ASSESSING THE SPATIAL-TEMPORAL LAND USE CHANGE AND ENCROACHMENT ACTIVITIES DUE TO FLOOD HAZARD IN NORTH COAST OF CENTRAL JAVA

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

By :
Imam Setyo Hartanto
UGM : 13/357428/PMU/08065
ITC : s6013597

Supervisors :
1. **Dr. Rini Rahmawati, M.T. (UGM)**
2. **Ir. Bart Krol, M.Sc. (ITC)**

THE GRADUATE SCHOOL
GADJAH MADA UNIVERSITY
FACULTY OF GEO-INFORMATION AND EARTH OBSERVATION
UNIVERSITY OF TWENTE
2015

Disclaimer

This document describes work undertaken as part of a Double Degree Program of Geo- Information for Spatial Planning and Risk Management at University of Gadjah Mada, Indonesia and Faculty of Geo-Information Science and Earth Observation, University of Twente, The Netherlands. All views and opinions expressed therein remain the sole responsibility of the author, and do not necessarily represent those of the institutes.

Yogyakarta, August 21st 2015

Imam Setyo Hartanto

Abstract

Human needed on space and physical development gradually encroach on the natural environment. Meanwhile, encroachment activities can trigger rapid land use change. Demak regency has significant contribution on agricultural yield in Indonesia. However, Demak is known the second largest region suffering land use change in Java's Noart Coast. In addition, the topographic condition in downstream area and role as final outflow of several rivers to Java Sea result this area become susceptible with flood hazard. Mijen and Wedung are two most impacted sub districts by flood hazard in Demak.

This research aims to assess the interactions between riverine flooding, land use change and land encroachment activities in Mijen and Wedung sub districts, Demak region, Central Java, Indonesia. This research combines the analyzing of Driving Force, Pressure, State, Impact and Response (DPSIR) to understand the root problem and the chain effect those relation. The supervised classification by Maximum Likelihood of time series Landsat image (2000, 2009 and 2014) was chosen for land cover mapping and analysis. Post-classification change detection technique was applied for land use analysis. Meanwhile, the land use accuracy was assessed by confusion matrix. Semi-structured interview with key informant and literature review are conducted as a tool to collect DPSIR data and analysis.

The results shows that the current effects of riverine flooding on land use include the area inundation for adequate period (1-2 weeks), economy losses especially agricultural production and psychological trauma. Although there is lack evidence flood hazard influences land use change in Mijen and Wedung sub district, the transformation of land use for 2000-2014 periods is strongly proved. The structural changes in 2000-2014 were happened in all level of land use classes. Paddy field area descended almost 6%, mangrove forest fall 79% in along 14 years meanwhile settlement grown up almost double in 2000-2014. The result of overall accuracy assessment is 78.23%. The DPSIR prove that land encroachment become one of pressure on riverine flooding. Based on flood event history; Jleper, Ngelokulon, Ngegot, Mutih Wetan and Mutih Kulon are villages at Mijen and Wedung sub district which have highest risk of flood. Technical, local knowledge and policy response is urge to anticipate and reduce the riverine flooding in the future.

Key words: Mijen, Wedung, Flood, Land Use Change, Encroachment, DPSIR

Acknowledgements

Alhamdulillahirobbil'alamin. Praise to Allah SWT, The Almighty and The Lord of the universe for the blessings that always strengthen me during my study and research period.

I profound gratitude to Badan Perencanaan dan Pembangunan Nasional (BAPPENAS) and Netherlands Education Support Office (NESO) for giving the great opportunity to continue my study at Post Graduate Program, University of Gadjah Mada (UGM) and ITC Faculty, University of Twente. I also would like to thank the Head of Teluk Cenderawasih National Park, Ministry of Forestry who fully support and gave permit me to go through Master Degree.

My great appreciation to all lectures and staff members at UGM and ITC for guidance, assistance and sharing knowledge, especially for Prof. Dr. Sudibyakto, Prof. Dr. Junun Sartohadi, Dr. David G. Rossiter, Dr. C.J. van Westen and Drs. N.C. Kingma.

My sincere thanks and regards go to my supervisors Dr. Rini Rachmawati, M.T. and Ir. Bart Korl, M.Sc for all support, guidance and constructive discussion to improve my knowledge and understanding, give valuable experience and suggestion for my research skill also the most important believing of me so I can finished my research.

I would love to extend my gratitude to all members of BPBD, PMI, KESBANGLINMAS and BAPPEDA of Demak Regency also all officers of Mijen and Wedung sub district for their kindness, data supporting, constructive discussion and friendly environment while I conducted my research.

Salute to all my colleagues in Geo-Info Batch 9 and ITC for precious learning and friendship. Thanks to my young brothers and sisters at Geo-Info Batch 10 for all support, kindness and learning.

Last, my heartfelt gratitude belongs to my parents, my parents in law, my brother and especially to my lovely wife Yulifia Kurnia Putri for her patience, prayer and love who never tired to support and assist me in any condition and helping me through tough times.

Yogyakarta, August 21st 2015

Imam Setyo Hartanto

TABLE OF CONTENTS

LIST OF FIGURE

LIST OF TABLE

ABBREVIATIONS

BAPPEDA	:	Regional Planning Agency
BAPPENAS	:	National Planning Agency
BASARNAS	:	National Search and Rescue Agency
BNPB	:	National Disaster Management Agency
BPBD	:	Regional Disaster Management Agency
BPS	:	Central Agency on Statistic
BPSDA	:	Water Resources Management Agency
DINKES	:	Department of Health
KESBANGPOLINMAS	:	National Unity, Politics and Public Protection Office
KODIM	:	District Military Command
PMI	:	Red Cross Indonesia
TRC	:	Emergency Response Team

CHAPTER I

GENERAL INTRODUCTION

1.1. Background

Human and environment have inseparable relation. The human expansion has changed land-cover and land-use patterns dramatically in global scale (Genxu et al., 2006). Kakisina et al., (2015) stated that the land utilizations changes have a potential negative impact for the sustainability of natural resources. Human activity on land-use especially built up area have removed vegetation and increased the impervious areas. Liu et al., (2014) mentioned that man-made land use change has influenced the characteristics and pattern of flooding or increased the risk of flood for the inner urban human sphere.

Land use change is a process which is related to the complex interactions between the driving physical, ecological and social factors (de Freitas et al., 2013). Quan et al., (2006) stated that the growth of the population, agriculture economic conditions, the level of affluence in farming population, agricultural production technology and policy factors are correlated with land use changes. Human interference on land use changes has been convinced play important role of global environmental changes (Wang et al., 2012).

Environmental factors have a close relation with land use change (Chen et al., 2001; Fu et al., 2006; Luo et al., 2014). Natural hazards, especially flooding become another consequence of the excessive land use activities. Land use change is also increased by the erosion capacity and runoff intensity (Panahi, 2010). Liu et al., (2014) argued that land-use changes are responsible for changing rainfall-runoff processes and increasing peak-flows. Land-use changes, especially the changes in land use activity in upstream area, significantly influence runoff processes, causing a significant decrease of water resources in the downstream area (G. Wang et al., 2006).

Human activities especially space needed gradually encroach on the natural environment. Greene & Harlin (1995) stated that in United States (US), urban encroachment on gonging to consume basis farmland especially on the outskirts of many metropolitan areas. El-Raey et al, (2000) studied that Rosetta City, Egypt was found to be suffering from unplanned urban expansion that encroached over surrounding land. They found that most of the encroachment area was changed to be an agricultural and tourist importance.

It is now well accepted that there exists causal links between environmental degradation, land use and vulnerability to disaster. In physical terms, for instance, flash floods are considered to be fast onset disasters, but the root cause may reside in a historically progressive process of environmental (WMO-GWP, 2007). G. Wang et al. (2006) concluded in their research that land-use changes, especially the transformation of large areas in the upstream basin become a main influence on run off processes in the downstream basin.

The holistic approach is needed to understand the root problem and find better solution in human-environment relationship. The DPSIR framework is an effective approach to organize information of policy making (Agyemang et al., 2007). The DPSIR application may allow for policy relevant research because it supports the explanation and communication of research results in an accessible and meaningful way to decision makers (Tscherning et al, 2012). Benini et al., (2010) applied a DPSIR-based conceptual framework to describe the effect of the agricultural land use change at Lamone river basin in Northern Italy. Hou et al., (2014) stated that the DPSIR model was applicable to capture the influence of socioeconomic on biodiversity, ecosystem services and human welfare in quantitative way.

1.2. Research Problem

Demak regency has significant contribution on agricultural yield in Indonesia. Demak is a major area of rice production and also as an economically developing region in Central Java-Indonesia. However the topographic condition in downstream area and final outflow of several rivers to Java Sea make Demak become susceptible with flood hazard. The two sub districts which are most impacted by flood hazard are Mijen and Wedung (BNPB, 2014). For example, in early 2014, flooding hit the Mijen and Wedung sub districts, which resulted in 2,400 houses inundated and causing evacuation of 12,000 residents (Kompas, 2014). Many crops and paddy fields in theses sub districts are frequently damaged by flooding. The problem is human needed on space and physical development there continuing grow up without considering the land capacity. It will affect the downstream area become more vulnerable.

Meanwhile, encroachment activities of land use can be happened to fulfill human needs. It can trigger rapid land use change. With an area of 232 Hectares affected by land use change in the period 2006 to 2009, Demak is the second largest region suffering land use change in Java's North Coast (Mustopa, 2011). The increase in population number directly affect to settlement and space area especially land availability. Liu et al. (2014) explain that the growth of human areas has been substantial decreasing the rivers, lakes, forest and grassland. All of this resulting rural area becomes fragile in land use change activities. It was clearly known that agricultural land encroached by rural settlements (Cao et al., 2011).

A general assumption is that land encroachment in floodplain causes more flooding in downstream areas. American researchers indicated that increased floodplain in periods of 1936 to 1957 was a major cause of increasing flood risk and rising flood losses (Parker, 1995). Because of construction, the capacity of the floodplain to convey flood flows has decreased and downstream flood levels have increased for the same river flow. Urban areas changes cause that large population and social resources concentrated in the floodplain areas directly increase the exposed populations and assets to flooding (J. Liu et al., 2014).

Meanwhile, annual flooding will push the development and intensification of land using in the other part of study area in aim to avoid more losses caused by flooding. However, Zhang, Ma, & Wang (2008) explained that removal vegetation as result of urban development resulted in the increasing of runoff and abnormal water level rise during the rainfall season, which, in turn, caused overload of the limited drainage systems and increased the risk of floods. The illustration is showed in figure 1.

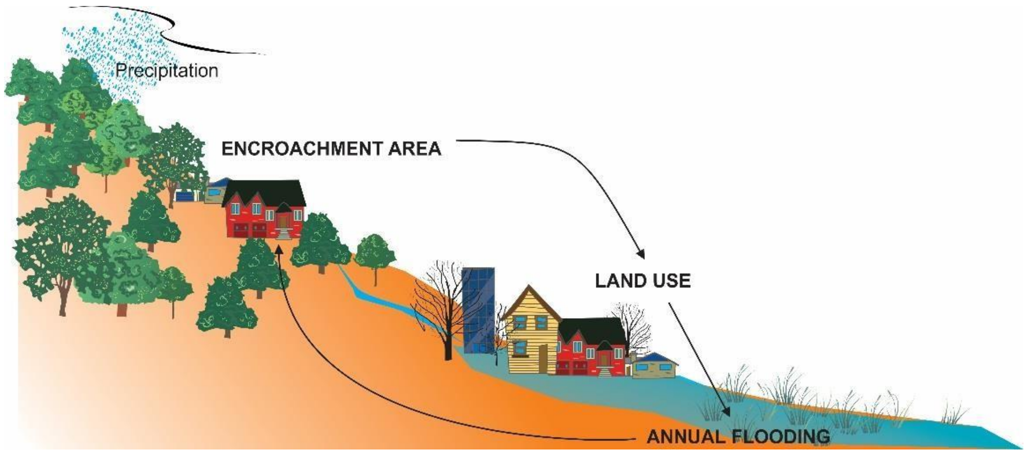

Figure 1. The General Relation between Flood, Land Use and Encroachment Activities.

The rural people living in the two sub districts have a lot of limitations in facing the flood hazard. Many of them depend for their livelihood on agricultural land use activities.

All this time, the general understanding if changing on land use can potentially trigger the flood. In this case, we will reveal the main causes of flood disaster, how the flood influence land use system activities and the role of encroachment activity between two other components (land use change and flood).

The holistic approach from upper to downstream to study this phenomenon will be scientific perfect. Unfortunately the limitation of data access and resources give occasion this research turns to issues of development on downstream area only. It is focused to determine and assess the interactions between flood, land use change and encroachment activities in Mijen and Wedung sub district, Demak regency, Indonesia. This study focused on both sub districts as representation of downstream area. It is also necessary because many there is lack of research at downstream area whereas this area is the most impacted from flood disaster.

This proposed study combines the analyzing of Driving Force, Pressure, State, Impact and Response (DPSIR) which is introduced by the European Environmental Agency (1999). The study about driving forces behind land use change and its relation with the riverine flooding are important to explain what has been going on in the past and for forecasting future pattern. By understanding this relation, it can help to predict future trends if nothing is changing (a business as usual kind of scenario) and to propose alternatives as input for the next spatial planning or land use management.

This research will be intent on several aspects. First, it will be producing information about the current effect of riverine flooding in land use. Second, this research will provide information about the trend of flooding in space and time. Third, this research will explain the relation between flood hazard and land encroachment. The last, this research will identify future trends in flooding-related land encroachment.

1.3. Objectives and Research Questions

The general objective of this research is to assess the interactions between riverine flooding, land use change and land encroachment activities in Mijen and Wedung sub districts, Demak region, Central Java, Indonesia.

Several questions were structured to answer the research objectives. Specific objectives and research questions are:

1. To determine the current effect of riverine flooding on land use in the study area.
    a. What is the flood hazard (areas affected, intensity, and frequency) in the study area?
    b. Which land use systems are affected by flood hazard?
    c. What is the vulnerability of the exposed land use systems, as perceived by land users?
2. To outline the effect of flood hazard on land use change over the period 2000-2014
    a. Which land use systems - and where are they located - have been exposed to flooding in mentioned period?
    b. What has been the response - in space and time - from direct land users, in terms of structural changes in land use?
3. To determine the relationship between riverine flooding and land encroachment
    a. What are the main causes and drivers for riverine flooding in the study area?
    b. How does land encroachment contribute to the development and/or maintenance of flood hazard in the study area?
4. To identify future trends in flooding-related land encroachment
    a. What will be the effect on land encroachment over the coming 5 years under a 'business as usual' scenario?
    b. What interventions can be proposed to reduce land encroachment?

1.4. Organization of the Thesis

This research is organized into six chapters, which are:

Chapter 1. General Introduction

This chapter consist of an introduction, research problem, objective, research question and organization of this thesis.

Chapter 2. Literature Review

This chapter provides the theoretical background and approaches to the research problem. The explanation about land use, land cover, riverine flooding and the relation among them are discussed. The DPSIR approach also provided here.

Chapter 3. Study Area

The aim of this chapter is provide an illustration where the research located and their condition.

Chapter 4. Research Methodology

Material and methodological framework applied to answer the problem of this research. It also describes the method of land cover-use mapping, land use change and flood event analysis. Qualitative method by DPSIR approach to understand the driving force and response of land use change and flooding are provided here.

Chapter 5. Result and Discussion

It presents the result of the research.

Chapter 6. Conclusion

This chapter summarizes the research by providing comparison between the objectives and the result. It also provides recommendation for further research.

CHAPTER 2.

LITERATURE REVIEW

2.1. Land, Land Cover and Land Use

Townshend (2001) cites from the Interdepartmental Working Group on Land Use Planning (IDWG-LUP) at FAO in 1994 explained the definition of *land* with “A delineable area of the earth's terrestrial surface, including all attributes of the biosphere immediately above or below this surface, including those of the near surface climate, the soil and terrain forms, the surface hydrology including shallow lakes, rivers, marshes and swamps, the near- surface sedimentary layers and associated groundwater and geo-hydrological reserves, the plant and animal populations, the human settlement pattern and physical results of past and present human activity (terracing, water storage or drainage structures, roads, buildings, etc.)”

‘Land’ is a widely-used and often loosely-defined term. For practical purposes land cover is restricted to the terrestrial surface and to allow land uses to be defined on, above or below this surface (e.g. buildings with shops at ground level, flats and offices above and car parking below ground level). For extractive industries, such as deep mining, and utilities with underground plant or resources, it is usual to restrict the extension of such activities to their physical impact at ground level (Harrison, 2006).

“Land Cover (LC)” and “Land Use (LU)” are clearly different terms but sometimes it is used interchangeably. Simply explanation, *land cover* defines as what covers the surface of the earth and *land use* describes how the land is used. According Manual of Concepts on Land Cover and Land Use Information Systems (2001), *land cover* corresponds to a physical description of space, the observed (bio) physical cover of the ground such as: vegetation (trees, bushes, fields, lawns), bare soil (even if this is a lack of cover), hard surfaces (rocks, buildings) and water bodies (sheets of water and watercourses, wetlands). Land cover refers as "observed" which is observation can be made from various "sources of observation" at different distances, for example: the human eye, aerial photographs, and satellite sensors. On the other hand *land use* relay on the description of areas in terms of their socio-economic purpose, for example: residential, industrial or commercial purposes, for farming or forestry, for recreational or conservation purposes, etc.

Land use and land cover classes represent analytical units, which allow establishing a first quantitative link between human activities, environmental impacts and its geographical (spatial) dimension. Information on land cover and/or land use change are of special value integrating the temporal dimension.

Townshend (2001) stated that in generally, there are two categories of land cover and land use change which are conversion and modification.

- Conversion defines as a change from one cover or use category to another (e.g. from agricultural land to built-up area)
- Modification defines as changes in physical or functional attributes of land cover or land use category (e.g. from agricultural area to irrigated cultivated area).

2.2. River Flooding

Flood risk has become one of the most severe risks on human lives. Flood disaster also happens more often and severe local economic development. The development of watershed area affects more hydrologically active, changing the flood volume and runoff components as well as the origin of stream flow (Y. B. Liu et al., 2004). In short term, floods become more frequent and more severe along with the development activities in watershed area.

