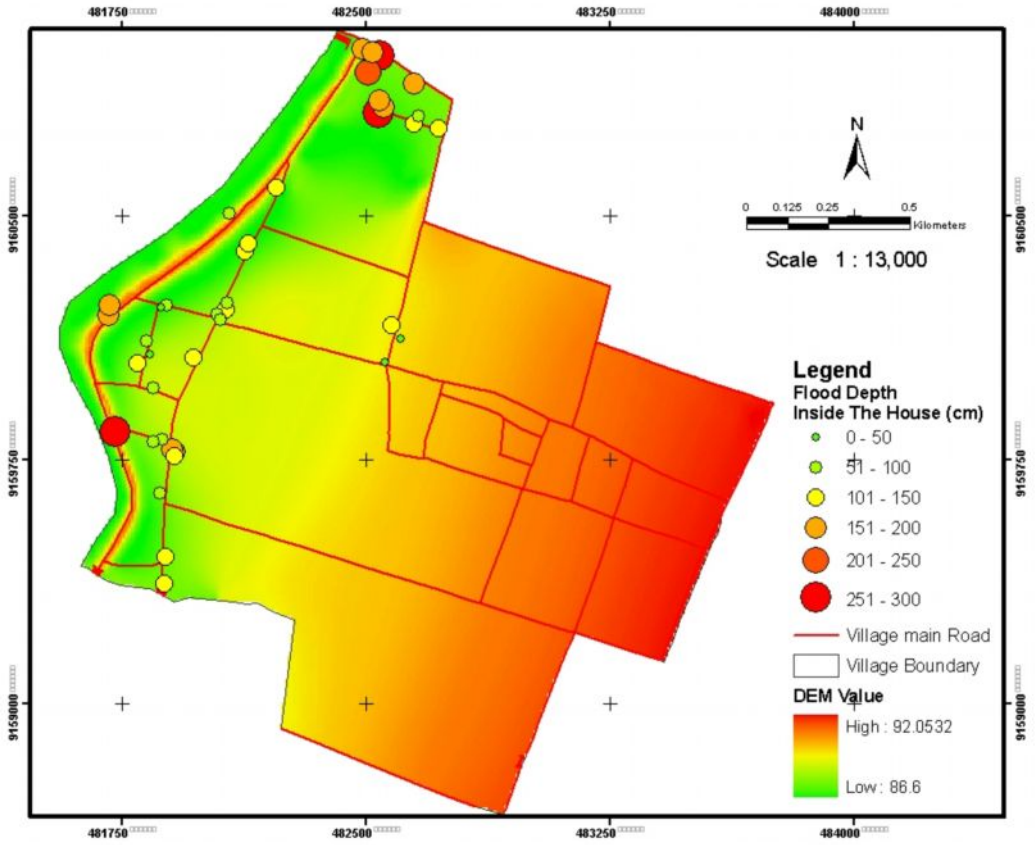



Figure 4-4. Flood Depth Inside The House in *Desa* Laban

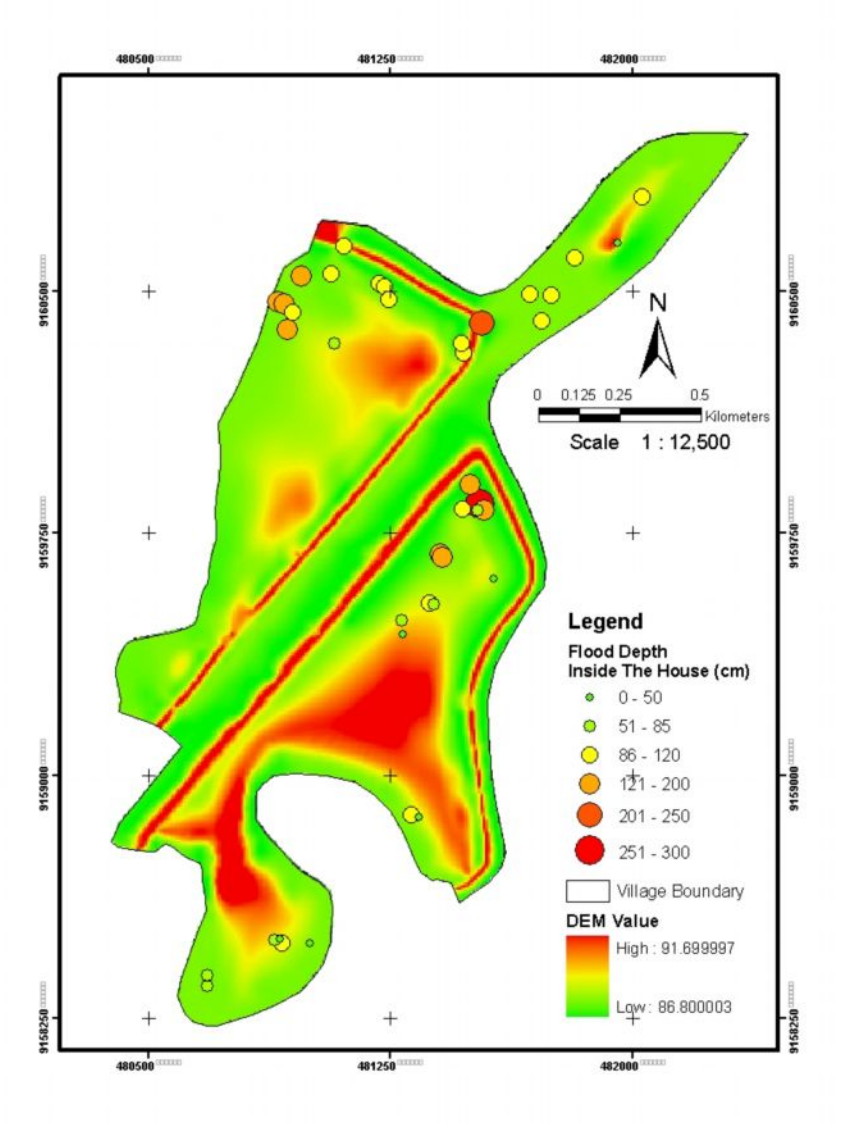



Figure 4-5. Flood Depth Inside The House in *Desa* Kadokan

Most of the respondent's houses were inundated 51-100 cm. The frequency is 33 houses or 41.25% of total respondent's houses. According to respondent's information in both villages, the highest inundation inside their houses occurred in the first day of inundation, 26$^{th}$ December 2007. The second inundation occurred the day after the first inundation, however the second inundation was not as high as the first one. This is reasonable since the rainfall on upper part of this basin of 26$^{th}$ December 2007 was higher than 27$^{th}$ December 2007. The water depth inside the house influenced to the damage/ losses level.

### 4.3.3. Flood Distribution

Based on interview result, with both respondent and local government, the flood in *desa* Laban is uneven distributed. There was only 1 *dusun* that was not inundated during the big flood. This is because *dusun* 1 is laid on the higher elevation than other 2 *dusun*.

Different from condition in *desa* Laban, flood distribution in *desa* Kadokan is more evenly distributed. Most of the area on this village was inundated. The main cause of flooding in both villages was the broken dike. However, there is 1 *dukuh* in Kadokan that is unprotected by dike. The main cause of flood in this area was the overflow of Bengawan Solo river. The 2007 flood event extent on both villages is shown in Figure 4-6 and 4-7.

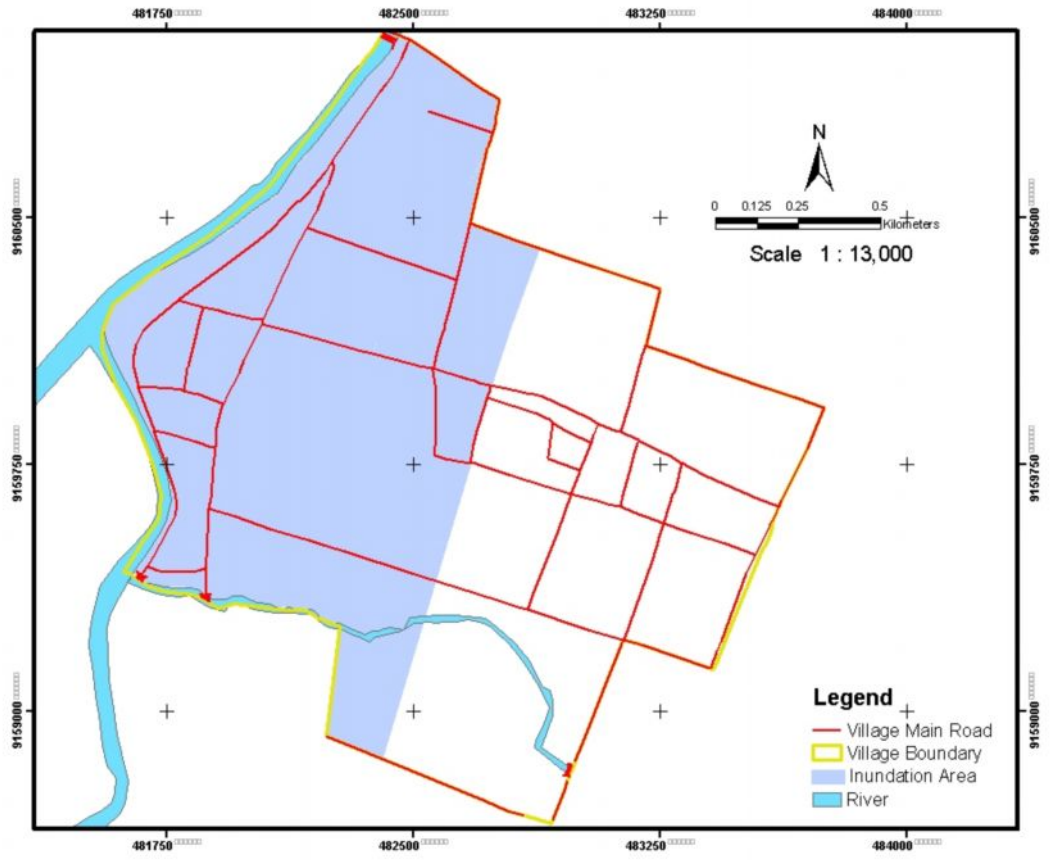



Figure 4-6. The 2007 Flood Extent Map of *desa* Laban
Source : FGD result

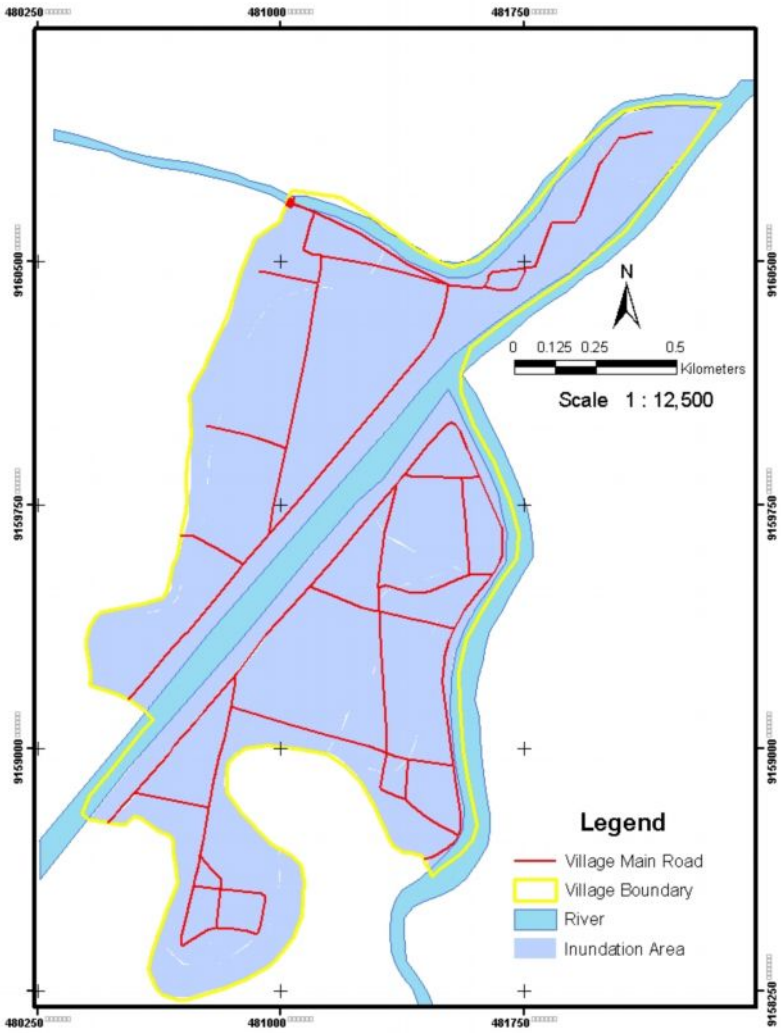



Figure 4-7. The 2007 Flood Extent Map of *desa* Kadokan
Source : FGD result

### 4.3.4. Flood Depth

The 2007 flood event inundated *desa* Laban and *desa* Kadokan in different depth. Based on Focus Group Discussion, there are three flood depth classes. They are deep (> 100 cm), moderate (50 – 100 cm), and shallow (< 50 cm). The depth was estimated from village main road, therefore it describes general flood depth in both villages. The people that became participant in Focus Group Discussion draw the line that described the boundary of the flood depth classes as shown in Figure 4-8 and 4-10. While Figure 4-9 and 4-11 overlaid the depth of water in respondent's house with flood depth of FGD result.

