Final Report

Impact of Climate Change on Households in the Indonesian CBMS Area

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The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support research and training in environmental and resource economics. Its objective is to enhance local capacity to undertake the economic analysis of environmental problems and policies. It uses a networking approach, involving courses, meetings, technical support, and access to literature and opportunities for comparative research. Member countries are Thailand, Malaysia, Indonesia, the Philippines, Vietnam, Cambodia, Lao PDR, China, and Papua New Guinea.

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Pekalongan

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IMPACT OF CLIMATE CHANGE ON HOUSEHOLDS IN THE INDONESIAN CBMS AREA

Akhmadi, Rahmitha, Yudi Fajar

1.0 INTRODUCTION

1.1 Background

Indonesia is the largest archipelago in the world with 17,508 islands and around 81,000 km of coastline where 60% of the total population of 237.6 million live (BPS, 2011: 74), thus it is particularly vulnerable to climate change. Rising sea levels and the resultant saltwater intrusion will affect many different sectors and pose a significant risk to the Indonesian economy and security. While most of the population will feel the impact of climate change, the poor and the near-poor will be the most vulnerable, aggravating their livelihoods and pushing them into poverty. With the poverty rate already at 13%, the threat posed by climate change has the potential to stall the already challenging poverty reduction efforts and negatively affect Indonesia's attainment of the Millennium Development Goals (MDGs). A research paper by Pierre van der Eng (2009) found that food production and distribution of food supplies across Indonesia have long been subject to geographic and temporal variations in climate.

With most of Indonesia's poor living along the heavily populated coastal areas, many of them are dependent upon natural resources for their livelihoods, and better information on how climate change will affect them is urgently needed. Especially in coastal areas where most of the poor depend on production from small scale fisheries, the changing climate and extreme weather has resulted in a dwindling catch. Moreover, flooding as result of rising sea levels and saltwater intrusion has shocked the livelihoods of many people who live in coastal communities, destroying or reducing their physical assets and decreasing their access to safe and clean water. In some cases, the flooding becomes permanent and forces them to leave their most important and valuable asset, their land.

Recent reports (UNDP, 2007) acknowledge the link between climate change and poverty, suggesting that there is an increasing need to acknowledge the impact of climate change on poverty reduction strategies. It is imperative to integrate the responses and adaptation measures of climate change into poverty reduction strategies as the impact of climate change will increasingly affect the livelihoods of the poor. To achieve this integration, data and information on vulnerability and risk mapping at the community level is vital to provide a more accurate assessment that can assist local policymakers in producing more informed policies that properly accommodate the impact of climate change.

The Economy and Environment Program for Southeast Asia (EEPSEA) vulnerability risk mapping and assessment framework can fulfill this need for an information gathering mechanism at the community level. Along with the policy of

decentralization which has given local governments a greater role and the authority to make policy, the utilization of this module and framework at the local government level will provide ample information on how this information and mechanism implemented at the local level can influence policymaking and development outcomes. Furthermore, the pilot implementation of the vulnerability assessment and mapping modules represents an opportunity for local governments to increase their capacity in social impact monitoring, while mainstreaming climate change into local development policies and creating more effective, climate-change sensitive, poverty alleviation strategies.

Most of the stakeholders—both at the national and regional levels—such as government, non-government organizations, and companies are aware that climate change presents a significant and growing risk to development, especially in coastal areas, such as in Pantura *(pantai utara)*, the northern coastal areas of Java. Kota Pekalongan is located within Pantura, in the Province of Central Java. Awareness by the government can be seen in the remarks from the Minister of National Development Planning/Head of Bappenas that "with its far reaching impact on the world's ecosystems as well as human security and development, climate change has emerged as one of the world's policymakers" (Republic of Indonesia, Indonesia Climate Change Sectoral Roadmap, Health Sector, March 2010).

One of the efforts of the Government of Indonesia (GoI) is to regulate geospatial information. Recently, the GoI has enacted legislation to produce a geospatial law (Undang-Undang Nomor 4 Tahun 2011). The purpose of this law is to guarantee the availability of, and access to, geospatial information and to encourage all levels of government in the use of geospatial information as part of the development process. The Law regulates the provision of information (basic map) related to the condition of the coastal environment. This is relevant to this study as it accommodates the availability of geospatial information on Kota Pekalongan related to the impact of climate change on this particular coastal region.

Kota Pekalongan has initiated a local action plan to mitigate climate change which is based on the City of Pekalongan Integrated Action Plan to Face Climate Change (RADPAKLIM), supported by the GoI and GiZ (Germany). Kota Pekalongan has collaborated with the industrial sector to develop a mitigation and adaptation plan to combat the impact of climate change.

1.2 Objectives

The study's focus on climate change vulnerability assessment and mapping used data generated by the Community-Based Monitoring System (CBMS) in Kota Pekalongan and other available data. Knowing the impact of one type of climate hazard on socioeconomic aspects of human life raised concerns on what could be found in Kota Pekalongan. Thus, the study aimed to provide relevant information related to which groups are most vulnerable to climate change, the levels of existing impact and the potential strategies that can be used to mitigate that impact.

The general objective of this study, other than to improve the CBMS database in selected sample *kelurahan*, is to identify which neighborhood unit and households in the selected *kelurahan* are the most vulnerable to climate change.

The specific objectives of this study are: (1) To understand local government and household awareness about climate change; (2) To understand the extent that climate change affects households' daily lives, particularly income generating activities; and (3) To show maps of vulnerable households and neighborhood unit in selected sample *kelurahan*.

2.0 CLIMATE CHANGE IN INDONESIA

2.1 Indonesia Description (Geography Profile)

The geographic position of Indonesia is on the equator between Asia and Australia spanning almost two million square kilometers with over 18,000 islands spread from Sabang (in Sumatera) to Merauke (in Papua). The combined total length of coastline of all the islands extends over 80,000kms, close to one third of the earth's circumference. Many of the smaller islands are still uninhabited, with the larger islands of Sumatera, Java, Kalimantan, Sulawesi, and Papua being home to most of the population base. Most of the people living in coastal areas are poor.

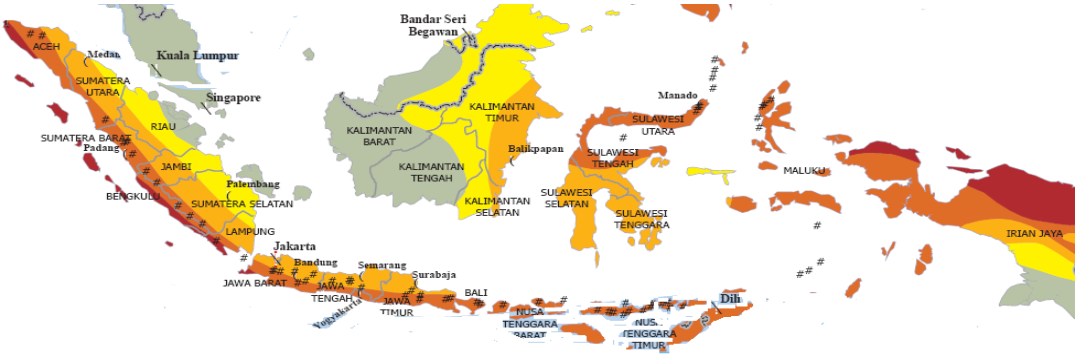


Figure 1. Global average temperature in Indonesia

Indonesia is a lower-middle income country with a gross national income per capita of US$2,963. The economic growth of Indonesia was around 5% per year during the last decade. This economic growth is lower than period before the 1997/98 Asian Financial Crisis. In the last three years, economic growth has been around 4%, the lowest recorded over the last two decades. On the other hand, the trend of the poverty rate during this period was also lower, with the exception of the economic crisis during 1998–99. Before this crisis, the level of poverty in Indonesia was decreasing in line with rapid economic growth. However, the economic crisis led to a significant increase in the number of poor, an estimated increase of 14 million people, in the period from 1996 to

1999. To decrease the poverty level that was worsened by the crisis, the government announced social safety net programs in mid-1998 in areas such as education, health, food, and labor intensive work schemes. These efforts were accompanied by development in various sectors to attain higher economic growth in order to absorb more of the workforce, so the level of poverty was reduced to 15.97% in 2005, down from 23.43% in 1999. Moreover, in September 2011 the poverty level had reduced further to 12.36%.[2] In 2007, and in 2010 the poverty rate has been reduced to 13.3%. Aside from the poor population, there are also people who are considered vulnerable, that is, the groups in the community who have expenditure levels close to the poverty line. This group will easily move out of or fall into poverty if there are fluctuations in prices.

Poverty in Indonesia has always been a predominantly rural phenomenon. Despite the increasing proportion of its urban population, that nowadays accounts for almost 50% of the total population, the rural poor still accounts for more than 60% of the total poor (BPS, 2012). Although the poverty rate in urban areas is lower than those in rural areas, the income inequality as reflected in the Gini ratio in urban areas is higher. Income poverty also varies across provinces. Although most of the poor are living in Java, the poverty rates in the provinces of eastern Indonesia remain among the highest. The variation of poverty rates among provinces is quite high: more than 25% of the people in Maluku, West Papua and Papua are categorized as poor; while only less than 5% of people in Jakarta and Bali are poor. The provincial performance in terms of a reduction in poverty rates also varies considerably and it appears that there is no clear correlation between the progresses in reducing poverty with the economic growth of the provinces.

The number of poor people (or high rates of poverty) is vulnerable to the effects of climate change. As mentioned above, most of the poor in Indonesia live in coastal areas. The impact of climate change on the poor consists of three broad groups namely the impact on farmers, the fishing industry, and on coastal communites (UNDP, 2007).

The impact of climate change on farmers, especially those in plateau areas, is that it can make the farmers lose their farms' top soil due to erosion. Furthermore, harvesting of crops commonly grown in plateau areas, such as soybean and maize, will decrease by 20%–40%. Whereas, the impact of climate change to fishers can be shown by the damage of coral reefs that will induce over fishing activities and the rising sea level will inundate many of shrimp and fishponds. As a vast archipelago, coastal areas in Indonesia are vulnerable to coastal inundation caused by rising sea levels. Around 80,000km is classified as coastal area, therefore if sea levels rise by one meter, it will cause 405,000 hectares of coastal land to sink (UNDP, 2007: 8).

2.2 Cause of Climate Change

Climate change is the phenomenon of alteration of elements of climate whether in terms of patterns or intensity in some sort of comparable period. The alteration includes average climatic conditions of or average condition of climate in term of climate

[2]Statistics Indonesia, "Poverty Profile of Indonesia, September 2011", in *Berita Resmi Statistik* No. 06/01/Th.XV, 2 January 2012.

distribution compared with the average possible condition. Such as the decreasing or increasing number of climate hazards and changing of climate patterns.

Indonesian Law 31/2009 defines climate change as the alteration of climate because of human activities, whether direct or indirect, which cause a change in the composition of the atmosphere globally and also a change in the natural climate variability which monitored in comparable period.

Yet, society has a diverse concept of conceiving what climate change is. Generally society comprehends that climate change is the irregularity between wet (rain) and dry seasons. Farmers have concluded that climate change is the increasing uncertainty between the wet and dry seasons which makes it increasingly difficult for them to decide the correct farming time (for planting, harvesting). Whilst fishers understand climate change as the difficulties of reading the signs of nature such as wind direction and sea flow which make it more difficult to estimate the correct area and time for fishing.

Global warming is indicated by an increase in average temperatures on the earth's surface and ocean since mid-20th century and projected will increase in the next years. Based on an IPCC study (2007), the global surface temperature has increased during 1860–2000, especially in the time period 1960–2000. Global warming is the main cause of climate change. Global warming involves both human and natural activities, such as a volcanic eruption.

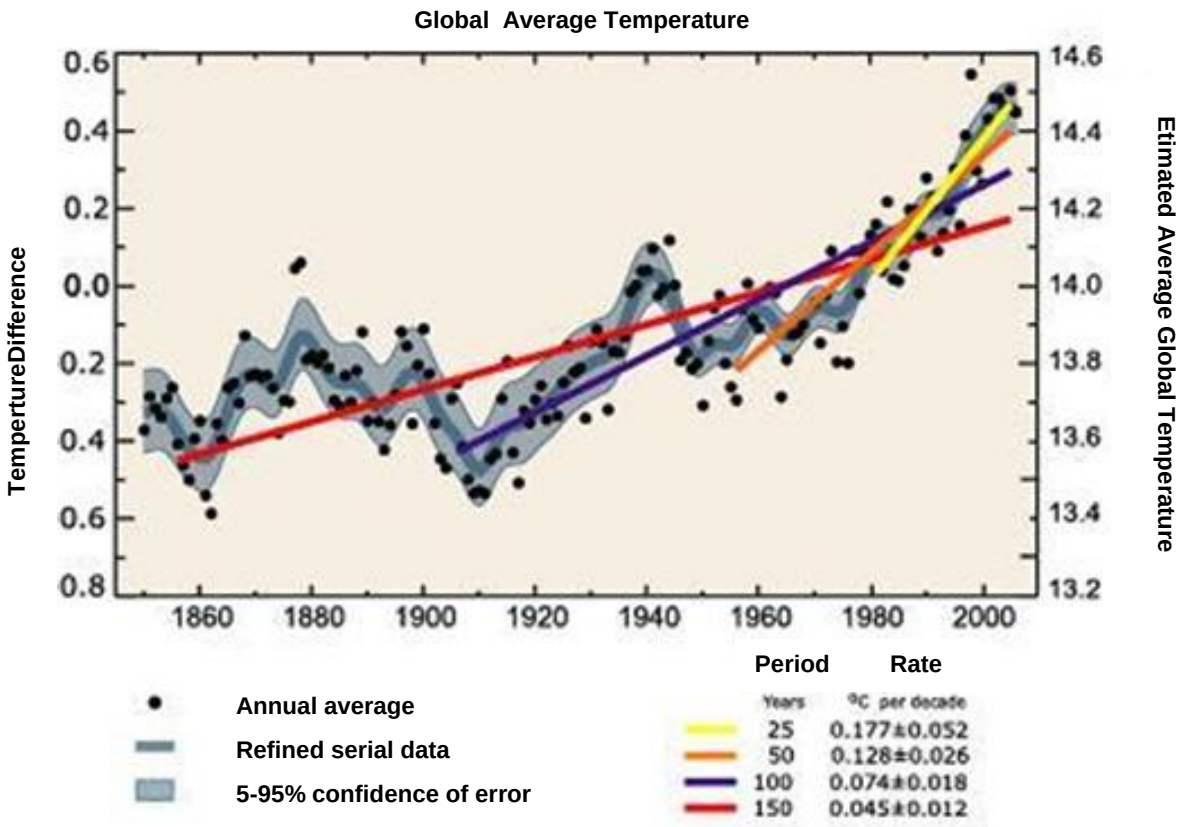


Figure 2. Global average temperature

Source: IPCC (2007).