Generally speaking, flood is caused by above normal rainfall that makes the water flow system that consists of natural rivers and tributaries and drainage and canal system not able to receive the accumulation of rainwater and overflow (BNPB, 2009). Based on the source of water, excess water/flooding can be categorized into three: (a) Flood that is caused by heavy rain that exceeds the capacity of the water flow system that includes natural river system and man- made drainage system; (b) Flood that is caused by the increase in water level in the river due to tidal water or storm-related sea wave; and (c) Flood that is caused by the failure in man-made water buildings such as dams, embankments and flood control facilities.

Riverine flooding is the amount of water from river which is flooding in flood plains. The causes of this flood can be happened from intensive rainfall and/or snowmelt, ice jam, clogging or collapse of dikes or other protective structures. This problem occurs since humans established their settlements and conducted various activities in floodplain areas. The land in such areas is usually fertile and offers various potentials and facilities, generating considerable interest for cultivation, settlement and industry (BAPPENAS-BNPB, 2010).

2.3. Encroachment

Encroachment defines as a process of most of ‘urban’ uses from ‘invading’ the floodplain (Parker, 1995). Encroachment can be happened in everywhere (upper, middle and even in the floodplain areas). Human encroachment into the floodplain can raise the possibility of flood damage. Manmade obstruction will affect the watercourse as to retard its capacity to pass flood flows.

Lulloff et al., (2013) in their research showed that the cumulative effects of human activity in the floodplain can increase flood and will be a serious threat to the environment. The effect of residential development and on adjacent communities is an increase in flood crests and wider areas being flooded. Zoebisch et al., (2005) explained that the increasing pressure on natural resources in the hills of Nepal happened as result of the population growth and local people have removed forest and grass cover to fulfill their basic needs for food, fodder, fuelwood, and timber.

2.4. The Relation among Human, Land Use and Flood

Soil, land cover, and topography are the three primary watershed characteristics that govern rainfall-runoff-erosion response in watersheds (Saghafian et al., 2007). The intensity of human activities on land use will affect the natural hazard probability. Human development and expansion change on a global scale in land-cover and land-use patterns in river catchments dramatically (G. Wang et al., 2006). The environmental-geological negative impact is caused by human activity i.e. natural resources utilization in upstream region (Kesbanglinmas, 2007).

In Nigeria, human activity especially land use change and encroachment has part on flooding. Orewole et al. (2015) discovered that the encroachment on riparian corridors have a significant deleterious effects such as flooding which damages properties and results in poor water quality in the watershed's streams and reservoirs.

2.5. Land Use Mapping

Lambin & Geist (2006) explained that a spatially and temporally global land cover picture has produced by satellite-based observations of the Earth now days. Satellite-based remote sensing began in 1959, with the first space photograph taken by the Explorer 6 satellite. NASA launched Landsat 1 in 1972 to monitor the Earth's natural resources. A series of Landsat satellites followed, with the most recent, Landsat 7, launched in 1999, making it the longest running space-based remote-sensing program. Landsat has 30 m spatial resolution multispectral data and has been used to monitor and study land-cover change around the world extensively.

The traditional classification method is supervised and unsupervised classification. Supervised classification assumes a priori knowledge of all cover types to be mapped within the classified scene. On contrary, unsupervised classification no require prior information about the land cover types. Unsupervised methods also divide the scene into more or less pure spectral cluster.

Unsupervised classification has beneficial when do not spend a lot of time and high accuracy is not needed. Unsupervised classification produces more comprehensive information on the spectral characteristics of the area and gives the opportunity to the analyst to group similar clusters into a smaller number of land cover classes. The main problem of this method is changes of controlled parameters for the same data set can produce different result of clusters.

Sharma et al., (2011) in their research proved that supervised classification method gave better result compare to unsupervised classification. The supervised approach performed better than the unsupervised in mapping the flood induced land-cover. Automated clustering technique (unsupervised classification) often failed (overestimated/underestimated) in classified on class type caused by similar spectral response and not separated properly. In addition, the unsupervised approaches produced lower accuracy than supervised classification.

Land use map are obtained from interpretation of time series Landsat images 2000-2014. Interpretation of Landsat images are conducted by employing supervised classification. Supervised classification (Richards & Jia, 2006) is the technique most often used for the quantitative analysis of remote sensing image data. The essential step in supervised technique is choosing known, representative pixels for each of the classes. Sharma et al., (2011) explain that supervised classification consist of three steps i.e. the training stage, the classification stage, and the output stage. It also needs knowledge of the study area to define training classes.

In this study, Maximum Likelihood is chosen as method to run supervised classification. In addition, Richards (2006) stated that this method is one of the most common supervised classification method and the first rigorous algorithm to be applied widely in remote sensing image data. The assumption of Maximum Likelihood is a pixel has equal probability to become a particular class.

2.6. DPSIR Assessment

The DPSIR framework (Smeets & Weterings, 1999) is useful in describing the relationships between the origins and consequences of environmental problems. In order to understand their dynamics, focusing on the links between DPSIR elements are necessary. Drivers (D) are the underlying factors leading to the potential risk problem; Pressures (P) are human activities/interferences directly affecting the environment; State (S) is defined as the conditions of the environment in terms of the level, quality and/or quantity of physical, biological, chemical phenomena in time and space; Impacts (I) are defined as the effects of changes in the quality of the environment on ecosystem and human health; and Response (R) is in this case efforts of the society (different actors) to mitigate the problem (Sanderson et al., 2009).

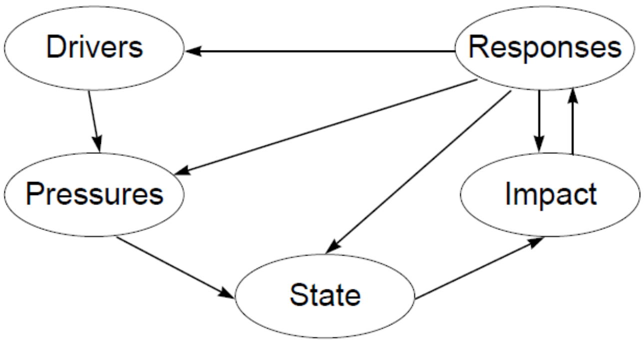

Figure 2. The DPSIR Framework for Reporting on Environmental Issues (EEA, 1999).

Set of selected indicators were chosen in order to describe the DPSIR model. The indicators were designated into different categories of the DPSIR framework refers to their positions on the casual chain. An appropriate list of indicators 'site-specifics' in purpose to explain the complex ecological and socio-economic processes in the studied area was required in DPSIR model application (Kagalou et al., 2012). Generally, the DPSIR framework explores the interdisciplinary links between socioeconomic drivers, environment-related pressures, state of the environment, impacts of environmental changes and social responses to prevent environmental degradation (Song & Frostell, 2012).

Karageorgis et al., (2006) in their research explained that DPSIR conceptual framework could be applied easily to catchment/coastal zone systems where human interventions growth during some period. It also would be providing a comprehensive and holistic approach on issues pertaining to environmental protection and the sustainable management of natural resources. DPSIR is a robust and reliable management tool which has ability to apply future scenarios. Many stakeholders could get advantages from such integrated analysis.

The DPSIR Framework has been applied for monitoring ecological river restoration applied by Bidone & Lacerda (2004). Tsai et al., (2009) in their study conclude that the DPSIR framework is proved as a suitable method for sustainable development indicators and linking their causalities within the European region. Environmental Impact Assessment of land use planning in Tianshui Region also used the DPSIR model for apllication (Shi & Xia, 2011). The DPSIR approach for an integrated river management framework is mentioned by Kagalou et al., (2012). In Guanabara Bay basin, Rio de Janeiro - Brazil, the DPSIR framework used to evaluate sustainability in coastal areas (Bidone & Lacerda, 2004).

This schema is important to solve the real problem in our society. Many studies become less effective because the result is not applicable. Tscherning et al., (2012) stated that DPSIR framework offers the chance to link scientific findings with “real world” issues. It may serve as a means of bridging the gap between research and decision making.

CHAPTER 3.

STUDY AREA

Demak regency in Central Java lies between 6°43’26”-7°09’43” south and 110°27’58”-110°48'47' east. It is located approximately 25 miles east of the city of Semarang. Administratively, Demak is bordered by Kudus regency in east, Semarang in west, Jepara in the north side and the south is Grobogan. Demak is crossed by national road which connects Jakarta-Semarang-Surabaya-Banyuwangi. Demak regency has total rainfall about 434-2671 mm/year. Demak has total land area of 89,743 Ha (Santoso et al., 2013a).

Demak is counted as downstream area with height surface 0-100 meters above the sea. This area is included Jratunseluna watershed which is covered Blora, Pati, Kudus, Jepara and Demak District. Demak itself is a final outlet of rivers direct to Java Sea from this huge watershed.

Mijen and Wedung sub district is located in the north side of Demak region. Physiographically, Mijen and Wedung sub district is included as low land. Both located at 1-5 m above the sea. Wedung has the largest area which 9,876 Ha (11%) and Mijen with 5,029 Ha (5.6%) of total area in Demak regency (Dinkes, 2012). Both are divided into 15 villages for Mijen and 20 villages for Wedung sub district.

Based on data of BPS (2014a), Mijen Sub District located at 110°39’31.64” - 110°45’22.73” east longitude and 6°45’46.32” - 6°51’58.75” south latitude. Mijen sub district abut on Demak sub district at south side, Karanganyar sub district at east, Wedung sub district at west and Welahan sub district (Jepara district) at north side. According to a recent statistical data, the number of population was counted 50.888 inhabitants in 2013.

Meanwhile, BPS (2014b) described Wedung Sub District is located at 110°32’04.66” - 110°40’29.24” east longitude and 6°42’20.24” - 6°50’09.16” south latitude. It has distance to the Demak capital about 14 km. The furthest distance of Wedung is Kedung Mutih village as much 20 km and the closest is

Ngawen village with 0.5 km. Inhabitants of Wedung sub district was counted 72,550 inhabitants in 2013.

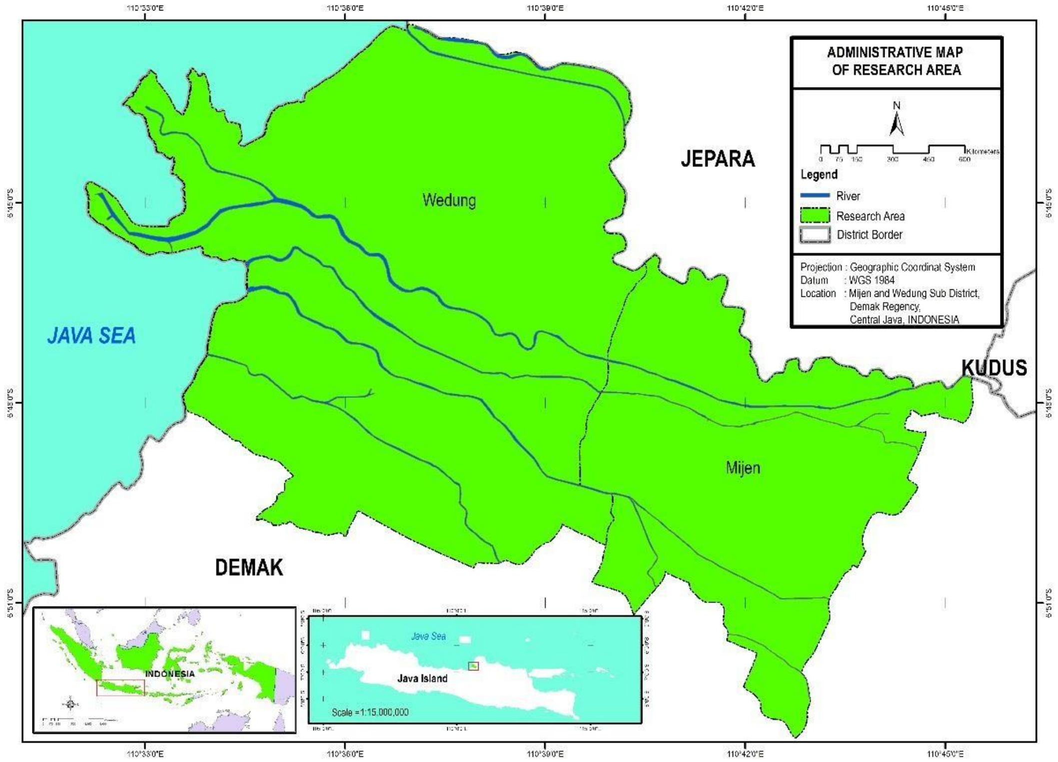

Figure 3. Research Study Area Map

Most of Mijen people depend on agriculture sector which has 3,574.82 Ha rice field total areas. Based on data, the total 808.6 Ha of Mijen area is garden and 499.58 Ha for building. Approximately 12,500 people work as farmer, this number is equal with merchant (Santoso et al., 2013b). Similar with Mijen, Wedung sub district consist of 5,580 Ha rice field and the rest is dry land. More than 24,000 inhabitants depend on their live as farmer (Santoso et al., 2013c). Beside farm land, Wedung is known as the largest fishery region in Demak. Wedung sub district has directly bordered with Java Sea so many fish pond build in those area.

Both sub districts have grumose soil type with old gray color (Kesbanglinmas, 2007). Mijen and Wedung Sub Dstrict are flowed by two rivers which are Serang River in the west side (as border with Jepara District) and Wulan River which flows across the region.

CHAPTER 4.

RESEARCH METHODOLOGY

4.1. Materials

Material needed for this research include satellite image in three (3) different periods which is needed in the temporal analysis. The other data collected during field work. The datasets requirement shows in the Table 1.

Table 1. The Research Dataset Requirements.

No	Data Type	Description	Source
1.	Landsat Image	a. Landsat 7 Entity ID: LE71200652000244EDC01 Acquisition Date: 31-AUG-00 Path: 120 Row: 65 b. Landsat 7 Entity ID: LE71200652009172EDC00 Acquisition Date: 21-JUN-09 Path: 120 Row: 65 c. Landsat 8 Entity ID: LC81200652014226LGN00 Acquisition Date: 14-AUG-14 Path: 120 Row: 65	United States of Geological Survey (USGS)
2.	Administrative Unit of Demak Regency	Shapefile (shp.)	Central Statistical Agency (BPS) 2010
3.	Digital Elevation Model (DEM)	Contour Map with 12,5 meter height interval range	Geospatial Information Agency (BIG) of Indonesia

4.	Preliminary Historical Data Flooding	Data of flooded area in 2013 and 2014.	Regional Disaster Management Agency (BPBD) and Water Resources Management Agency (Balai PSDA) Kudus
5.	River	Major and minor river appropriate with study area	Topographic Map Scale 1:25,000 by Geospatial Information Agency (BIG) of Indonesia
6.	Road	Primary and secondary road appropriate with study area	Topographic Map Scale 1:25,000 by Geospatial Information Agency (BIG) of Indonesia

4.2. Equipment and Software

There are some equipment which is used in this research include for field work data collection and processing.

Table 2. Research Equipment and Software.

No	Equipment and Software	Utility
1.	EVERCOSS Elevate Y 2	Photograph capture device and application
2.	GPS Oregon 550 by Garmin	Manual geotagging utilities
3.	Arc GIS	Image and remote sensing data processing
4.	Notebook	Processing device
5.	Interview Guide	In depth interview guidance

4.3. Methods

The methodological approach of this research is illustrated on the Figure 4.

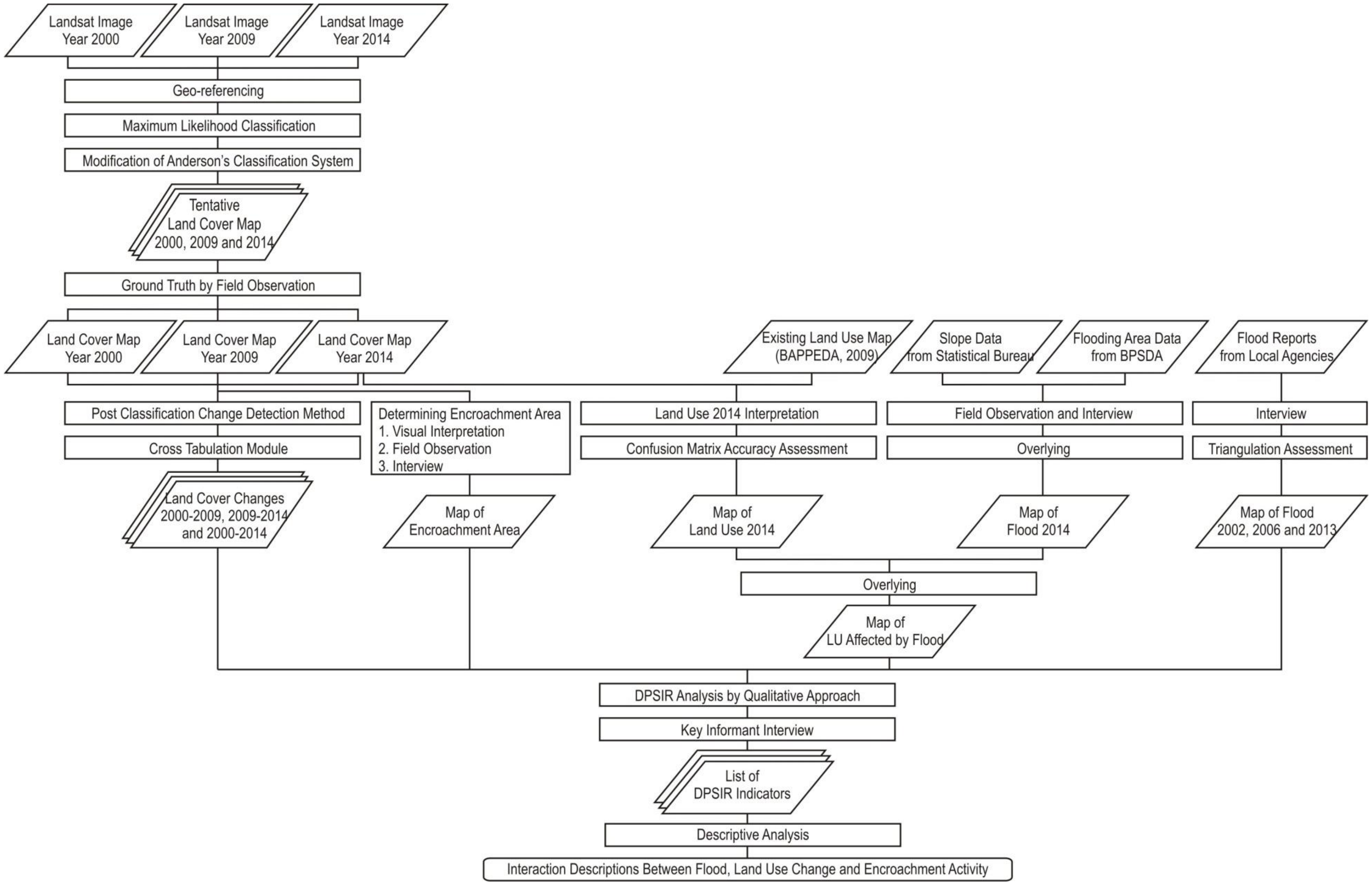

Figure 4. Flow Chart Methodology of Research

4.3.1. Land Cover-Use Mapping and Analysis

Several numbers of multi-temporal images that cover a certain period of time is used for this research. Time series Landsat image (2000, 2009 and 2014) is applied in land use change analysis. This research want to use Landsat image which has seven years sequence differences (2000, 2007 and 2014), but Landsat image of 2007 has limited availability and poor quality of image. Because of that, Landsat image 2007 was changed with 2009 to maintain good quality of image and ease on analysis.