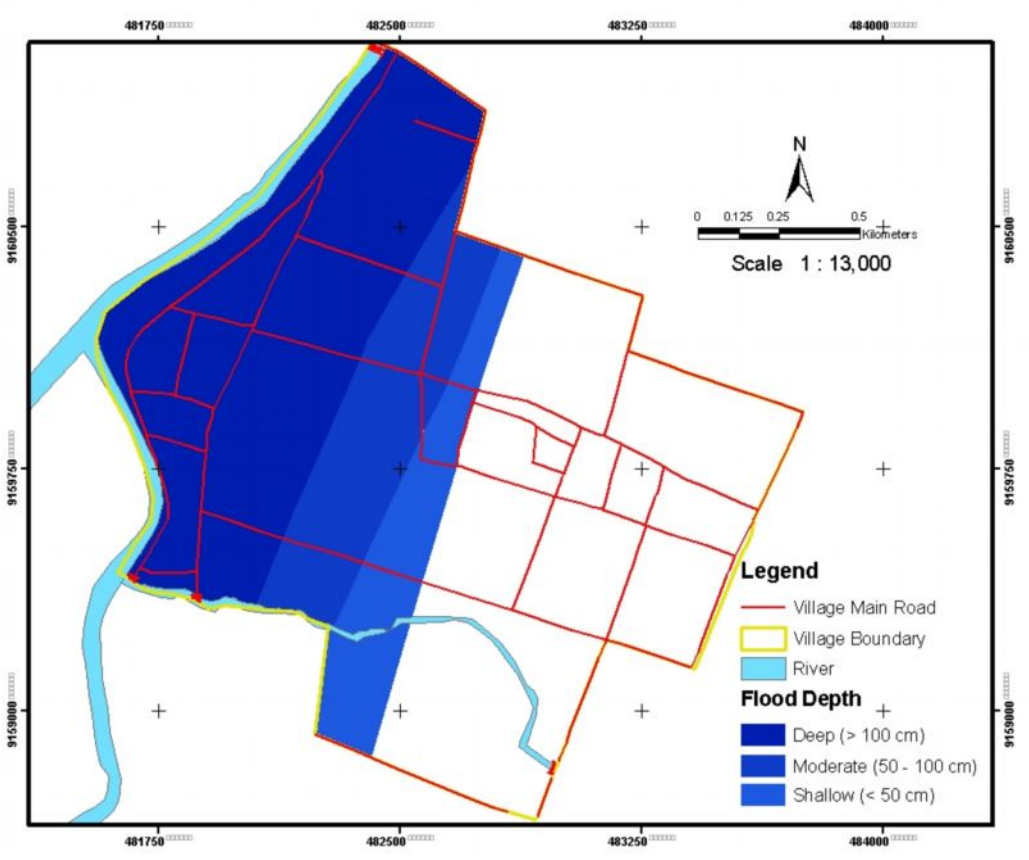



Figure 4-8. Flood Depth in *desa* Laban
Source : FGD Result

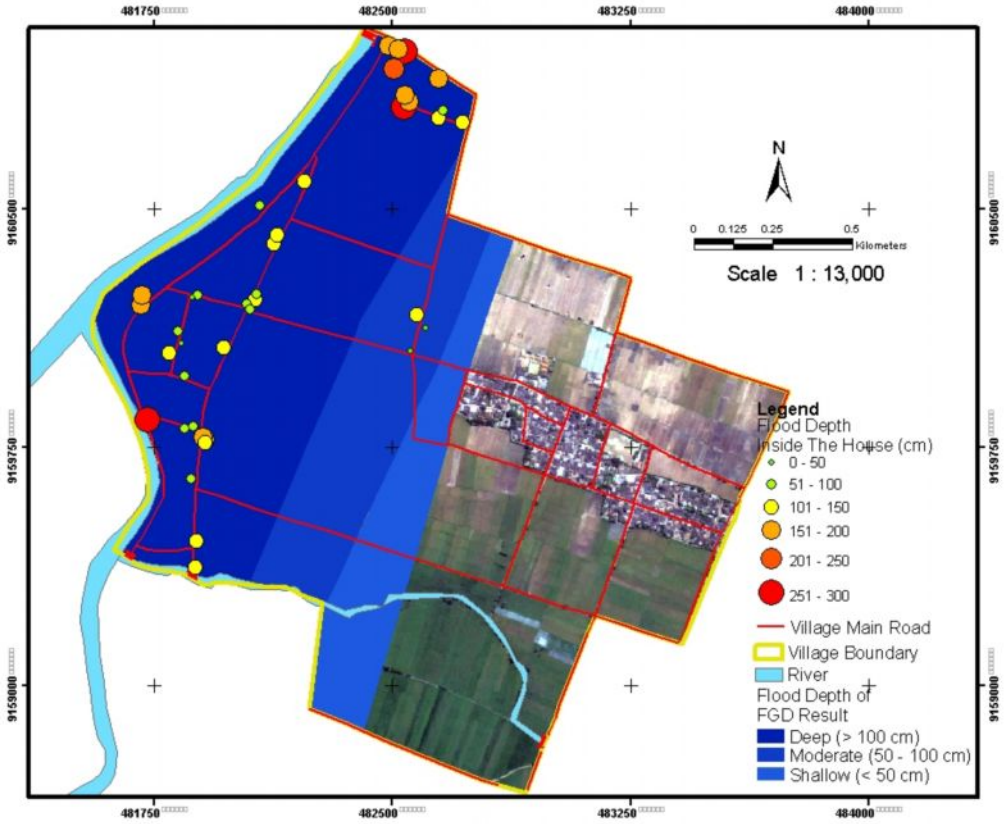



Figure 4-9. Flood Depth Based on FGD and Interview in *desa* Laban

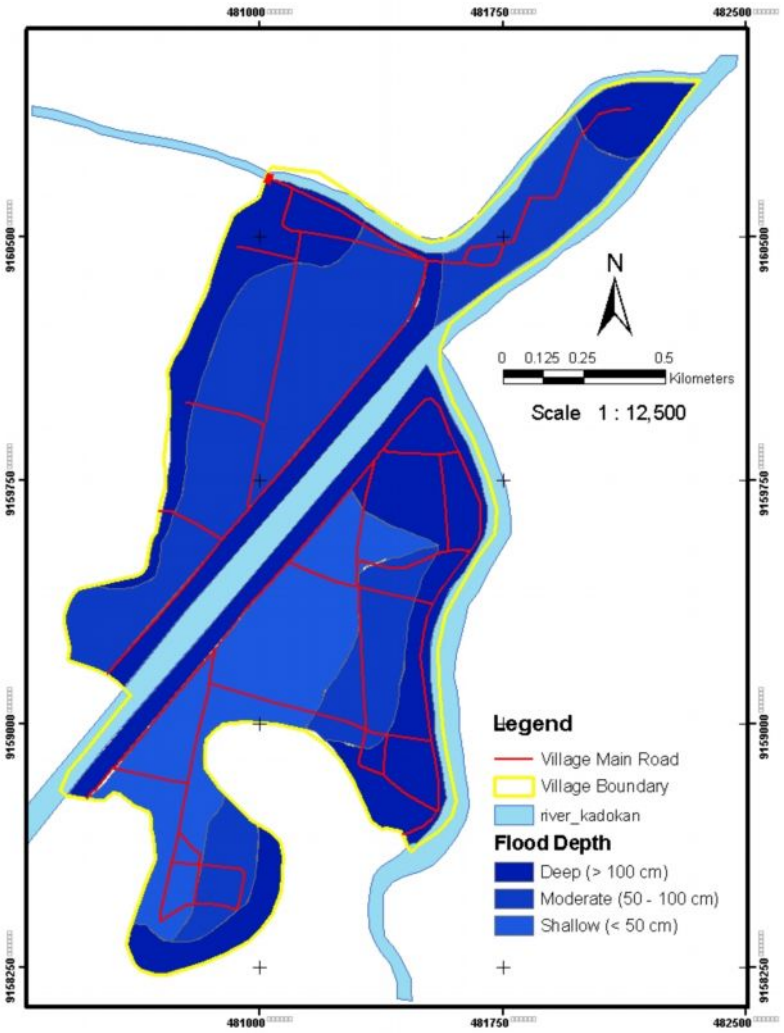



Figure 4-10. Flood Depth in *desa* Kadokan
Source : FGD Result

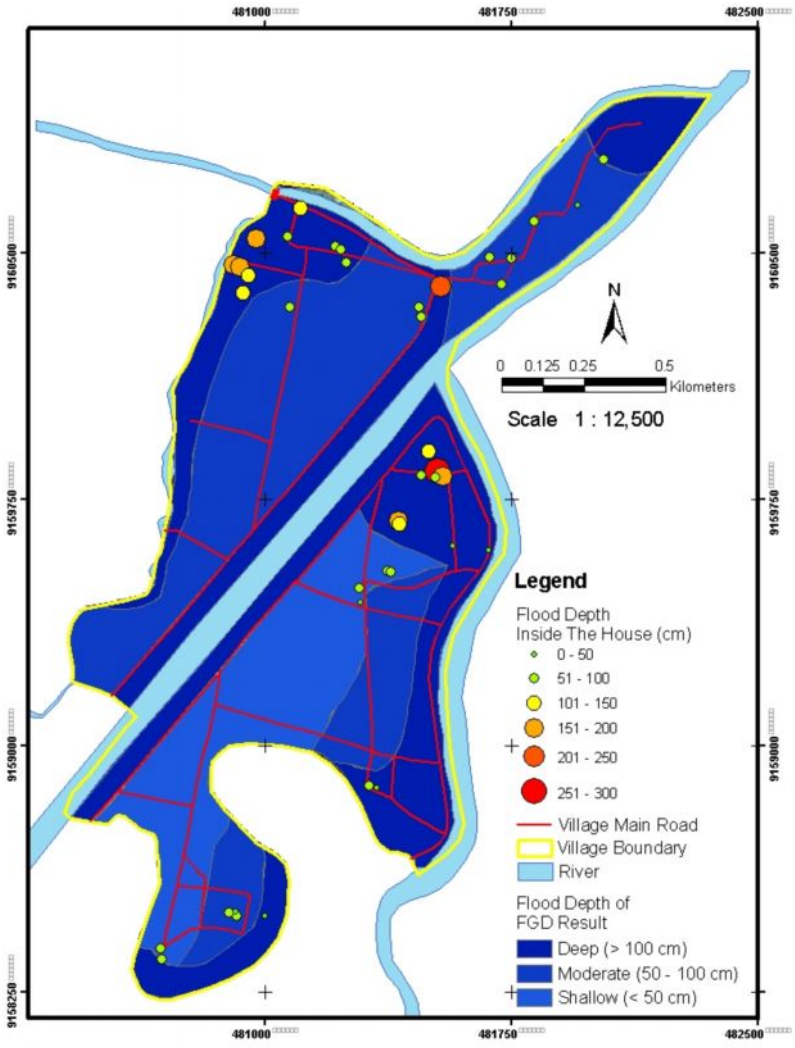



Figure 4-11. Flood Depth Based on FGD and Interview in *desa* Kadokan

The result of Focus Group Discussion in both villages shows different pattern of flood depth. The pattern of flood depth in *desa* Laban decreases gradually from west to east. While the pattern of flood depth in *desa* Kadokan is more vary. The pattern of flood depth is influenced by distance to river. The nearer an area to river is the deeper flood depth. This is reasonable since general elevation dips when it is closer to river. However, this reality is rather different in *desa* Kadokan. Although there is river in the middle of the village, the pattern of flood depth is decreasing when it is closer to the river. This is because the river is an artificial one, which

naturally was made on the higher elevation than its surrounding. Furthermore the flood depth was also influenced by the location of broken dike as shown in Figure 3-15 and 3-16.

The overlaying of flood depth of FGD and interview result shows the unique result. The depth pattern of FGD shows gradually as well as the general elevation. However, the depth pattern of respondent's house is distributed randomly. Although being placed on the same flood depth zone based on FGD result, each house shows different flood depth. Coping mechanism that people did by raising the floor foundation had caused the flood depth variation inside respondent's house.

### 4.3.5 Flood Duration

The 2007 flood event inundated both villages in different duration. The duration difference of inundation was described generally by participant in FGD in both villages as shown in Figure 4-12 and 4-13. There are three classes of flood duration, e.g. long (> 2 days), moderate (1 – 2 days), quick (< 1 day).

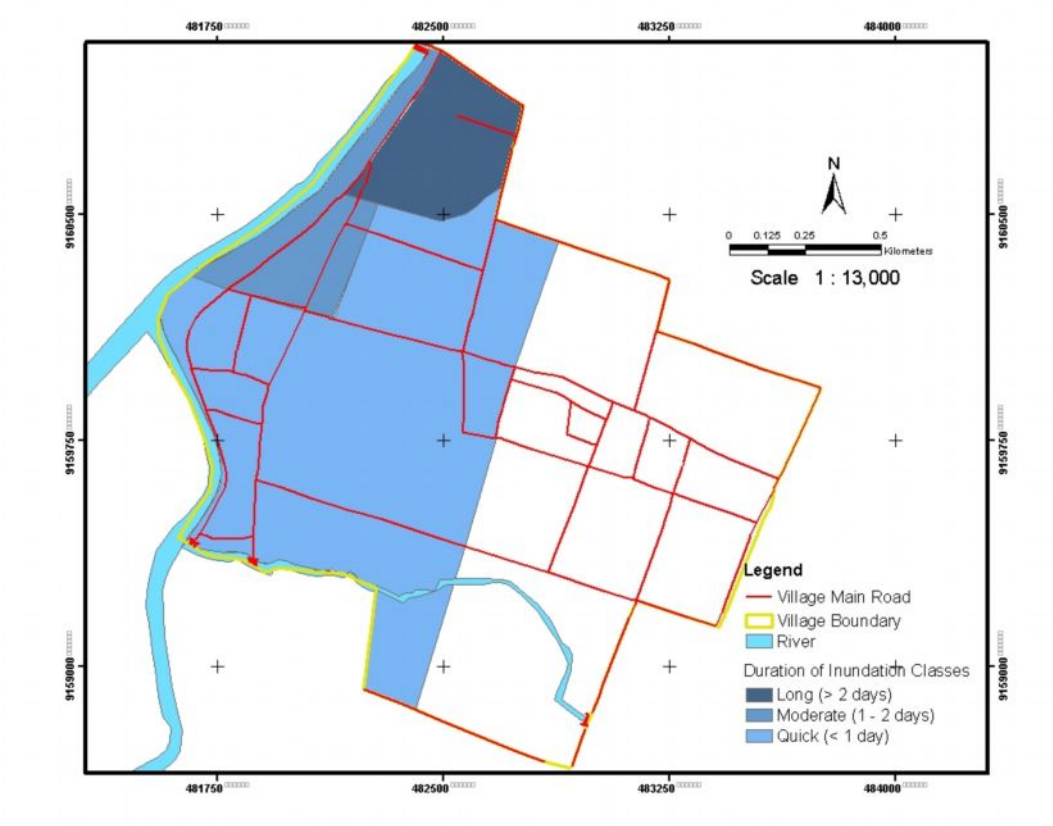



Figure 4-12. Flood Duration in *desa* Laban

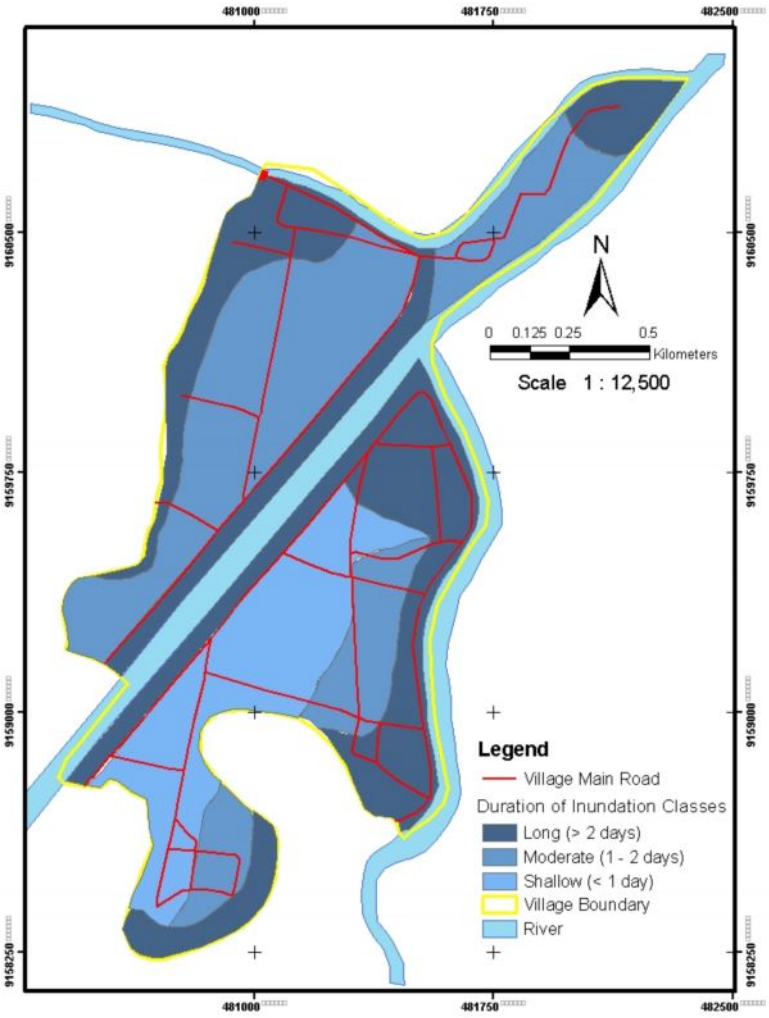



Figure 4-13. Flood Duration in *desa* Laban

The flood duration was determined by general elevation, total automatic door, and barrier factor. There are differences results when flood duration of FGD is overlaid by flood duration inside respondent's houses. Figure 4-14 and 4-15 show the overlying flood duration based on FGD result and flood duration inside the house of respondent. The differences were caused by different standardization of inundation height. Sometimes people did not consider as inundation when the road can be passed by people easily although the water height is several cm. However, when water in the same height inundated respondent's house, they would consider it as inundation. Moreover, the 2007 flood event occurred in two times, which each event had different time. This reason also influenced in counting the flood duration.

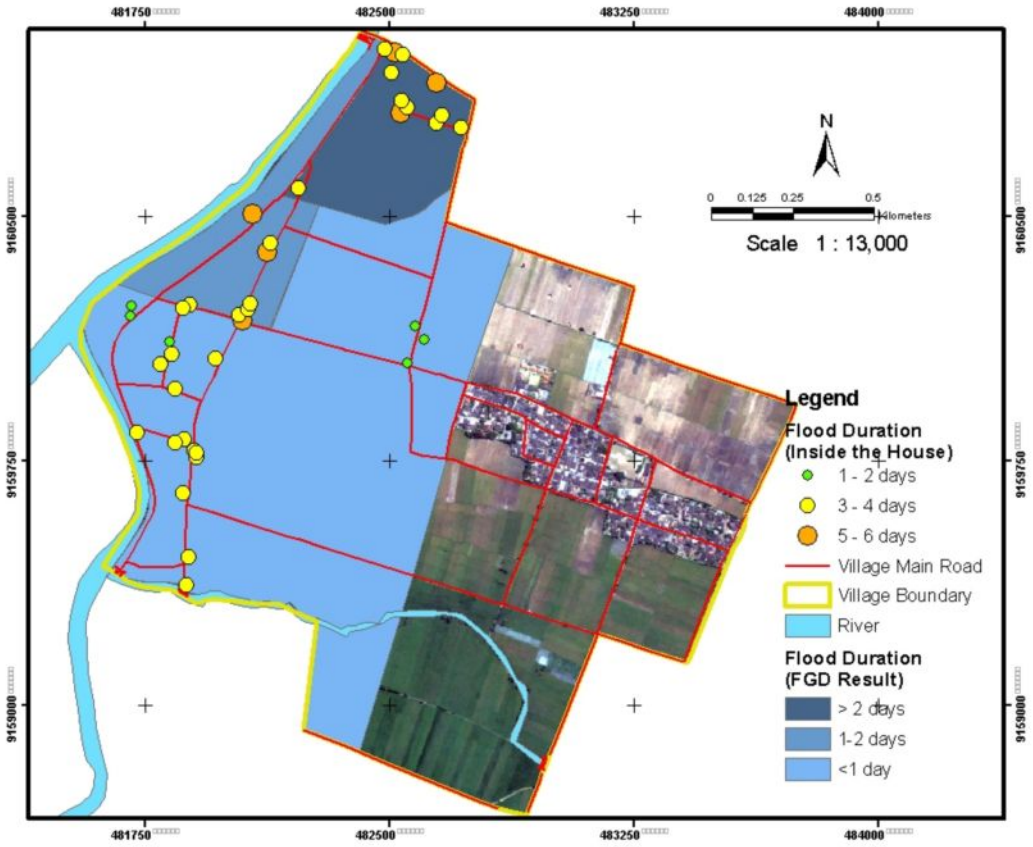



Figure 4-14. Overlying of Flood Duration based on FGD Result and Inside Respondent's Houses in *desa* Laban

water would only inundate village road like ordinary flood that usually occurs in every rainy season. But the sudden broken dike had moved water from Samin river into their house. Most of them were not ready of the condition. Based on data analysis, total respondent that still feel traumatized is shown in Table 4-7 and 4-8. The spatial distribution of traumatized respondent for *desa* Laban and *desa* Kadokan is displayed in Figure 4-16 and 4-18. While the overlying between traumatized respondent and flood depth can be seen in Figure 4-17 and 4-19.