The main global warming indicators are; an increase in temperatures on the earth's surface, a rise in sea levels, and a decrease in the size of areas covered by ice. The increase in temperatures is evident on land and oceans as well as in the temperature of the earth's atmosphere. One of the effects of this condition on earth is the increasing rates of melting of polar ice. The melting ice at the poles causes an increase in global sea levels. The increasing sea levels are caused by additional water volume due to the melting ice and the expansion of water molecules due to the increasing temperatures of the ocean's surface.

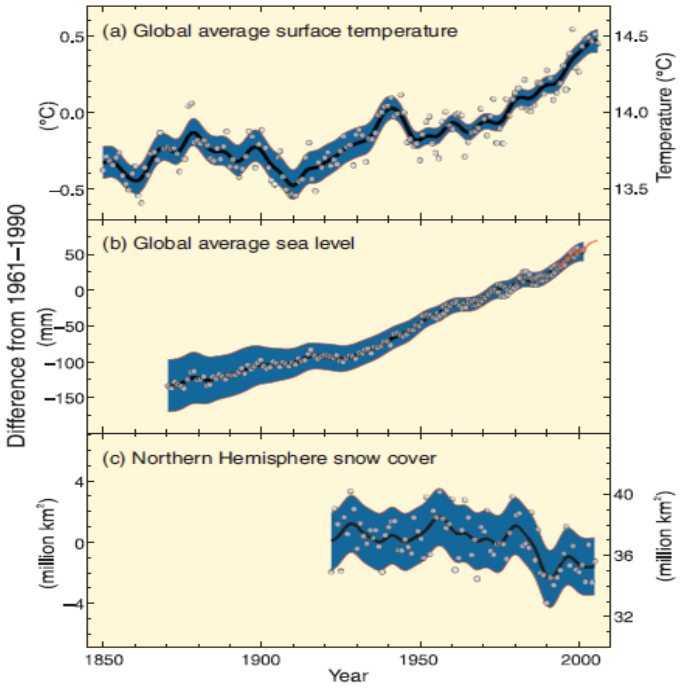


Figure 3. Changes in temperature, sea level and Northern Hemisphere snow cover

Source: IPCC (2007).

2.3 Climate Change Impact in Indonesia

Several agencies and organizations connected with measuring the impact of climate change in Indonesia such as the BMKG and the PNPB have made several disaster maps for Indonesia. These maps are based on the time period of the disaster, the cause of the disaster, and the range of impact on the effected areas. The information shown on the maps concerns wind approximation, flood sensitive areas, tidal wave areas, approximation of monthly rainfall, and atmospheric conditions. One of the maps is a map of climate predictions of cities and provinces in Indonesia with information including rainfall, temperature, and humidity (Figure 4).

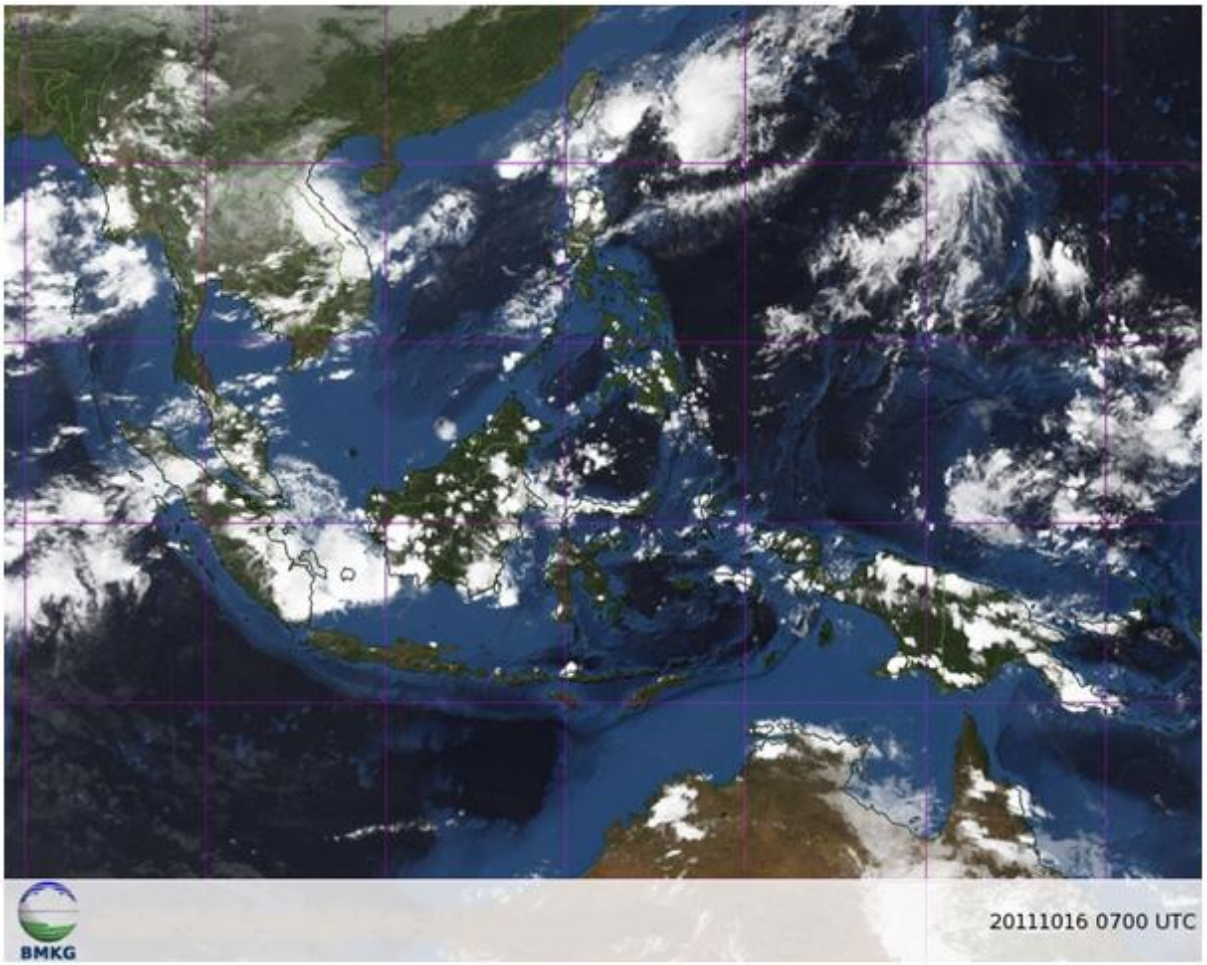


Figure 4. Rainfall in Indonesia

Source: BMKG.

Related to the maps predicting high susceptibility flood areas, the BMKG produced a map of susceptible flood areas in the Province of Central Java including Kota Pekalongan. The September 2011 map of susceptible flood areas in Central Java shows that the categories of susceptibility to flooding are divided into four broad categories, being: high, moderate, low and free from flooding.

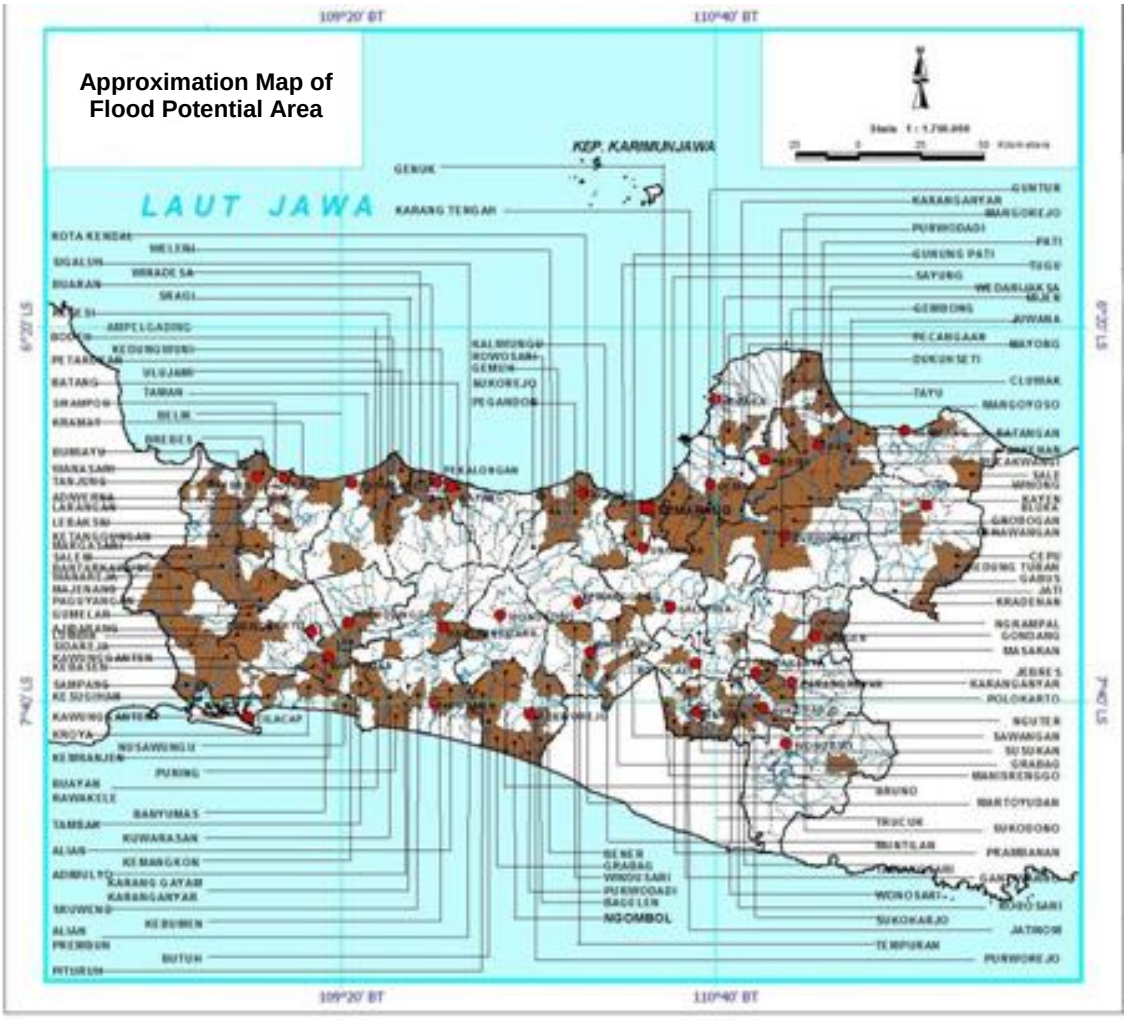


Figure 5. Approximation map of potential flood areas

Source: BMKG.

The impact of climate change is not only on global climate but also on the climate in Indonesia. Some of the effects in Indonesia include alteration to rain intensity and to the duration of the wet (rain) season. This seasonal alteration includes the start times of the rain or dry season and also the length of time of each season. This situation of unreliablity has the biggest impact on communities whose livelihoods are directly connected with climate such as farmers and fishers, as it becomes difficult for them to decide the start and end of particular phases of farming and fishing.

2.3.1 Policy and program

Indonesia has responded to these issues by integrating sustainable approaches into its national development and mainstreaming climate change issues into relevant

government policies and programs. Several new laws and regulations were introduced to support the implementation of mitigation and adaptation in addressing climate related disasters and climate change, which among others include:

1. Law No. 5/1992 on Cultural Heritage
2. Law No. 28/2002 on Building Development
3. Law No. 24/2007 on Disasters Management
4. Law No.26/2007 on Spatial Planning
5. Law No.27/2007 on Coastal and Small Islands Management
6. Law No. 32/2009 on Environmental Protection and Management
7. National Action Plan for Climate Change, 2007.
8. Indonesia Climate Change Sectoral Roadmap (ICCSR), 2010.

Law No. 5/1992 on Cultural Heritage regulates the government's control and protection concerning human-made objects and cultural matters. The term heritage includes the following things such as man-made constructions that are at least 50 years old, historical relics and cultural items. Whereas Law No. 28/2002 regulates the design and construction standards of buildings especially the physical conditions of the building, the technical planning process, and activities related with utility, conservation, and demolition or modification of buildings. Building conservation consist of maintenance, restoration, and cultivation activities of a building and its surrounding area.