Time series Landsat Images which is used for analysis of this research are:

a. Landsat 7 of Mijen and Wedung Sub District in 2000, Band: 321

b. Landsat 7 of Mijen and Wedung Sub District in 2009, Band: 321

c. Landsat 8 of Mijen and Wedung Sub District in 2014, Band: 432.

All band type was made as obtain to resemble the truly field condition.

Land cover map are obtained from interpretation of time series Landsat images 2000, 2009 and 2014. Interpretation of Landsat images are conducted by employing supervised classification (Richards & Jia, 2006) as the technique most often used for the quantitative analysis of remote sensing image data. The essential step in supervised technique is choosing known, representative pixels for each of the classes.

Three stage of supervised classification were implemented for this supervised classification, including the training stage, the classification stage and the output stage (Sharma et al., 2011). The Maximum Likelihood was chosen as supervised classification method for this research. First step of supervised classification was making training site selection. Several training pixels were produced by considering the homogeneous sample pixels. The training area was made in aim to discerning the individual classes.

The next step classified the training area into several classes based on image interpretation and the knowledge of the study area. It applied five (5) classes (built up, agriculture, wetland, forest and water body) as representative of land cover in the image. Approximately, 10-15 areas of interest were chosen as training sample for each land cover type. This research applied 10 areas of interest samples for forest and 15 samples for the other classes. The total area of interest for input of supervised classification is 70 samples. These training samples were as pure as possible and their location was maintained, when possible, over the three images. After the satisfactory of training samples are completed, supervised classification was applied for all the time period images of study area as the last stage. The output of this step is tentative land cover map.

The land use classification in this study uses the Anderson's classification system (Anderson et al., 1976) that helps to transfer from land cover to land use classes in a structural manner. The Anderson's classification system gives flexibility in developing categorization at the more detailed levels. This classification allows the users not depend themselves limited to the existing categories such as these but should develop categories of almost utility based on their particular needs and each region characteristic. Most of the components of Anderson's classification are similar with Indonesia land using.

The Anderson's classification was to be modified to the land cover and land use based on region characteristic in Indonesia especially in Mijen and Wedung sub district. The Anderson's classification modification was applied in several countries too. Ding et al., (2007) provide an example from China of modification land use scheme to the characteristics of their area study. In India, Gupta & Roy (2012) modified Anderson's classification depends upon the available features of Burdwan municipality. A similar approach will be used in this study. The detail applied land use classification is shown on the appendix 2. The output of this step is land use map 2000, 2009 and 2014.

The first column of Anderson's classification table/level contains generalized information (earth surface showing from air) for general purposes. The second (2nd) and the third (3rd) column is more detail information about earth surface including the using of land. The second and third columns of Anderson's classification are the break down from land cover classes (1st column). The nomenclature of land use classes was taken from 2nd and 3rd columns of Anderson's classification. From those understanding, this research applied the first column of Anderson's was used for land cover classification class. Meanwhile, the 2nd and 3rd column was used for land use classification.

Each land cover and land use class has unique and different representation. In agriculture class, Mijen and Wedung sub district divided into paddy field and orchid. Most of the people there are farmers and their main commodity is rice which is paddy fields exist along year. Orchid class comes from water guava plantation. The other farmers planted water guava as other main commodity. It is kind of hardwood plantation and has been become a fruit icon of Demak regency. Residential class always grouped in some area as represent village or sub village. On contrary, commercial and services (ex: school, industry company, government office) is separate distributed.

Ponds are located along or closely with the sea with the clear borders which required water submergence along the year. In rainy season the fisherman grow fish than in dry season they make salt. In images, it is detected by light to dark blue color with square shapes nearly or along the sea. Meanwhile, dry empty land and beaches almost have similar spectrally and difficult to be separated; therefore they were grouped into a single barren land category. Forest in Mijen and Wedung sub district only located in coastal area, with this condition only mangrove plantation lived there. It becomes a reason the using of some coastal area as mangrove forest class.

Field observation is needed to assess the accuracy tentative land cover classes and get detail information about land using. Ground truth is conducted by employing Global Positioning System (GPS) to collect information of recent land cover. Stratified random sampling is proposed in this procedure consider to accessibility and class representation of study area. Random number is used for point location choosing and it selected 124 sample points for verification of land use in 2014. This sample points have to evenly distributed and cover all land use classes representation.

Meanwhile, the lack information and source map for past time period become another challenge. For that reason, the assessment for image classification accuracy of 2000 and 2009 was used Google Map Image and Existing Land Use Map 2009 from BAPPEDA of Demak Regency for reference. Accuracy of classified maps was evaluated using 75 sample points which is chosen randomly with considering the representation of each class.

The land use accuracy was assessed by confusion matrix. It is applied by selecting test points (or pixels) and comparing the land cover or land use attribute with the same information from a field survey (*ground truth*). The result is a matrix where the commission and omission errors also the producer and the user accuracy for each class.

The producer accuracy is count as a percentage relates the number of points correctly classified in the image or map to the total number of ground truth point of that land use type. While the user accuracy is calculated as a percentage relates the number of points correctly classified to the total number of points classified for a certain land use type. It also takes into account the wrongly classified points in the map and allows a better assessment of the quality of the classification.

4.3.2. Land Use Change Analysis

Remote sensing data and GIS provide opportunities for integrated analysis of spatial data. Generally, the change detection methods of multi-spectral image data can be classified into three categories which are: characteristic analysis of spectral type, vector analysis of spectral changes and time series analysis. This research only focuses on the last category in time series analysis.

In this research, post-classification change detection technique was applied. Shalaby & Tateishi (2007) stated that post-classification comparison proved to be the most effective technique. It can minimize the problem of normalizing for atmospheric and sensor differences between two dates because data are separately classified.

Post classification is suitable for general low resolution of multispectral image and simple spectral characteristic of certain area. The advantage of this method is not only ascertaining the spatial distribution of changes but also illustrates the nature of changes. In general terms, the transition information from one class to another is well known.

Post classification method is the most simple change detection analysis technique. Cross tabulation of Spatial Analysis Module was applied in this procedure. Each image of multi temporal images was classified separately and then the classification result images were compared each other. If the corresponding pixels have the same category label, the pixel has not changed, or else the pixel has changed. The type of change of each changed pixel is determined in the change detection matrix. A change matrix was constructed for each pair of gridded datasets in land use change quantification (Guo et al., 2009).

Then, for each LUC category i in a change matrix A, the change between the two periods was calculated according to equation (1), and for each LUC type we calculated the percentage of "conversion to" (loss) or "conversion from", (gain) in relation to the total "loss or gain" conversion of a LUC type according to equation (2).

$$C_i = \frac{P_{ci} - P_{ri}}{P_{ri}} \times \frac{1}{t} \times 100$$

where Ci is the dynamic degree of land use change in row i relative to the previous year in the comparison; Pci is the column total of grid cells for category i; Pri is the row total of grid cells for category i; t is the study period, when t is set for year, the value of Ci is the annual change rate of land use.

$$\begin{cases} P_{loss\ (i),j} = \frac{P_{i,j} - P_{j,i}}{P_{ci} - P_{ri}} \times 100 \\ P_{gain\ (i),j} = \frac{P_{j,i} - P_{i,j}}{P_{ci} - P_{ri}} \times 100 \end{cases} \qquad i \neq j$$

where P_{loss} $(i),j$ is the percentage taken by type j in the total "conversion loss" of category row i; P_{gain} $(i),j$ is the percentage taken by type j in the total "conversion gain" of category row i ; Pi,j and Pj,i is the individual entry in a change matrix A.

4.3.3. Flood Event Monitoring and Analysis

Flood event data in 2013 and 2014 was collected from Water Resources Management Agency (Balai PSDA) Kudus report. Unfortunately, the report only explains the flood depth in average. This limitation was overcome by key informant interview. It is important to know the boundaries and the depth of real flood in the study area. In addition, interview to local people is applied to get the flood event and depth data around 2000-2014.

The aim of interview process is to clarify the previous flood event report. On this stage, three to five (3-5) key informants per village were chosen to understand the flood depth and boundaries. The informant should be someone who not only understands the issue, but also thinks about solving/preventing the issue. A good informant will be able to express thoughts, feelings, opinions, and their perspective on the topic. It is necessary that the informant knows what is going on in the community and is able to articulate that knowledge. In this research, the key informants were chosen based on the knowledge of their society and area representation of each village such as head of village, secretary, chief of sub village, head of farmers group etc.

The interview questions were tried free flowing and allow the informant to provide their knowledge and expertise on the topic. Most of the question related with the flood event information such as the flood happened story, the depth of flood, causes, impact and losses, how to solve and other relevant question.

This interview result was strengthened by flood depth tracing observation data. By looking the print of flood event in cement wall of the interviewee (informant), the measurement of the depth can be applied. If there is no cement wall house, the informant was asked to describe the approximately of the depth flooding with their body such as high as breast or knee etc. This step will produce the flood depth data and description of impacted flood area. The sample of flood depth observation is showed in Figure 5.

Figure 5. Flood depth tracing observation at the house of informant in Pecuk Village (Fieldwork, 2014).

The flood data result was applied by delineating flooded area in spatial analysis process. The flood depth was produced by interpolate the depth value of each ground observation point. Interpolation refers to the process of estimating the unknown data values for specific locations using the unknown data values for other points. The interpolation surfaces in spatial analysis used Inverse Distance Weighted (IDW).

IDW defines cell values using a linear weighted combination set of sample points. The weight determined is a function of the distance of an input point from the output cell location. IDW is an exact interpolator that produces surfaces similar to a bull's eye shape (Sterling, 2003). This method applies an assumption that sampled points closer to the unsampled point have more similar values to it than those further away. The visual effect of this interpolator is more obvious when interpolating sparse datasets over a large spatial extent. Those processes resulted flooded area distribution map and flood depth map.

Time series flood map in part time of 2000-2014 is compared in purpose to understand the trend and the wide of flood overtime. The analysis is done for each land parcel inundated by flood and other finding.

4.3.4. Assessing Land Parcels are Affected by Flooding

4.3.4.1. Relationship Analysis between Land Use and Flooding

Overlying between flood map and land use map is urgent to know the land type and location where the flooding occurs. Geo-processing analysis is used by making intersect between land parcels and inundated flood area. Geometry calculation command applied to get the total land use affected by flooding per class. The result of this process is kind of land parcel and wide of inundated flood area.

Key informant interview was conducted to get the description about land use and flooding relationship. The question about it included at list of key informant interview question. Overall, this process would show whereas flood disaster will change the land utilization or land use changing affected or trigger the flood disaster.

4.3.4.2. Determine Encroachment Activities

Encroachment activity is known by detecting unusual feature of land use/cover change map. The lack of data and time limitation given occasion this research focused on indication of encroachment in downstream area. Although it cannot generalize the condition in a watershed, at least it will bring a few descriptions about relation between three components (land use, encroachment and flood) in sequential downstream area.

Watson et al., (2014) indicated unusual feature ‘human-impacted’ of encroachment activities in their study as the cultivated or otherwise cleared area features. They used field-validated remote sensing imagery to develop a simple method to detect and assess encroachment in

Zambia. After known the existence of remote cultivated areas, they verified the establishment and expansion of an isolated encroachment area by walking its perimeter and confirmed by interview result.

The similar procedure was applied in this research. Encroachment in this research defines as conversion of conservation and protection area into development and productive land which is change the main utilization.

Visual interpretation of land use change maps 2000-2014 is needed to detect encroachment features. The result of land cover change analysis could be an indicator of encroachment activity. On screen digitizing of encroachment area was applied on this research. The fall of forest or protected area became productive area and the significant increasing of settlement have high probability encroachment activity is happened. After the area with has high probability of encroachment activity been selected, the delineation was used for area with has significant differences of pixel value at certain period.

Ground truth by field observation is important to assess the correctness of encroachment feature interpretation. It conducted by taking documentation and direct measurement of encroachment feature candidate. The next step is applied key informant interview. Key informant interview (such as: head villages, Sub District and BPBD governmental officers) will provide information about their region development and encroachment activity there.

4.3.5. Land Use Response Analysis

The other part of this study method is DPSIR analysis. DPSIR framework (EEA, 1999) is useful in describing the relationships between the origins and consequences of environmental problems. In order to understand their dynamics, focusing on the links between DPSIR elements are necessary. Qualitative approach was applied in this analysis. As the first step, the database development is built by selecting a list of indicator for each category of the DPSIR (Pirrone et al., 2005; Kagalou et al., 2012). Secondly, semi-structured interview method with key informant applied to assess DPSIR indicator and gathering additional information (Agyemang et al., 2007). Third is summarizing and categorizing information from interviews result. The last step is providing a framework for developing models or decision support tools which can be used to evaluate and compare decision outcomes.

Semi-structured interview with key informant is conducted as a tool to collect DPSIR data assessment. Semi structured interview is the type of interview where the interviewer uses an interview guide with question that are mostly open-ended, designed to encourage the respondent to give information freely about the topic (Groenendijk & Dopheide, 2003). The interview process applied to representatives of each stakeholder group. Key informant interview was applied to gain insight on what the stakeholders perceive as outcomes. Key informant interview is needed as comparison with established causes and drivers for flooding and land use change in the study area. Eleven (11) key informants were selected including representative from farmers, Head Villages, Chief of Wedung and Mijen Sub District also official representative of Regional Disaster Management Agency. They are important respondents to understand about causes-effect of flood, land use change or encroachment activities in different perspectives.

This research applied triangulation method to assess the validity of interview results. Guion (2002) explain that triangulation is a method used by qualitative researchers to check and establish validity in their studies. In qualitative analysis it is believed that individuals (from different background and position) provide different perspectives or opinion about some issues. Therefore if each of them interprets the information in the same way (draws the same conclusions), then validity is established.

Triangulation reinforce the validity and confident of research results. Triangulation may also help to uncover the deviant or off-quadrant dimension of a phenomenon. Moreover, divergent results from multi-stakeholders (perspective) can lead to an enriched explanation of the research problem. However, triangulation needs creativity from its user ingenuity in collecting data and insightful interpretation of data (Jick, 1979).

The secondary data collection from the agencies was triangulated by looking for outcomes that are agreed upon by all stakeholder groups. The weight of evidence suggests that if every stakeholder, who is looking at the issue from different points of view, sees an outcome then it is more than likely to be a true outcome. The way to assess flood inundated area for example. The secondary data of flood inundated area from BPSDA Kudus was cross checked with the result of interview and flood tracking observation.

CHAPTER 5.

RESULT AND DISCUSSION

This chapter will present the result of research and discuss overall analysis, including analysis of land cover and land use change, flood event and encroachment activity. The other section of this chapter mainly shows the using of DPSIR element in aim to know the relation among land use, flood and encroachment activity.

Three different period of satellite image is processed to get representative band for analysis. It is important to make easier on land cover-use class determining process.

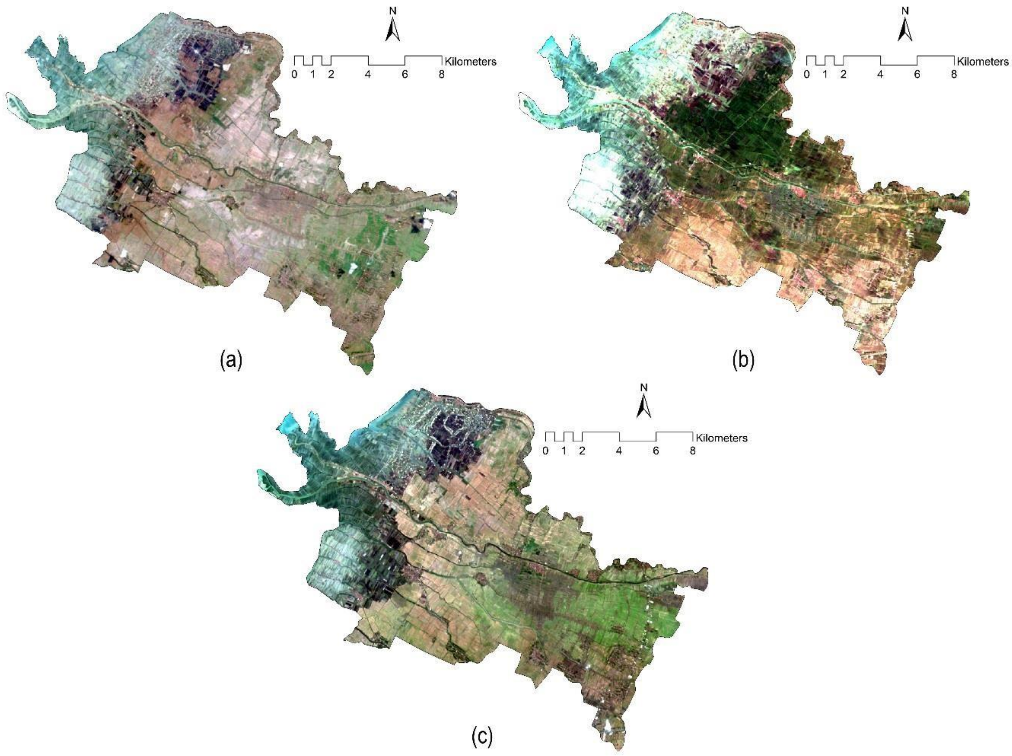

Figure 6. Landsat Images of Mijen and Wedung Sub District (a) L7 Band: 321 in 2000, (b) LE7 Band: 321 in 2009 and (c) L8 Band: 432 in 2014.