Table 4-7. Psychology Condition of Respondent Toward Flood 2007

| Psychology Condition | Frequency | Percent (%) |
|---|---|---|
| No Trauma | 35 | 43.75 |
| Trauma | 45 | 56.25 |
| Total | 80 | 100 |

Table 4-8. Psychology Condition of Respondent Based on Gender

| Gender | Trauma (Percent) | No Trauma (Percent) |
|---|---|---|
| Male | 18.75 | 36.25 |
| Female | 37.5 | 7.5 |

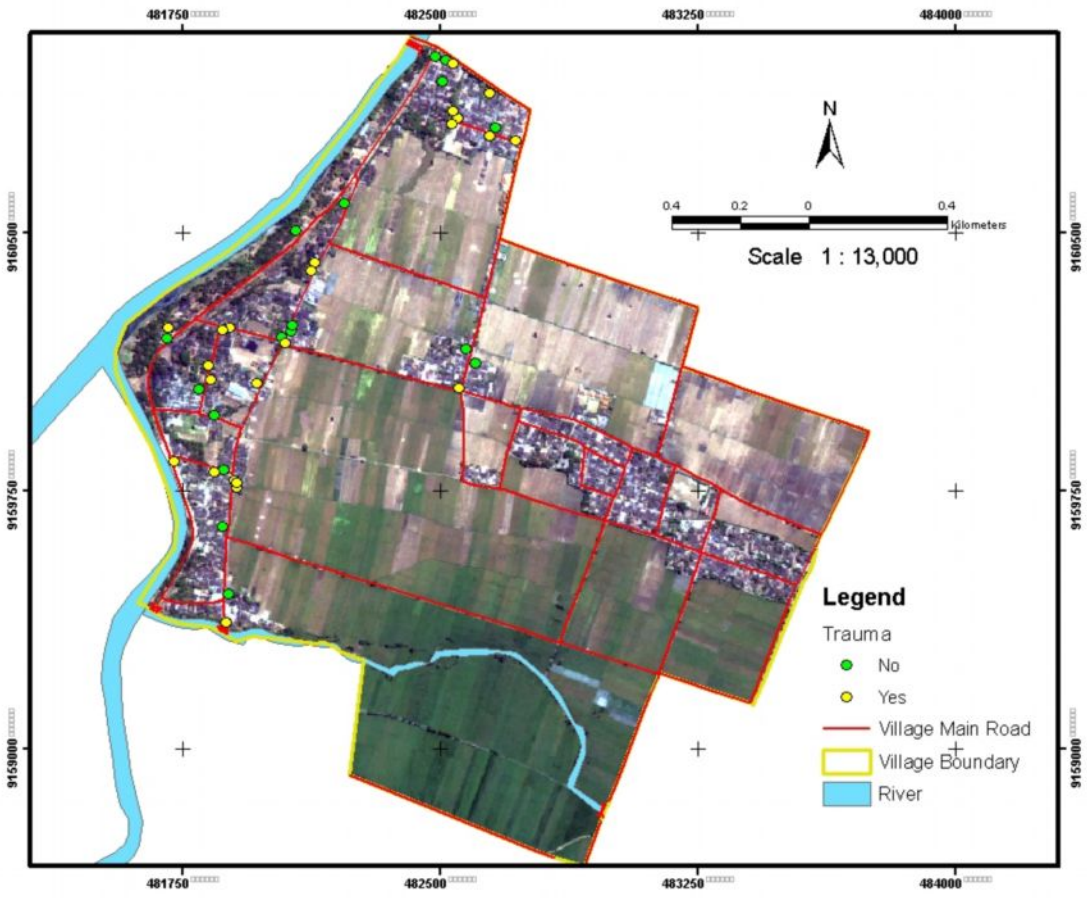



Figure 4-16. Traumatized Respondent Spatial Distribution in *desa* Laban

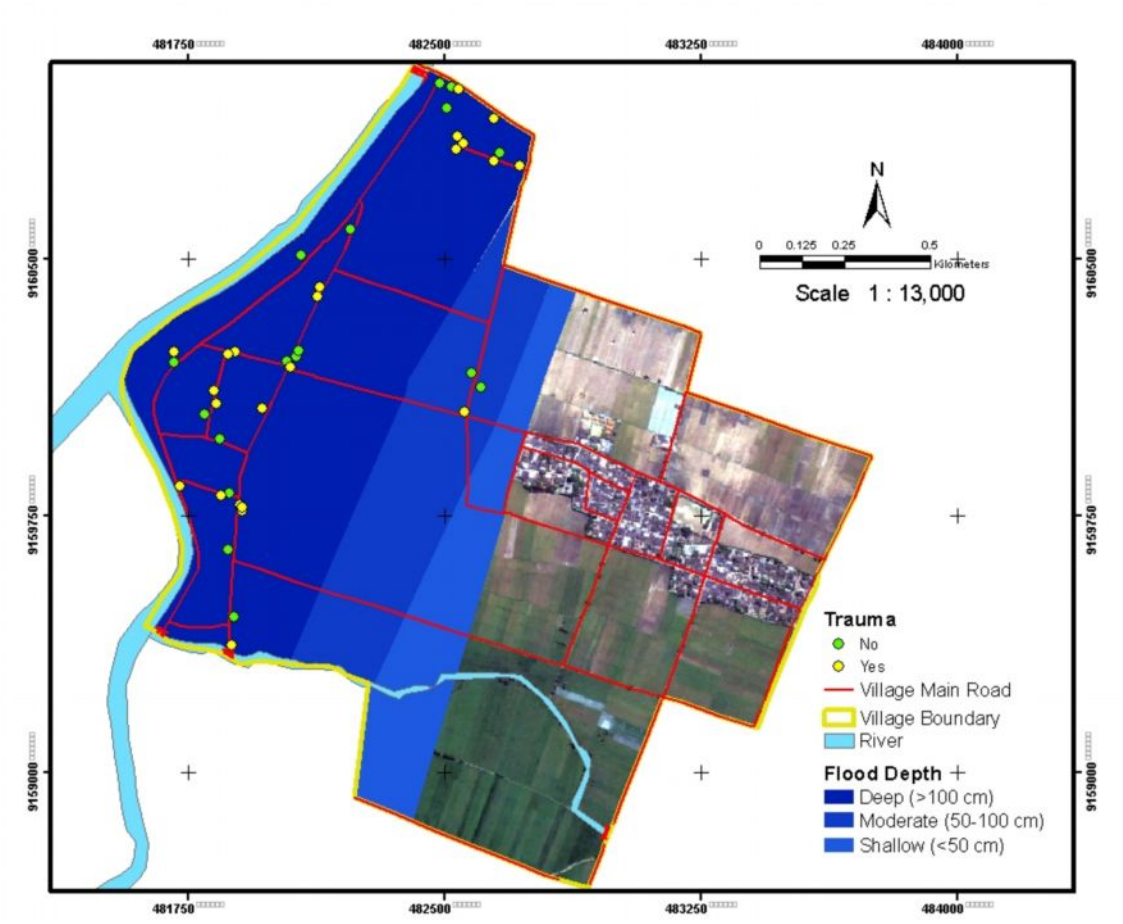



Figure 4-17. Traumatized Respondent Spatial Distribution Based on Flood Depth in *desa* Laban

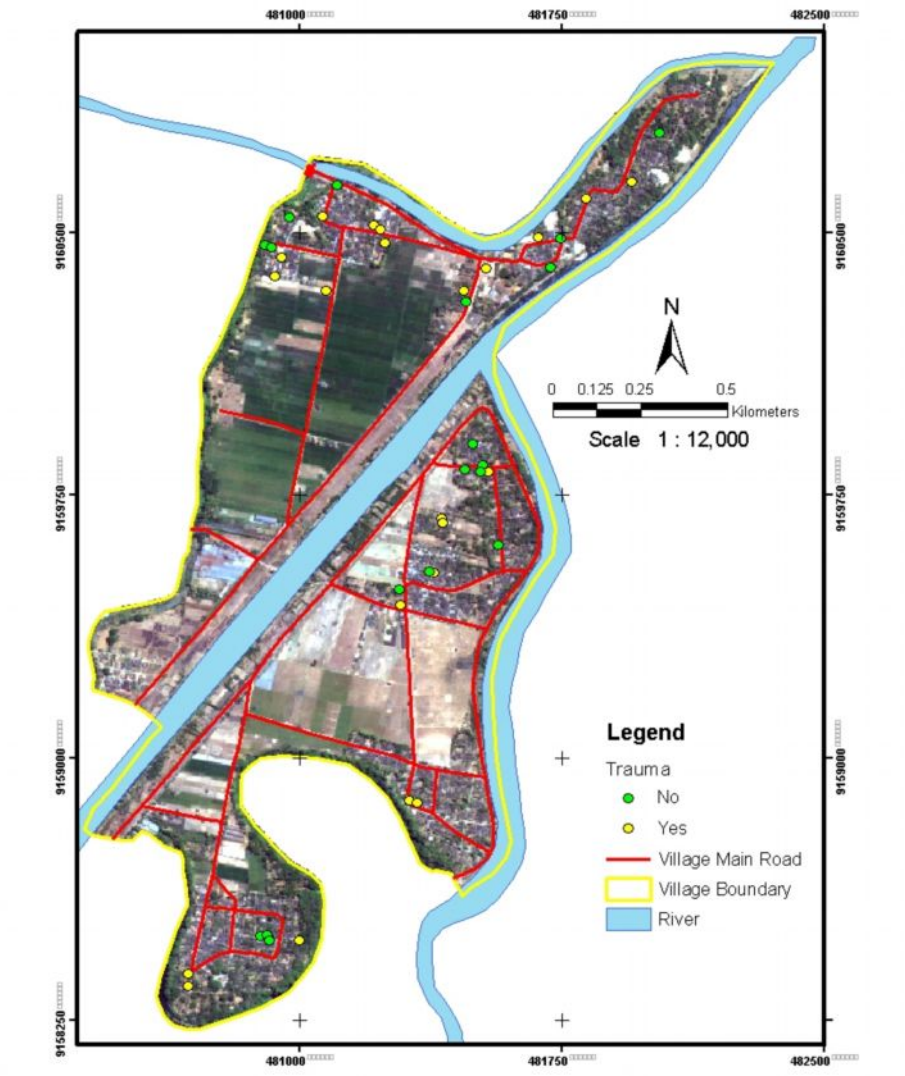



Figure 4-18. Traumatized Respondent Spatial Distribution in *desa* Kadokan

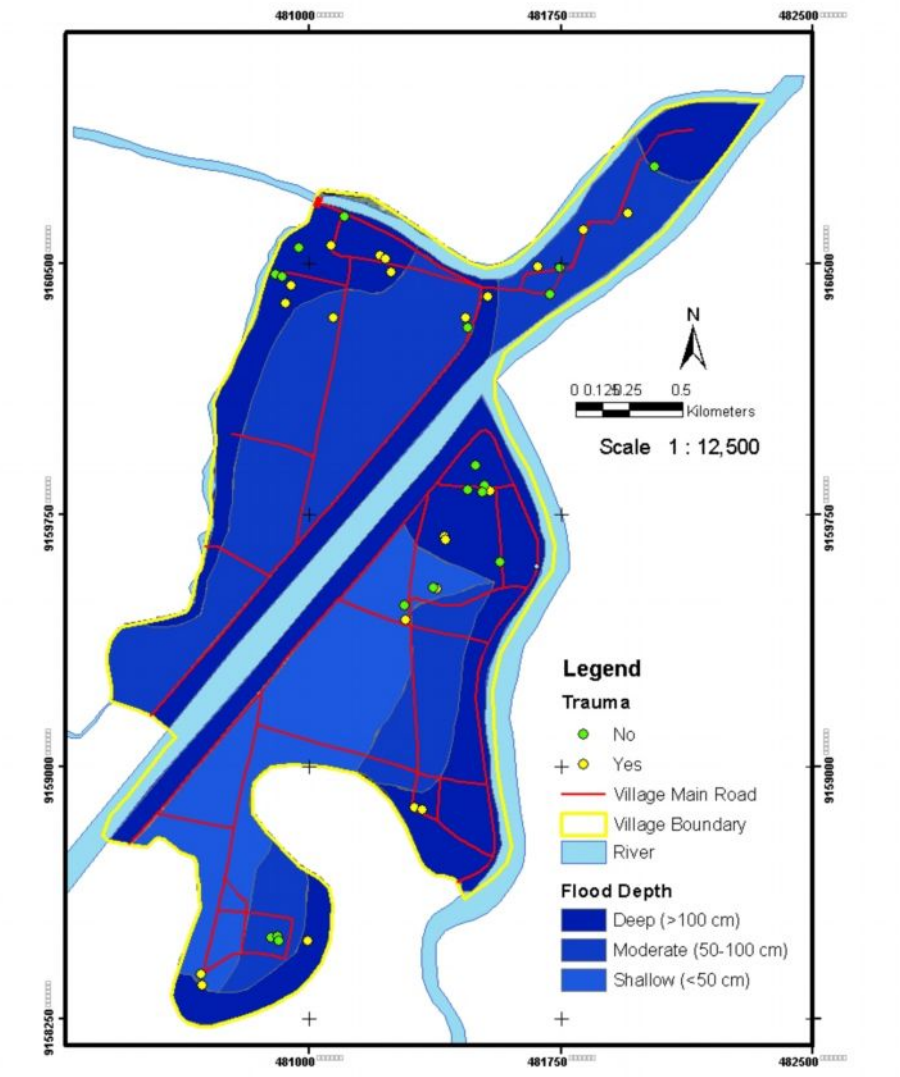



Figure 4-19. Traumatized Respondent Spatial Distribution Based on Flood Depth in *desa* Laban

Two figures above, Figure 4-18 and 4-19 shows that the traumatized respondents are distributed randomly in the study area. Traumatic circumstance is more caused by gender factor than other factor such as flood depth and flood experiences. A psychology study in America reveals that woman is more sensitive to the emergence of stress hormones, *corticotropinreleasing factor* (CRF), than man (Dewi, 2010). Therefore woman is more prone to depression, trauma, and other psychological problems. Table 4-9 and figure 4-20 show the traumatic respondent number based on traumatic influence factor.