Under Law No. 27/2007 on Coastal and Small Islands Management, the GoI recognizes the risks associated with the adverse impacts of climate change on local communities in urban areas particularly in coastal areas, which could become a significant barrier to achieving MDG targets. Poor communities will be hit first and most likely the hardest by climate change.

Based on Law No. 24/2007 on Disaster Management, Law No. 26/2007 on Spatial Planning, and Law No. 32/2009 on Environmental Protection and Management, the government has prepared a National Action Plan for Climate Change (2007) and the Indonesian Climate Change Sectoral Roadmap (ICCSR) to develop sustainable cities through mitigation and adaptation initiatives in addressing climate change.

The Indonesia Climate Change Sectoral Roadmap (ICCSR) is designed to provide inputs for the next five year Medium-term Development Plan (RPJM) 2010–2014, and also for the subsequent RPJMN until 2030, laying particular emphasis on the challenges emerging in the forestry, energy, industrial, agricultural, transportation, coastal area, water, waste and health sectors.. The content of the roadmap has been formulated through rigorous analysis and encompasses vulnerability assessments, prioritized actions including capacity-building and response strategies, and associated financial assessments. The ICCSR sought to develop a coherent plan that could be supported by line Ministries and relevant strategic partners and donors.

The spatial planning strategy and policy for mitigation and adaptation in addressing climate change (Jakstra PR-MAPI) has been prioritized for areas highly sensitive areas to climate change, sensitive and adaptive capacity in residential area, industrial areas, energy and transportation infrastructure, and health facilities.

Local governments have also encouraged their communities to participate in green city programs. The basic policy message from them is that efforts must be made by

communities to apply all feasible and economically viable adaptation and mitigation measures as key elements of a sustainable development strategy for Indonesian cities. The current global economic crisis offers Indonesian cities an opportunity to start a transition towards a climate resilient and low-carbon economy by introducing green stimulus programs that can support economies, create jobs, reduce poverty, lower carbon emissions, and prepare for the worst effects of climate change.

Nevertheless, given the unprecedented scale and pace of urbanization and the problems compounded by climate change, it is clear that new approaches are needed to shape the way in which Indonesian cities are planned, managed and governed. Urgent action is required from all levels of government to address issues related to climate change; both mitigation and adaptation, water security and to better utilize the growing streams of urban solid waste and wastewater. The scale of this action means that cooperation between countries, governments, business and communities will be required at a level not seen before in the region. Differences in language, politics, culture, history and the extent of economic development will impede such cooperation, but they must be overcome if Indonesian cities are to become more sustainable and better places to live in.

3.0 METHODOLOGY AND DATA PROCESSING

3.1 Methodology

The methodology of this study consists of quantitative and qualitative data collection. The quantitative data collection aims to construct a climate change vulnerability index in order to indicate the most vulnerable areas to climate change located within the mapped area. The qualitative data collection aims to support the quantitative findings and gauge the perceptions of the government and the community in terms of the effects of climate change in Kota Pekalongan.

In reference to the index showing the areas in Indonesia most vulnerable to climate change, a methodology related to disaster management has been developed under the authority of the National Agency for Disaster Management (BPPB), namely the Indonesian Disaster Risk Index (IRBI). The IRBI is based on the history disasters and losses in a given area. The index is implemented at the provincial and *kabupaten* levels, and consists of six main indicators, which are; the number of disasters that have occurred, the number of injured people, the number of deaths, the population density, the number of houses damaged, and the damage to infrastructure and facilities. Each main indicator has its own weight and is classified into one of three risk categories, being; high, medium or low. The data is based on a database produced by Indonesia Disaster Data and Information that is managed by the National Agency for Disaster Management. Unfortunately, this study cannot implement the IRBI method due to a lack of availability of the relevant data. Data for Kota Pekalongan in the database of Indonesia Disaster Data and Information is only available at the *kabupaten* level; however this study intends to describe the climate change area in terms of lower administrative levels such as at the *kecamatan*, *kelurahan*, or household level.

The climate change vulnerability index of this study is based on the framework of the United Nation's Inter-governmental Panel on Climate Change (IPCC) (Yusuf and Francisco, 2009). According to this framework, the climate change vulnerability in an area includes exposure, sensitivity and adaptive capacity. In reference to the IPCC report, Yusuf and Francisco (2009) mention that exposure is defined as "the nature and degree to which a system is exposed to significant climatic variations"; sensitivity is defined as "the degree to which a system is affected, either adversely or beneficially, by climate-related stimuli"; and adaptive capacity is defined as "the ability of a system to adjust to climate change (including climate variability and extremes), to moderate the potential damage from it, to take advantage of its opportunities, or to cope with its consequences".

$$\text{Vulnerability} = f\,(\text{exposure, sensitivity, adaptive capacity}) \qquad (1)$$

As shown in Table1 the exposure to climate hazards in Kota Pekalongan consists of floods, rising sea levels, and landslides. The sensitivity to climate change is compiled from factors such as; risks to livelihoods, risks to the ecology/natural environment, and risks to the population. The adaptive capacity of Kota Pekalongan in managing climate change involves infrastructure, technological information, health facilities, other institutions, and economic conditions.

Table 1. The Indicators and weights of climate change vulnerability index of Kota Pekalongan

Weight	**Category**	**Weight**	**Category**	**Weight**	**Indicator**
0.34	**Exposure**	0.39	**Floods**	1.00	Proportion of households located in flood area
		0.31	**Sea level rise**	1.00	Proportion of households located in sea level area
		0.30	**Landslide**	1.00	Proportion of households located in landslide area
0.30	**Sensitive**	0.31	**Livelihood at risk**	0.25	Proportion of population who work in the batik sector
				0.25	Proportion of population who work in the fisheries sector
				0.25	Proportion of population who work in the agricultural sector
				0.25	Proportion of school population
		0.15	**Ecology**	0.27	Number of rivers

			at risk	0.73	Proportion of road surface made from asphalt
				0.13	Proportion of houses with a poor water canal condition
		0.53	**Population at risk**	0.13	Proportion of households who consume unsafe drinking water
				0.13	Proportion of disabled population
				0.13	Population density
				0.13	Proportion of children (below 15)
				0.13	Proportion of elderly (65 and above)
				0.13	Proportion of households who live by the side of a river
				0.13	Proportion of households who live near the sea bank
0.37	**Adaptive Capacity**	0.26	**Infrastructure**	1.00	Proportion of households having a permanent house
		0.14	**Technological Information**	0.37	Proportion of households with a fixed telephone line
				0.32	Proportion of households with a cellular phone
				0.31	Proportion of households who access a news services
		0.19	**Health**	1.00	Proportion of population who work in a medical field
		0.2	**Institution**	0.33	Number of people involved in disaster organizations
				0.33	Proportion of household who are active in organizations
				0.33	Proportion of productive population (15-64)

		0.21	**Economic**	1.00	Average number of assets per household

The weight of each category and indicator in the climate change vulnerability index of Kota Pekalongan is based on the Philippines climate change index (see Appendix 1). The weight of the climate change in the Philippines index is constructed using the Analytical Hierarchy Process (AHP) method[3]. A similar weight is explicated in this study because the Philippines and Indonesia have some similarity in terms of climate change. Both countries are archipelagos in the South East Asian region and the characteristics of their social and economic situation is similar so the effect of climate change is likely to also be very similar. The weight of several indicators is adjusted to acknowledge the conditions peculiar to Kota Pekalongan. For several categories, for which there is no information on the importance of each indicator and category in assessing its vulnerability, the assumption of equal weight is implemented.

In addition to providing a complete picture of the climate change situation in Kota Pekalongan we also conducted secondary data collection and semi-structured interviews with relevant government and non-government institutions at the national, provincial, and *kabupaten* levels. At the national level the interviews were conducted with; the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG), the National Agency for Coordinating Surveillance and Mapping (Bakosurtanal), and the National Agency for Disaster Management (BNPB). Whereas, secondary data collection and semi-structured interviews at the provincial level were conducted with; the provincial office of the Agency for Meteorology, Climatology, and Geophysics (BMKG) Climatology Semarang, the Tegal office of BMKG, the Semarang provincial office of BMKG (Maritime) Semarang, the Semarang provincial office of BNPBD Semarang, and Gesellschaft fur Internationale Zusammenarbeit (GIZ) Semarang. At the *kabupaten* level, secondary data collection and semi-structured interviews were conducted with relevant government and non-government institutions consisting of Bappeda, the Climate Change Working Group, the Public Works Agency, DPPK, the Environmental Office and the National Community Empowerment Program (PNPM) consultant office.

At the *kecamatan* level, relevant information was collected using focus group discussions (FGD) in the sample *kecamatan* (Pekalongan Utara and Pekalongan Barat). The FGDs involved *kecamatan* officers who are familiar with the climate hazard conditions and are involved in programs related to climate hazards in the area. The focus group discussions were also conducted at the *kelurahan* level in the sample *kelurahan* of Panjang Wetan and Pasirsari. These FGDs involved *kelurahan* officers and the community who are relevant in the discussion of climate hazards. The FGDs aimed to gain the community's perceptions about climate change trends, the impact on the environment and livelihoods, particularly on vulnerable groups. SMERU has developed an indepth interview guideline and tools for focus group discussions (see Appendix 2). The sample *kecamatan* and *kelurahan* are chosen because these particular areas are the

[3]AHP is a structured technique for organizing and analyzing complex decisions.

most vulnerable to climate hazards based on information from CBMS using the Kota Pekalongan database.

At the household level, information was gathered using interviews with several households in the *RT*[4] of the sample *kelurahan*. The chosen households were recommended by the head of the *RT* with consideration of the households most vulnerable to climate hazards such as floods and sea level rise in their locale. The interview aims to gain local-specific strategies at the household level in terms of dealing with climate change.

3.2 Data Specification

Data in this report is divided into quantitative and qualitative data. The quantitative data from several administrative levels is required to construct the climate change vulnerability index of Kota Pekalongan which will be presented in the vulnerability maps. The main source of quantitative data is based on the CBMS Kota Pekalongan database which was collected through a census in Kota Pekalongan in 2008 and 2009. The census in 2008 was conducted in Pekalongan Timur and Pekalongan Selatan, whilst the census in 2009 was conducted in Pekalongan Utara and Pekalongan Barat. The other sources of quantitative data are from the Regional Spatial Planning (Rencana Tata Ruang Wilayah) Kota Pekalongan 2009–2029, medium-term poverty reduction programs (PJM Pronangkis) 2011, and from the social officer of Kota Pekalongan.

The interviews at the national level were conducted in late 2011, while the interviews and the FGDs at the *kabupaten*, *kecamatan*, and *kelurahan* levels were conducted on two separate occasions. Firstly in late 2011 followed by a second round of interviews and FGDs in early 2012. The interviews with households were conducted in early 2012.

Due to limited resources, this study selected the sample area based on CBMS Kota Pekalongan data in order to collect quantitative information. Pekalongan Utara and Pekalongan Barat were the sample *kecamatan*. The sample *kelurahan* in each *kecamatan* were Panjang Wetan in Pekalongan Utara and Pasirsari in Pekalongan Barat. In Panjang Wetan the sample *RW* was *RW* 09 and *RW* 03 was the sample *RW* in Pasirsari. In terms of unit analysis, the climate change vulnerability index utilized at the *kecamatan* level to show the most vulnerable *kecamatan* in the *kabupaten* area of Kota Pekalongan. The index was also utilized at the *kelurahan*, *RW*, and *RT* levels to show the most vulnerable area. The household status related to the indicators of the climate change vulnerability index were also computable as part of this study.

3.3 Data Processing

This study generated a climate change vulnerability index in Kota Pekalongan. The index was constructed using several categories and indicators as shown in Table 3.1. The indicators were selected based on the IPCC framework and with consideration of the

[4] Neighborhood unit consist of several households

results of the focus group discussions at the *kelurahan* level. Most of the indicators in this study are proxies of indicators that were used in the IPCC framework. This occurred due to the unavailability of data from administrative levels lower than the level of *kabupaten*. Due to the index being used to describe the vulnerability condition down to the household level therefore most of the indicators are household based data.

Following the established categories and indicators in the climate change vulnerability index, the data selected was from every analysis unit from the administrative level down to the household level. Then, to make the data comparable, normalization of the data is implemented. The normalization methodology used in this study is Min-Max methodology, as indicated in the following formula:

(2)

where $Z_{i,j}$ is the standardized climate hazard of type i of region j; $X_{i,j}$ is the un-standardized climate hazard of type i of region j; X_i^{MAX} is the maximum value of the climate hazard indicator over region j, and X_i^{MIN} is the minimum value of the climate hazard indicator over region j. Once the data was normalized, it has to be weighted to finalize the index.

After the index has been established, it was then transferred onto vulnerability maps for each administrative level. This index was implemented at the *kecamatan*, *kelurahan*, *RW*, *RT*, and household level. The vulnerability map was divided into four color ranges which show the degrees of vulnerability.

4.0 CLIMATE CHANGE & VULNERABILITY ASSESSMENT IN KOTA PEKALONGAN

4.1 Description of Study Area (Geography, Demography, & Socioeconomic Conditions)

4.1.1 Geography

Kota Pekalongan is located on a lowland plain situated along the northern coast of Java called Pantura. The gographical location of Kota Pekalongan is between 6 50’ 42"–6 55’ 44” South latitude and 109 37’ 55”–109 42’ 19” East longitude. The average height of the city is one meter above sea level and the highest point within the city boundaries from north to south is only 6.5m.