The most known human eyes composite is chosen in producing training site. It is needed for the next step to get the best classification result. After several different satellite images band trial, it is founded that the best combination is the band which has closely similar color with the reality. The combination band applied for this research is 321 for L7 and LE 7 whereas 432 for L8.

5.1. Land Cover Map 2000, 2009 and 2014

This research defined five land cover classes that could be identified from Landsat image in three different periods, which are: water body, mangrove forest, settlement, ponds and paddy field. The description for each class mentioned in the Table 3 below.

Table 3. Description of Land Cover Classes

Land Classes	Description
Paddy Field	Wet and dry land which is dominated by low level and seasonal plants
Ponds	Operational and abandoned fish and salt ponds
Mangrove Forest	Tree crown areal density in coastal area, are stock with trees capable of producing timber or other wood products, and exert an influence on the climate or water regime
Water Body	All areas within the land mass that persistently are water covered, including river, transition zone from river mouth to sea also other natural and artificial water catchment
Settlement	Residential area and socio-cultural facilities, including houses, schools, offices, public buildings and industrial areas

Supervised classification by Maximum Likelihood was applied for producing the land cover map. The result of land cover classification in three different periods could be seen in the figure 7, 8 and 9.

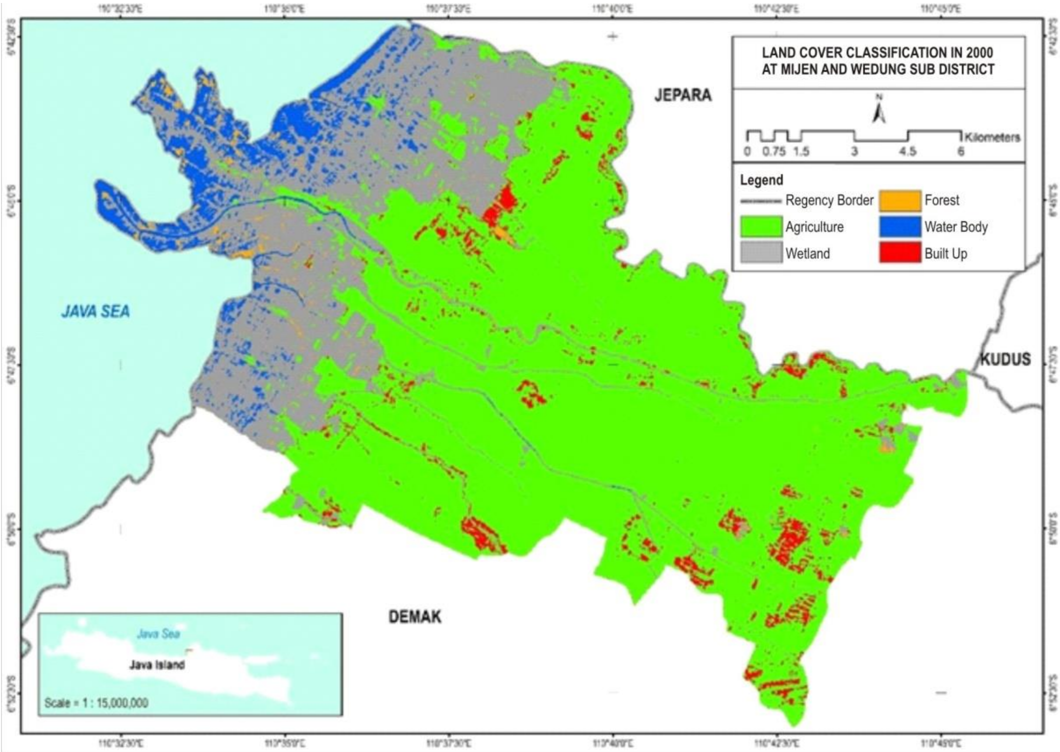

Figure 7. Map of Land Cover at Mijen and Wedung Sub District at 2000.

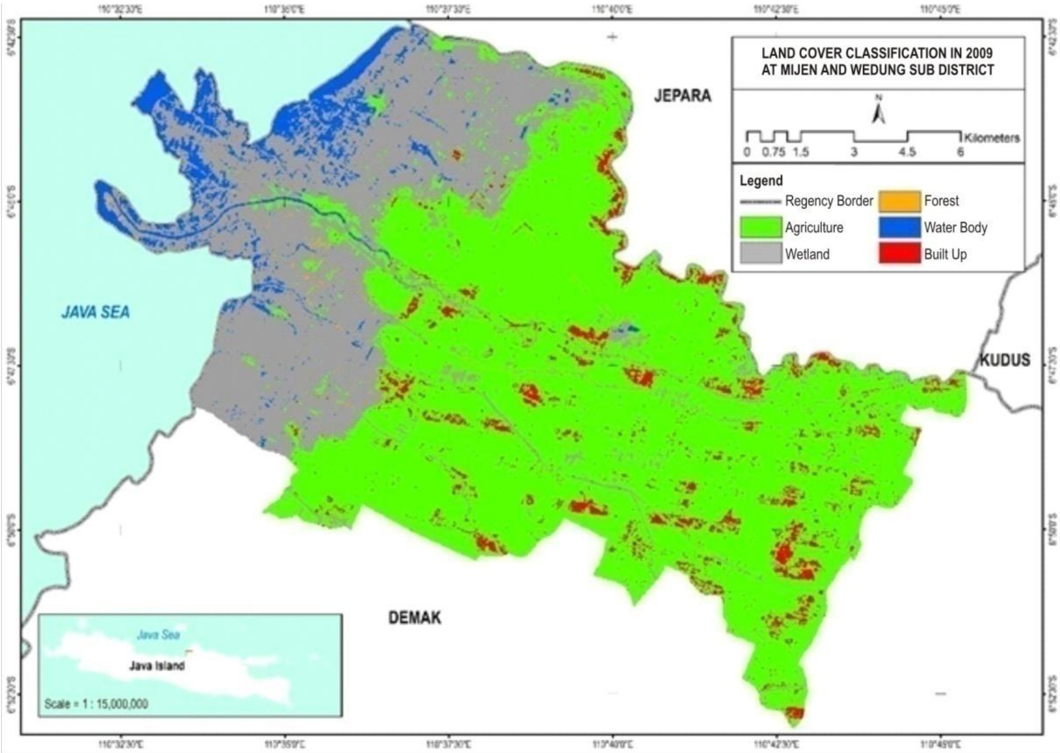

Figure 8. Map of Land Cover at Mijen and Wedung Sub District at 2009.

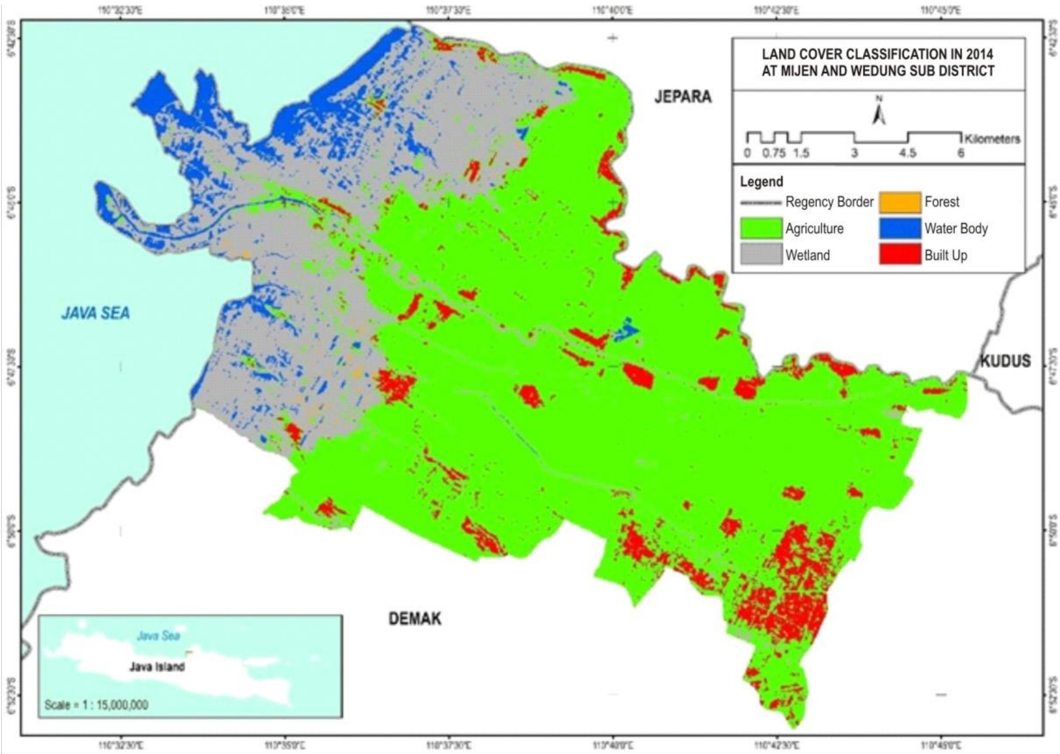

Figure 9. Map of Land Cover at Mijen and Wedung Sub District at 2014.

The three (3) previous pictures show the changes of land cover in Demak and Wedung Sub District from 2000, 2009 and 2014. Those areas were covered by four dominant land classes which are agriculture, wetland, water body and built up area. The other land class was known as forest.

Built up area was grown up respectively each period. Interestingly, they were transformed from the separated location from the first became collected settlement as known as villages/sub-villages. Most of villages/sub-villages located at along sub district bordered.

The development of built up area happened especially in along region border also on side of Serang and Wulan rivers. It was founded that this development is along with the needed of accessibility especially road. Along region border with Jepara and Kudus district, it was connected with regency main road. Another finding that people who lives at side of Serang and Wulan rivers most of them are farmers. They choose lived there because the accessibility to the water resources. Not only for their own living but also this water resource is primary needed for agricultural plantation such as paddy, corn, water guava etc.

Unfortunately, the development of built up area in 2009 is not clearly showed. It is caused by quality of satellite image was not clearly enough, although it is the best image from that period. Several part of the Landsat image in 2009 get refraction and color distortion. The alternative solution to understand the increasing of built up area is detected (counted) the number and total settlement classes.

The development of wetland rise significantly. It is know from the three previous maps where map in 2000 shows that the wetland class area is rare in some region and it completed in the next periods (2009 and 2014). Some green area (agriculture) is also changed into wetland in 2009 and 2014 periods.

Meanwhile, forest exists on along north coast of Wedung sub district in map of 2000. The numbers become smaller and almost disappear in 2009 and 2014. It happens because some of them were transformed into wetland (such as ponds) and influenced by tidal flow also abrasion from Java Sea.

5.2. Land Cover Change Analysis

The land cover change analysis considered pixel calculation for each class. The calculation of land cover changes is done by matrix (pixel) analysis of Maximum Likelihood. The patterns of land cover change over time are presented in table 4.

Table 4. The Matrix of Land Cover Change from 2000 to 2014

Land Cover	**Land Cover (Ha)**			**Change (Ha)**	**Percentage**
	2000	**2009**	**2014**	**(2000-2014)**	**(%)**
Agriculture	9854	9189	9304	-550	-5.58
Wetland	3735	4402	3802	67	1.79
Forest	90	46	19	-71	-78.89
Water Body	732	651	817	85	11.61
Built Up	494	618	963	469	94.94
Total	14905	14906	14905		

Based on the land cover change matrix above; it is known that forest and agriculture area have tendency in decreasing. Meanwhile, built up area always increase significantly over time. Built up area dramatically transformed almost double from 2000-2014 with annual change is 6.78%. The smallest changing happened to wetland which is altered 1.79% in 14 years. Agriculture area descended amount 550 Ha from 2000 to 2014. On contrary, wetland falls almost 78% in along 14 years.

The interesting thing is both agriculture and wetland has similar trend on different way. From 2000-2009, agriculture area lost around 665 Ha. Just the opposite, wetland class rises in similar number. This condition is supported by the fact that many land owners in Mijen and Wedung sub district changed their land become ponds. They believe that ponds are more beneficial than agriculture productions.

The detail changing process of each land use class was detected by post classification analysis. Post classification analysis is applied by using cross tabulation module. This research quantified three different period of land cover change (2000, 2009 and 2014).

The calculation of cross tabulation five land cover classes at 2000 to 2009 was indicated the number of wetland and built up area were moved up. Both majorities are supported from agriculture transformation. Around 1,200 Ha area of agriculture was transformed into other land classes especially wetland (743 Ha) and settlement (473 Ha). The biggest changing happened to agriculture area. Around 1,200 Ha area of agriculture was changed into other land cover classes especially wetland (743 Ha) and built up (473 Ha).

Cross tabulation in 2009-2014 describe that built up continuing rise (963 Ha). Forest becomes smaller which leave only 19 Ha. This tabulation also has different pattern than 2000-2009 period before where agriculture and water body increase. Meanwhile, wetland area is down to be 3,802 Ha.

The increasing of water body is caused by abrasion. It can be detected from the previous land cover map. The figure 7 shows that there is any addition of water body classes in a long of coastal area. There is strong evidence where a lot of wetlands (ponds area in this case) near Java Sea have been leave by the owner because the effect of tidal flow becomes higher.

In 2000-2014, as much 750 Ha of agriculture area changes into built up to fulfill human needed of house, office and other commercial building. At the same period, most of forest transforms into wetland and water body. Abrasion has significant role to change wetland into water area. As much 331 Ha wetland area is already transformed into water body. Kesbanglinmas (2007) in their report stated that from 12.5 km coast length in Wedung sub district, 5.5 km of them is hit by abrasion. In addition, ponds area which is affected by abrasion is 175 Ha.

5.3. Land Use Map 2014

Land use map was constructed from existing land use map from BAPPEDA (2009) and land cover map in 2014. Anderson's classification is considered to define the classes and nomenclature. The result of this process is illustrated in Figure 10.

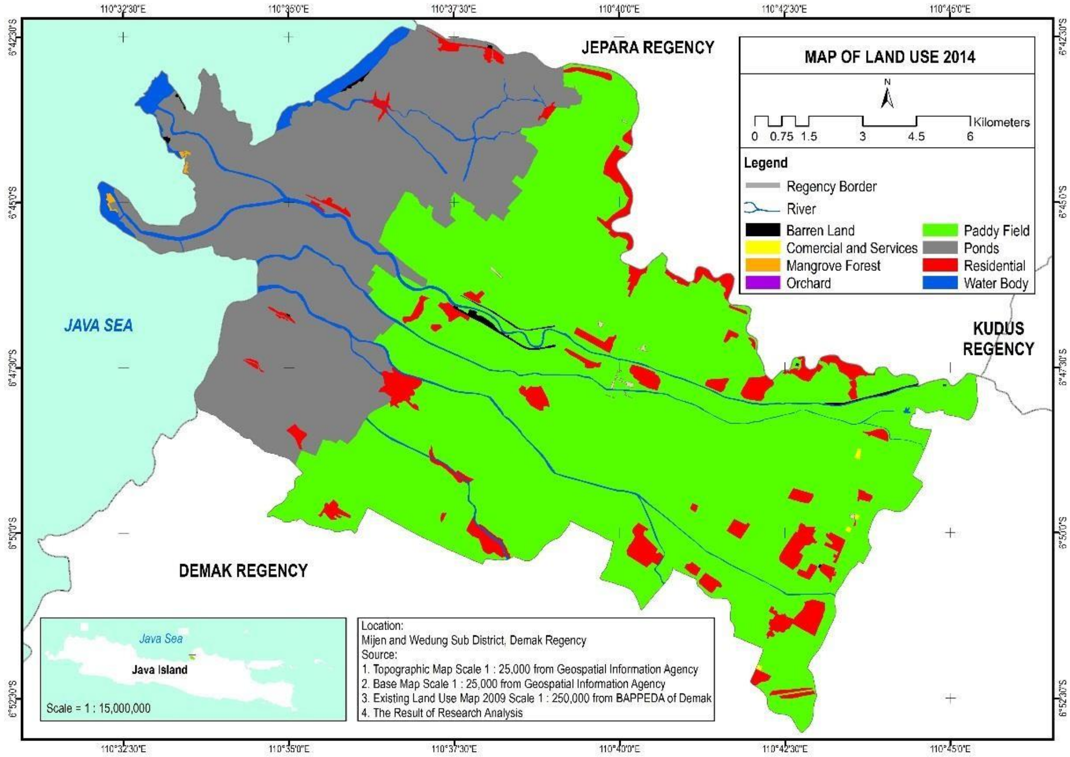

Figure 10. Land Use Map of Mijen and Wedung Sub District in 2014

Land use map is important for understanding how people tendency to use their land properly. In addition, this map is needed to describe and estimate the total losses of flood disaster.

The land use map of 2014 actually is a derivation from land cover map of 2014 as main source. Several classes of land cover are breakdown into land classes. Built up area is divided into residential and commercial & services. Orchad and paddy field is derivation from agriculture. Meanwhile, mangrove is the only kind of forest area in Mijen and Wedung sub district. The wetland utilization in Mijen and Wedung sub district is used for pond areas.

This research realizes that there is a little bit different of land cover and land use map in 2014 especially on settlement class. It happens because land cover map is assessed with the higher resolution satellite image such as Aster from Google Map; meanwhile land use need more detail verification by ground truth. The total point for verification of land cover and land use map is also different. About 70 sample points was applied for land cover map verification and 124 sample points taken for ground truth of land use map of 2014. Land cover map is constructed from pixels (likelihood) approach whereas land use is developed considering also from field reality. Overall, the location of each land use has no different with the land cover map of 2014.

Mijen and Wedung sub district consist of 8 (eight) land use classes which are barren land, commercial and services, mangrove forest, orchard, paddy field, ponds, residential and water body. The total area of each land use class is showed in the table 5.