Table 4-9. Cross Tabulation of Traumatic Respondent and Traumatic Factor

| Respondent Condition/ Traumatic Factor | | No Trauma | | Trauma | | Total Respondent |
|---|---|---|---|---|---|---|
| | | Frequency | Percent | Frequency | Percent | |
| Gender | Male | 29 | 65.91 | 15 | 34.09 | 44 |
| | Female | 6 | 16.67 | 30 | 83.33 | 36 |
| Flood Depth | Deep | 25 | 40.98 | 36 | 59.02 | 61 |
| | Moderate | 8 | 57.14 | 6 | 42.86 | 14 |
| | Shallow | 2 | 40.00 | 3 | 60.00 | 5 |
| Flood Experience | 1 time | 9 | 26.47 | 25 | 73.53 | 34 |
| | 2-5 times | 8 | 47.06 | 9 | 52.94 | 17 |
| | 6-10 times | 2 | 100.00 | 0 | 0.00 | 2 |
| | >10 times | 16 | 59.26 | 11 | 40.74 | 27 |

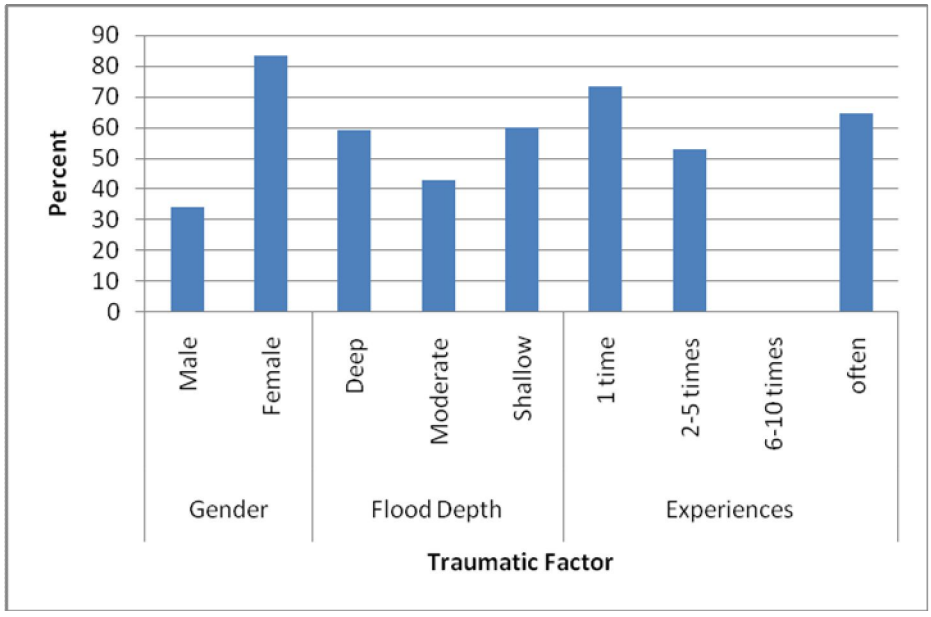
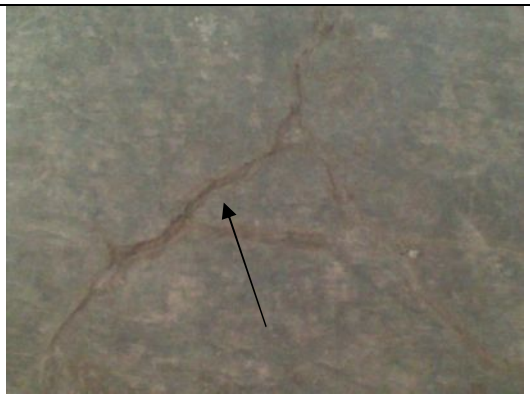



Figure 4-20. The Influence of Traumatic Factor to Traumatic Respondent

### 4.4.2. Losses

Losses that are caused by the 2007 flood event vary among community. The variation depends on goods belonging to the people before flood and the flood preparedness. Some people that have more flood experiences seem to be more prepared than people that do not, such as having *ranggon* inside the house. *Ranggon* is place bellow the roof that is used for keeping goods during flooding. *Ranggon* is made from bamboo or wood. The suddenly flood also influenced the losses level. The losses variation among people varied between Rp. 0, - until Rp. 100,000,000,-. Most losses of respondent are less than Rp. 2.000.000,-. Losses variation among respondent as the impact of the 2007 flood event can be displayed on Table 4-10. The losses could be damage to house such as cracked wall or floor, damage to merchandise, damage to home furnishing, electronics and other belongings. Furthermore the example of flood impact to the house is shown in Figure 4-21. While the overlying losses and flood depth of both villages is describe in Figure 4-22 and 4-23

a. Cracking Wall as The Impact of Flood



b. Cracking Floor as The Impact of Flood

Figure 4-21. Flood Impact to the House

Table 4-10. Losses Variation Among Respondents

| Losses | Frequency | Percent |
|---|---|---|
| 0 - 2.000.000 | 51 | 63.75 |
| 2.000.000 - 4.000.000 | 7 | 8.75 |
| 4.000.000 - 6.000.000 | 7 | 8.75 |
| 6.000.000 - 8.000.000 | 3 | 3.75 |
| 8.000.000 - 10.000.000 | 6 | 7.5 |
| > 10.000.000 | 6 | 7.5 |

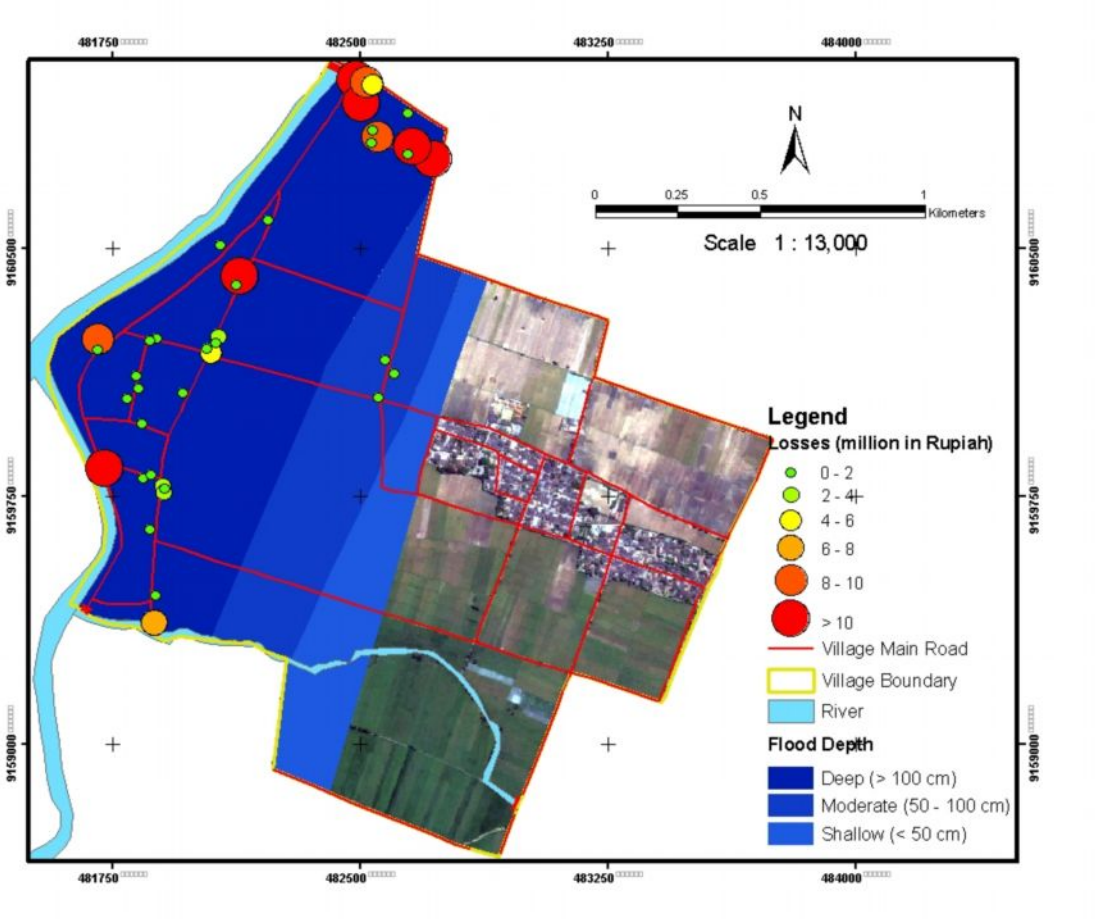



Figure 4-22. Losses as the Impact of Flood in *desa* Laban

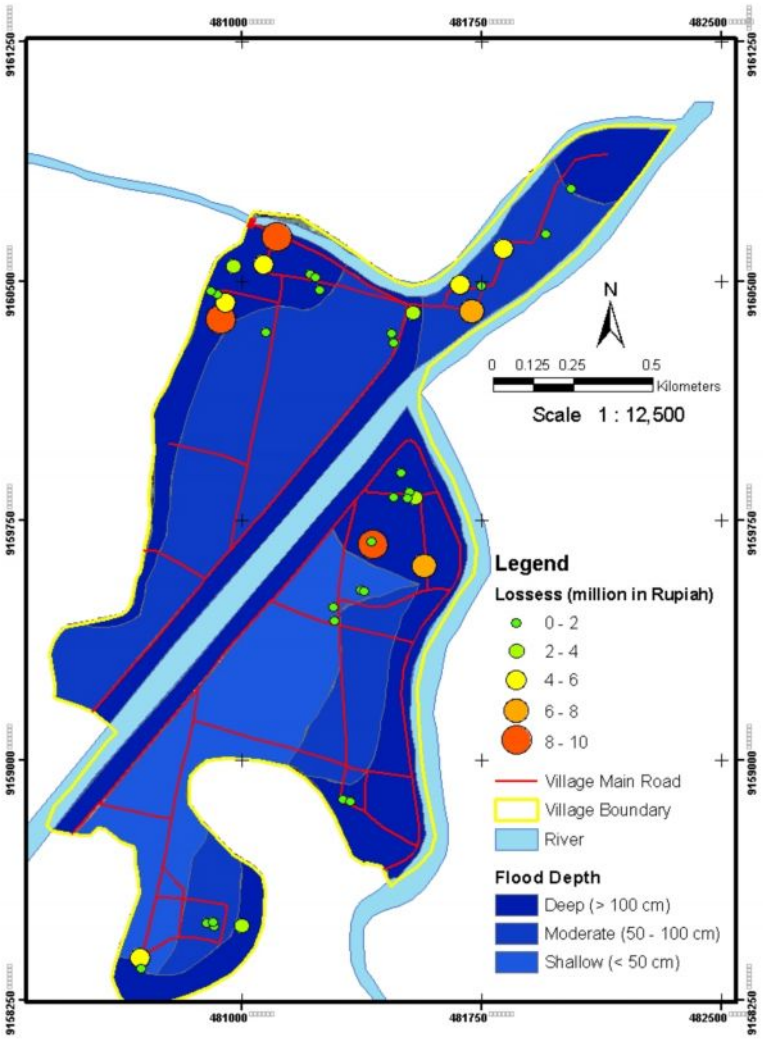



Figure 4-23. Losses as the Impact of Flood in *desa* Kadokan

Figure 4-22 and 4-23 describe the spatial distribution of respondent's losses in both villages. The dot of losses is distributed randomly in its size in different flood depth classes. The big dot of losses places in the deep zone of flood depth class. This fact proofs that there is correlation between flood depth and losses level. However not all of dots that place in deep zone have the same size. It means that the losses vary among the same flood depth zone. The variation of losses is influenced by some factors. They are flood depth, the total of belonging, and flood preparedness.

### 4.4.3. Impact to Income

Flood also influenced to respondent's income. This is reasonable since most of their occupation is in non-formal sector. People could not go to work during and some days after flood. People needed some days for cleaning up their house. Moreover for some merchants, the flood also caused damage on their merchandise. However, income of some other people was not influenced by the flood. The percentage of this group is about 28 percent. Table 4-11 shows the influence of flood to respondent's income.

Table 4-11. Flood Influence to Income of Respondent

| Influence to Income | Frequency | Percent (%) |
|---|---|---|
| Yes | 57 | 71.3 |
| No | 23 | 28.8 |

The types of occupation that were influenced by flood in the study area are trader, factory workers/ laborer, farmer, entrepreneur, and *gamelan* craftsman. Workers absenteeism in the factory affects to the amount of salary they receive because they are paid daily. Flood also damages to agricultural crops and merchandise which affect to farmer's and trader's income. Some craftsmen also suffered losses since their *gamelan* damaged by flood. The other types of occupation that were not influenced by flood are civil servants, teacher, and retired people because they are paid monthly.

# 5. COMMUNITY RESILIENCE TOWARD FLOOD IN SUKOHARJO REGENCY

*This chapter discusses the resilience among community which is represented by respondent in selected villages toward flood. The resilience can be described by weighting the resilience factors, i.e. human capital and economical capital. This chapter also discusses speed of recovery after flood.*

## 5.1. Introduction

Islam et al. (2010) mentioned that there are five capital major forms in building community resilience, e.g. natural capital, physical capital, social capital, economic capital, and human capital. Three of five capitals, e.g. natural capital, physical capital, and social capital, are not investigated deeply since they do not relate to each respondent's resilience. However, natural capital, physical capital and social capital also contributes in determining community resilience.

According to Islam et al. (2010), natural resources and environmental possesses are natural capital of community resilience. In the both villages, river is natural capital since it can give benefit to their life. Kompas (2009) mentioned that floodplain along Bengawan Solo river is used by people who is living there as agricultural area. The river also becomes a place for fishing for some people. The benefit of river to human life also becomes a reason why settlement pattern firstly started and developed in the area along it, as seen in both villages.

The second capital is physical capital. Islam et al. (2010) categorized residential housing, public buildings, dams, and levees and shelters into physical capital. Moreover, lifelines such as electricity, water, telephone and critical facilities are also categorized into this second capital (Mayunga (2007) in Islam et al. (2010)). During inundation time, there was blackout in both villages. The blackout was for safety reason. However, this condition was also disturbing and liable of pilferage. Government activated the general power sooner after the emergency time. Public building such as village head office, that was not inundated, became evacuation area for some people in *desa* Laban. The building also became assistance center in the village. On the other hand, village head office of *desa* Kadokan could not be used as evacuation center since the building also inundated during the 2007 flood event. However, as in other head office village, the building became assistance center soon after the depth of water was decreased. Levees/ dikes that is higher than area surround it also became evacuation area and connecting way from and to

both villages. Broken dike in some parts of it, that became the major cause of flooding in both villages, has been recovered by government. Even government has raised its height and added the width.

Putnam (1995) in Islam et al. (2010) defined social organizations such as networks, norms and social trust as social capital. Moreover emergency managements of government such as Red Cross and Salvation Army were really helpful during disaster/ emergency time. Some private companies in Sukoharjo regency and other cities also paid attention to the 2007 flood event. They gave aid to people in both villages such as food, instant noodle, sugar, rice, and other essential needs. Even the aid also came from individual person who care to this humaneness problem. The spirit of togetherness in working together and helping each other to overcome problem, so called as "gotong royong", also became social capital. The spirit of interacting with others is constructed on two basic ethics, namely harmony and respect. This spirit was implemented during and after disaster. During disaster, people helped each other in distributing food and medicines, updating water level and informing evacuation road and places. The spirit of "gotong royong" also seemed in recovery time, i.e. cleaning village main road from mud and refining temporary the broken dike before government handled it.

This research focused on individual resilience by doing investigation to respondents. There are two of five capitals in building community resilience that were investigated, e.g. economic capital and human capital. This research also considered to recovery time, in terms of the speed of cleaning up the house. This activity is the first step that usually people do after disaster.

### 5.2. Human Capital

As mentioned in previous section, there were two elements of human capital in building community resilience that investigated in this research. Sullivan and Sheffrin (2003) in Islam et al. (2010) mentioned that skills and knowledge are human capital in building community resilience. Skills and knowledge can be gained through education and experiences. Education and experiences can increase understanding or perception of community risk and also increase the ability in developing and implementing risk reduction strategies. Therefore this research investigated both factors in determining community resilience in study area.

### 5.2.1. Flood Experiences

Naturally *Desa* Laban and *desa* Kadokan are prone to flooding since there are some rivers on its sides. Even river straightening of Bengawan Solo river in *desa* Kadokan has made this village is more prone to flood. Flood experience is one of some human capital in community resilience elements.

Most of respondents do not have any experiences with flood. About 41.3% of respondent said that the 2007 flood event is their first flood experience. These respondents mostly do not experience the 1966 flood event which is worse (in case of flood depth and its duration) than the 2007 flood event. On the other hand, the old respondents experienced the 1966 flood event. Before river straightening and dike construction in 1988 also Wonogiri dam construction, the two villages were experienced flood frequently. Flood experiences of respondent in both villages can be seen in Table 5-1 and 5-2.

Table 5-1. Flood Experiences of Respondent in *Desa* Laban

| Flood Experiences | Frequency | Percent |
|---|---|---|
| 1 time | 19 | 47.5 |
| 2-5 times | 10 | 25 |
| 6-10 times | 1 | 2.5 |
| > 10 time | 10 | 25 |
| Total | 40 | 100 |

Table 5-2. Flood Experiences of Respondent in *Desa* Kadokan

| Flood Experiences | Frequency | Percent |
|---|---|---|
| 1 time | 12 | 30 |
| 2-5 times | 10 | 25 |
| 6-10 times | 1 | 2.5 |
| > 10 time | 17 | 42.5 |
| Total | 40 | 100 |

### 5.2.2. Education

The second element in human capital is education. As mentioned in previous section, education level in *desa* Laban and *desa* Kadokan is vary from elementary school to college. Even, some respondents were not educated. The educational level was distributed in some age ranges from 20 until 74 year. The level of education in *desa* Laban and *desa* Kadokan can be seen in Table 5-3 and 5-4.