Kota Pekalongan has a total area of 45.25km^2. The largest distance from north to south is 9km and from west to east is 7km. The administrative border of north Pekalongan is the Java Sea, Kota Batang in the east and south and Kabupaten Pekalongan in the south and west. Kota Pekalongan has four *kecamatan/kelurahan* which are;

Pekalongan Utara, Pekalongan Barat, Pekalongan Timur, and Pekalongan Selatan which contain a total of 47 *kelurahan* (Figure 6). Below the *kelurahan* level, there is the *RW* which is local administration area consisting of several *RT*. The *RT* is a neighborhood unit consisting of several households. According to Kota Pekalongan's regional spatial planning, there are seven rivers flowing through the city which are; the Pekalongan River, the Banger River, the Baros River, the Dekoro River, the Asem Binatur River, the Bremi River, and the Sebulan River.

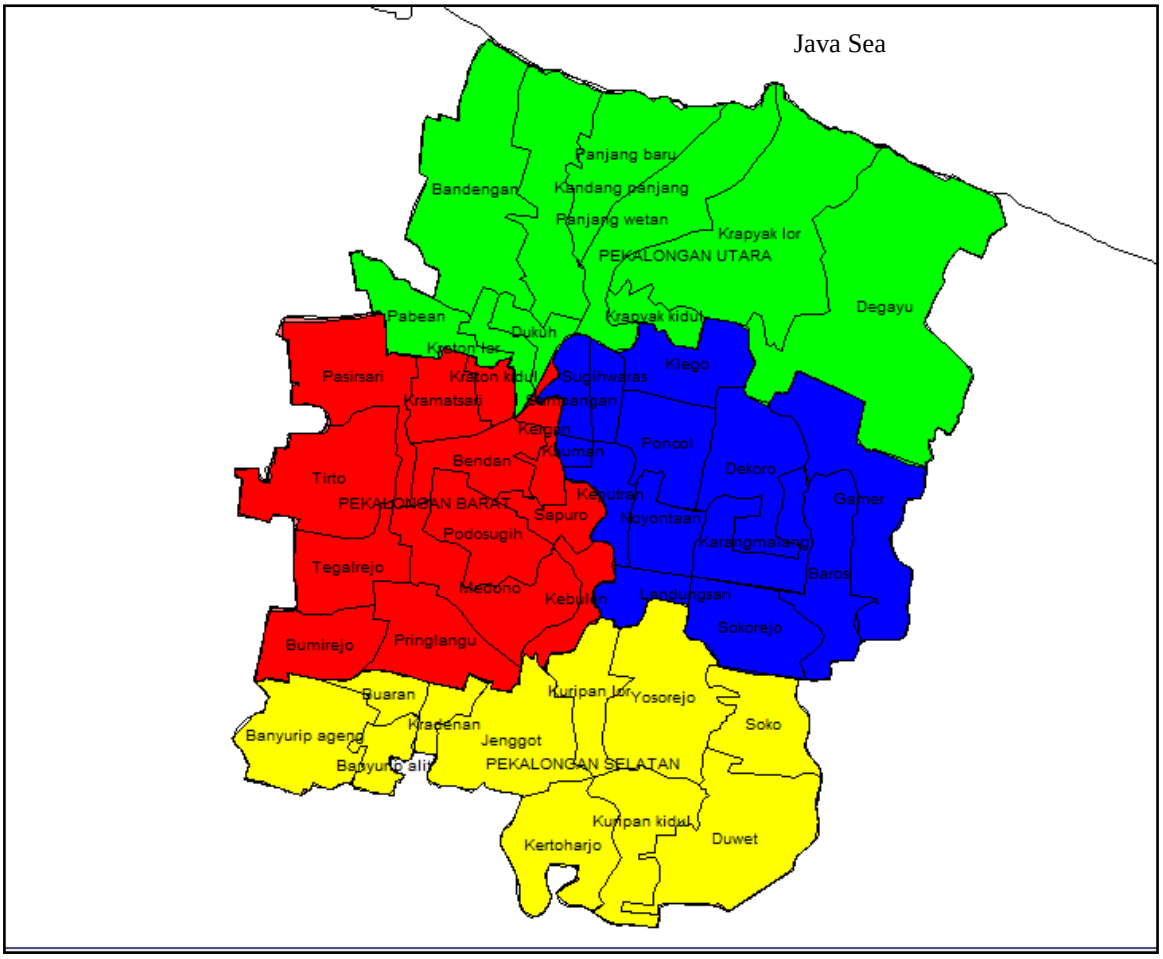


Figure 6. Map of Kota Pekalongan

As the sample *kelurahan* of this study, Panjang Wetan is one of the *kelurahan* in Pekalongan Utara. It has 1.36Km^2 in total area which is 9.2% of Pekalongan Utara's total area. This *kelurahan* has a boundary with the Java Sea to the north. The Pekalongan River lows though the *kelurahan* which is the main river in Kota Pekalongan. Pasirsari is one of the *kelurahan* in Pekalongan Barat. Pasirsari shares a border with Kabupaten Pekalongan in the west. The total area of Pasirsari is 1.11Km^2 which is 11% of Pekalongan Barat's total area.

Panjang Wetan has 13 *RW* and Pasirsari has eight *RW* (Figure 7 and 8). In Panjang wetan the sample *RW* is *RW* 9 and in Pasirsari is *RW* 3. The yellow map shows *RW* level in each *kelurahan*, whilst the pink map shows the *RT* level in each sample *RW*.

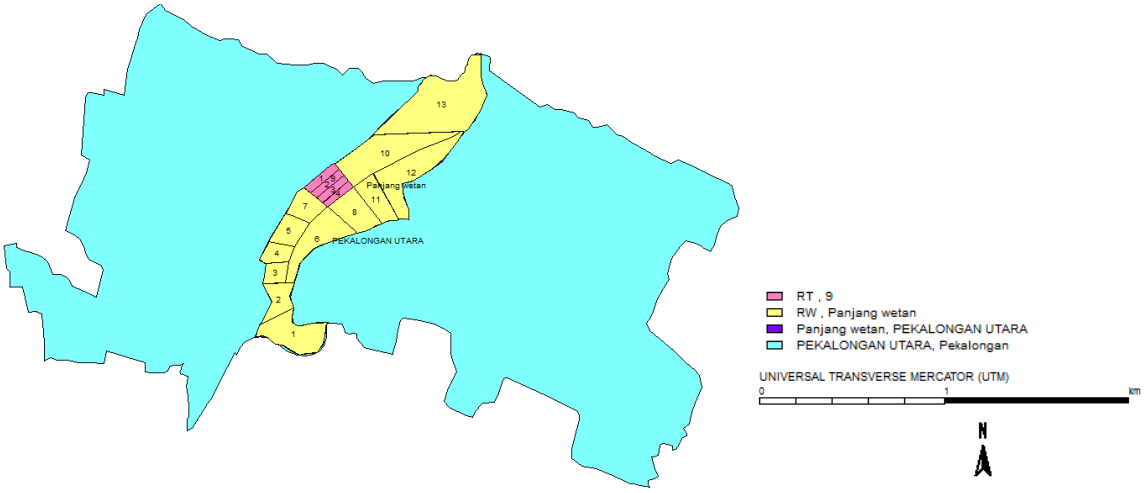


Figure 7. Map of *RT* and *RW* of sample area in Panjang Wetan

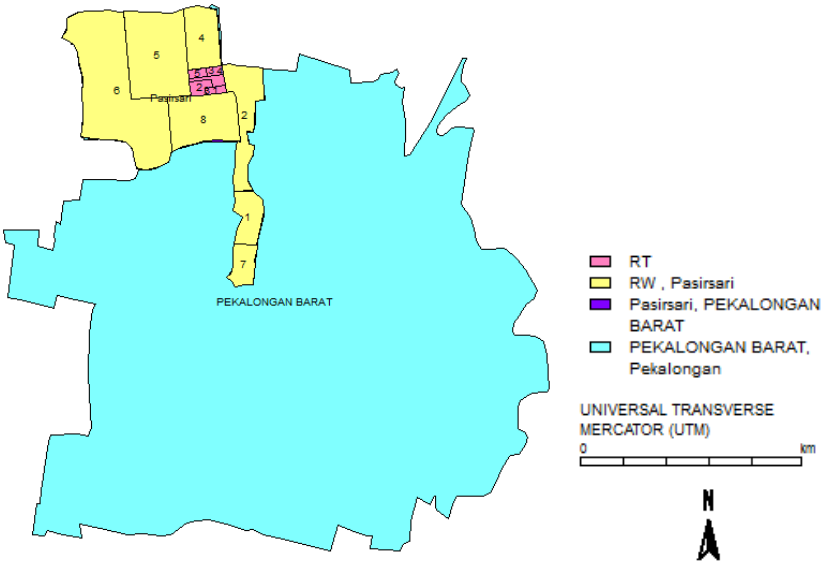


Figure 8 . Map of *RT* and *RW* of sample area in Pasarisari

4.1.2 Demography

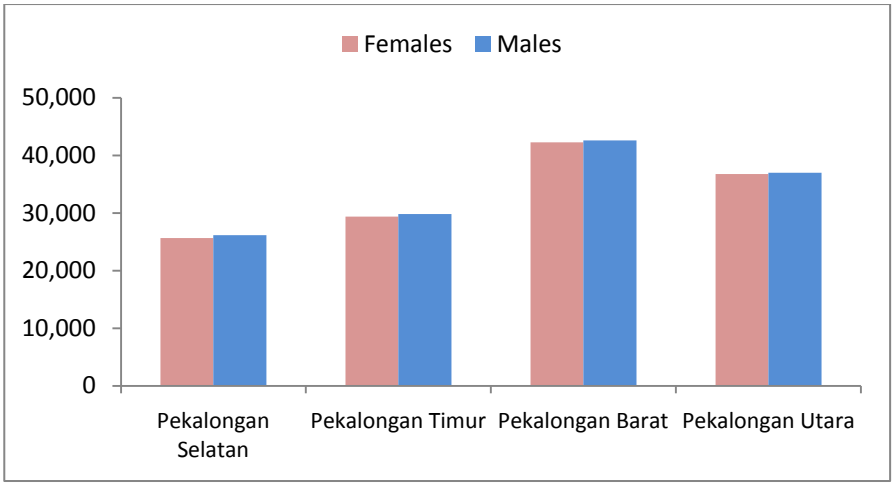
Most people in Kota Pekalongan live in the *kecamatan* of Pekalongan Barat. There are more than 84,000 people living there which represents 31% of Kota Pekalongan's total population (Table 2). This number is in line with the largest number of families living here (22,095 families) compared with others districts,. Pekalongan Barat also has the highest population density at 8,450 people per km^2. Whilest the data shows that Pekalongan Selatan is the *kecamatan* with the lowest total population and population density at 4,799 people per km^2.

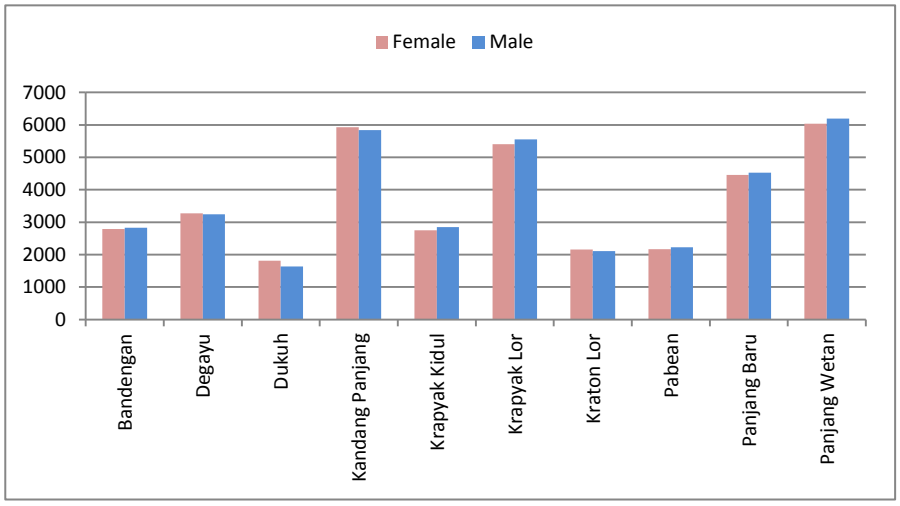
Table 2. Population statistics for Kota Pekalongan

***Kecamatan* (Subdistrict)**		**Total Persons**	**Total Households**	**Area (Km^2)**	**Density per Km^2**
2008 census	Pekalongan Selatan	51,830	12,713	10.80	4,799
	Pekalongan Timur	59,178	15,476	9.52	6,216
2009 census	Pekalongan Barat	84,919	22,095	10.05	8,450
	Pekalongan Utara	73,778	19,556	14.88	4,958
TOTAL		269,705	69,840	45.25	5,960

Source: Author's calculation using CBMS Kota Pekalongan database.

In terms of gender, there is no significant difference in numbers amongst the population of Kota Pekalongan (Figure 9). The total number of females and males in the population is only slightly different in each of the *kecamatan*. The total number of males in the population is larger than females in each *kecamatan*, the same proportions also occur at the *kelurahan* level. Panjang Wetan is the *kelurahan* with the highest population in Pekalongan Utara.