Table 5. Total Area Each Land Use Class

No	Land Use Class	Total Area (Ha)
1	Barren Land	44
2	Commercial and Services	6
3	Mangrove Forest	9
4	Orchard	12
5	Paddy Field	9017
6	Pond	4524
7	Residential	802
8	Water Body	491
	Total	***14,905***

The table shows that the biggest area of Mijen and Wedung sub district is paddy field (9,017 Ha) followed by ponds with 4,524 Ha. It is appropriate with the statistic data that most of Mijen and Wedung sub district people depend on agricultural area and worked as farmers. The smallest area is commercial and services (6 Ha) because in both sub district are lack of company or industry built there. Mangrove forest also limited with 9 Ha only. The observation shows mangrove area only located in certain region near Java Sea especially at Berahan Wetan. Meanwhile along coast of Kedungkarang and Kedungmutih, there is limited mangrove plantation with spread individually.

5.4. Accuracy Assessment of Land Use Classification

This research was conducted the ground truth checking for accuracy assessment of land use classes. This method applied 124 sample points which are selected by stratified random sampling (Figure 11).

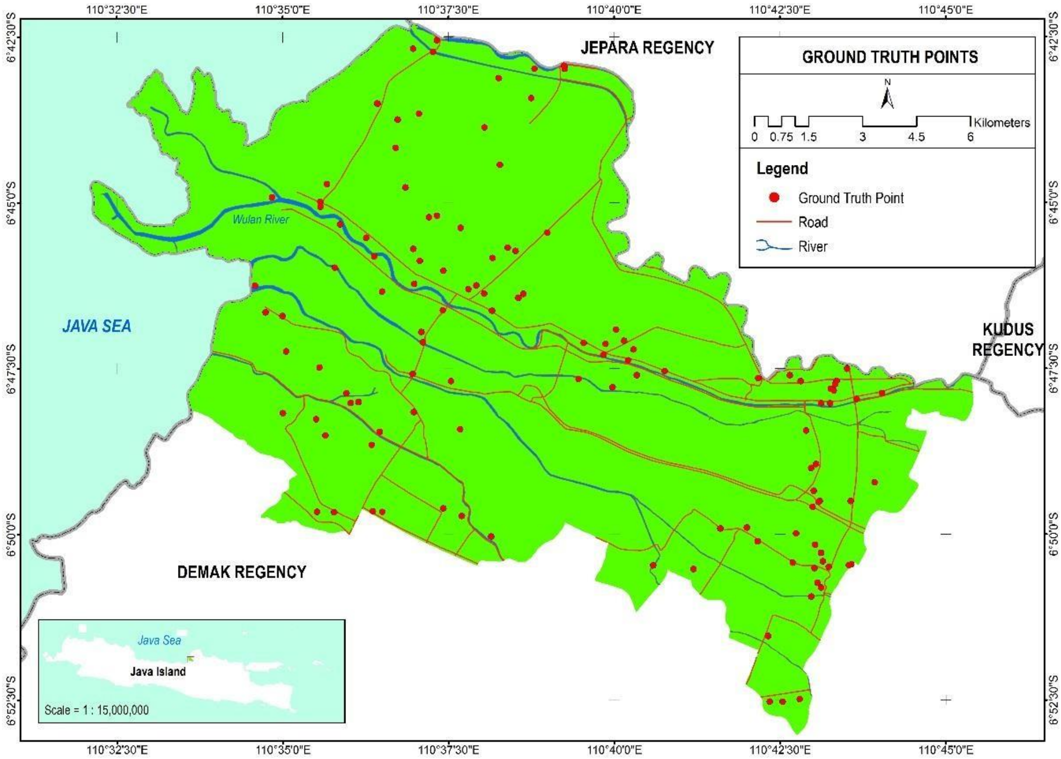

Figure 11. Map of Ground Truth Point

From the calculation, the highest producer accuracy is ponds with 89.47% followed by paddy field (89.36%) and residential (76.19%). The accuracy value indicates that ponds are the highest probability of a reference site being correctly classified. The lowest accuracy is water body with 42.86% followed by mangrove forest and orchard both in the same value with 50%.

Based on the user accuracy, residential becomes the most accurate reach to 84.21%. Almost reach similar value is paddy field with exactly 84% accuracy. This value implies that pixel on the map is implied on the field. Meanwhile, the weakest user accuracy is mangrove forest (50%). Mangrove forest become the most difficult area to be found in field because the area is very limited and most of the location is took place at outer research area.

The result of overall accuracy assessment is 78.23%. It implies that 78.23% of the classification result matches with the reference data. The tabulation of assessment is described on the table 6 below.

Table 6. Accuracy assessment of land use classification 2014.

CLASS	BL	CS	MF	OR	PF	PO	RS	WB	Total	User Accuracy
BL	9	0	0	0	2	1	0	0	12	75.00
CS	0	6	0	0	0	0	5	0	11	54.55
MF	1	0	1	0	0	0	0	0	2	50.00
OR	0	0	0	3	2	0	0	0	5	60.00
PF	2	0	0	3	42	1	0	2	50	84.00
PO	2	0	0	0	0	17	0	2	21	80.95
RS	0	2	0	0	1	0	16	0	19	84.21
WB	0	0	1	0	0	0	0	3	4	75.00
Total	14	8	2	6	47	19	21	7	124	
Producer Accuracy	64.29	75.00	50.00	50.00	89.36	89.47	76.19	42.86		
Overall Accuracy	78.23									

Classification :

BL	=	Barren Land	PF	=	Paddy Field
CS	=	Commercial and Services	PO	=	Ponds
MF	=	Mangrove Forest	RS	=	Residential
OR	=	Orchid	WB	=	Water Body

5.5. Flood Events

From interview result and secondary data collection, Mijen and Wedung sub district were hit flood four times in period 2000-2014. In 2002, river flood happened in Kedungkarang, Tedunan, Kedung Mutih, Babalan, Kendal Asem, Mutih Wetan and Mutih Kulon. In January 24th, 2006, flood localized at Jleper, Ngelokulon, Pasir and some area in Ngegot villages. The big riverine flooding in April 2013 striked Mijen sub district (Mijen, Pecuk, Jleper, Ngelokulon, Pasir, Ngegot and Legosari) and some village in Wedung sub district

(Jungsemi, Mutih Wetan and Mutih Kulon). In early 2014, flood inundated all villages which are bordered directly with Jepara district (from Kedungkarang to Mijen village).

5.5.1. Flood Events in 2002

When flood occured in early year of 2002, Kedung Mutih and Mutih Kulon inundated not more than 50 cm. In addition, Kendal Asem, Kedung Karang and Tedunan flooded around 50-70 cm.

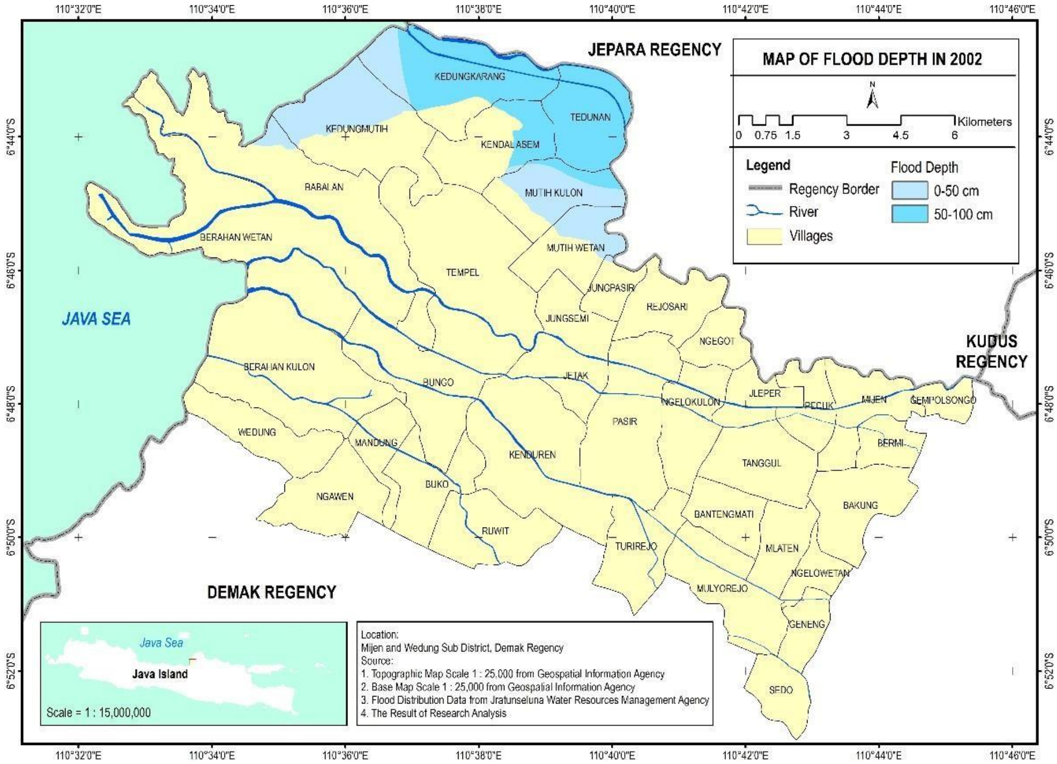

Figure 12. Map of Flood Depth in 2002

Flood attacked most of north area in Wedung sub district. The high intensity of rainfall resulted the water of Wulan and SWD 1 river overflow (Table 11). At the same time, the sea level raised as result of tidal flood. The amount of rainfall at Wedung sub district (Jungsemi and Bungo) is almost double than Mijen sub district. That is the reason flood in 2002 only happened in Wedung sub district.

Table 7. Rainfall Data in 2002 at Mijen and Wedung Sub District.

Rainfall Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Des	Total (mm/year)
Jungsem	710	939	205	243	32	0	0	0	14	0	187	390	2720
Bungo	604	808	227	99	0	0	0	0	0	0	17	386	2141
Mijen	185	758	155	139	43	0	0	0	0	17	131	278	1706
Bakung	169	601	43	35	42	0	0	0	0	15	118	201	1224

Source: BPSDA, 2014

5.5.2. Flood Events in 2006

In January 24th, 2006, flood happened in limited area of Mijen sub district. Almost similar with flood in 2002, this disaster event was caused by high intensity of rainfall. It shows in the Table 12. From the interview result, it is known that flood in 2006 occurred was supported by ineffective irrigation and the crowded of settlement.

Table 8. Rainfall Data in 2006 at Mijen and Wedung Sub District.

Rainfall Station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Des	Total (mm/year)
Jungsemi	1048	402	366	295	0	0	0	0	0	0	0	0	2111
Bungo	755	339	300	137	0	0	0	0	0	0	0	0	1531
Mijen	1142	264	405	193	0	0	0	0	0	0	0	0	2004
Bakung	605	44	71	70	0	0	0	0	0	0	0	0	790

Source: BPSDA, 2014

This flood was localized at certain villages because the dam building can work well to channel the river water to the sea. Some part of Jleper, Ngegot, Ngelokulon and Pasir village was inundated by flood. The depth of flood in 2006 not more than 50 cm. Red Cross Indonesia recorded that 300 households evacuated.

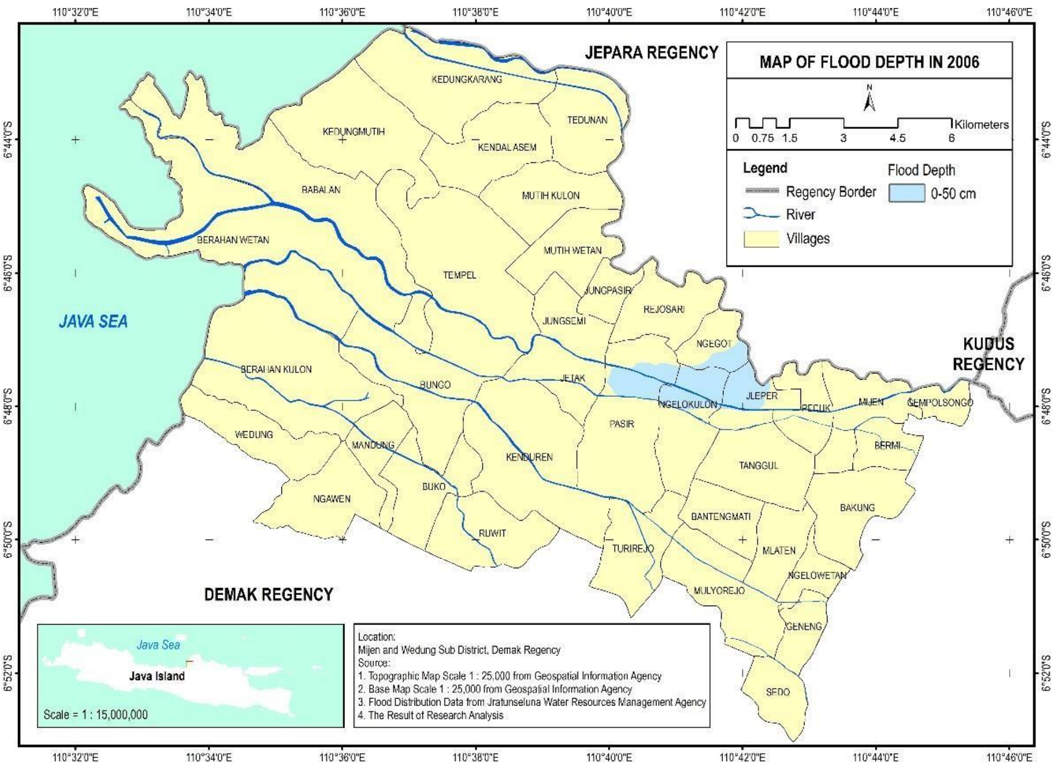

Figure 13. Map of Flood Depth in 2006

5.5.3. Flood Events in 2013

Flood event in 2013 happened on April 8th, 2013. Based on April 2013 Flood Event Report of Serang Lusi Juana Watershed Management Agency *(Balai PSDA)*, in a week, April 8th had the highest rainfall intensity.

Table 9. Rainfall Data in April 5-10th 2013 at Serang and Wulan River.

No	Rainfall Station	Rainfall at April 2013 (mm)					
		5th	6th	7th	8th	9th	10th
Serang River							
1	Sidorejo	26	98	7	38	0	42
2	Sedadi	0	77	0	66	0	26
3	S2 (Pengkol)	0	24	0	36	0	13
4	BSR 13	0	87	0	88	0	25

Wulan River							
1	Beru	0	0	0	38	0	42
2	Wilalung	0	14	0	35	0	0
3	Karanganyar	0	0	8	47	0	19
4	Mijen	0	4	16	27	0	9

Source: BPSDA, 2014

The high rainfall amount was added by the overflow from upper part as significantly increased the Wulan river rate of flow. This condition made the dike could not restrain the pressure of water river and resulted the right side of Wulan river dike at Mijen village broken down.

Figure 14. Flood hit Mijen (right) and Pecuk village (left) in early 2013 (BPBD, 2013).

This flood inundated almost all area in Mijen sub district and some part of Wedung sub district for a week. Unfortunately, not completed the dike repaired by people; in April 20th, the after flood occurred. The villagers went to take refuge area in a pinch.

In 2013, the flood had different depth each village. The highest flood event occurred in Jungsemi village with 300 cm, followed by Ngelokulon and Jungpasir which reach 200 cm deep. The flood depth in Jleper village around 100-150 cm and Mijen village is 100 cm.

Meanwhile, Pecuk village reach 80 cm depth and the shallowest is Ngegot (40 cm). The illustration of the flood event in 2013 is showed in the figure 15 below.

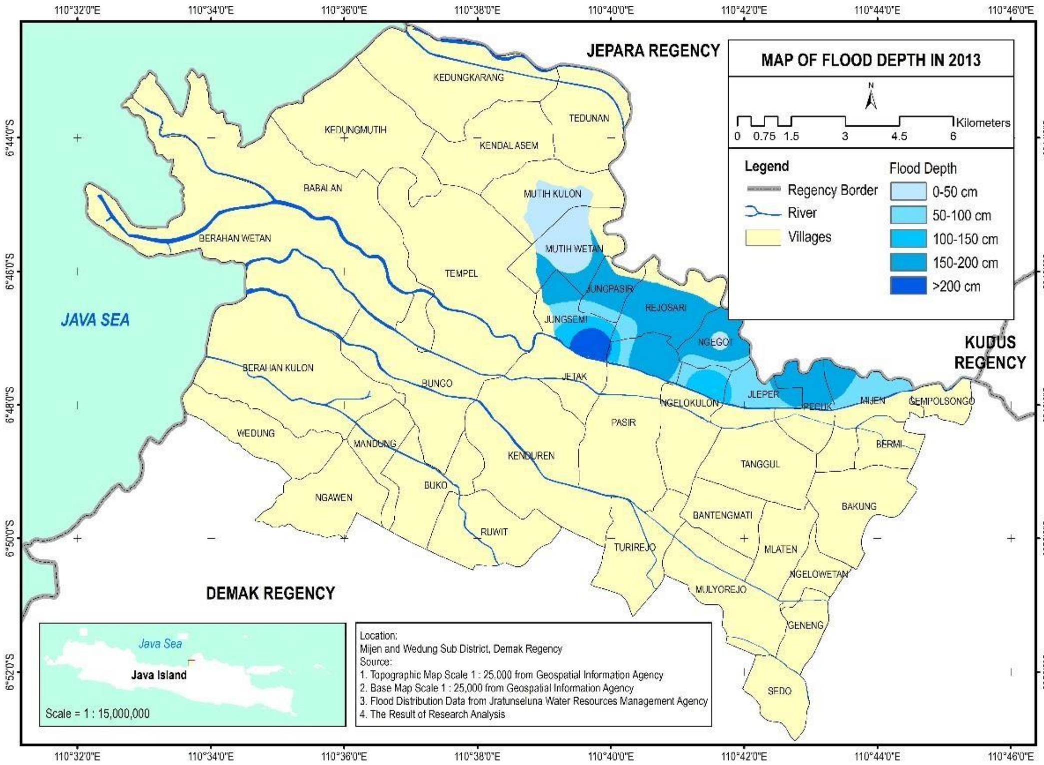

Figure 15. Map of Flood Depth in 2013

This disaster resulted losses in Mijen and Wedung sub district. It was recorded that seven villages in Mijen sub district and six villages in Wedung sub district had affected. In Mijen sub district, flood inundated 500 houses of Mijen village and about 48 Ha of agricultural field (including: paddy field age about 15 days and red onion ready for harvesting). In Pecuk village, flood was inundated 600 houses and 75 Ha of paddy field age 15 days. About 2,000 houses and 151 Ha paddy field 20 days in Jleper village was also inundated. Almost similar, 1,500 houses and 67 Ha paddy fields in Ngelo Kulon had affected. Ngegot village (50 houses and about 51 Ha of 20 day's paddy) was flooded too. In Rejosari (53 Ha paddy field age 20 day's) and Pasir village (41 Ha paddy fields) were inundated.