Table 5-3. Education Level of Respondent in *desa* Laban

| Educational Level | Frequency | Percent |
|---|---|---|
| No Education | 7 | 17.5 |
| Elementary School | 13 | 32.5 |
| Junior High School | 8 | 20 |
| Senior High School | 10 | 25 |
| College | 2 | 5 |

Table 5-4. Education Level of Respondent in *desa* Kadokan

| Educational Level | Frequency | Percent |
|---|---|---|
| No Education | 5 | 12.5 |
| Elementary School | 19 | 47.5 |
| Junior High School | 5 | 12.5 |
| Senior High School | 8 | 20 |
| College | 3 | 7.5 |

Most of the respondent's education level, both in *desa* Laban and *desa* Kadokan, is elementary school. The age of respondent that is included in this group is between 51 until 60 year. On the other hand there were only 5 respondents in both villages that receive their last education in college. The different level of respondent's education was seemed in their first

acceptance when researcher came to their house. People who have higher education, generally is easier in accepting researcher.

People who has lower education, frequently is elderly, accept flood as their risk since they are staying nearby river. Coping mechanism that they did before, during and after flooding is knowledge that they got down for years from their parents/ ancestor. On the other hand, younger person who has higher education is generally more aware to this hazard. They more active in updating information related to flood by using telecommunication tools, such as hand phone. The flood information that was updated among community before, during, and after disaster were flood depth, flood extent, evacuation route, evacuation places, assistance center, and aid.

### 5.3. Economic Capital

Economic capital means financial resources that people use in recovery. It includes saving, income, investment, and other fund sources. Mayungan (2007) in Islam et al. (2009) states that economic resilience can increase people's ability and capacity to absorb disaster impact and speed up recovery.

Flood had caused losses for people, which the losses would be recovered after disaster. Therefore people need financial resource for the recovery. The main source for the recovery is income, which is assumed it was used automatically by people in recovery. However sometimes income is not enough. Therefore people needed other financial resources to support the recovery. The more financial resources are the faster recovery process.

Generally income can be described by the type of occupation. People who work in non formal sector, such as farmer, usually have a low income. On the other hand income of people who work in formal sector, such as civil servant or teacher, is more certain. Moreover the income is above regional minimum wage. Income of household is an indicator that cannot be relied to measure the level of family welfare, since the distribution of income is different among family (Todaro and Smith, 2006).

The income of household or people who work in non formal sector usually was influenced by the flood. The flood influence to income of respondent can be seen in Table 4-8. Flood had disrupted to their income. Even flood disrupted the income source, such as trader and

entrepreneur. Flood caused damage to the merchandise. In this case, they needed another financial source to recover from flood impact including refund the business. On the other hand, people who work in formal sector such as civil servant or teacher still could get their income normally. The income was not influenced by flooding.

Based on the result of interview, most of respondent used their own financial ability to recover after flood, in this case their income. Table 5-5 shows the number of people who used other financial resources.

Table 5-5. Community Financial Resource for Recovery toward the 2007 Flood Impact

| Financial Resources | Yes | | No | |
|---|---|---|---|---|
| | Frequency | Percent | Frequency | Percent |
| Saving | 17 | 21.3 | 63 | 78.8 |
| Selling thing | 8 | 10.0 | 72 | 90.0 |
| Relation Help | 16 | 20.0 | 64 | 80.0 |
| Loan | 18 | 22.5 | 62 | 77.5 |

Although they used one financial resource or more, it does not mean that the condition is as the condition before the disaster. Even some people can not recover totally. However they can accept the condition and live normally. The acceptance attitude among the people is influenced by factors, e.g. culture and religion. In the religion view, disaster is trial from God which can measure person's level of faith. Moreover, disaster is also a warning from God to human in order that we can be wiser in utilizing natural resource. Beside, Javanese culture influences to people daily life. There is a belief among Javanese people that every occurrence is the way of nature in balancing the ecosystem. Moreover, there is a popular attitude in Javanese culture that is called as "nrimo ing pandum". This attitude teaches people to accept every challenge in their life with sincere, face the challenge with hard work, then let God determines the result (Kompasiana, 2010). Both factors has made people recovery in terms of psychology.

### 5.4. Speed of Recovery

The first activity that people did after flood is cleaning up the house and house ware from mud. This research also asked the speed of recovery of respondents in term of cleaning up the house after inundation time. Speed of recovery among respondent was vary. The variation of the recovery speed was influenced by different factors. They are the damage level inside the house, flood experiences, family member, flood preparedness, and external aid.

Damage level inside the house of each respondent is different, depends on the height of water inside the house and inundation duration. The damage level was also influenced by total belonging inside the house and building quality which it is determined by building type in term of its material and building age. The higher and longer inundation is worse damage.

Respondent's flood experiences also influenced to speed of recovery. Flood experience could help people in cleaning up the house and their belonging. People who have more experience knew what should do for evacuating their belonging before inundation. For example, they put some stones or bricks inside cupboard after taking out some clothes from it. The stones or bricks would keep the cupboard standing during inundation time. Furthermore, they also knew the way to clean up their house faster than people who have no flood experience. Flood usually brings also mud, sediments, garbage, and other contaminants in its water. When water subsided gradually (about 10 cm from floor), they used the water to wash the wall and floor from mud, and then drove away flood water from the house. Therefore, when water was completely out from their house, the mud that left on wall and floor was not thick. This made cleaning costs could be reduced. Moreover, flood experience has given them knowledge about flood sign. When the sky on the south (Wonogiri) and east (Lawu mountain) parts are dark, and hard rain occur in that area, they can predict that flood is possible will occur in their area. In this case, they have more time to prepare and evacuate their belonging in order to minimize the damage. The cross tabulation of recovery time and flood experiences of both villages can be seen in Table 5-6 and 5-7

Table 5-6. Cross Tabulation of Recovery Time and Flood Experiences in *desa* Laban

| Flood Experiences | Recovery Time (Frequency) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | < 1 week | | | | 1-2 weeks | 2-4 weeks | > 1 month | Frequency | Percent |
| | 0-2 days | 3-4 days | 5-7 days | Total | | | | | |
| 1 time | 2 | 2 | 12 | 16 | 2 | - | 1 | 19 | 47.5 |
| 2-5 times | 1 | - | 7 | 8 | 2 | - | - | 10 | 25 |
| 6-10 times | - | - | - | 0 | 1 | - | - | 1 | 2.5 |
| > 10 times | - | - | 6 | 6 | 3 | 1 | - | 10 | 25 |
| Total | 3 | 2 | 25 | 30 | 8 | 1 | 1 | 40 | 100 |

Table 5-7. Cross Tabulation of Recovery Time and Flood Experiences in *desa* Kadokan

| Flood Experiences | Recovery Time (Frequency) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | < 1 week | | | | 1-2 weeks | 2-4 weeks | > 1 month | Frequency | Percent |
| | 0-2 days | 3-4 days | 5-7 days | Total | | | | | |
| 1 time | 4 | 1 | 8 | 13 | 2 | - | - | 15 | 37.5 |
| 2-5 times | 1 | 3 | - | 4 | 2 | - | 1 | 7 | 17.5 |
| 6-10 times | 1 | - | - | 1 | - | - | - | 1 | 2.5 |
| > 10 times | 6 | 4 | 6 | 16 | - | 1 | - | 17 | 42.5 |
| Total | 12 | 8 | 14 | 34 | 4 | 1 | 1 | 40 | 100 |

Family member also can increase the speed of recovery. Cleaning up the house after flooding usually was done by family member. A family that had more teenagers/ adolescene and adults, could clean the house faster than family that had less one. According to Belajar Psikologi Online (2010), teenager is person who has age in the range of 12 until 22. While law of Republic of Indonesia no. 13 states that elderly is person who has age more than 60 year. Therefore, this research defined that a family member that could help in cleaning up the house is person who has age in the range of 12 until 60 year. In the fact, sometimes person who has age less than 12 or more than 60 could help the cleaning up the house process, in this case depends on the physical condition. The example of this case can be seen in the first row of Table 5-5. Since there is no person in the family that has age in the range of 12 until 60, the total family number is written as 0. Most of the respondents did not get any help from neighbor in house cleaning. This is reasonable since every family must be responsible for cleaning up their own house. The relation

between recovery time, in term of cleaning up the house, and family number can be seen in Table 5-8 and 5-9.

Table 5-8. Cross Tabulation of Recovery Time and Family Number in *desa* Laban

| Family Number | Recovery Time (Frequency) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | < 1 week | | | | 1-2 weeks | 2-4 weeks | > 1 month | Frequency | Percent |
| | 0-2 days | 3-4 days | 5-7 days | Total | | | | | |
| 0 | - | - | - | 0 | - | - | - | 0 | 0 |
| 1 | - | - | - | 0 | - | - | - | 0 | 0 |
| 2 | 1 | - | 3 | 4 | - | - | 1 | 5 | 12.5 |
| 3 | 1 | 1 | 8 | 10 | 5 | - | - | 15 | 37.5 |
| 4 | - | 1 | 3 | 4 | 2 | 1 | - | 7 | 17.5 |
| 5 | - | - | 5 | 5 | 1 | - | - | 6 | 15 |
| 6 | 1 | - | 4 | 5 | - | - | - | 5 | 12.5 |
| 7 | - | - | 2 | 2 | - | - | - | 2 | 5 |
| Total | 3 | 2 | 25 | 30 | 8 | 1 | 1 | 40 | 100 |

Table 5-9. Cross Tabulation of Recovery Time and Family Number in *desa* Kadokan

| Family Number | Recovery Time (Frequency) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | < 1 week | | | | 1-2 weeks | 2-4 weeks | > 1 month | Frequency | Percent |
| | 0-2 days | 3-4 days | 5-7 days | Total | | | | | |
| 0 | 1 | - | 2 | 3 | - | - | - | 3 | 7.5 |
| 1 | - | - | - | 0 | - | - | - | 0 | 0 |
| 2 | 1 | 2 | 2 | 5 | - | - | - | 5 | 12.5 |
| 3 | 5 | 1 | 4 | 10 | 3 | - | - | 13 | 32.5 |
| 4 | 2 | 1 | 3 | 6 | - | 1 | 1 | 8 | 20 |
| 5 | 1 | 1 | 2 | 4 | - | - | - | 4 | 10 |
| 6 | 2 | 3 | 1 | 6 | 1 | - | - | 7 | 17.5 |
| 7 | - | - | - | 0 | - | - | - | 0 | 0 |
| Total | 12 | 8 | 14 | 34 | 4 | 1 | 1 | 40 | 100 |

The next factor that influenced in recovery time was flood preparedness. Information related to dike condition and water level is important in flood preparedness. Unfortunately some people did not suppose that the dike would break and cause flooding in their area. There was no flood after Wonogiri dam and dike construction in 1988. The 2007 flood event was unpredictable

flood for some people. Therefore some people did not prepare themselves in facing the flood. When water came to their area, they just go for saving their family and left their house. On the other hand some other people were more ready with flood. They actively monitored water level of river and communicated among community related to the current condition. When water level in Bengawan Solo and Samin river increased significantly, they saved their belonging by keeping them in save places, such as *ranggon*, or put it in second floor. Therefore, although their house inundated during the 2007 flood, the damage was little. This condition could minimize the damage level and influence to recovery time.

External aid is the next factor that influences the recovery time. Some people got external aid, but some other people did not. The aid could be from family or relations. After flood water completely out from the house, family from other area came and helped in cleaning up the house. Moreover, the family of some people also gave some money and/ or goods to replace the broken one, such as stove and other kitchen equipment. Relations of people also helped in cleaning up the house. They lend mud cleaning machine and made the house cleaning time was faster than cleaned it manually. For some trader and other entrepreneur, they also got aid by borrowing some money from some financial institutions such as bank and *koperasi.* The money was used as capital of their business. Cross tabulation of recovery time and external aid of both villages can be shown in Table 5-10 and 5-11.

Table 5-10. Cross Tabulation of Recovery Time and External Aid in *desa* Laban

| External Aid | Recovery Time (Frequency) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | < 1 week | | | | 1-2 weeks | 2-4 weeks | > 1 month | Frequency | Percent |
| | 0-2 days | 3-4 days | 5-7 days | Total | | | | | |
| No | 3 | 2 | 20 | 25 | 3 | 1 | 1 | 30 | 75 |
| 1-5 persons | - | - | 4 | 4 | 2 | - | - | 6 | 15 |
| 6-10 person | - | - | 1 | 1 | 3 | - | - | 4 | 10 |
| > 10 person | - | - | - | 0 | - | - | - | 0 | 0 |
| Total | 3 | 2 | 25 | 30 | 8 | 1 | 1 | 40 | 100 |

Table 5-11. Cross Tabulation of Recovery Time and External Aid in *desa* Kadokan

| External Aid | Recovery Time (Frequency) | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | < 1 week | | | | 1-2 weeks | 2-4 weeks | > 1 month | Frequency | Percent |
| | 0-2 days | 3-4 days | 5-7 days | Total | | | | | |
| No | 9 | 7 | 13 | 29 | 3 | - | 1 | 33 | 82.5 |
| 1-5 persons | 1 | - | - | 1 | 1 | - | - | 2 | 5 |
| 6-10 person | 1 | 1 | - | 2 | - | - | - | 2 | 5 |
| > 10 person | 1 | - | 1 | 2 | - | 1 | - | 3 | 7.5 |
| Total | 12 | 8 | 14 | 34 | 4 | 1 | 1 | 40 | 100 |

It can be seen from Table 5-11 that most of respondents need less than 1 week for recovery. Recovery in this case is cleaning up the house from the mud and repairing the damage household such as refrigerator, bed, etc. The time that people needed to recover as shown in Table 5-6 was the result of combination of factors that influenced to the speed of recovery. Not all of the damage household are repaired, but they can live normally now. The general recovery time that was needed by respondents in both villages can be displayed on Table 5-12.

Table 5-12. Recovery Time in *desa* Laban and *desa* Kadokan

| Recovery Time | Frequency | Percent |
|---|---|---|
| < 1 week | 64 | 80 |
| 1-2 days | 15 | 18.75 |
| 3-4 days | 10 | 12.5 |
| 5-7 days | 39 | 48.75 |
| 1-2 weeks | 12 | 15 |
| 2-4 weeks | 2 | 2.5 |
| > 1 month | 2 | 2.5 |

## 5.5. Weighting Value for Community Resilience

Based on FGD result, the score and weighting value in community resilience can be shown in Table 5-9 and Table 5-10. There are three factors in resilience that was discussed with community in order to determine the score. They are flood experiences, financial resources, and educational level. Sub-factors score of flood experiences and educational level have the same sequences in both villages. While sub-factors sequence of financial resources is different between *desa* Laban and *desa* Kadokan. In the FGD, participant decided the range of flood experiences and the sequence of financial source sub-factor. This was aimed to make participant classified each sub-factor easily. Table 5-13 and 5-14 shows the value of resilience factors that were investigated in this research.