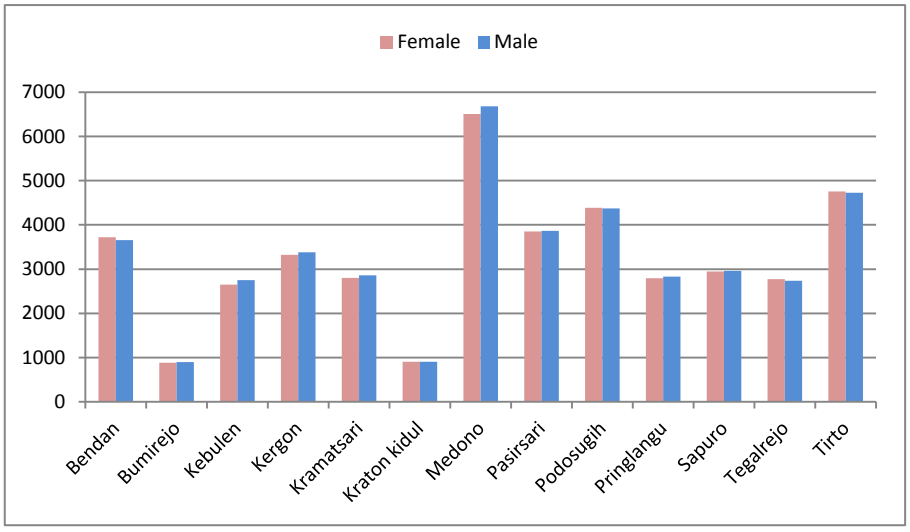


Figure 9. Population of Kota Pekalongan by gender

Source: Authors calculation using CBMS Kota Pekalongan database.

4.1.3 Social and economic condition

According to the CBMS database, most of the citizens residing in Kota Pekalongan are working as casual laborers (Table 3). Kota Pekalongan is also known as "the batik city", where 7% of people in the working population are employed in the batik industry as laborers, painters, finishers, or business/gallery owners. Textiles and fisheries provide the main export commodity in Pekalongan according to Kota Pekalongan government statistics from 2009. Almost 2% of the working population in Pekalongan are employed in the fishing industry.

Table 3. Main work of people in Kota Pekalongan

Main Work	Percentage
Casual laborer	26.71
Employee of private company	13.74
Trader	10.96
Entrepreneur	7.48
Batik laborer/painter/finisher /owner	7.27
Stitcher	2.63
Civil servant	2.54
Becak/pedicab driver	2.00
Fishing laborer/fisher/fishing industry worker	1.98
Farmer/farm hand laborer	0.93
Husbandry farmer	0.14
Others	23.62
Total	100

Source: Authors calculation using CBMS Kota Pekalongan database.

The poverty situation in Kota Pekalongan can be seen from some of the Healthy and clean life behavior (PHBS) categories. The government of Indonesia has announced PHBS program since 1996. One of the conditions of a healthy house is the area of a house must be at least 8m² per person. This can be an indicator of poverty in terms of cramped or substandard housing. In Kota Pekalongan there are only 10 to 13 percent of

households in each *kabupaten* who live in a house less than 8m² per person (Table 4). Pekalongan Utara is the *kecamatan* with the highest amount ofhouseholds living in poor housing conditions.

Table 4. Percentage of household with poor housing condition

***Kecamatan* (Subdistrict)**	**Percentage of Household with Poor Housing Condition <8m² per capita**
Kecamatan Selatan	11.11
Kecamatan Timur	10.82
Kecamatan Barat	12.76
Kecamatan Utara	12.91

Source: Authors calculation using CBMS Kota Pekalongan database.

4.2 Climate hazard

According to the results of FGDs and in-depth interviews in Kota Pekalongan, there have been four types of climate hazards experienced there recently; namely floods, coastal inundation caused by a rise in sea levels, landslides, and cyclones. Floods and coastal inundation commonly occur in Kota Pekalongan. The data of CBMS Kota Pekalongan indicates that more than a quarter of households in Kota Pekalongan are vulnerable to floods with Pekalongan Utara being the most vulnerable *kecamatan* (Table 5). The number of households in Kota Pekalongan that are vulnerable to coastal inundation totals 12%. Coastal inundation commonly occured in Pekalongan Utara and Pekalongan Timur. According to interviews with some people in Kota Pekalongan, landslides infrequently happened there and usually only along the banks of the rivers. It is estimated that 4% of households in Kota Pekalongan are vulnerable to landslide. Most of these households are located in Pekalongan Utara and Pekalongan Barat. In 2008 cyclones occured in Pekalongan Utara (*Kelurahan* Degayu) and Pekalongan Barat (*Kelurahan* Sapuro). Unfortunately there is no specific data about the incidences of cyclones in the CBMS database.

Table 5. Incidence of floods, coastal inundation, and landslides at the *kecamatan* level

***Kecamatan* (Sub-district)**		**Floods**		**Coastal inundation**		**Landslide**		**Total Households**
		N	**%**	**N**	**%**	**N**	**%**	
2008 census	**Pekalongan Selatan**	1,591	*12.51*	154	*1.21*	142	*1.12*	12,713
	Pekalongan Timur	2,825	*18.25*	695	*4.49*	107	*0.69*	15,476
2009 census	**Pekalongan Barat**	6,289	*28.46*	428	*1.94*	186	*0.84*	22,095
	Pekalongan Utara	7,591	*38.82*	6,804	*34.79*	224	*1.15*	19,556
	Total	**18,296**	***26.20***	**8,081**	**11.57**	**659**	**3.80**	**69,840**

Source: Authors calculation using CBMS Kota Pekalongan database.

The exposure to climate change index describes coastal inundation, floods, and landslide hazards and transfers this information onto a map of exposure (Figure 10). The darker areas on the map show most exposure in that area, while the lighter color shows less exposure has occurred in that area. It shows that Pekalongan Utara and Pekalongan Barat are the most vulnerable amongst the other *kecamatan*. Pekalongan Timur is the *kecamatan*with the least exposure to climate hazards which is reflected by its white high exposure index. It is not surprising that Pekalongan Utara is the most vulnerable *kecamatan* in terms of exposure because of its location. The northern border of Pekalongan Utara is the Java Sea which periodically causes direct coastal inundation of this area. Therefore the qualitative approach in this study is focuses on floods and coastal inundation in Pasirsari (Pekalongan Barat) and Panjang Wetan (Pekalongan Utara) as *kelurahan* samples.

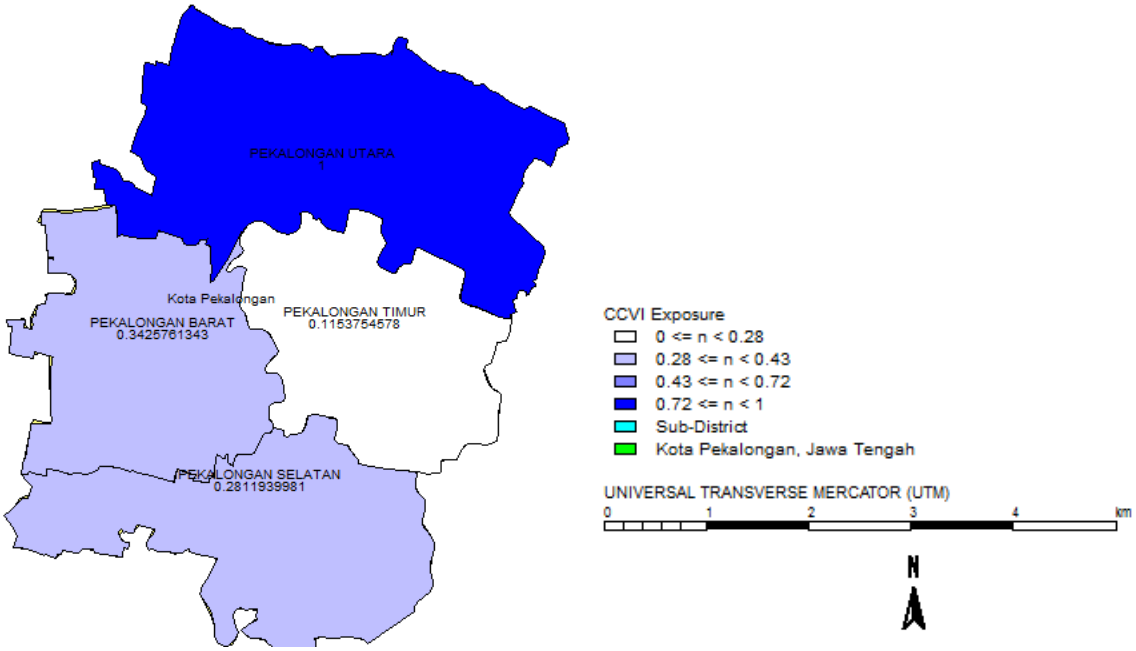


Figure 10. Climate change exposure map of Kota Pekalongan

Source: Authors calculation.

Table 6. Climate change exposure index of Kota Pekalongan

Kecamatan	**Floods**	**SLR**	**Landslide**	**Exposure Index**
Pekalongan Barat	0.236484	0.0067	0.099393	0.342576
Pekalongan Timur	0.085101	0.030274	0	0.115375
Pekalongan Selatan	0	0	0.281194	0.281194
Pekalongan Utara	0.39	0.31	0.3	1

Source: Authors calculation.

Along with that finding, this study focuses on the climate hazards in two of the most vulnerable *kecamatan*. which are Pekalongan Barat and Pekalongan Utara. In Pekalongan Barat, most households who are vulnerable to floods live in *Kelurahan* Pasirsari (23% of households) (Table 7). Households in Pasirsari are also vulnerable to coastal inundation (70% households). In Pekalongan Utara, *Kelurahan* Panjang Wetan is the *kelurahan* most vulnerable to floods and Krapyak Lor the most vulnerable to coastal inundation and landslides. Despite the large percentage of households that are vulnerable to landslides, it is not considered to be significant in terms of the total number of households especially when compared with the exposure of the others.

Table 7. Incidence of floods, coastal inundation, and landslide in *kelurahan* level in 2009 (%)

Kecamatan Pekalongan Barat					**Kecamatan Pekalongan Utara**				
No	***Kelurahan***	**Floods**	**Coastal Inundation**	**Landslide**	**No**	***Kelurahan***	**Floods**	**Coastal inundation**	**Landslide**
1	BENDAN	11.43	2.8	4.84	1	BANDENGAN	3.5	0.9	4.02
2	BUMIREJO	1.37	0.23	1.08	2	DEGAYU	2.96	1.34	3.13
3	KEBULEN	8.57	1.87	16.13	3	DUKUH	2.46	0.03	0.45
4	KERGON	9.72	10.75	22.58	4	KANDANG PANJANG	9.7	8.01	14.73
5	KRAMAT SARI	3.53	0.7	0.54	5	KRAPYAK KIDUL	6.2	4.2	12.50
6	KRATON KIDUL	2.05	0.23	0.54	6	KRAPYAK LOR	15.16	26.98	26.34
7	MEDONO	6.54	5.14	4.84	7	KRATON LOR	1.61	0.28	2.23
8	PASIRSARI	22.69	70.09	10.22	8	PABEAN	14.31	12.33	5.36
9	PODOSUGIH	5.12	1.17	2.15	9	PANJANG BARU	19.65	25.03	9.82
10	PRINGLANGU	4.4	1.4	8.06	10	PANJANG WETAN	24.44	20.9	21.43
11	SAPURO	6.49	1.17	4.84					
12	TEGALREJO	1.62	0.23	2.15					
13	TIRTO	16.47	4.21	22.04					
Total households		**100 (n=6,289)**	**100 (n=428)**	**100 (n=186)**	**Total households**		**100 (n=7,591)**	**100 (n=6,804)**	**100 (N=224)**

Source: Authors calculation.

The exposure to climate hazards at the *kelurahan* level shows that most *kelurahan* located in the north and west areas of Pekalongan are more exposed to climate hazards. This is indicated by the dark blue color on the map (Figure 11). *Kelurahan* located in south and east Kota Pekalongan are facing less exposure to the three climate hazards. *Kelurahan* Pabean has the highest climate exposure and Duwet has the lowest exposure.

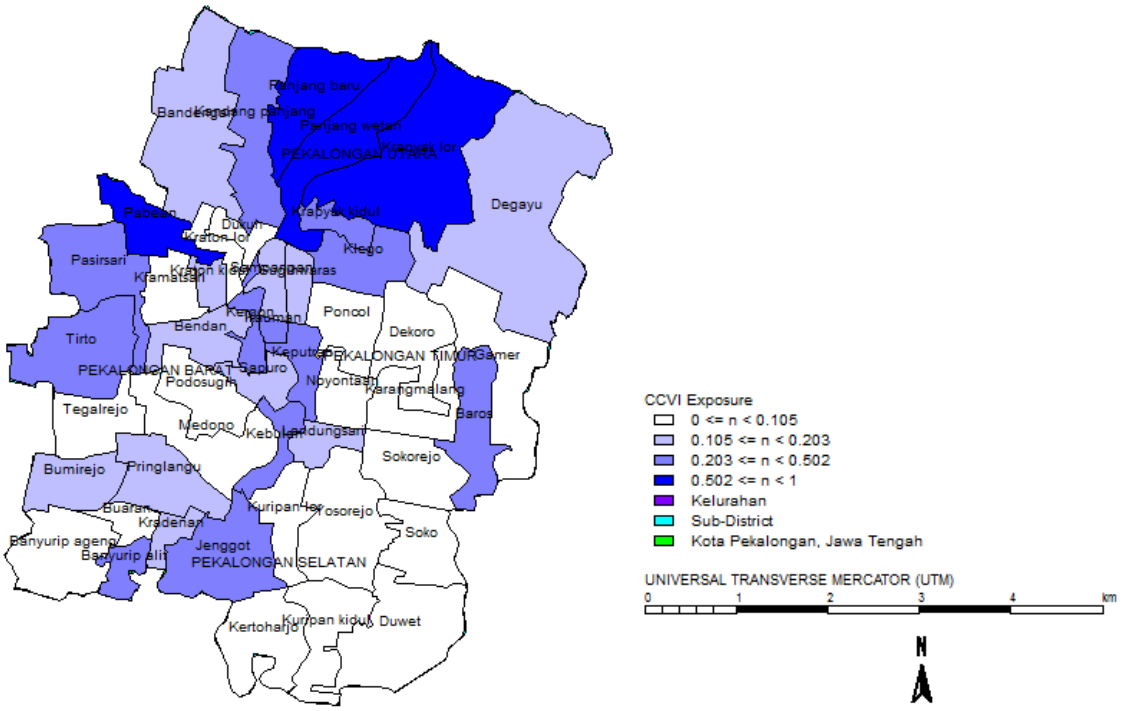


Figure 11. Climate change exposure map at *kelurahan* level in Kota Pekalongan

Source: Authors calculation.