Meanwhile in Wedung sub district, 1,000 houses and around 151 Ha paddy field of Jetak village was inundated. Jungsemi village suffered inundation for 250 houses and 81 Ha agricultural fields. Bungo village was affected on 500 houses and 567 Ha agricultural areas. Jungpasir and Mutih Kulon village were only affected on paddy field area with 200 Ha and 480 Ha in a row. Arround 30 Ha paddy field at Mutih Kulon was also inundated by flood. All paddy plantations which are inundated by flood had 10 to 20 days old.

Overall, the total losses calculation of April 2013 flood in Mijen and Wedung sub district is 10 billion rupiah in appraisal.

5.5.4. Flood Events in 2014

Flood event in 2014 is wider than 2013. The January 2014 flood event was caused by SWD River could not intercept run off from the upper part. As the result, 11 villages were almost inundated by flood for a week.

Figure 16. Flood 2004 hit Pecuk (right) and Mijen (left) village (BPBD, 2014).

Mutih Wetan village inundated until 270 cm. In Mijen, the deepness of the flood is around 220 cm. Mutih Kulon and Jungpasir had flood depth around 140-180 cm. Tedunan and Kendal Asem was inundated until 100 cm deep. Meantime, flood in Kedungkarang and Ngegot reached around 90-100 cm.

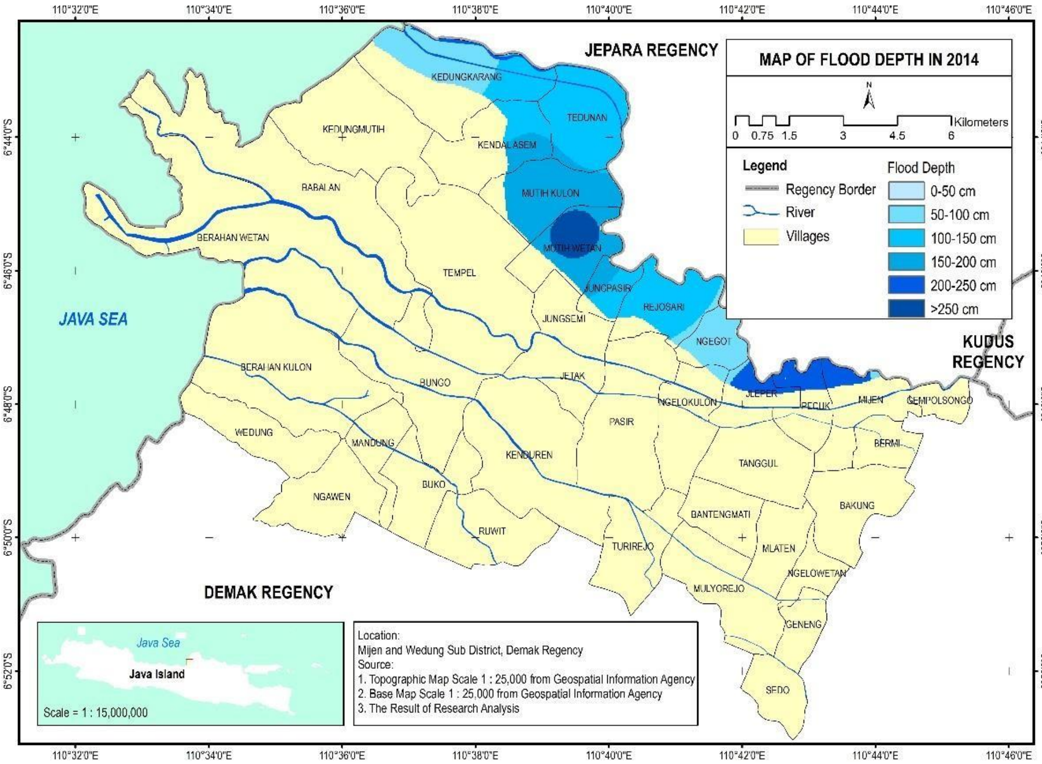

Figure 17. Map of Flood Depth in 2014

Based on Damage and Losses Assessment Report by BPBD Demak Regency in 2014; in Mijen sub district, flood at January 2014 inundated permanent and semi-permanent resident in Pecuk, Jleper and Ngegot village. In agricultural sector, this flood made damage on paddy field plantation in Mijen 113 Ha, Pecuk 26 Ha, Jleper 23 Ha, Ngelokulon 42 Ha, Pasir 74 Ha, Rejosari 51 Ha, Ngegot 8 Ha, Bermi 28 Ha and Gempolsongo 21 Ha. Orchard plantation (including corn, sweet potato and red onion) around 38 Ha which is separated in Mijen, Pecuk, Jleper, Bermi and Gempolsongo village were inundated too. The total losses in Mijen sub district was calculated about 7.3 billion rupiahs.

Meanwhile in Wedung sub district, semi-resident permanent at Kendalasem, Kedungkarang, Mutih Kulon, Mutih Wetan and Tedunan village was inundated by flood. As much 210 Ha paddy field at Tedunan, Kendalasem (128 Ha), Mutih Kulon (300 Ha), Mutih Wetan (403 Ha) and Jungpasir (229 Ha). In addition, ponds area (including salt, fish and shrimp) in Tedunan, Kedungkarang and Kendal Asem was affected by flood. The amount of damage and loses caused this disaster is 8.2 billion rupiahs.

Although Mijen and Wedung sub district located on relatively flat area, the depth of inundated area was various. The distribution of flood water depth is showed in the figure 9. The depth of flood in 2002 was not more than 1 meter whereas in 2006 became smaller to be less than 50 cm. Flood event in 2013 reached until arround 2 meters. Flood event in 2014 was the biggest with the water depth reach more than 2.5 meters.

From the four flood events (2000, 2006, 2009 and 2014) data, it is known that flood disaster is influenced by the amount of rainfall. *World Meteorological Organization* (WMO) is classified the rainfall intensity into five groups. It is applied also by Meteorological and Geophysics Agency of Indonesia.

Tabel 10. Classification of rainfall amount based on WMO International Standard.

Criteria	**Rainfall Intensity**	
	(mm/day)	**(mm/month)**
Very Light	< 5.0	10-15
Light	5.0 – 20	70-85
Normal	20 – 50	250-295
Heavy	50 – 100	400-500
Very Heavy	> 100	510-845

The previous rainfall data shows that Mijen and Wedung sub district classified as heavy – very heavy rainfall intensity. The collapse of the dike is the result of the high intensity of rainfall which cannot accommodated by river banks or outlet tunnels. Tidal flow is another supporting factor of flood that can happen, flood 2002 in mention.

Agricultural sector is the most impacted from previous flood disaster. Not only causes of plantation destruction but also economic losses after harvesting period.

5.6. Land Use Affected by Flood

In April 2013, flood inundated Mijen and Wedung sub district which extent about 2,171 Ha. The five classes affected flood which are barren land (12 Ha), orchard (4 Ha), paddy field (1,965 Ha), residential (188 Ha) and water body (2 Ha). Meanwhile, six land use classes are affected by flood in January 2014 especially near Jepara district. The total area affected is 3,052 Ha which is divided into barren land (2 Ha), orchard (2 Ha), paddy field (2,070 Ha), pond (636 Ha), residential (315 Ha) and water body (27 Ha). The illustration is showed in Figure 18 and 19.

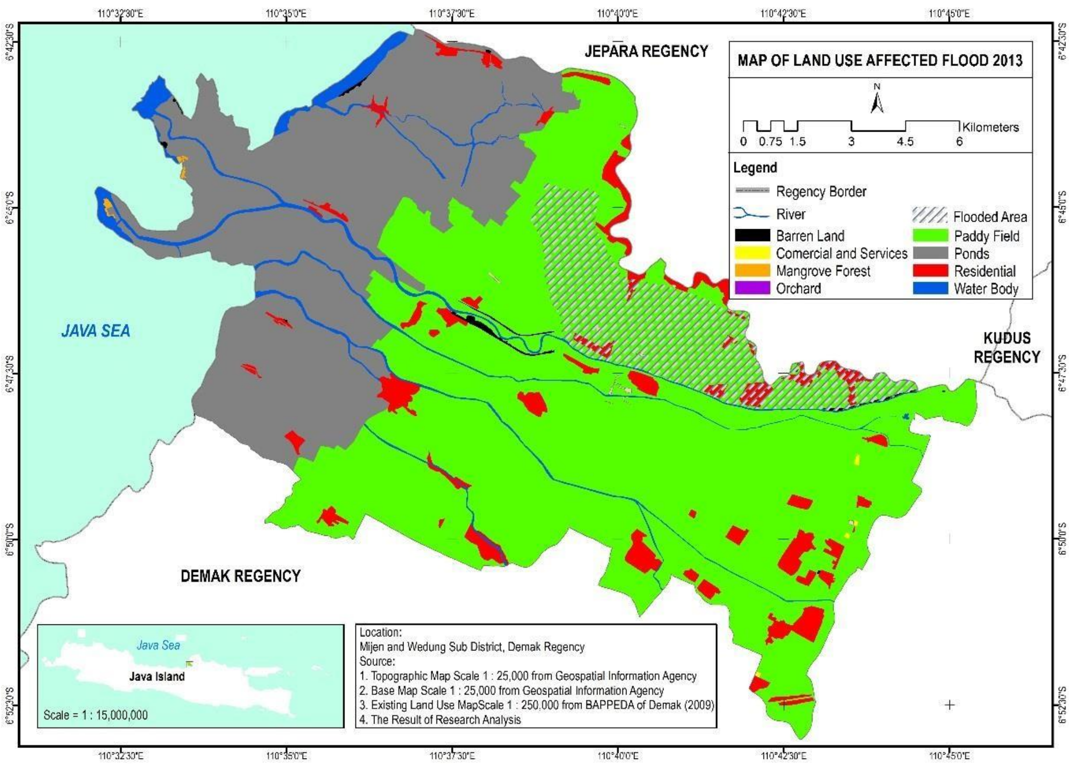

Figure 18. Map of Land Use Affected by Flood in April 2013 at Mijen and Wedung Sub District.

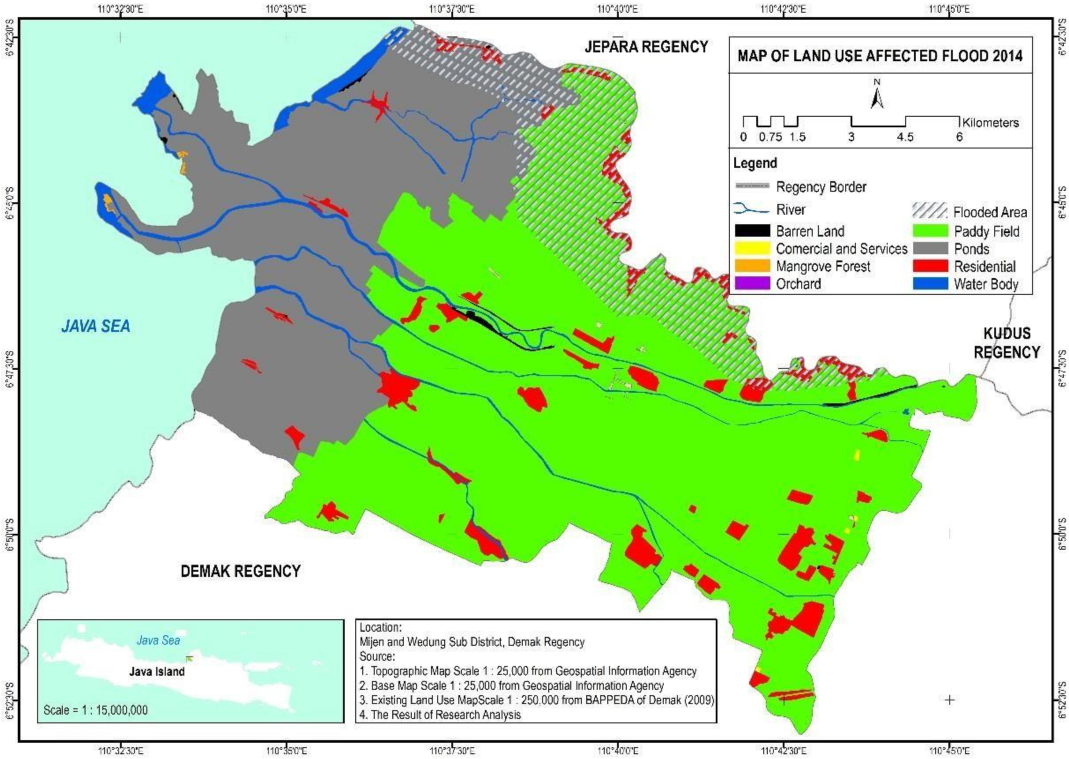

Figure 19. Map of Land Use Affected by Flood in January 2014 at Mijen and Wedung Sub District.

Although the affected flood area in 2014 only one a half of 2013, the amount of damage and loses is double. The maps indicate that ponds and residential have significant contribution in damage and losses calculation. BPBD (2014) recorded the total losses from ponds is almost 6.3 billion rupiahs.

Paddy field, ponds and settlement is the major land use system which is affected directly from riverine flooding. Although flood always happens in rainy season (October to March) but people cannot predict when it comes. On the other hand, along rainy season it is period for paddy production (seedling-planting-harvesting). This condition causes many losses in agricultural during planting time (such as flood in 2014) or harvesting time (such as flood in 2013).

In planting period (1-25 days paddy field), flood fully inundated the paddy plantation. Beside the roots is not strength enough, the height of plantation are still short. In the mean time during harvesting period, people will spread out their paddy harvesting (grains) in the sun to dry. The other keeps their harvest inside the house. In farms, paddies have fully seed and ready to cut. The flood disaster inundated the plant and farmer failed to harvest. Inside the house, many un-rescue sacks of grains were inundated by flood. Although it not makes farmers losses their entire grains but the flood fails the paddy seed quality. Economically, the farmers suffer financial losses. Meanwhile, many fishermen have losses their fish or shrimp because the flood sweeps away their ponds.

Figure 20. Agricultural losses which caused by flood (BPBD, 2014).

From the interview result it is known that many farmers have to cut their paddy plantation early before optimum harvesting period to avoid other losses. The others, perforce to sell their grains as soon as possible with low price before fall into decay.

Interestingly, only a few farmers who have intention to change land use activities. Most of the key informants inform that although flood happens more intense especially in 2013 and 2014, the farmer activities will continue as usual. It is caused several factors:

a. Land ownership is a legacy from their ancestor. Most of traditional Javanese people have custom bequeath their own land to their next generation or family. They never sale or change their land if there is no insist (emergency) condition.

b. Most of the people in Mijen and Wedung sub district only have single occupation as farmer or fishermen. Their only have skill and knowledge on agricultural and marine sectors. It confines their ability to find better livelihood.

c. The flood effect did not reduce the farmland productivity. The farmers could plant their farm land after flood end. Some farmers even stated that flood increase land productivity and fertility. Flood sweep the residue of pesticide and pest. Moreover it will return the degree of soil acid/alkali (pH) into normal level.

After two previous floods in a series, people in Mijen and Wedung sub district try to find better solution to reduce the agricultural losses. They are looking for new paddy seed that can grow higher in the beginning planting period. By this choosing, the paddy plants still can grow up after flood because it not fully inundated.

The change of land activities in agriculture sector is some of farmer moved to plant water guava. Although it needed more financial capital in the beginning but in the end the productivity is continue and without extra maintenance. The sale value of this fruit is high. As hard wood plantation, water guava is not affected by flood. This is the reason some of paddy field class transform into orchard area.

5.7. Encroachment Area

Although not in satisfactory level, this research successfully detected several encroachment activities in study area. It found that encroachment area is difficult to be detected by using Landsat images because:

a. Detecting encroachment needs large covered area. At least 30 x 30 m is needed as representative one pixel on Landsat image.

b. The resemblance of pixel should be carefully and clearly differentiated. Low resolution satellite image needed extra concentration, experience and local knowledge to decide encroachment area or not. It also effected many encroachment pixel have similar representation with other pixel classes (e.g. color, roughness etc.).

c. It founded that encroachments happen not in massive way because there are still many legal land ownership to be developed. The interview revealed that each farmer at least has one fourth hectares of legal land ownership.

d. Moreover, 14 years period analysis is less adequate time for detecting encroachment at rural area. Some researches which have similar aim to identify encroachment activity have longer period data analysis. They applied 40 years range periods data (1960-2000) to identify informal occupation in city of Cuiaba´, Brazil (Zeilhofer & Piazza Topanotti, 2008). Tavares et al., (2012) analyzed a half century data of occupation activity in peri-urban area.

In purpose to get the trusting encroachment area indication, this research combined the result of visual interpretation analysis of Landsat images with interview and field observation result. The indication of encroachment activity was known by the result of land cover change analysis. The significant fall of mangrove forest and the double growth up of settlement can be indicator the probability of land encroachment activities.

Another indication is the development of riparian area. Based on President Regulation No. 38 Year 2011 about River, river corridor is one of river structures. River corridor has aimed as buffer zone between river and land ecosystem so the river function and human activity not be disturbed each other. As two of main rivers in the North Coast of Java, Wulan and Serang rivers has minimum 15 meters of corridor along right and left side of the river. The consequence is the development not allowed there. Unfortunately, this research found some development activities in river corridor.

Overall, the total encroachment area is about 8 Hectares (Ha). It shows that encroachment activity happened only in small scale at the research area.

Encroachment activities occurred on mangrove and riparian area. The evidence strongly showed that most of mangrove forest transformed into ponds area. In addition, settlement development take place in riparian area especially Wulan and Serang river. The illustration shows on figure 21.