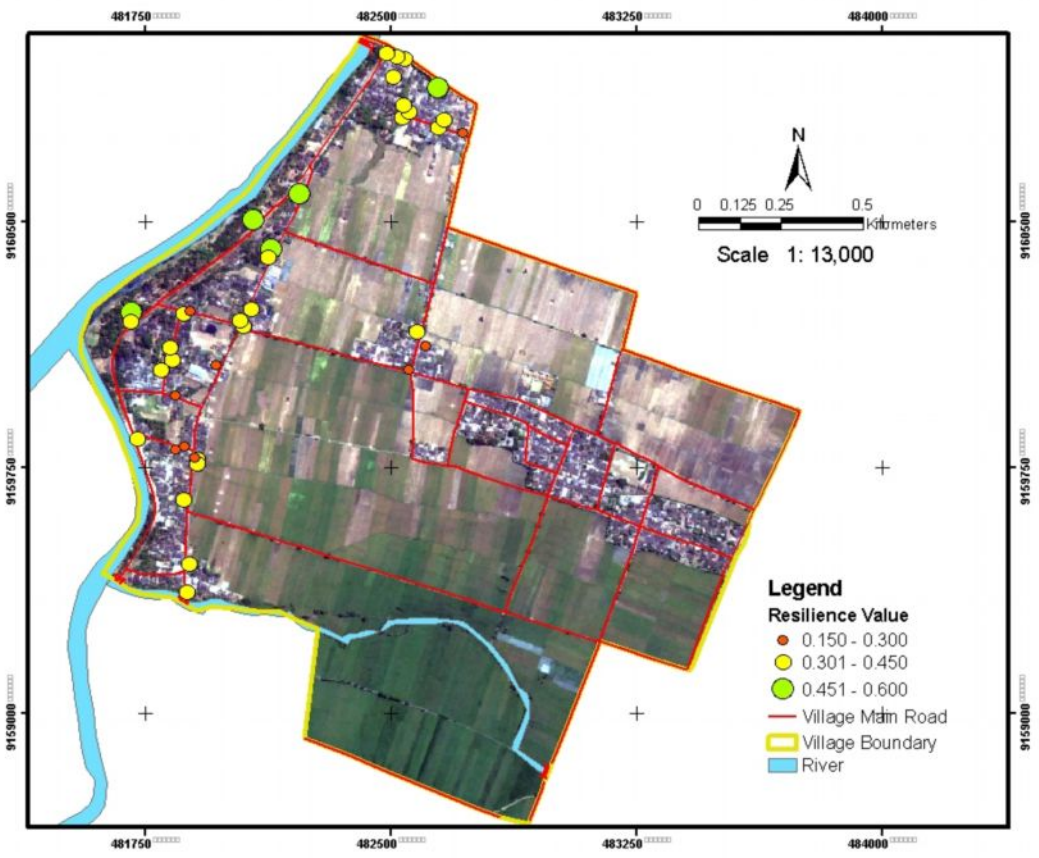
Table 5-13. Resilience Factor Score in *desa* Laban

| Factor | Sub-Factor | Sub-sub Factor | | Sub-sub-sub Factor |
|---|---|---|---|---|
| Economical Capital (0.50) | Financial Sources (1) | Income (0.3) | | Not Influenced (1)<br>Influenced by Flooding (0) |
| | | Relation Help (0.25) | | |
| | | Saving (0.20) | | |
| | | Loan (0.15) | | |
| | | Selling Thing (0.10) | | |
| Human Capital (0.50) | Education Level (0.50) | College | (1.00) | |
| | | Senior High School | (0.80) | |
| | | Junior High School | (0.60) | |
| | | Elementary School | (0.40) | |
| | | No Educated | (0.20) | |
| | Flood Experiences (0.50) | > 10 time | (1.00) | |
| | | 6-10 time | (0.75) | |
| | | 2-5 time | (0.50) | |
| | | 1 time | (0.25) | |

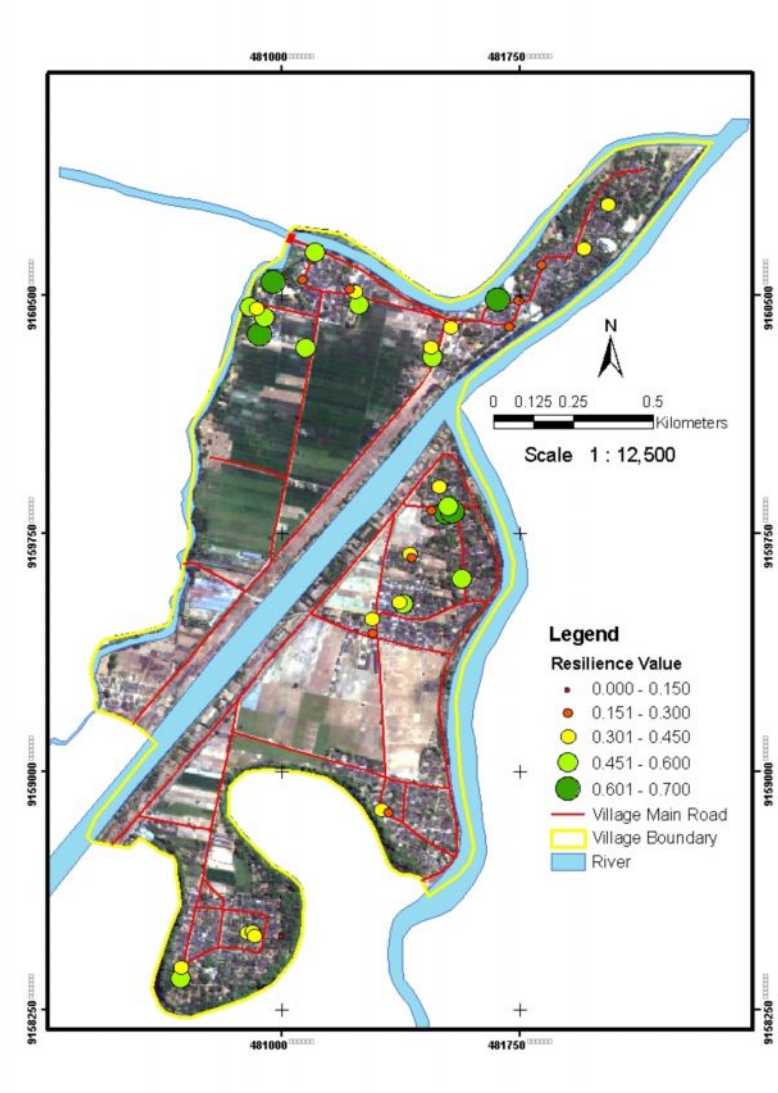
Table 5-14. Resilience Factor Score in *desa* Kadokan

| Factor | Sub-Factor | Sub-sub Factor | | Sub-sub-sub Factor |
|---|---|---|---|---|
| Economical Capital (0.50) | Financial Sources (1) | Income (0.3) | | Not Influenced (1)<br>Influenced by Flooding (0) |
| | | Loan (0.25) | | |
| | | Relation Help (0.20) | | |
| | | Saving (0.15) | | |
| | | Selling Thing (0.10) | | |
| Human Capital (0.50) | Education Level (0.50) | College | (1.00) | |
| | | Senior High School | (0.80) | |
| | | Junior High School | (0.60) | |
| | | Elementary School | (0.40) | |
| | | No Educated | (0.20) | |
| | Flood Experiences (0.50) | > 10 time | (1.00) | |
| | | 6-10 time | (0.75) | |
| | | 2-5 time | (0.50) | |
| | | 1 time | (0.25) | |

Based on resilience value above, the resilience value for each respondent in both villages can be calculated. The distribution value of resilience in *desa* Laban is from 0.163 until 0.600. While distribution value of resilience in *desa* Kadokan is more vary, from 0.113 until 0.700. Figure 5-1 until 5-6 show respondent resilience spatial distribution in both villages and its relation with flood depth and flood duration based on FGD result.




Figur 5-1. Resilience Distribution of Respondent in *desa* Laban




Figur 5-2. Resilience Distribution of Respondent in *desa* Kadokan

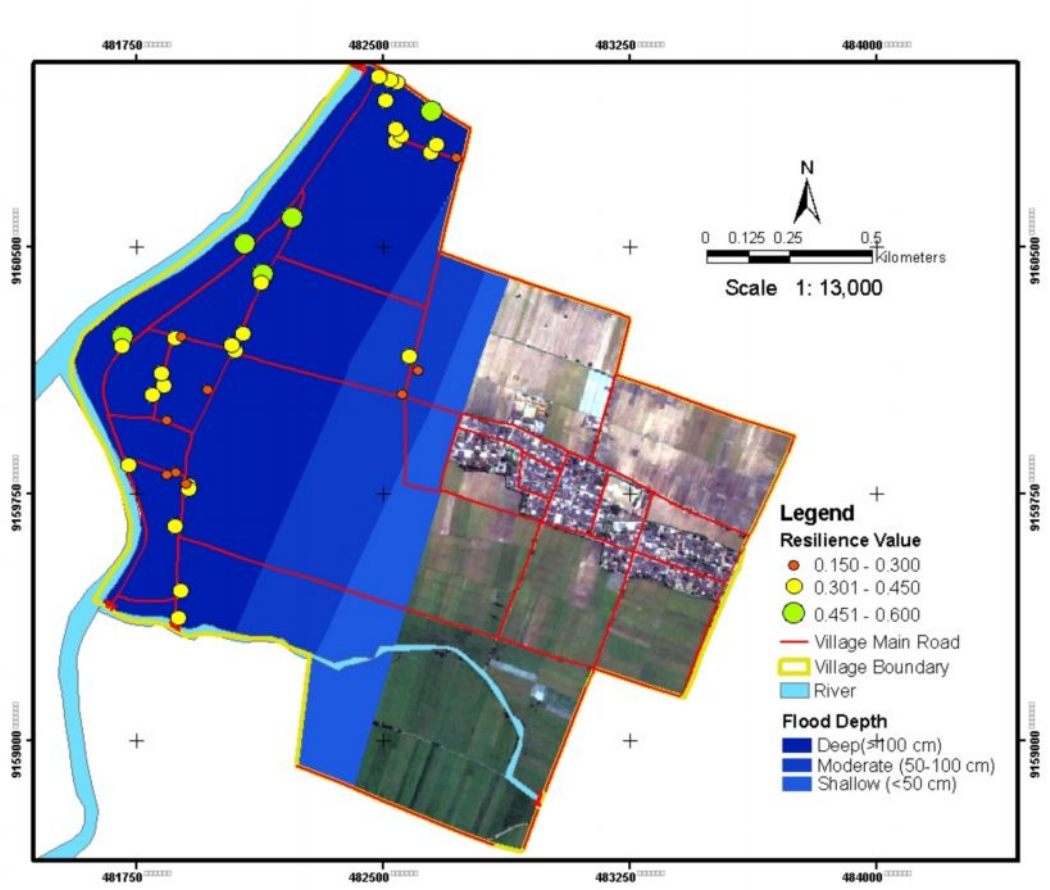



Figure 5-3. Resilience Distribution of Respondent and Flood Depth in *desa* Laban

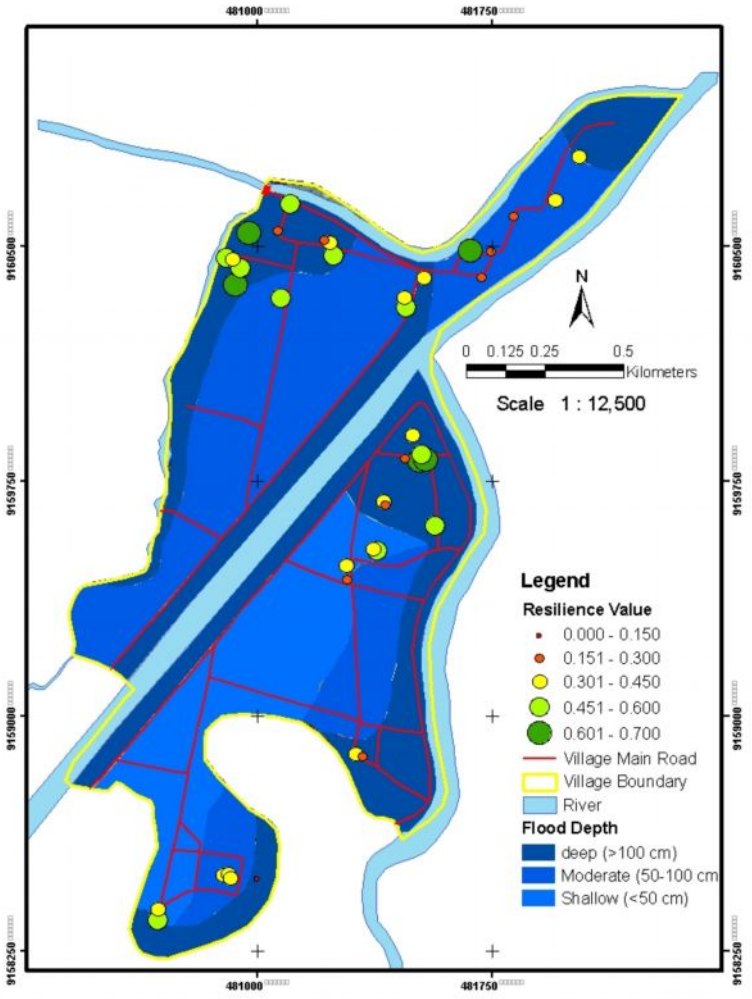



Figure 5-4. Resilience Distribution of Respondent and Flood Depth in *desa* Kadokan

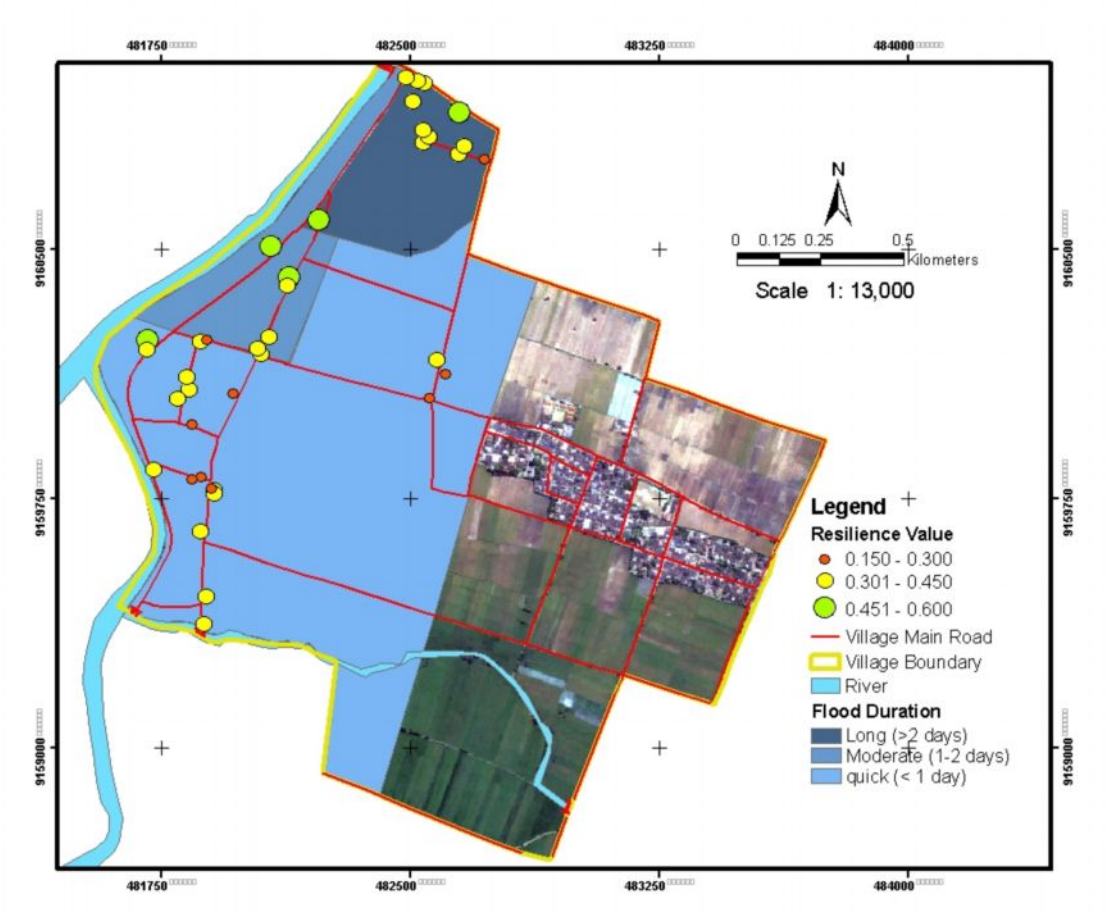



Figure 5-5. Resilience Distribution of Respondent and Flood Duration in *desa* Laban

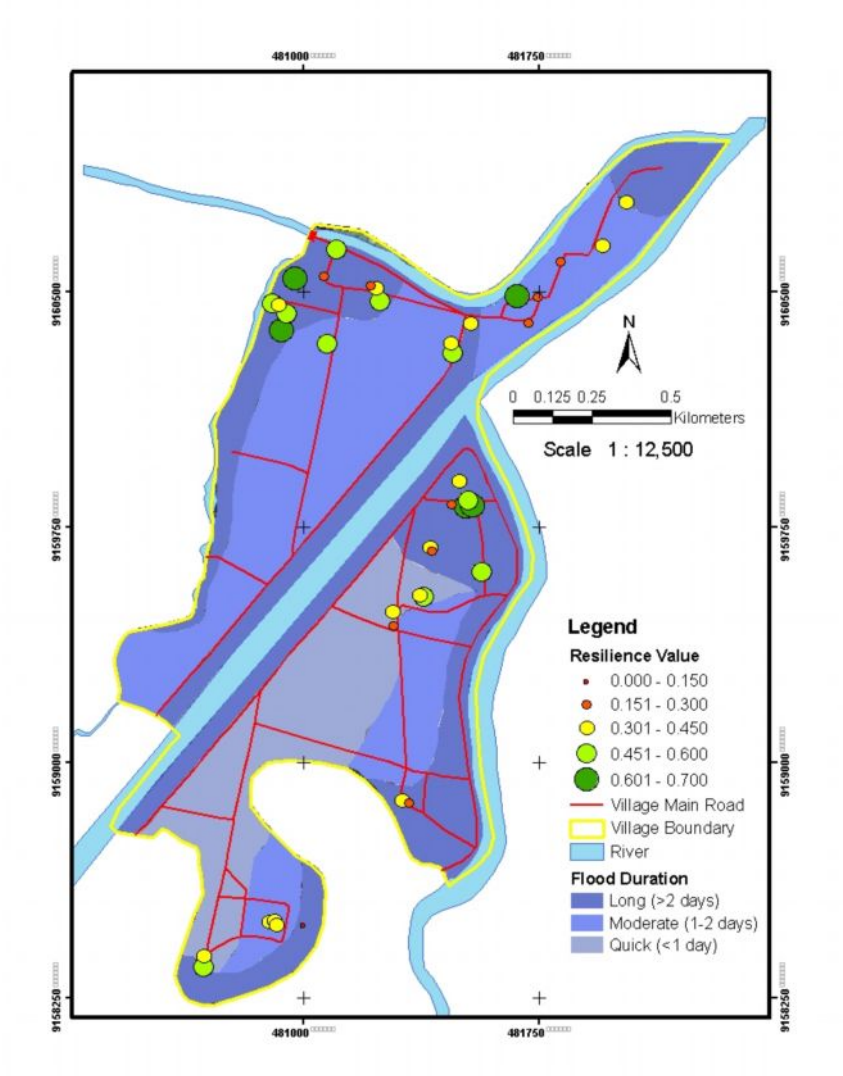



Figure 5-6. Resilience Distribution of Respondent and Flood Duration in *desa* Kadokan

Resilience value in both villages is distributed randomly, both in flood depth and flood duration pattern. Respondent who have smaller resilience value, in theory, will be more vulnerable than respondent that have bigger resilience value. This condition will be worse by the flood dept and duration. Therefore, respondent who has the smallest resilience value and located on deep zone of flood depth classes and/ or on long zone of flood duration classes, is the most vulnerable person toward flood. On the other hand, respondent who has biggest resilience value and located on shallow zone of flood depth classes and/ or on quick zone of flood duration classes, is the least vulnerable toward flood.