Table 8. Climate change exposure index at *kelurahan* level in Kota Pekalongan

Kecamatan	***Kelurahan***	**Floods**	**SLR**	**Landslide**	**Exposure Index**
Pekalongan Utara	Pabean	0.39	0.31	0.101	0.801
Pekalongan Utara	Krapyak Lor	0.172	0.282	0.211	0.665
Pekalongan Utara	Panjang Baru	0.263	0.309	0.09	0.662
Pekalongan Utara	Panjang wetan	0.228	0.181	0.141	0.55
Pekalongan Timur	Klego	0.194	0.127	0.13	0.45
Pekalongan Barat	Pasirsari	0.28	0.061	0.087	0.428
Pekalongan Selatan	Jenggot	0.106	0.016	0.3	0.423
Pekalongan Utara	Krapyak Kidul	0.131	0.083	0.19	0.403
Pekalongan Barat	Kebulen	0.16	0.002	0.218	0.38
Pekalongan Barat	Kergon	0.137	0.011	0.231	0.379

Pekalongan Timur	Kauman	0.174	0.002	0.192	0.368
Pekalongan Barat	Tirto	0.174	0.003	0.166	0.344
Pekalongan Utara	Kandang Panjang	0.095	0.073	0.101	0.269
Pekalongan Timur	Baros	0.211	0.001	0.045	0.256
Pekalongan Timur	Keputran	0.072	0.006	0.164	0.242
Pekalongan Selatan	Banyurip Alit	0.086	0.005	0.117	0.207
Pekalongan Selatan	Kradenan	0.078	0.004	0.118	0.2
Pekalongan Barat	Bendan	0.144	0.002	0.039	0.185
Pekalongan Barat	Pringlangu	0.075	0.002	0.097	0.174
Pekalongan Barat	Sapuro	0.104	0.001	0.051	0.157
Pekalongan Timur	Sampangan	0.101	0.002	0.047	0.15
Pekalongan Utara	Bandengan	0.066	0.016	0.05	0.133
Pekalongan Barat	Kraton Kidul	0.102	0.001	0.013	0.117
Pekalongan Timur	Sugihwaras	0.019	0.002	0.095	0.115
Pekalongan Timur	Bumirejo	0.075	0.001	0.037	0.113
Pekalongan Barat	Landungsari	0.062	0.002	0.049	0.113
Pekalongan Utara	Degayu	0.052	0.022	0.035	0.11
Pekalongan Selatan	Kuripan Lor	0.006	0.003	0.089	0.099
Pekalongan Selatan	Banyurip Ageng	0.064	0.001	0.029	0.095
Pekalongan Timur	Dekoro	0.036	0.003	0.052	0.091
Pekalongan Utara	Dukuh	0.079	0.001	0.004	0.084
Pekalongan Timur	Sokorejo	0.043	0.001	0.033	0.076

Pekalongan Timur	Poncol	0.041	0.003	0.03	0.074
Pekalongan Barat	Medono	0.05	0.003	0.021	0.073
Pekalongan Utara	Kraton lor	0.035	0.001	0.036	0.073
Pekalongan Barat	Podosugih	0.058	0.001	0.012	0.071
Pekalongan Selatan	Buaran	0.038	0.001	0.029	0.069
Pekalongan Barat	Kramatsari	0.06	0.001	0	0.061
Pekalongan Selatan	Soko	0.002	0.002	0.056	0.059
Pekalongan Timur	Tegalrejo	0.028	0	0.022	0.051
Pekalongan Barat	Karangmalang	0.014	0.002	0.035	0.051
Pekalongan Timur	Noyontaan	0.026	0.001	0.023	0.05
Pekalongan Selatan	Yosorejo	0.005	0.001	0.029	0.036
Pekalongan Selatan	Kuripan Kidul	0.004	0	0.019	0.024
Pekalongan Selatan	Kertoharjo	0	0.001	0.02	0.021
Pekalongan Timur	Gamer	0.004	0	0.003	0.008
Pekalongan Selatan	Duwet	0	0	0.005	0.006

Source: Authors calculation.

According to information sourced from the focus group discussions, the first flood happened in Kota Pekalongan in 1972. Almost all areas in Kota Pekalongan were flooded at that time because of a damaged dam. That incident caused water to flow to the residential area as high as 70cm or up to chest height for those people living along or close to the river bank. This was the worst flooding incident in Kota Pekalongan's recent history.

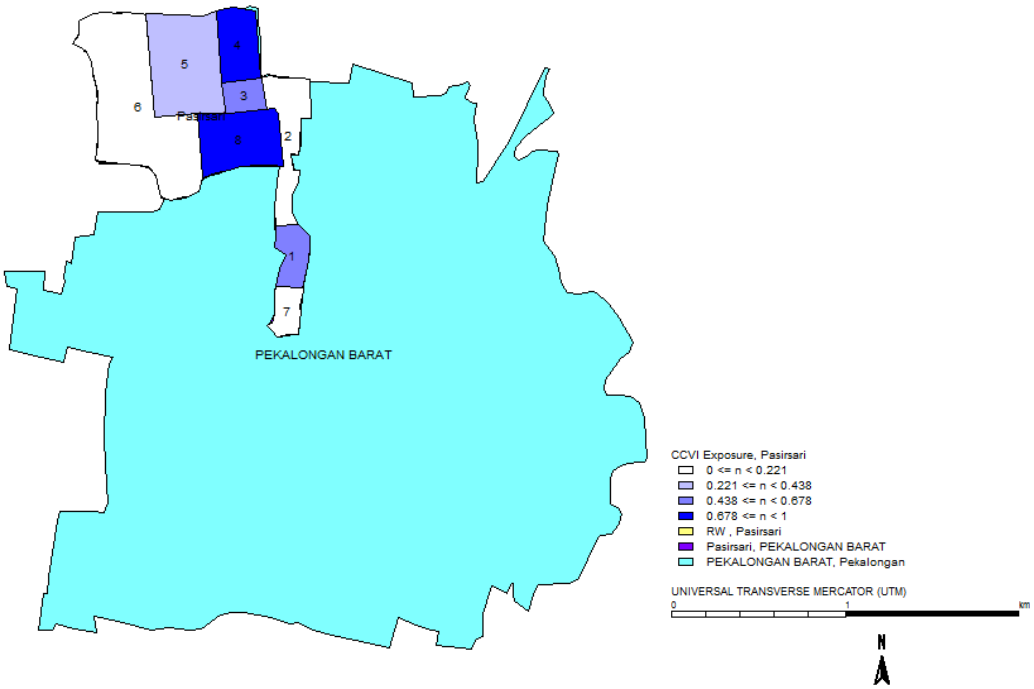


Figure 12. Climate change exposure index at *RW* level of Pasirsari in Kota Pekalongan

Source: Authors calculation.

Table 9. Climate change exposure index at *RW* level of Pasirsari in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Floods**	**SLR**	**Landslide**	**Exposure Index**
Pekalongan barat	Pasirsari	1	0.390	0.018	0.112	0.519
Pekalongan barat	Pasirsari	2	0.000	0.004	0.000	0.004
Pekalongan barat	Pasirsari	3	0.360	0.039	0.186	0.585
Pekalongan barat	Pasirsari	4	0.371	0.310	0.238	0.919
Pekalongan barat	Pasirsari	5	0.382	0.004	0.051	0.437
Pekalongan barat	Pasirsari	6	0.129	0.027	0.038	0.195
Pekalongan barat	Pasirsari	7	0.095	0.000	0.000	0.095
Pekalongan barat	Pasirsari	8	0.342	0.111	0.300	0.753

Source: Authors calculation.

In Pasirsari, flooding has occured every year since 1972 (Table 10), mainly in the rainy season. Coastal inundation in Pasirsari happened for the first time in 2006. The rise

in sea levels causes coastal inundation to knee depth. During 2006, coastal inundation occured consistenly for almost three months of the year and usually occured in the morning but had subsided by the afternoon. The worst case of coastal inundation in Pasirsari took place in 2010. It caused floods with thigh-high water levels for almost half a year in 2010 and the sea level rose unpredictably every morning and afternoon. In 2010 the incidence of coastal inundation was very similar to the situation in 2006.

According to FGD, in the beginning only households situated in the northern part of Pasirsari suffered from rising sea levels (*RW* 3, *RW* 4, and *RW* 6) but recently seawater has also intruded into the southern areas of Pasirsari (*RW* 8). Coastal inundation in Pasirsari has become even more frequent since the local government decided to split the Besar River into the Bermi and Meduri Rivers. This caused seawater to intrude into the land far more quickly. The impact of coastal inundation becomes much worse when it coincides with floods caused by heavy and seasonal rain. The map of exposure index at *RW* level in Pasirsari shows that the most vulnerable *RW* are *RW* 1, *RW* 3, *RW* 4, and *RW* 8. It is shown by the darker blue *RW* (Figure 12). At the *RT* level, *RT* 2 and *RT* 4 are the higest exposure climate hazard (Figure 13).

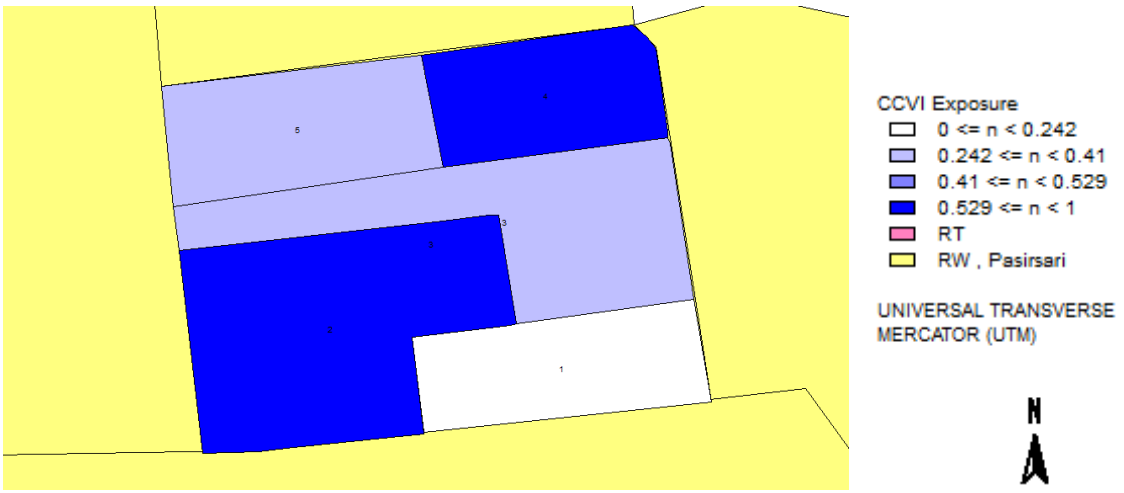


Figure 13. Climate change exposure index at *RT* level of *RW* 3 Pasirsari in Kota Pekalongan

Source: Authors calculation.

As flood is one of the climate hazard that describe exposure, the map of climate change flood index at *RT* level shows that the most vulnerable *RT* from floods are *RT* 3, *RT* 4, and *RT* 5 (Figure 14). It is indicated by the dark blue map. At the household level, most of floods incidence are experienced by household which located in *RT* 3, *RT* 4, and *RT* 5. It shows by red dots. The dots indicate the household location. In term of coastal inundation, *RT* 1 and *RT* 2 are the most vulnerable from this climate hazard (Figure 15). Although there is no landslide incidence in Pasirsari according to FGD, the CBMS data shows that there are three households experience landslide in there. The landlide index

shows that *RT* 1 and *RT* 4 are the most vulnerable *RT* indicated by the blue map color (Figure 16).