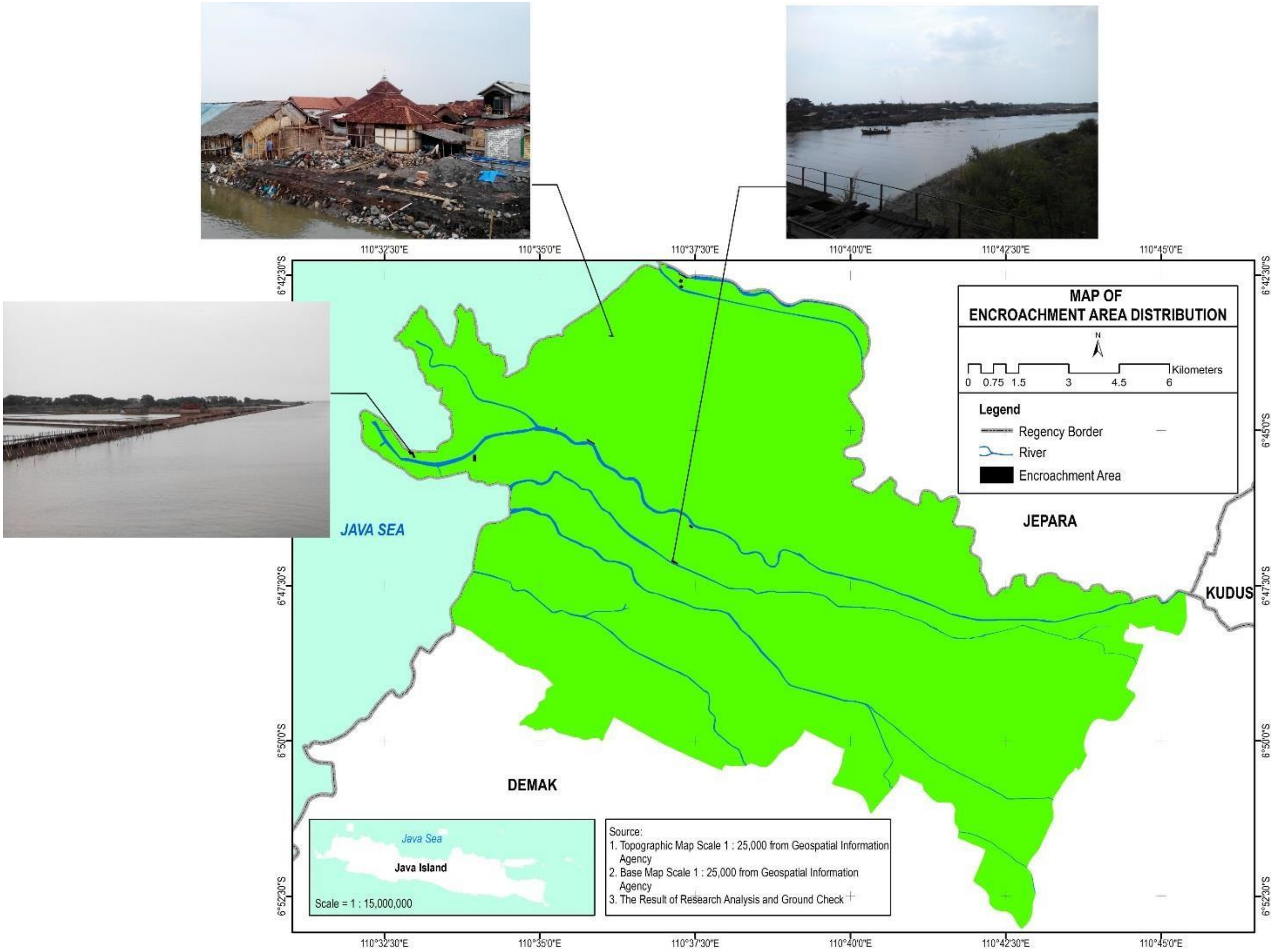

Figure 21. Map of Encroachment Area Distribution

The right picture of previous map shows the existing of settlement along Wulan River at Babalan village. On the left, the picture describes the development of permanent and semi-permanent houses near canal at Kedung Mutih village. The rocks and sand already drooped for the beginning of construction phase. The left picture of the map shows the ponds area. People expropriated the mangrove forest and changed it into ponds. The remaining mangrove forest only left on the top of the Wulan river that abutted on sea.

5.8. Cause Effect of Riverine Flooding

A qualitative technique by using key informant interview is applied to understand the component and relation between it. Descriptive analyze were used to analyze the data gathered from agency reports and interviews result.

Driving Force and Pressure

Each key informant has different opinion about the main driver of flood hazard. However, most of them stated that high intensity of rain fall and the collapse of dikes is the main driver of flood. It is supported by informant statement.

"This disaster happened is caused the high intensity of rainfall, shallowness of river, and the fragile of soil structure. Human factor can be another cause too. Several people plant on the dike area with grass may be it can reduce the sturdiness of the dike." (Informant 8, Mijen Sub District)

Figure 22. Critical dike condition (Mijen Sub District Documentation, 2013).

"The rainfall is huge. Human factor also has important role in flooding. Undisciplined behavior, you can see in front, they build settlement in irrigation area. It should be not allowed." (Informant 7, Wedung Sub District)

State

State defines as the conditions of the environment. *Conditions* here mean the level of physical, biological, chemical phenomena in time and space (quality and or quantity). Demak regency (including Mijen and Wedung sub district) is the lowest part of Jratun-Seluna Watershed. Mijen and Wedung area is one of the final outlets of watercourse to Java Sea. The probability of flooding disaster is always there especially from the river and high sea water. This probability will be higher if the rainfall intensity bigger too.

"Flood in 2002 happened caused by sent flood from the upper part. Meanwhile, high sea water occurred in the same time. So the overflow from the river detained by sea water and finally inundated most of coastal region in Wedung sub district including Babalan, Kedung Mutih, Kedung Karang, Tedunan, Kendalasem, Mutih Kulon and Mutih Wetan villages." (Informant 7, Wedung Sub District)

Impact

Mijen and Wedung flooding disaster especially in 2013 and 2014 resulted high economic loses. Based on the report (BPSDA, 2014), as much 6,400 houses are inundated by flood. In agricultural sector, most of paddy seedlings 15-25 days in north side of Wulan River are inundated. The total loses from 2013 flooding is 10 billion rupiah appraisal. It is supported by the informants.

"We already plant the seed around 15 days before and when the flood coming, we got nothing. We could not see the farm, even the seed because all inundated by flood." (Informant 4, Pecuk Village*)*

"In 2014, the flood inundated all region in Kedung Mutih where more east the area the flood became deeper. At the village office, the flood level was around 50 cm, the other reach to 1.5 meter." (Informant 6, Kedung Mutih Village)

BPBD of Demak Regency also calculated that flood in 2014 caused damage and loses as much 15.5 billion rupiahs. In addition, their occupation is disturbed for a while because most of them is a farmer. Most of them have to wait until the flood move away.

Figure 23. Flood refuges condition (Mijen Sub District Documentation, 2013).

Beside economical loses, psychological aspect of people is disturbed too. "*People became traumatic after flood 2013.*" *(Informant 1, BPBD) Informant 8 (Mijen Sub District)* said that:

"After flood disaster in 2013, some people felt trauma. It can be understood because it is the first big disaster in this region. Even when they stayed in refuge, they still asked and worry if the continuation flood would be happened."

Generally, the impact of riverine flooding in Mijen and Wedung sub district divide into tangible and intangible loses.

1. Tangible Loses
    - Agricultural production
    - Crops
    - Income
    - Residential Damage
2. Intangible Loses
    - Psychological trauma

Response

People and local government responded the flood disaster in two way which are directly respond (short term) and future respond (long term).

"The Sub District office coordinates with District government, Regional Disaster Management Agency (BPBD) and Red Cross Indonesia (PMI) directly. We decide to build refuge shelter. To build general kitchen was helped by District Military Army (KODIM). The most important is the existing of the logistic. Meantime, the District government supported with rice." (Informant 8, Mijen Sub District)

Meanwhile, people prepare several ways to anticipate next flood disaster.

"After flood disaster, people make prop pillar 'anjang' to place the goods when the flood coming. Government also made Emergency Response Team (TRC 'Joko Tingkir') to prevent disater" Informant 8 (Mijen Sub District)

Interestingly, land farmer and owner had no action to solve the flood in their farm land.

"We could not do anything to our farmland. We busy moved our crops harvesting to the safe area. The farmland will be OK because the flood water did not bring much mud." (Informant 5, Pecuk Village)

"Not mean we hope the flood coming but the flood water good for farmland. It cleans the farmland. The pest disappear, the plant become fertile, pH soil usually 5.3 increased to 7." (Informant 3, Pecuk Village)

Figure 24. Health (right) and general kitchen post (left) in flood emergency period (BPBD, 2014).

In short term people and government responded the flood disaster by built the general kitchen and refuge shelter. People also bring their good (that they could save from flood) to the higher places. The local government also actively invents and provides the people needed also coordinated with higher level government (BPBD, District and Central Java Province Government).

After flood disaster in 2013 and 2014, some people built prop pillar above or beside the house ‘anjang’ to place their goods and harvest when the flood coming. Emergency Response Team was set up, socialization and training of disaster management also provided to the people.

Figure 25. Crops storage “Anjang” of Mijen villagers (Field Work, 2014).

Overall, based on interview result the response indicators consist of three types which are:

a. Technical Response

   Technical response is applied by repairing and develop building which is can reduce or prevent the flood disaster. This response included rebuilds the dike and dredging the river sediment.

b. Local Knowledge Response

   This response came from society where they used their knowledge and natural resources there to solve the problem. Prop pillar building "*anjang*", paddy seed and other plantation selection became an example response from local people. It is important in aim to reduce the losses on agricultural sectors.

c. Policy Response

   Several police was proposed to avoid flood disaster in future such as Emergency Response Team formation, disaster management training and hazard destruction assessment by BPBD of Demak Regency, proposal of watergate operation mechanism by Water Resources Management Agency etc.

The detail list of DPSIR element and the indicator of flood are showed in the figure 26.

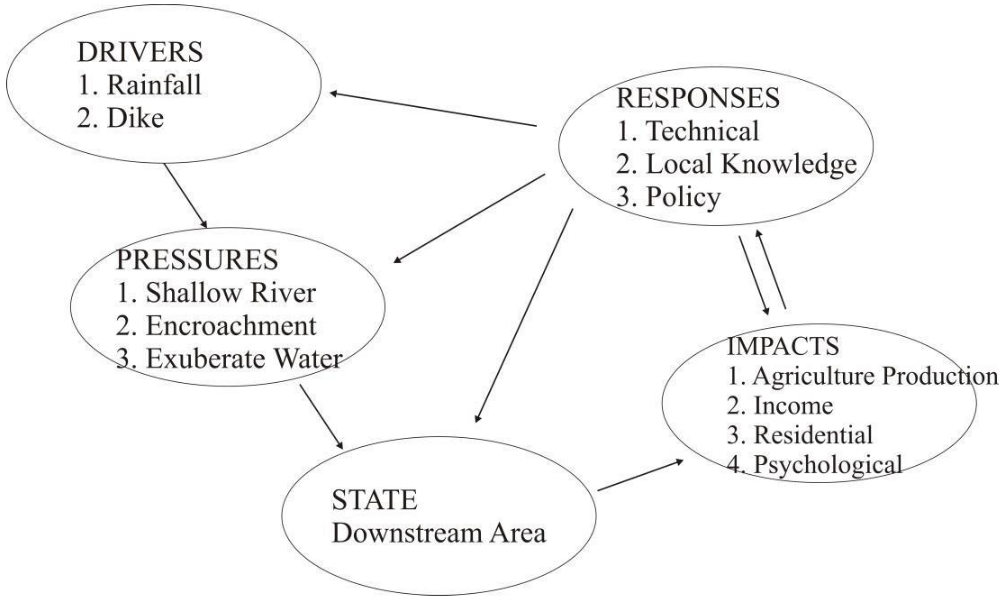

Figure 26. List of DPSIR Indicator of Flood in Mijen and Wedung Sub District (Source: Interview Result, 2014)

5.9. The Relation among Land Use Change, Encroachment and Flood

The analysis result shows that in downstream area (Mijen and Wedung sub district), land use change does not directly influence the flood event. Most of flood events at Mijen and Wedung sub district are caused by meteorological (high intensity of rainfall) and technical factor (collapse of the dike). WMO-GWP (2007) explain that rainfall include as meteorological factor contributing to flooding despite land use change and occupation of the flood plain as human factors.

On the other side, land encroachment at Mijen and Wedung sub district has tendency contribute on development of flood hazard. The indication shows encroachment happened in research area especially at riparian (river conservation) site. It was strength by interview result. *Informant 3 (Farmer Association)* stated that:

“A lot of illegal buildings are raised upper the dike. It happened without permission whereas the owner of that land is Public Worker Agency. Most of them are used for trade activity, for instance food stall and onion storehouse.”

Mangrove forest losses, illegal settlement and development at riparian area reduce the river body and decrease the water catchment capacity. As a consequence, if the heavy rainfall happens, the river cannot accommodate the amount of water (overflow). Other research also supports it. Sukardi et all., (2013) stated that the increasing of the population affects the more residential areas are required especially at watersheds and riversides. This condition results the changes of land use and causes an increase of the discharge from the land during rainy season because of the covering of land surface and decrease of discharge during dry season.

However, people in Mijen and Wedung sub district tend to stay permanently in their region. They prefer cope the flood disaster, rather than find new save area outside their region.

"There is no will from people to leave their village after flood happened. That region has been their ancestor legacy and main of support." (Informant 1, BPBD)

"There are several household choose to move outside Wedung rather than hold out and faced the annual flood. The percentage is small. Some of them used the transmigration program and the other go to Jakarta. There are 3-4 household from Wedung join the transmigration program annually." (Informant 7, Wedung Sub District)

5.10. The Future Trends in Flooding Related Land Encroachment

Based on flood event history, it is founded that almost all village between Wulan and Serang rivers have high risk of flood. Area which is consist of 19 villages cope risk on Serang river dike collapse probability in the north, Wulan river dike collapse in the south and tidal sea water level in west side. However, there are several villages at Mijen and Wedung sub district have highest risk of flood which are Jleper, Nglokulon, Ngegot, Mutih Wetan and Mutih Kulon. The finding shows that those villages affected flood disaster three (3) times from four times of big floods.

The wide and the depth of flood in the future are difficult to predict because there is no precise interval of flood event. Meanwhile the depth of flood always changing depends on the driving factor and flood source location. Nevertheless, people indicate that there will be happen a big flood in future.

"Please try to come here again in next 12 years; I'm sure there will be a big flood again in here." (Informant 7, Wedung Sub District)

Meanwhile, encroachment activity development is not too significant comparing the total area of Mijen and Wedung sub district. With 8 Ha area was encroached since 2000 to 2014, it can be predicted grow up only 2-3 Ha in next five year under a 'business as usual'. Although the scale is small, most of encroachment area located at riparian where it will affect the capacity of river.

Socialization and information about the danger of encroachment activity is needed. Furthermore, local government should be insist on law (President Regulation No. 32 Year 1990 about Protection Area) to maintain and reduce all encroachment and development activities especially in riparian area.

The intervention to anticipate the flood disaster in the future can be form as technical and policy solution. For technical aspect, the main intervention proposed by people is repairing and strengthen the dike also river normalization.

Figure 27. Rebuilt the collapse dike caused by flood (BPBD, 2013).

"The people want the dike is repaired. Normalization of river become obligatory to do" (Informant 6, Kedung Mutih village)

"The people will is only one, repair the dike! Especially at Jleper and Pecuk villages' boundary" (Informant 9, Jleper village)

"We made a report of flood disaster; we also proposed the repairing of Wulan river dike. There are 14 critical points in Wulan river dike." (Informant 8, Mijen Sub District)

BPBD as main institution in disaster management proposed more detail needed to anticipate the disaster in the future.

"We have been preparing operational procedure disaster management. In 2015, we put down several budgeting account to provide equipment and infrastructure to prevent the disaster such as boat, life boat jacket, tent, kitchen set etc." (Informant 1, BPBD)

Mijen and Wedung sub district, Demak as general has been applied regulation to control the land use development.

"Actually, the land use changing from agricultural land to settlement or industry is relatively fast. However, this time is applied regional regulation for controlling. Land use change permit is become difficult. This regulation applied effective since 2012." (Informant 2, BPBD)

This policy has aim to keep the function of river and reduce the risk of losses if the flood happen. In addition, study about disaster risk management is urging to apply.

"Because the limitation of resources, we need strengthen the cooperation with academician to study and analysis about the risk of disaster." (Informant 2, BPBD)

CHAPTER 6

CONCLUSION

6.1. Conclusion

This research is aimed to assess the interactions between riverine flooding, land use change and land encroachment activities in Mijen and Wedung sub districts by using Driving Force, Pressure, State, Impact and Response (DPSIR) approach.

Based on the result and analyzing, this research meet with several findings, which are:

a. Along years of 2000-2014, there are four major flood events (2002, 2006, 2013 and 2014) hit Mijen and Wedung sub district.

b. The main causes for riverine flooding in Mijen and Wedung sub district is meteorological (high intensity of rainfall) and technical factor (collapse of the dike).

c. Area between Wulan and Serang rivers is the most affected by flood. Jleper, Ngelokulon, Ngegot, Mutih Wetan and Mutih Kulon are villages which suffer flood disaster regularly.

d. From the historical data flooding, it is known that ponds, paddy field and residential are the three (3) land use systems which affected by flood hazard.

e. Fish ponds and agricultural plantation assets are the most vulnerable land use system on flood disaster.

f. The structural changes in 2000-2014 were happened in all level of land use classes. Paddy field area descended almost 6%, mangrove forest fall 79% in along 14 years meanwhile settlement grown up almost double in 2000-2014.

g. The interview result shows that majority people in Mijen and Wedung sub district does less response in structural land use change because they believe it has no significant influence to their life.

h. This research found that most of encroachment activity is happened at riparian area and it becomes one of pressure on riverine flooding. Encroachment at riparian area will decrease the river bank capacity and increase flood disaster risk.

i. It is necessary to inform the danger and effect of encroachment activity which has potency trigger the disaster (such as: riverine flooding) to the local people. The local government should also insist on President Regulation No. 38 Year 2011 about River.

6.2. Recommendation

The lack information and studies gave occasion to this research was focused on downstream area as the most impacted flood hazard. Meanwhile, in order to understand the holistic relation between the three components (flood, land use and encroachment activity), similar research should be applied ongoing at a full watershed area which covered upper, middle and low stream.