Based on value weighting, the average of resilience value of respondent in *desa* Laban is 0.368. About 28.74% of the value came from economic capital factor, while 71.26% came from human capital. The average resilience value for *desa* Laban is 0.403, which is 28.57% came from economic capital factor and 71.43% came from human factor. This research shows that human capital gave bigger influence than economic capital in determining resilience value of community, especially in study area.

## 5.6. Community Resilience Toward Flood Hazard in Sukoharjo Regency and Semarang City; a Comparison

Resilience comprises many measurements. As mentioned before, there are five major factors in building community resilience, i.e. natural capital, physical capital, social capital, human capital, and human capital. This research also made comparison of community resilience toward flood in Semarang city and Sukoharjo. Generally people in both areas have the same culture, Javanese culture. However flood characteristic in both areas is different. Therefore, this research compares community resilience in both areas in term of similarity and difference. However, the result cannot represent all local communities suffering flooding in Indonesia.

### 5.6.1. Similarities

There are similarities of factors that build community resilience in both areas. The same type of hazard, flood, has influenced to community resilience. Table 5-15 shows the similarities of factors in resilience in both areas.

Table 5-15. Similarities of flood characteristic and factors that build community resilience in Sukoharjo Regency and Semarang City

| Elements | Similarities |
|---|---|
| Flood Characteristics | - Inundates houses and has potential in damaging houses and its property |
| Natural Capital | - People use water resource (river and marine)for livelihood |
| Physical Capital | - Dike rehabilitation |
| Social Capital | - Have the same spirit in social life, so-called "gotong royong" in facing common problem |
| Human Capital | - Rely on flood experience in facing flood and coping strategy |
| Economic Capital | - Looking for additional financial sources against flood impact |

### 5.6.2. Differences

Since there are differences of flood characteristic, community resilience between two areas is also different. The differences of factors that build community resilience can be seen in Table 5-13.

Table 5-16. Differences of flood characteristic and factors that build community resilience in Sukoharjo Regency and Semarang City

| Elements | Differences | |
|---|---|---|
| | Sukoharjo | Semarang |
| Flood Characteristics | - Caused by the overflow of river and broken dike as the impact of hard rainfall in the rainy season | - Caused by land subsidence<br>- Impact of the increasing of sea tide<br>- Result of the bad of drainage system and river condition |
| | - The duration of inundation is about 1 until 7 days depends on water level in river and total | - The duration of inundation depends on tidal pattern |

| | | |
|---|---|---|
| | automatic doors that regulates water flowing | |
| Natural Capital | - Use river for additional income purpose | - Use marine as main source income (fisherman) |
| Physical Capital | - Dike Rehabilitation that is conducted by government to protect settlement from river overflowing<br>- Raising dike height<br>- Early Warning System Establishment | - Construction of dike and embankment and East Banjir Kanal to regulate water flowing |
| Social Capital | - Work together doe to flood recovery such as cleaning up village road from mud | - Work together due to avoid flood such as increasing the height of road |
| Human Capital | - People experience is vary depend on duration of staying on the area | - Most people experience tidal flood as well as its frequency of occurrence |
| Economic Capital | - Looking for other financial source for recovery such as loan, saving, selling thing, and relation help | - Diversifications of income source |

Fishing is an activity that related to natural resource utilization. People in Semarang use water resource as the main source income. They work as fisherman. This occupation also became the reason people still stay in flood prone area along seashore on the north part of Java, especially in Semarang City. On the other hand, the utilization of water resource in Sukoharjo is for additional income of several people. The main occupation in Sukoharjo is on agricultural sector. Most of them are a farmer. However, the poverty had caused them to add another income.

The different type of flood had caused different dike construction purpose. The dike construction purpose in Sukoharjo is for protecting settlement from overflowing river, while in Semarang is for regulating the water flowing. As the downstream area, there are several canals that have estuary on that area. Therefore a good drainage system is an important thing to be established to overcome the flood problem.

Javanese culture that grows on villagers in both areas leads to the spirit of togetherness in facing community problem. “Gotong royong” is the implementation of the spirit. Related to

community resilience toward flood, “gotong royong” became an important factor in social capital. However, since the flood characteristic is different, the aim of work together among the people is also different. In Sukoharjo, people work together to clean up village main road from the impact as flood, while people in Semarang work together to avoid flood such as increasing the height of village road.

The different type of flood also influence to the different flood experience among people. People in Semarang experience flood almost every rainy season even most everyday due to tidal inundation. Therefore they are used to this kind of hazard. On the other hand, people in Sukoharjo are not used to flood, especially younger people and/ or people who started to stay on study area after the construction of dike.

Flood also causes damage on houses and other home furnishing. People in Semarang tend to make diversification of occupation ( Dewi, 2007). The diversification of occupation is aimed to gain additional income as financial source in flood recovery. However, people in Sukoharjo prefer to look for additional financial source which can be directly used in recovery.

# 6. INSTITUTIONAL RESPOND

*This chapter describes the general respond of government that is related to flood in flood prone area, especially in selected villages. The respond comprises dike rehabilitation, emergency respond training, and water pump and early warning system establishment*

## 6.1 Dike Rehabilitation

Since flood in 2007, government has increased the dike height. The dike increasing and refinement was conducted by BBWS Bengawan Solo. The additional height is about 1.8- 2 meter from the old dike surface. Moreover the width of the dike is also added. The dike rehabilitation has been focused on refinement of damage part of the dike and raising the height. Even government also strengthened the embankment slope in some places.

a. Dike along the river that has been raised

b. The strengthened embankment slope

Figure 6-1. Dike rehabilitation after the 2007 flood event

Although government has rehabilitated the dike, some people still feel worry about the strength of the dike. They believe that the strength of the new dike is less than the old one. Moreover there is erosion on some parts of the embankment slope. Therefore, they still feel worry whenever hard rain occur.

### 6.2. Emergency Response Training

Government also conducted some trainings for community related to emergency respond. The training focused on facing flood during emergency time. This training was attended by community representatives such as RT and RW head. Some youths in the village also involved in this training. Even some of them team up with "*Tagana"*. *Tagana (Taruna Siaga Bencana*) is a team that has focused the activity on disaster emergency respond. The membership of Tagana is legitimated by the head of regency. According to interview result with one of *Tagana* member, the instructor in training came from army and paramedics.

### 6.3 Water Pump and Early Warning System Establishment

After the 2007 flood event, government built flood control devices. Two of the devices are located in *kelurahan* Joyotakan, Surakarta municipality. The devices are water pump and early warning light. Water pump in Joyotakan pumps water from Gijikan river into Premulung river. When water level in Premulung river is high, the automatic door will be closed. This makes water in Gijikan cannot enter Premulung river. Then the water will overflow and inundates some area nearby the river, includes *desa* Kadokan, especially *dukuh* Plalan and Buntarejo. In this situation, water from Gijikan river will be pumped into Premulung river. Flood early warning light nearby the pump also gives an alert when the water level is high. There are three lights in this device. The green light warn the community that people must be ready, the yellow lamp is for alert 2 for preparedness, and the red lamp is for emergency condition.

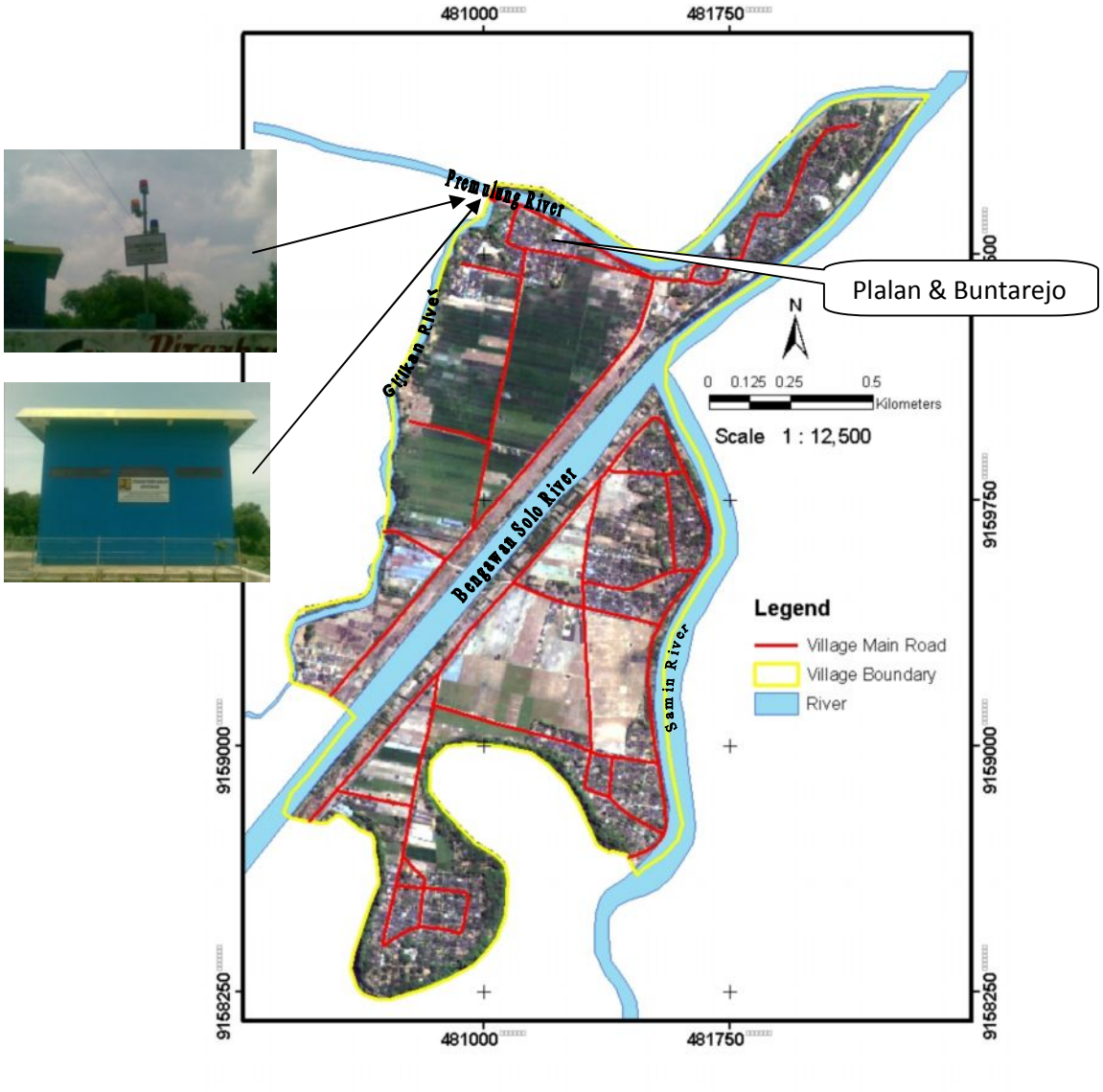



Figure 6-2. Some flood Control Devices

# 7.CONCLUSION AND RECOMENDATION

*This chapter concludes the discussions and summarizes the findings this research related with the objectives of the research. Some recommendations also will be described in the last part of this chapter.*

## 7.1 Conclusion

### 7.1.1. Flood Characteristic

The distribution of the 2007 flood event is different between *desa* Laban and *desa* Kadokan. The distribution of flood in study area was influenced by several factors, i.e. distance from river, general elevation, and broken dike location. All of the *desa* Kadokan area was inundated by the 2007 flood event, while *desa* Laban was not. Geographically *desa* Kadokan is more prone to flood than *desa* Laban since there are several rivers bounds the village.

Flood depth in study area was influenced by the general elevation. The pattern of flood depth in *desa* Laban was increased gradually. The deep zone of flood depth was located nearer to flood. This is reasonable since generally general elevation is decreasing when it is closing to river. The condition is rather different in *desa* Kadokan. The deep zone of flood depth was not always located nearby river. This condition can be seen in area nearby the dike along Bengawan Solo river. The strengthened of Bengawan Solo river crosses the middle of *desa* Kadokan which the elevation is higher than area nearby the old Bengawan Solo river. Therefore the flood depth of area nearby Bengawan Solo river was categorized into moderate and shallow. However the flood depth of area outside the dike was deep as the impact of the increasing of water level in the river.

The next flood characteristic of the 2007 flood event that was investigated in this research is flood duration. The duration of flood in both selected villages was classified into three classes. They are long, moderate, and quick. The pattern of flood duration in *desa* Laban was same as the pattern of flood depth. The deep zone of flood depth is the long zone of flood duration. The flood duration pattern in *desa* Laban was different. Not all of deep zone of flood depth was the long zone of flood duration. The long zone of flood duration was located on the west-north of the village. This is reasonable since the area has the lowest elevation in the village. Moreover

railroad that lies on the north part of *desa* Laban that acted like dike had influenced to the long duration of inundation on the west-north of *desa* Laban.

Flood also caused damage to houses of people in both villages. The losses of people is vary depends on flood depth, flood duration and flood preparedness conducted by people. Based on interview result, the losses variation due to the 2007 flood event was distributed from Rp. 0,- until Rp. 100,000,000,-. However most of respondent's losses were less than Rp. 2,000,000,-. Moreover, flood preparedness also influenced to the level of damage. Losses of people who had saved the belonging before flood came generally were lower than people who had not. Move belonging to the safer place could reduce the losses.

### 7.1.2. Community Resilience

There are definitions of resilience. There are five major forms of capital in building community that were used in defining community resilience in study area. They are natural capital, economic capital, physical capital, social capital, and human capital. Human capital and economic capital were investigated through the respondent in order to get resilience value.

In order to quantify community resilience, 80 respondents had been selected to be interviewed related to resilience. Factors that were investigated in human capital were flood experiences and educational level. Financial source of recovery was the factor that was investigated in economic capital. The sequence of financial source and range of flood experiences was defined by people in Focus Group Discussion.

The distribution value of resilience in *desa* Laban is from 0.163 until 0.600. While distribution value of resilience in *desa* Kadokan is more vary, from 0.113 until 0.700. The average resilience value of respondents in *desa* Laban is 0.368, while in *desa* Kadokan is 0.403. This can be seen that the average resilience value in *desa* Kadokan is higher than resilience value in *desa* Laban. The value was constructed from human capital and economic capital. Based on weighting result, about more than 70% of the resilience value of respondent in both villages came from human capital.

Resilience value in both villages is distributed randomly, both in flood depth and flood duration pattern. Since flood duration and flood depth influenced to level of losses, people who

has small resilience value in theory will be more vulnerable when located on deep zone of flood depth and/ or long zone of flood duration.