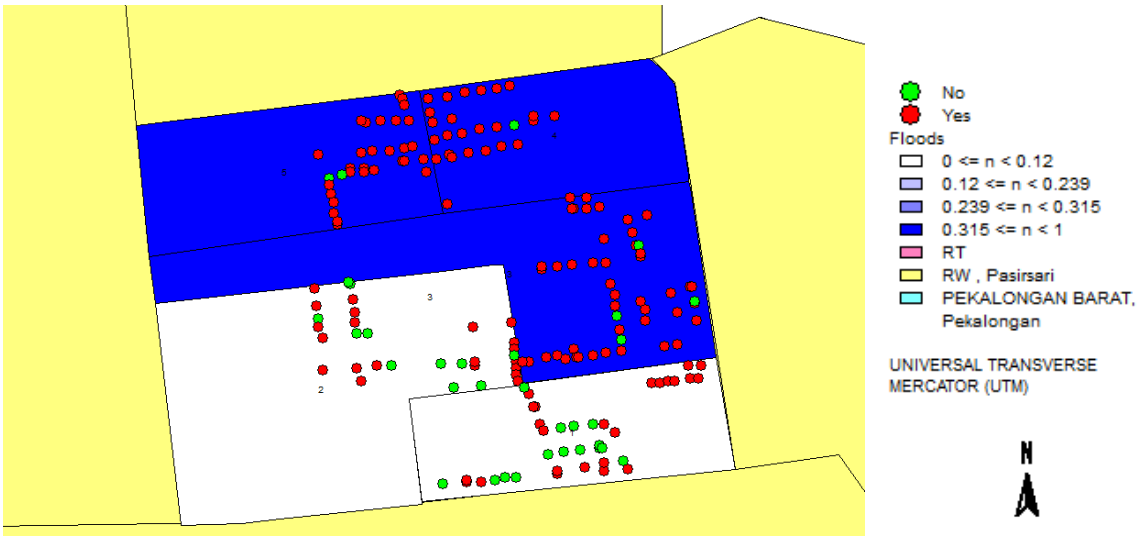


Figure 14. Climate change floods index at *RT* level and floods incidence at households level of *RW* 3 Pasirsari in Kota Pekalongan

Source: Authors calculation.

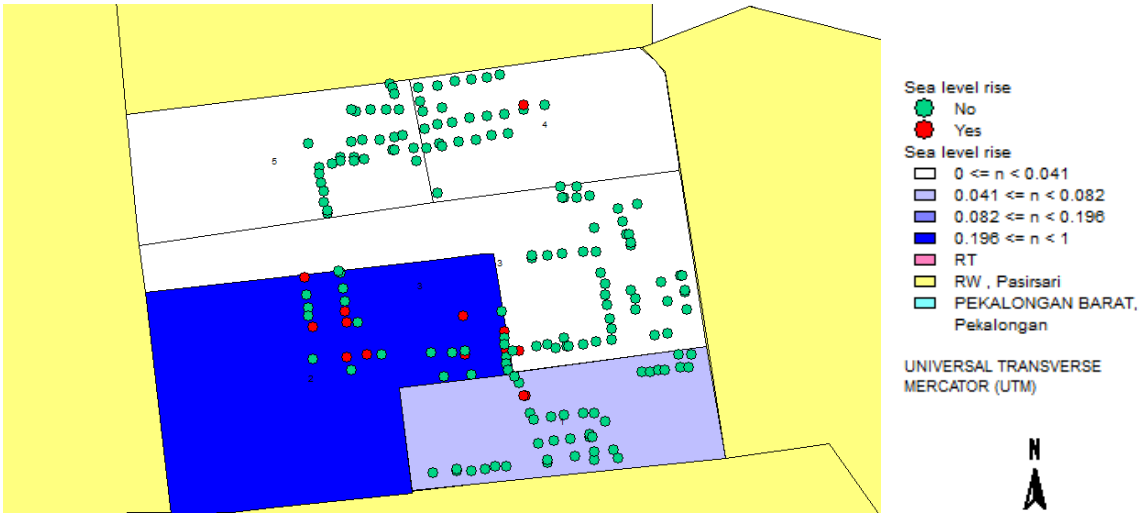


Figure 15. Climate change sea level rise index at *RT* level and floods incidence at households level of *RW* 3 Pasirsari in Kota Pekalongan

Source: Authors calculation.

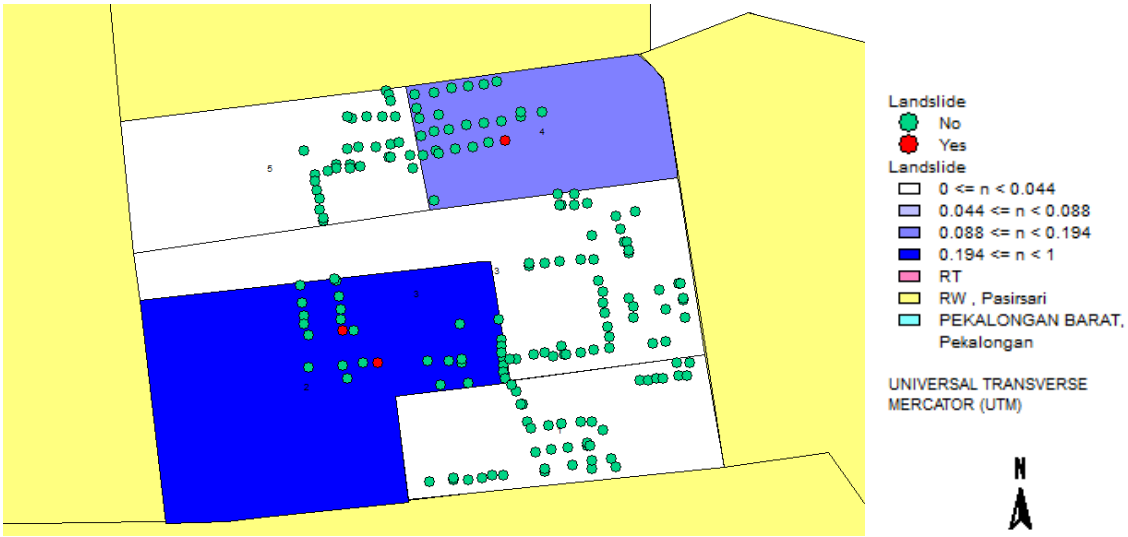


Figure 16. Climate change landslide index at *RT* level and floods incidence at households level of *RW* 3 Pasirsari in Kota Pekalongan

Source: Authors calculation.

Table 10. Flood and coastal inundation incident in Pasirsari and Panjang Wetan

	Pasirsari	**Panjang Wetan**
Flood	Every year (rainy season)	Every Year (torrential rains)
Coastal inundation	2006, 2010, 2011	2008, 2010, 2011

Source: Focus group discusion at *kelurahan* level, Kota Pekalongan.

Flooding occurs in the lowest land areas of Panjang Wetan every year, usually coinciding with torrential and seasonal rains (Figure 10). In 1992 a flood reached knee high levels in areas of Panjang Wetan. Different to the case of Pasirsari, floods in Panjang Wetan have become less frequent after the government finished a project to split the river. Coastal inundation first happened in Panjang Wetan in 2008. The seawater level reached 50cm or knee high levels (FGD). At that time almost all areas in Panjang Wetan were flooded as a result of the rise in sea levels except for *RW* 2, *RW* 3, *RW* 4 and *RW* 5. This information is inline with the exposure map where these *RW* are the least exposure *RW* shown by the white map (Figure 17). In 2010, the incidence of coastal inundation occuring together with floods caused by torrential rains increased. In 2011, the frequency of coastal inundation becomes more frequent with a lower flooding level. The incidence of coastal inundation in Panjang Wetan is hard to predict. It might happen in the morning at around 2 a.m., 7–10 a.m., or in the afternoon. As was the case in Pasirsari, the impact of coastal inundation in Panjang Wetan is made much worse when it coincides with flooding caused by rain.

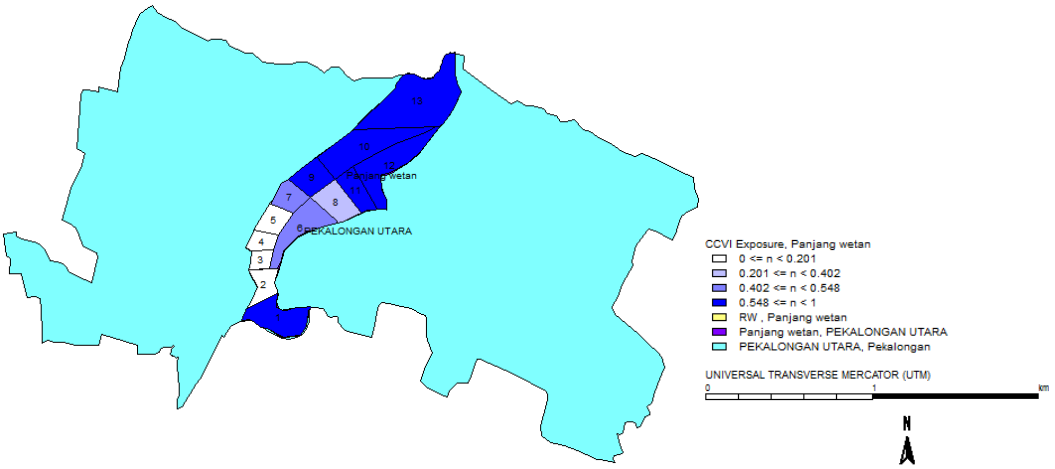


Figure 17. Climate change exposure index at *RW* level of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

Table 11. Climate change exposure index at *RW* level of Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Floods**	**SLR**	**Landslide**	**Exposure Index**
Pekalongan utara	Panjang wetan	1	0.369	0.213	0.112	0.694
Pekalongan utara	Panjang wetan	2	0.014	0.003	0.000	0.016
Pekalongan utara	Panjang wetan	3	0.000	0.000	0.000	0.000
Pekalongan utara	Panjang wetan	4	0.000	0.000	0.000	0.000
Pekalongan utara	Panjang wetan	5	0.109	0.001	0.000	0.110
Pekalongan utara	Panjang wetan	6	0.221	0.139	0.185	0.546
Pekalongan utara	Panjang wetan	7	0.311	0.006	0.103	0.420
Pekalongan utara	Panjang wetan	8	0.184	0.155	0.025	0.363
Pekalongan utara	Panjang wetan	9	0.390	0.108	0.067	0.565
Pekalongan utara	Panjang wetan	10	0.331	0.213	0.046	0.591
Pekalongan utara	Panjang wetan	11	0.200	0.185	0.300	0.685
Pekalongan utara	Panjang wetan	12	0.175	0.265	0.154	0.594

Pekalongan utara	Panjang wetan	13	0.268	0.310	0.060	0.639

Source: Authors calculation.

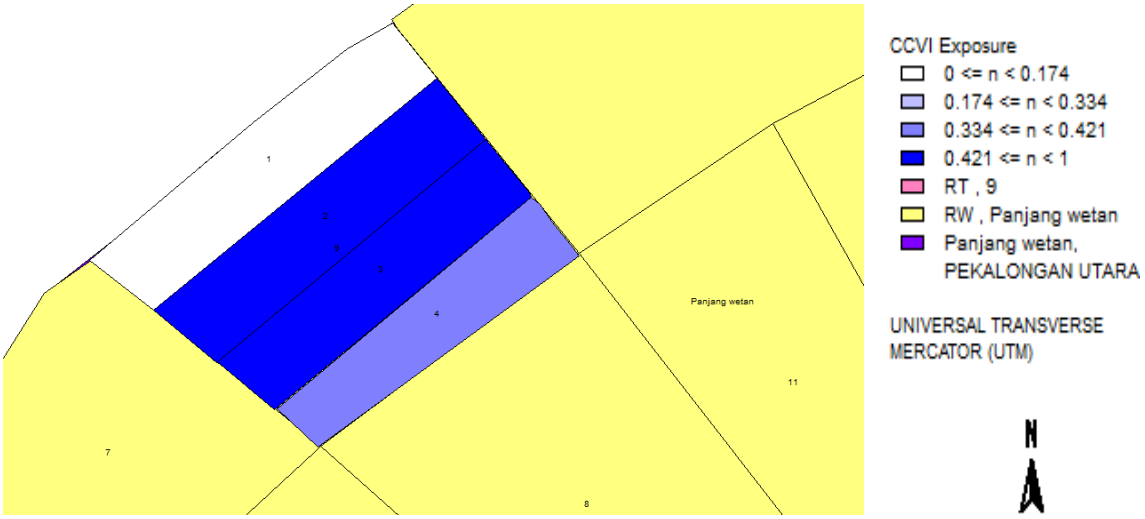


Figure 18. Climate change exposure index at *RT* level of *RW* 9 Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

Climate change exposure index at *RT* level in Panjang Wetan shows that *RT* 2 and *RT* 3 experience the higest exposure climate hazard (Figure 18). In term of floods the map of climate change flood index at *RT* level shows that the most vulnerable *RT* from floods is *RT* 4 (Figure 19) which is indicated by the dark blue map. At the household level almost every households in *RW* 9 in Panjang Wetan experience the floods incidence. In term of coastal inundation, *RT* 2 is the most vulnerable from this climate hazard (Figure 20). Similar with FGD result in Pasirsari, there is no landslide incidence in Panjang Wetan according to FGD but the CBMS data shows that there are two households in *RT* 3 who experience (Figure 21).