High resolution satellite image should be applied to determine the encroachment area in detail and better result. Detail analysis on development in riparian area and more rapid urban-land use change is needed as follow up. Assessing spatial-temporal land use change and encroachment activity due to flood hazard by DPSIR approach can be strength by modeling simulation. If there was any conception gained and the identified knowledge gaps in the future, follow up studies are advisable.

REFERENCES

Agyemang, I., McDonald, A., & Carver, S. (2007). Application of the DPSIR Framework to Environmental Degradation Assessment in Northern Ghana. *Natural Resources Forum*, *31*(3), 212–225.

Anderson, J. R., Hardy, E. E., Roach, J. T., Witmer, R. E., & Peck, D. L. (1976). A Land Use And Land Cover Classification System For Use With Remote Sensor Data. *A Revision of the Land Use Classification System as Presented in U.S. Geological Survey Circular 671*, *964*, 41.

BAPPENAS-BNPB. (2010). *National action plan for disaster risk reduction 2010 - 2012*. Jakarta.

Benini, L., Bandini, V., Marazza, D., & Contin, A. (2010). Assessment of land use changes through an indicator-based approach : A case study from the Lamone river basin in Northern Italy, *10*, 4–14.

Bidone, E. D., & Lacerda, L. D. (2004). The use of DPSIR framework to evaluate sustainability in coastal areas. Case study: Guanabara Bay basin, Rio de Janeiro, Brazil. *Regional Environmental Change*, *4*(1), 5–16.

BNPB. (2009). *National Disaster Management Plan 2010-2014*.

BNPB. (2014). Data Kejadian Bencana Banjir. Retrieved July 30, 2014, from http://geospasial.bnpb.go.id/pantauanbencana/data/databanjir.php

BPS. (2014a). *Statistik Daerah Kecamatan Mijen Tahun 2014*. Demak.

BPS. (2014b). *Statistik Daerah Kecamatan Wedung Tahun 2014*. Demak.

BPSDA. (2014). *Laporan Kejadian Banjir 8 s/d 11 April 2013*. Kudus.

Cao, Y., Zhou, W., Wang, J., & Yuan, C. (2011). Spatial-Temporal Pattern and Differences of Land Use Changes in The Three Gorges Reservoir Area of China During 1975-2005. *Journal of Mountain Science*, *8*(4), 551–563.

Chen, L., Wang, J., Fu, B., & Qiu, Y. (2001). Land-Use Change in A Small Catchment of Northern Loess Plateau, China. *Agriculture, Ecosystems & Environment*, *86*(2), 163–172.

De Freitas, M. W. D., Santos, J. R. Dos, & Alves, D. S. (2013). Land-Use and Land-Cover Change Processes in The Upper Uruguay Basin: Linking Environmental and Socioeconomic Variables. *Landscape Ecology*, *28*(2), 311–327.

Ding, H., Wang, R.-C., Wu, J.-P., Zhou, B., Shi, Z., & Ding, L.-X. (2007). Quantifying Land Use Change in Zhejiang Coastal Region, China Using Multi-Temporal Landsat TM/ETM+ Images. *Pedosphere*, *17*(6), 712–720.

El-Raey, M., Fouda, Y., & Gal, P. (2000). GIS for Environmental Assessment of The Impacts of Urban Encroachment on Rosetta Region, Egypt. *Environmental Monitoring and Assessment*, *60*(2), 217–233.

Fu, B. J., Zhang, Q. J., Chen, L. D., Zhao, W. W., Gulinck, H., Liu, G. Bin, … Zhu, Y. G. (2006). Temporal Change in Land Use and Its Relationship to Slope Degree and Soil Type in A Small Catchment on The Loess Plateau of China. *Catena*, *65*(1), 41–48.

Genxu, W., Yu, Z., Guimin, L., & Lin, C. (2006). Impact of land-use change on hydrological processes in the Maying River basin , China, *49*(10), 1098–1110.

Greene, R. P., & Harlin, J. M. (1995). Threat to High Market Value Agricultural Lands from Urban Encroachment: A National and Regional Perspecitve. *The Social Science Journal*, *32*(2), 137–155.

Groenendijk, E. M. C., & Dopheide, E. J. M. (2003). Planning and management tools. *ITC Special Lecture Notes Series*, 154. Retrieved from

Guion, L. A. (2002). *Triangulation : Establishing the Validity of Qualitative Studies* (No. FCS6014). Gainesville.

Guo, L., Wang, D., Qiu, J., Wang, L., & Liu, Y. (2009). Spatio-Temporal Patterns of Land Use Change Along the Bohai Rim in China During 1985-2005. *Journal of Geographical Sciences*, *19*(5), 568–576.

Gupta, S., & Roy, M. (2012). Land Use / Land Cover classification of an urban area- A case study of Burdwan Municipality, India, *2*(4), 1014–1026.

Harrison, A. R. (2006). National Land Use Database: Land Use and Land Cover Classification, version4.4, 81.

Hou, Y., Zhou, S., Burkhard, B., & Müller, F. (2014). Socioeconomic influences on biodiversity, ecosystem services and human well-being: A quantitative application of the DPSIR model in Jiangsu, China. *Science of the Total Environment*, *490*, 1012–1028.

Indonesia Govermental Regulation No. 38 Year of 2011 about Rivers (2011). Jakarta: Statutory Book No 74, 2011.

Jick, T. D. (1979). Mixing Qualitative and Quantitative Methods : Triangulation in Action. *Administrative Science Quarterly*, *24*(December).

Kagalou, I., Leonardos, I., Anastasiadou, C., & Neofytou, C. (2012). The DPSIR Approach for an Integrated River Management Framework. A Preliminary Application on a Mediterranean Site (Kalamas River -NW Greece). *Water Resources Management*, *26*(6), 1677–1692.

Kakisina, T. J., Anggoro, S., Hartoko, A., & Suripin. (2015). Analysis of the Impact of Land Use on the Degradation of Coastal Areas at Ambon Bay-mollucas Province Indonesia. *Procedia Environmental Sciences*, *23*(Ictcred 2014), 266–273.

Karageorgis, A. P., Kapsimalis, V., Kontogianni, A., Skourtos, M., Turner, K. R., & Salomons, W. (2006). Impact of 100-year human interventions on the deltaic coastal zone of the Inner Thermaikos Gulf (Greece): A DPSIR framework analysis. *Environmental Management*, *38*(2), 304–315.

Kesbanglinmas (Ed.). (2007). *Laporan Akhir Penelitian Penanganan Bencana Alam di Daerah Rawan Bencana di Kabupaten Demak*. Demak: Pemerintah Kabupaten Demak.

Kompas. (2014, January 22). Banjir Demak, 12.000 Warga Mengungsi. Demak. Retrieved from http://regional.kompas.com/read/2014/01/22/1729350/Banjir.Demak.12.000.Warga.Mengungsi

Lambin, E. F., & Geist, H. (Eds.). (2006). *Land-Use and Land-Cover Change Local Processes and Global Impacts*. Springer-Verlag.

Liu, J., Wang, S., & Li, D. (2014). The Analysis of the Impact of Land-Use Changes on Flood Exposure of Wuhan in Yangtze River Basin , China, (28), 2507–2522.

Liu, Y. B., Smedt, F. De, Hoffmann, L., & Pfister, L. (2004). Assessing land use impacts on flood processes in complex terrain by using GIS and modeling approach, 227–235.

Lulloff, A. R., Johnson, S., Larson, L., Carlton, D., Thomas, E., Beik, S., & Knipe, D. (2013). *The Floodway Encroachment Standard : Minimizing Cumulative Adverse Impacts*.

Luo, Y., Yang, S., Zhao, C., Liu, X., Liu, C., Wu, L., … Zhang, Y. (2014). The effect of environmental factors on spatial variability in land use change in the high-sediment region of China’s Loess Plateau. *Journal of Geographical Sciences*, *24*(5), 802–814.

Mustopa, Z. (2011). *Analisis Faktor-faktor yang Mempengaruhi Alih Fungsi Lahan Pertanian di Kabupaten Demak*. Diponegoro University.

Orewole, M. O., Alaigba, D. B., & Oviasu, O. U. (2015). Riparian Corridors Encroachment and Flood Risk Assessment in Ile-Ife : A GIS Perspective, *2*(1), 17–32.

Panahi, A. (2010). The Effect of the Land Use/Cover Changes on the Floods of the Madarsu Basin of Northeastern Iran. *Journal of Water Resource and Protection*, *02*(04), 373–379.

Parker, D. J. (1995). Floodplain development policy in England and Wales. *Applied Geography*, *15*(4), 341–363.

Pirrone, N., Trombino, G., Cinnirella, S., Algieri, a., Bendoricchio, G., & Palmeri, L. (2005). The Driver-Pressure-State-Impact-Response (DPSIR) approach for integrated catchment-coastal zone management: Preliminary application to the Po catchment-Adriatic Sea coastal zone system. *Regional Environmental Change*, *5*(2-3), 111–137.

Quan, B., Chen, J.-F., Qiu, H.-L., Römkens, M. J. M., Yang, X.-Q., Jiang, S.-F., & Li, B.-C. (2006). Spatial-Temporal Pattern and Driving Forces of Land Use Changes in Xiamen. *Pedosphere*, *16*(4), 477–488.

Richards, J. A., & Jia, X. (2006). *Remote Sensing Digital Image Analysis* (4th ed.). Springer-Verlag Berlin Heidelberg.

Saghafian, B., Farazjoo, H., Bozorgy, B., & Yazdandoost, F. (2007). Flood Intensification due to Changes in Land Use. *Water Resources Management*, *22*(8), 1051–1067.

Sanderson, H., Thomsen, M., & Fauser, P. (2009). *Real-Time and Deliberative Decision Making*. (I. Linkov, E. Ferguson, & V. S. Magar, Eds.) (pp. 191–201). Dordrecht: Springer Netherlands.

Santoso, E., Fatichuddin, M., Utami, S. B., Ratnaningrum, A., & Rukhedi (Eds.). (2013a). *Demak in Figure 2013* (p. 340). Demak: Statistic of Demak Regency.

Santoso, E., Fatichuddin, M., Utami, S. B., Ratnaningrum, A., & Rukhedi (Eds.). (2013b). *Kecamatan Mijen Dalam Angka 2013* (p. 77). Demak: Statistic of Demak Regency.

Santoso, E., Fatichuddin, M., Utami, S. B., Ratnaningrum, A., & Rukhedi (Eds.). (2013c). *Kecamatan Wedung Dalam Angka 2013* (p. 70). Demak: Statistic of Demak Regency.

Shalaby, A., & Tateishi, R. (2007). Remote sensing and GIS for mapping and monitoring land cover and land-use changes in the Northwestern coastal zone of Egypt. *Applied Geography*, *27*(1), 28–41.

Sharma, C. S., Behera, M. D., Mishra, A., & Panda, S. N. (2011). Assessing Flood Induced Land-Cover Changes Using Remote Sensing and Fuzzy Approach in Eastern Gujarat (India). *Water Resources Management*, *25*(13), 3219–3246.

Shi, W., & Xia, P. (2011). Application of DPSIR Model and Improved Entropy Method in Environmental Impact Assessment of Land Use Planning in Tianshui Region, 2647–2651.

Smeets, E., & Weterings, R. (1999). *Environmental indicators : Typology and overview Prepared by : Project Managers* (Vol. 25). Copenhagen.

Song, X., & Frostell, B. (2012). The DPSIR Framework and a Pressure-Oriented Water Quality Monitoring Approach to Ecological River Restoration, *4*, 670–682.

Sterling, D. L. (2003). *A Comparison of Spatial Interpolation Techniques For Determining Shoaling Rates of The Atlantic Ocean Channel Approved : A Comparison of Spatial Interpolation Techniques For Determining Shoaling Rates of The Atlantic Ocean Channel*. Virginia Polytechnic Institute and State University.

Tavares, A. O., Pato, R. L., & Magalhães, M. C. (2012). Spatial and temporal land use change and occupation over the last half century in a peri-urban area. *Applied Geography*, *34*, 432–444.

Townshend, J. R. G. (2001). *Manual of Concepts on Land Cover and Land Use Information Systems* (2000th ed.). Luxembourg: European Commission.

Tsai, H., Tzeng, S., Fu, H., & Wu, J. C. (2009). Managing multinational sustainable development in the European Union based on the DPSIR framework, *3*(11), 727–735.

Tscherning, K., Helming, K., Krippner, B., Sieber, S., & Gomez, S. (2012). Land Use Policy Does research applying the DPSIR framework support decision making ? *Land Use Policy*, *29*(1), 102–110.

Wang, D., Gong, J., Chen, L., Zhang, L., Song, Y., & Yue, Y. (2012). Spatio-temporal pattern analysis of land use/cover change trajectories in Xihe watershed. *International Journal of Applied Earth Observation and Geoinformation*, *14*(1), 12–21.

Wang, G., Zhang, Y., Liu, G., & Chen, L. (2006). Impact of land-use change on hydrological processes in the Maying River basin, China. *Science in China Series D: Earth Sciences*, *49*(10), 1098–1110.

Watson, F. G. R., Becker, M. S., Milanzi, J., & Nyirenda, M. (2014). Human encroachment into protected area networks in Zambia: implications for large carnivore conservation. *Regional Environmental Change*.

WMO-GWP. (2007). *The Role of Land-Use Planning in Flood Management - A Tool for Integrated Flood Management*. WMO/GWP Associated Programme on Flood Management.

Zeilhofer, P., & Piazza Topanotti, V. (2008). GIS and ordination techniques for evaluation of environmental impacts in informal settlements : A case study from Cuiaba central Brazil. *Applied Geography*, *28*, 1–15.

Zhang, H., Ma, W., & Wang, X. (2008). Rapid Urbanization and Implications for Flood Risk Management in Hinterland of the Pearl River Delta, China: The Foshan Study, 2223–2239.

Zoebisch, M., Cho, K. M., Hein, S., & Mowla, R. (Eds.). (2005). *Integrated Watershedd Management Studies and Experiences from Asia* (pp. 1–351). Pathumthani: Asian Institute of Technology. Retrieved from www.ait.ac.th

ANNEXES

Annex 1. The Modification of Anderson's Land Use Classification Scheme

Level I		Level II		Level III	
Code	**Land Use**	**Code**	**Land Use**	**Code**	**Land Use**
1	Urban or Built Up	11	Residential	-	-
		12	Commercial and Services	-	-
		13	Industrial	-	-
		16	Mixed Urban or Built Up Land	-	-
2	Agriculture	21	Cropland	211	Paddy Field
				212	Other Cropland
		22	Orchard	-	-
4	Forest	42	Evergreen Forest	423	Mangrove Forest
		43	Mixed Forest	-	-
5	Water Body	-	-	-	-
6	Wetland	62	Non Forested Wetland	621	Ponds
7	Barren Land	72	Beaches	-	-
		73	Sandy Area other than Beaches	-	-

Annex 2. Interview Guide Questioner

INTERVIEW GUIDE

ASSESSING THE SPATIAL-TEMPORAL LAND USE CHANGE AND ENCROACHMENT ACTIVITIES DUE TO FLOOD HAZARD IN NORTH COAST OF CENTRAL JAVA

Researcher :

Time of Interview :

Location of Interview :

I. Informant Data

Name :

Age :

Education :

Employment :

II. Organization Activity

Name of Organization :

Position :

Scope :

Type :

QUESTIONS

1. How long you lived here Sir/Mom?
2. Would you tell us about the historical condition of this village/area in past time, especially flood event?
3. What is the main commodity at this village?
4. What are kinds of river across this village?

FLOODING

5. How is the river flow condition?
6. Is flood happened in this village? If yes, how often is the flood happened?
7. Could you tell about the flood event at this village in 2000-2014?
8. How is the wide of flood inundation?
9. How long the flood happened?
10. What is the flood caused?
11. What is the main driving force of this flood?
12. What is the other reason of this flood?
13. How the intensity of rainfall in this region?
14. How much the average of flood in this village?
15. What is the flood impact?
16. How the intensity of flood (water volume and speed)?
17. What is the effect of flooding to the people?
18. How the people response to the flood?
19. How the people solve the flood problem?
20. What is the role of government to solve the flood?

LAND ENCROACHMENT

21. After the flood event, was there any possibility for people to leave their area? If yes, please explain?
22. Where are the people choose for stay and leave the flood area?
23. Is there any possibility for people to use the land illegally?
24. Is there any influence of land encroachment to flood?

LAND USE CHANGE

25. Would you mind to tell about the structural and occupation of people in this village?
26. What is the land use change in this village?
27. How is the people growth in this village?
28. Is the people growth factor influence land use change activity?
29. Could you tell how the development of land uses in this village?
30. What is the driving force of land use change in this village?
31. What is the pressure of land use change in this village?
32. What is the impact of land use change in this village?
33. How are the people respond to land use change in this village?
34. Is there any effect of land use change to flooding event in this village? Explain?
35. How to reduce the land use change activity in this village?

LAND USER

36. How wide the agricultural land in average?
37. What kind of land using in this village?
38. What is the impact of flooding to the land?
39. How are the people respond to face the flood event?
40. What kind of effort from land owner-user from flood in the future?
41. Is there any suggestion to solve the flood problem in this village?

Annex 3. List of Key Informants

Code	Name	Occupation	Interview Date
Informant 1	Agus Budiono, S.IP., MM.	Head of Reconstruction Section Regional Disaster Management Agency (BPBD) of Demak	Oktober 28th, 2014
Informant 2	Mahfudz	Head of Logistic Regional Disaster Management Agency (BPBD) of Demak	Oktober 28th, 2014
Informant 3	Hambali	Head of Farmer Association "Tirto Kencono" Pecuk Village	November 8th, 2014
Informant 4	Azizah	Official Representative of Pecuk Village Secretary	November 10th, 2014
Informant 5	Matrokhim	Farmer Representative of Pecuk Village	November 10th, 2014
Informant 6	Ahmad Mushonef	Official Representative of Kedung Mutih Village Secretary	November 11th, 2014
Informant 7	Syahrie Muhammad, S.E., MP.	Head of Wedung Sub District	November 11th, 2014
Informant 8	Anang Ruhiyat	Head of Mijen Sub District	November 12th, 2014
Informant 9	Abdul Fakih	Head of Jleper Village	November 12th, 2014