## 7.2. Recommendation

From the result and conclusion, there are some following recommendations can be proposed:

1. The deeper study on relation between resilience and flood characteristic will be valuable to provide information related to community resilience in risk assessment
2. Concerning the resilience assessment, the more indicator in capitals that build community resilience is the better result in describing community resilience. Therefore, deeper investigation related each capital will be valuable to inform community resilience
3. Focus Group Discussion by relying on community knowledge is the effective way to get information in wide scope. This method can be easily to be adopted and implemented. Therefore, FGD can be used by government in order to gain information related to wide scope, since this need low cost.
4. Utilizing of detailed DEM map is important to compare flood map that was made by community, especially in the flat area. Therefore, in order to analyze flood more accurate, it is needed very detail contour in the study area.

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# Appendix

| | | |
|---|---|---|
| Appendix 1 | : | Questionnaire for Resilience for the 2007 Flood Event, in *desa* Laban and Kadokan<br>*Kuisioner untuk Daya Pulih Masyarakat Terhadap Banjir 2007 di Desa Laban dan Kadokan* |
| Purpose<br>*Tujuan* | : | This survey is intended only for scientific research purpose to study community resilience for the 2007 flood event in part of Sukoharjo Regency<br>*Survei ini ditujukan hanya untuk kepentingan penelitian ilmiah untuk mempelajari daya pulih masyarakat terhadap kejadian banjir 2007 di sebagian wilayah Kabupaten Sukoharjo* |
| Researcher<br>*Peneliti* | : | Sinta Damayanti |
| Contact<br>Kontak | : | damayanti_7379@yahoo.com; damayanti24617@itc.nl |
| Research Title<br>*Judul Penelitian* | : | Resilience for the 2007 Flood Event, Using Community Knowledge, A Case in Part of Sukoharjo Regency, Indonesia<br>*Daya Pulih terhadap Banjir 2007, Menggunakan Pengetahuan Masyarakat, Kasus di Sebagian Wilayah Kabupaten Sukoharjo, Indonesia* |

(Part of this questioner is adopted from some questionnaires of previous researchs done by Dewi (2007) and Marschiavelli (2008), and Febrianti (2010))

*(Sebagian dari kuisioner ini diadapsi dari beberapa kuisioner penelitian sebelumnya, yang dilakukan oleh Dewi (2007), Marschiavelli (2008), dan Febrianti (2010))*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Questionnaire No<br>*Kuisioner no* | : | …… | Interviewer<br>*Pewawancara* | :……. | Date<br>*Tanggal* | :……. | Time<br>*Waktu* | :…. |
| House No.<br>*Nomor Rumah* | : | …… | Name of Respondent<br>*Nama Responden* | :…… | | | | |
| GPS No | : | Lat…… | | Long…… | | | | |
| Sub-District<br>*Kecamatan* | : | …… | | | | | | |
| Dukuh | : | …… | Village<br>*Desa* | :…… | | | | |

1. Respondent Profile Information
   *Informasi Profil Responden*

| | | | | | |
|---|---|---|---|---|---|
| (1). Age : *Umur* : | …… Year *tahun* | (2). Sex : *Jenis Kelamin* | Male *Laki-laki* | ☐ | Female *Perempuan* ☐ |
| (3). Position in Houshold : *Posisi dalam keluarga* | …… | | | | |
| (4). Education : *Pendidkan* | …… | (5). Year of Stay in this Location : *Tahun mulai menetap di desa ini* | …… | | |
| (6). Job (Source of Income) : Pekerjaan (Sumber Pendapatan) | | Teacher Guru | ☐ | | Merchant Pedagang ☐ |
| | | Civil Servant *PNS* | ☐ | | Police *Polisi* ☐ |
| | | Farmer *Petani* | ☐ | | Labor *Buruh* ☐ |
| | | Other *Lainnya* …… | | | |

2. Family Information/ Family Profile
   *Informasi of Keluarga/ Profil Keluarga*

| Name *Nama* | Sex (M/F) *Jenis Kelamin (L/P)* | Age (at 2007) *Umur (pada 2007)* | Last Education *Pendidikan Terakhir* |
|---|---|---|---|
| …… | …… | …… | …… |
| …… | …… | …… | …… |
| …… | …… | …… | …… |
| …… | …… | …… | …… |
| …… | …… | …… | …… |
| …… | …… | …… | …… |
| …… | …… | …… | …… |
| …… | …… | …… | …… |

3. The 2007 Flood Characteristics
   *Karakter Banjir 2007*

(1). When did flood start to inundate this area?.....
*Kapan air mulai menggenangi daerah ini?*
(2). What is water increasing velocity?.....(m/s)
*Berapa laju kecepatan penambahan air?*
(3). What is the maximum depth of flood that inundated your house?..... m

*Berapa tinggi maksimal air yang menggenangi rumah anda?*

(4). How long did water inundate?.....

*Berapa lama air menggenang?*

4. Damage

*Kerusakan*

(1). Was your house and/ or your belonging damaged by the 2007 flood event?

*Apakah rumah dan/ atau asset anda rusak akibat banjir 2007?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(2). If your answer "Yes", what were the damages?

*Jika jawaban anda "Iya", apa saja kerusakan tersebut?*

| No No | Type of Damages *Jenis Kerusakan* | Losses (Rp) *Kerugian (Rp.)* | Repairing of Damages *Perbaikan/ Penggantian Kerusakan* | | |
|---|---|---|---|---|---|
| | | | Yes (*Iya*) | Not Yet (*Belum*) | No (*Tidak*) |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

(3). Was the damage influenced to your daily life?

*Apakah kerusakan tersebut berpengaruh terhadap kehidupan sehari-hari anda?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(4). Did you think you need repair the damages?

*Apakah anda merasa perlu memperbaiki kerusakan tersebut?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

5. Disaster Perception

*Persepsi Bencana*

(1). Do you think flood threat your daily life and your occupation?

*Apakah menurut anda banjir di daerah anda mengancam kehidupan sehari-hari dan mata pencaharian anda?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(2). What is your perception about the 2007 flood event?

*Bagaimana pendapat anda mengenai banjir 2007 di daerah anda?*

☐ No Problem *Tidak masalah* ☐ Nuisance *Mengganggu* ☐ Disastrous *Merupakan bencana*

(3). Do you think dike can reduce the flood risk?
*Apakah menurut anda tanggul masih cukup/ mampu mengurangi resiko banjir?*
☐ Yes (*Iya*) ☐ No (*Tidak*)

6. Flood familiarity
*Keterbiasaan dengan Banjir*

(1). Are you accustomed to flood?
*Apakah anda terbiasa dengan banjir?*
☐ Yes (*Iya*) ☐ No (*Tidak*)
(2). How many flood have you experience with?..... times
*Berapa kali banjir yang pernah anda alami?*..... kali
(3). Do you know the signs that flood will occurred?
*Apakah anda tahu tanda-tanda akan datangnya banjir?*
☐ Yes (*Iya*) ☐ No (*Tidak*)
(4). If flood occurs, do you know what you should do to save your family and belonging?
*Bila banjir terjadi lagi, apakah anda tahu apa yang harus anda lakukan untuk menyelamatkan keluarga dan harta benda anda?*
☐ Yes (*Iya*) ☐ No (*Tidak*)

7. Social Status
*Status Sosial*

(1) . How long have you been staying in this area?
*Berapa lama anda tinggal di desa ini?*
☐ 0 – 5 years *0 – 5 tahun* ☐ 5 – 10 years *5 – 10 tahun* ☐ 10 – 20 years *10 – 20 tahun* ☐ > 20 years *>20 tahun*

(2) . What is your social in this village?
*Apakah posisi social anda di desa ini?*
☐ Village officer *Perangkat Desa* ☐ RT/ RW/ Dukuh head *Ketua RT/ RW/ Dukuh* ☐ Youth Organization leader/ Other community organization leader *Ketua karang taruna/ organisasi kemasyarakatan yang lain*
☐ Religion leader *Pemuka agama* ☐ Village elder *Sesepuh desa* ☐ Community member *Anggota masyarakat*

(3) What is the average distance your neighbor's house and yours?

*Berapakah rata-rata jarak antara rumah anda dan rumah tetangga?*

☐ 0 – 3 m ☐ 3 – 6 m ☐ 6 – 10 m ☐ >10 m

8. Physical Recovery Process
   *Proses Pemulihan Fisik*

(1). The repair of your house/ asset as the impact of flood was done professionally by the expert? (bricklayer/ carpenter, and soon)
*Perbaikan rumah/ asset akibat banjir dilakukan secara professional oleh ahlinya (tukang batu/ kayu,dsb)*
☐ Yes (*Iya*) ☐ No (*Tidak*)

(2). If "yes", the total cost of the repair by the expert is Rp……
*Jika "Iya", total perbaikan oleh ahli tersebut sebesar Rp……..*

(3). The repair the house/ asset as the impact flood was done together with society
*Perbaikan rumah/ asset akibat banjir dilakukan secara bersama dengan masyarakat*
☐ Yes (*Iya*) ☐ No (*Tidak*)

(4). The number of people that was involved in the repair was……. persons
*Jumlah orang yang terlibat dalam perbaikan tersebut adalah……..orang*

(5). The repair was done for ……. days
*Perbaikan tersebut berlangsung selama……..hari*

9. Recovery aid and financing
   *Bantuan Pemulihan dan Pembiayaan*

(1). When the 2007 flood event occurred, did you have any saving?
*Ketika banjir 2007 terjadi, apakah anda punya tabungan?*
☐ Yes (*Iya*) ☐ No (*Tidak*)

(2). Did you use your saving for financing the repair as the impact of flood?
*Apakah anda menggunakan tabungan anda tersebut untuk biaya perbaikan akibat banjir?*
☐ Yes (*Iya*) ☐ No (*Tidak*)

(3). If "Yes", total saving that was used for repairing cost as the impact of the 2007 flood event was Rp…….
*Bila "Iya", total tabungan yang digunakan untuk biaya perbaikan akibat banjir 2007 adalah Rp……..*

(4). Did you sell your asset for financing the repairing cost as the impact of the 2007 flood event?
*Apakah anda menjual barang pribadi anda untuk biaya perbaikan akibat banjir 2007?*
☐ Yes (*Iya*) ☐ No (*Tidak*)

(5). If "Yes", the proceed was Rp……
*Bila "Iya", maka hasil penjualan barang pribadi tersebut adalah Rp…….*

(6). Did you use all of the proceed to finance repairing cost?
*Apakah anda menggunakan semua hasil penjualan barang tersebut untuk biaya perbaikan akibat?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(7). If "No", total proceed that was used for financing repairing cost was Rp……
*Jika "Tidak", hasil penjualan yang digunakan untuk biaya perbaikan adalah Rp……*

(8). Did you get any help/ aid from family for the repairing?
*Apakah anda mendapatkan bantuan dari keluarga anda dalam perbaikan tersebut?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(9). If "Yes", total of help/ aid from family that you got for repairing was Rp…….
*Jika "Iya", total bantuan dari saudara yang anda terima untuk perbaikan adalah Rp…….*

(10). Did you borrow any fund for the repairing cost?
*Apakah anda meminjam dana untuk biaya perbaikan?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(11). If "Yes", the detailed loan fund was
*Jika "Iya", pinjaman tersebut secara detail adalah sebagai berikut :*

| No *No* | Loan Source *Sumber Pinjaman* | Total of Loan *Total Pinjaman* | Loan Duration (Year) *Waktu Peminjaman (Tahun)* | Returning Period *Periode Pengembalian* | |
|---|---|---|---|---|---|
| | | | | Starting Year *Mulai tahun* | Ending Year *Selesai tahun* |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

(12). Did you get any supporting fund from government in the repairing?
*Apakah anda mendapat dukungan dana dari pemerintah dalam perbaikan?*

☐ Yes (*Iya*) ☐ No (*Tidak*)

(13). If "Yes", the total supporting fund from government was Rp…….
*Jika "Iya", jumlah dukungan dana dari pemerintah tersebut adalah Rp. ……*

(14). Did you get any help supporting fund from NGO in the reapiring?
Apakah anda mendapatkan dukungan dana dari LSM dalam perbaikan akibat banjir?

☐ Yes (*Iya*) ☐ No (*Tidak*)

(15). If "Yes", the total of supporting fund from NGO was Rp…….
Jika "Iya", jumlah dukungan dana dari LSM tersebut adalah Rp…….

10. Psychology Recovery Process

*Proses Pemulihan Psikologi*

(1). Do you still feel trauma with flood?
Apakah anda masih merasa trauma dengan kejadian banjir?
☐ Yes (*Iya*) ☐ No (*Tidak*)

(2). How many time did you need to relieve the trauma?
*Berapa lama waktu yang anda butuhkan untuk menghilangkan rasa trauma tersebut?*

(3). Was there any assistance from government/ NGO to reduce your traumatic?
*Apakah ada pendampingan dari pemerintah/ LSM untuk mengurangi trauma anda?*
☐ Yes (*Iya*) ☐ No (*Tidak)*

(4). If "Yes", mention the programmem……
*Jika "Iya" tolong sebutkan programnya*……..

(5). If "No", what did you do to reduce your traumatic?
*Jika "Tidak", apa yang anda lakukan untuk mengurangi rasa trauma anda?*
☐ Nothing. Time will release the traumatic
*Tidak ada. Waktu akan menghapus rasa trauma tersebut*
☐ Religious approach
*Pendekatan agama*

11. Institutional Respond

*Respon Institusional*

(1). Was there any action from government related to mitigation?
*Apakah ada tindakan pemerintah terkait dengan mitigasi/ pengurangan bahaya banjir?*
☐ Yes (*Iya*) ☐ No (*Tidak)*

(2). If "Yes", the action was……..
*Jika "Iya", apakah tindakan tersebut?*.....

(3). Was there any rule related to disaster risk reduction from local government that emerged after the occurrence of the 2007 flood event?
Apakah ada peraturan terkait dengan pengurangan resiko bencana dari pemerintah setempat yang muncul setelah banjir 2007?
☐ Yes (*Iya*) ☐ No (*Tidak)*

(4). If "Yes", the rule was……..
*Jika "Iya", peraturan tersebut adalah ……..*

---------- Thank you for your cooperation ----------

Appendix 2 : Total Runoff in Each Sub Watershed in Solo Hulu at 26th December 2007

| Zone | Sub Watershed | Total Area (Ha) | Q (m3) | Q (m3/ha) | % Total Runoff |
|---|---|---|---|---|---|
| Gajah Mungkur Dam Catchment | Keduang | 44,186 | 37,536,749 | 850 | 8.96 |
| | Wiroko | 22,051 | 16,264,263 | 738 | 3.88 |
| | Wuryantoro | 17,231 | 15,976,542 | 927 | 3.81 |
| | Alang-ngunggahan | 17,791 | 15,477,610 | 870 | 3.69 |
| | Solo hulu | 17,919 | 13,795,672 | 770 | 3.29 |
| | Temon | 7,591 | 10,222,581 | 1,347 | 2.44 |
| Lawu Barat | Sawur | 58,027 | 35,231,378 | 607 | 8.41 |
| | Samin | 37,701 | 33,843,412 | 898 | 8.08 |
| | Mungkung | 28,062 | 27,133,029 | 967 | 6.48 |
| | Grompol | 25,904 | 25,539,183 | 986 | 6.10 |
| | Kenatan | 23,036 | 18,501,871 | 803 | 4.42 |
| | Walikan | 19,399 | 17,229,189 | 888 | 4.11 |
| | Jlantah | 14,605 | 11,764,420 | 805 | 2.81 |
| | Dengkeng(Skh) | 12,285 | 9,623,336 | 783 | 2.30 |
| | Kalikatir | 8,279 | 8,232,506 | 994 | 1.96 |
| Merapi-Merbabu | Pepe | 45,316 | 27,287,486 | 602 | 6.51 |
| | Cemoro | 25,257 | 23,822,489 | 943 | 5.69 |
| | Dengkeng(Klt) | 50,999 | 14,543,326 | 285 | 3.47 |
| | Brambang | 32,573 | 14,061,848 | 432 | 3.36 |
| | Padas | 9,488 | 11,221,792 | 1,183 | 2.68 |
| | Kedungdowo | 15,805 | 9,600,593 | 607 | 2.29 |
| | Banger | 15,309 | 7,859,253 | 513 | 1.88 |
| | Papungan | 20,853 | 7,488,431 | 359 | 1.79 |
| | Jenar | 5,878 | 1,842,237 | 313 | 0.44 |
| | Kedungaren | 3,888 | 1,489,257 | 383 | 0.36 |
| | Tangen | 2,891 | 1,352,645 | 468 | 0.32 |
| | Japoh | 4,421 | 1,339,064 | 303 | 0.32 |
| | Kedungbanteng | 2,074 | 692,547 | 334 | 0.17 |
| Jumlah : | | 588,818 | 418,972,710 | 713 | 100.00 |