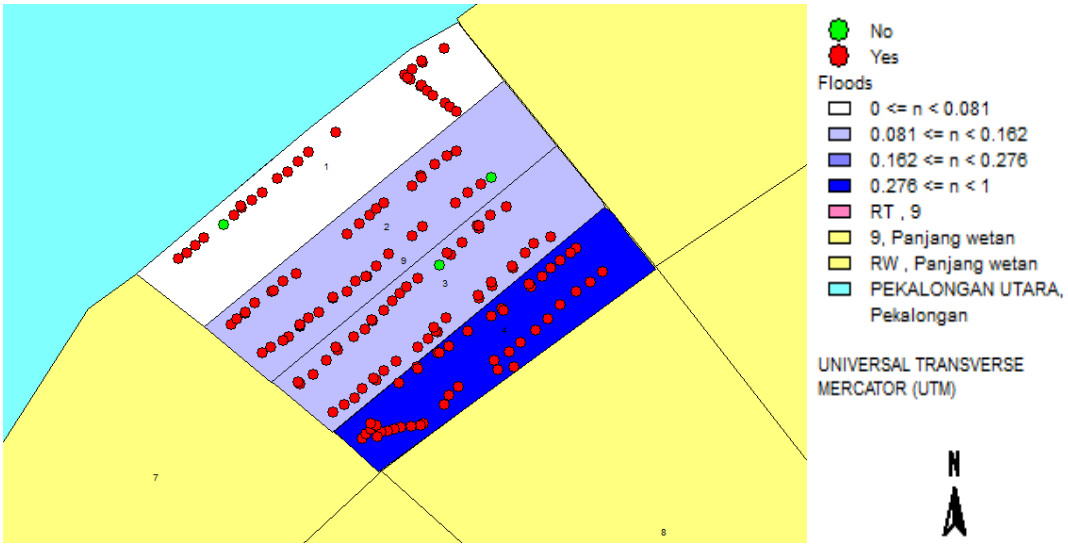


Figure 19. Climate change floods index at *RT* level and floods incidence at households level of *RW* 9 Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

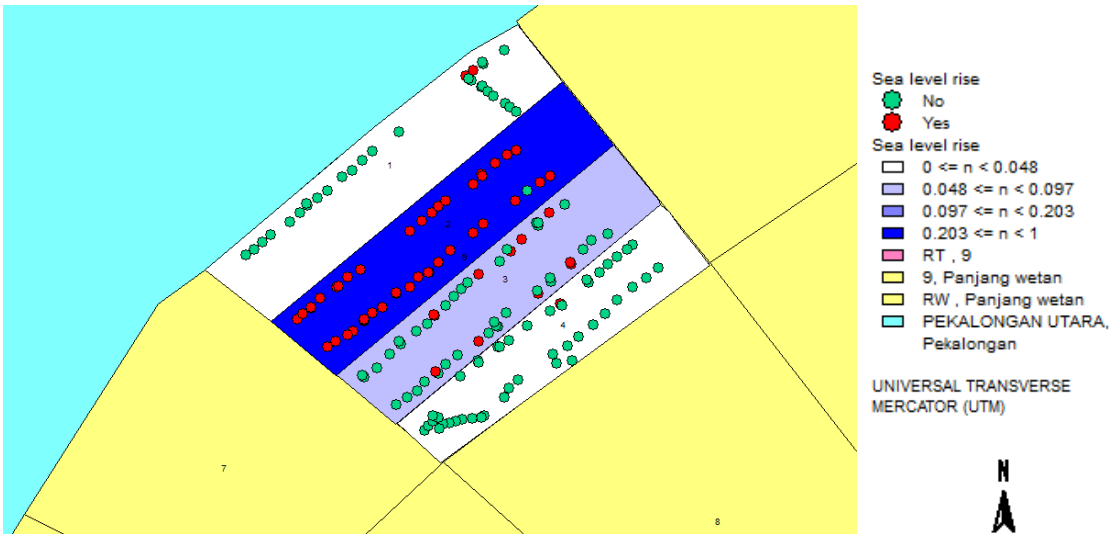


Figure 20. Climate change sea level rise index at *RT* level and floods incidence at households level of *RW* 9 Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

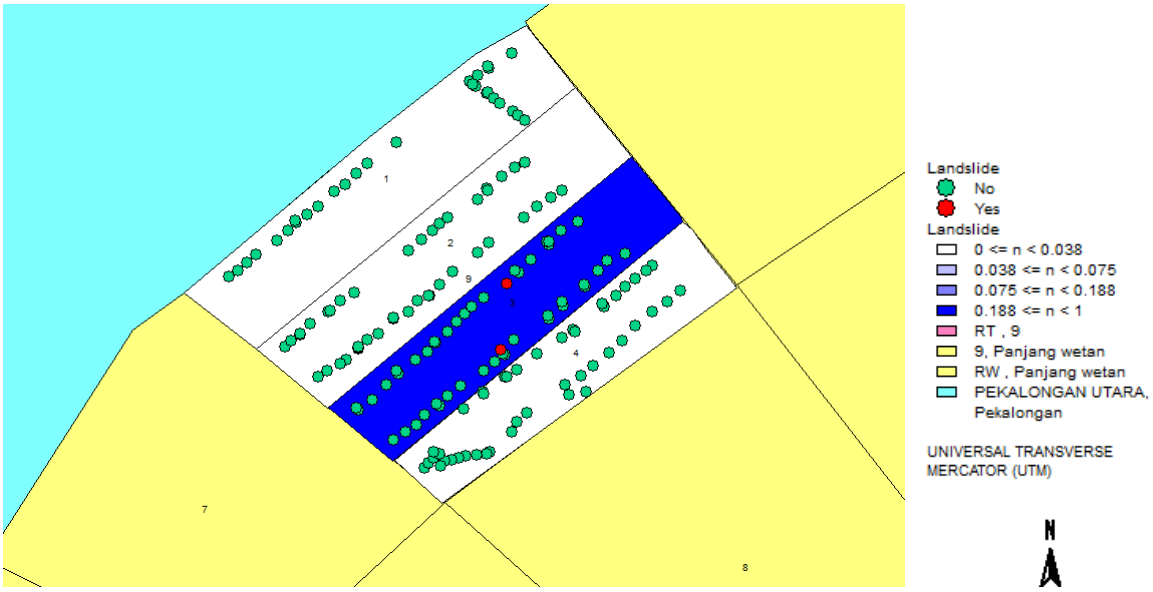


Figure 21. Climate change landslide index at *RT* level and floods incidence at households level of *RW* 9 Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

Table 12. Climate change exposure index at *RT* level of Pasirsari and Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	***RT***	**Floods**	**SLR**	**Landslide**	**Exposure Index**
Pekalongan utara	Panjang wetan	9	1	0.000	0.014	0.000	0.014
Pekalongan utara	Panjang wetan	9	2	0.113	0.310	0.000	0.423
Pekalongan utara	Panjang wetan	9	3	0.145	0.063	0.300	0.509
Pekalongan utara	Panjang wetan	9	4	0.390	0.000	0.000	0.390
Pekalongan barat	Pasirsari	3	1	0.000	0.075	0.000	0.075
Pekalongan barat	Pasirsari	3	2	0.039	0.310	0.300	0.649
Pekalongan barat	Pasirsari	3	3	0.377	0.000	0.000	0.377
Pekalongan barat	Pasirsari	3	4	0.390	0.027	0.142	0.558
Pekalongan barat	Pasirsari	3	5	0.390	0.000	0.000	0.390

Source: Authors calculation.

4.3 Cause of Climate Hazard

The main cause of flooding in Kota Pekalongan are torrential rains and unmanaged rivers. According to BMKG Semarang, there has been no alteration in rain intensity and patterns in Central Java. Flooding is most often caused by torrential rain falling in a short period of time. Unmanaged rivers impede the large amounts of rain water flowing into the sea and therefore they overflow into nearby residential areas. Unmanaged rivers are identified by having a lot of vegetation both in them and on their banks as well as being shallow. Shallow rivers are caused by a build-up of muddy deposits and sediment. In Panjang Wetan, the shallowing of rivers is not only caused by muddy deposits but also by sand dragged in by boats which pass from the sea into the river.

Coastal inundation is caused by rising sea levels flowing into normally dry residential areas. It usually happens when the peak height of the tidal wave is higher than 90cm. The sea water will flow from downstream towards the headwaters along the river or through the drainage system when the high tide occurs. The data of real time tidal wave monitoring in Semarang shows that highest tidal waves usually happen in the morning around 7 am to 8 am and at night around 9 pm (Figure 22).

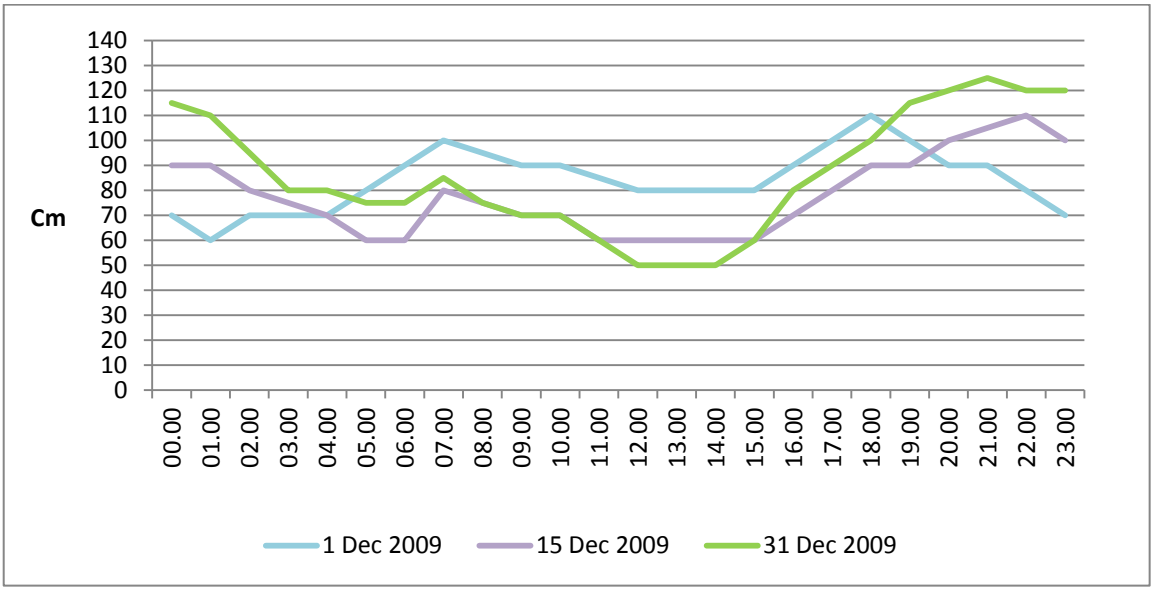


Figure 22. Real time tidal wave monitoring in Semarang, December 2009

Source: BMKG Semarang.

Other than that, the location of Kota Pekalongan which is situated in a lowland area also makes floods and coastal inundation more likely to happen. The high population density of a city will cause and increase in housing and building development, the consequences being less green areas and therefore less water absorption areas. These conditions will also affect the ability of floods and coastal inundation to quickly subside after the water has flooded the land.

4.4 Human and Ecological Sensitivity (Climate Change Impact on Physical Aspects & Household Livelihoods)

4.4.1 Economic sector

The impact of flooding caused by rain or rising sea levels are almost similar. Both of these hazards flood the land and effect the livelihoods of people. In Kota Pekalongan the most vulnerable economic sectors are; the batik and garment industry, the fishing industry, and the entire agricultural sector. Most people in Pasirsari are working in the batik industry and agricultural sectors. According to FDG in Pasirsari, the flooded land also disturbs the informal sector, such as the activities of informal traders. They have to close their kiosks when flooding or coastal inundation occurs. For those who work in the batik industry, the floods might affect the drying process of the batik material because normal drying areas are covered in puddles as well as a deterioration in the quality of the batik color because the immersion waters are contaminated. In the agricultural sector, flooding and coastal inundation are causing the land to become water-logged or saturated to the extent that the farmer cannot engage in farming. One hectare of a farm land might produce Rp30 million in agricultural produce annually. In Pasirsari there are examples of 50ha farms where half of the arable land area is flooded and cannot be cultivated because of constant flooding and coastal inundation.

Figure 23 .Traditional Drying Process of Batik in Pasirsari, Kota Pekalongan

According to working sector map of *RW* 3 in Pasirsari, most of households in there are working at batik sector. The households who are working in batik sector are scatter almost in every *RT* (Figure 24). Some of households are working at agrigulture sector and only a few who are working at fishery sector (Figure 25 and Figure 26).

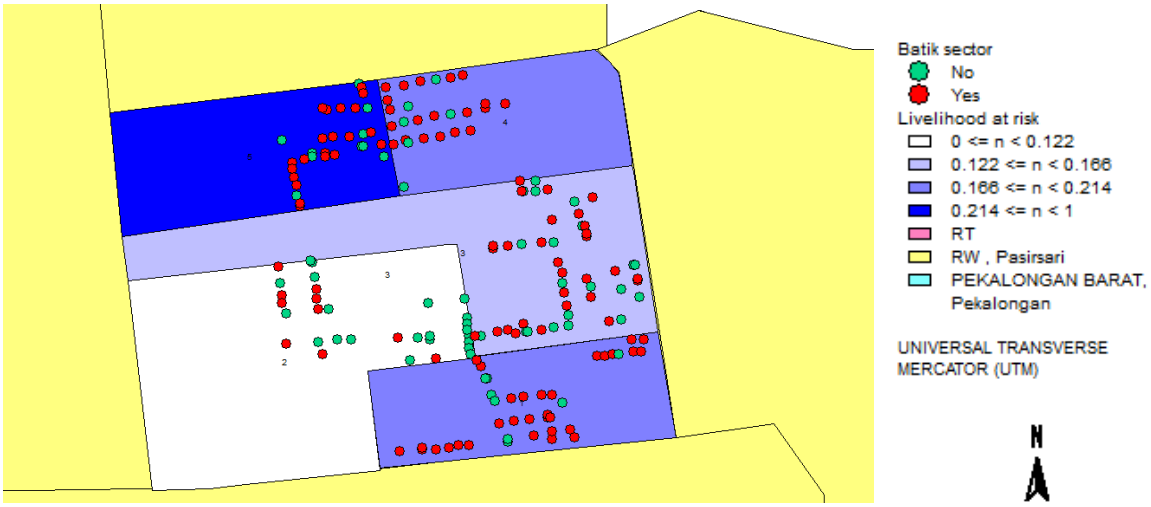


Figure 24. Households work in batik sector at *RW* 3 of Pasirsari in Kota Pekalongan

Source: Authors calculation.

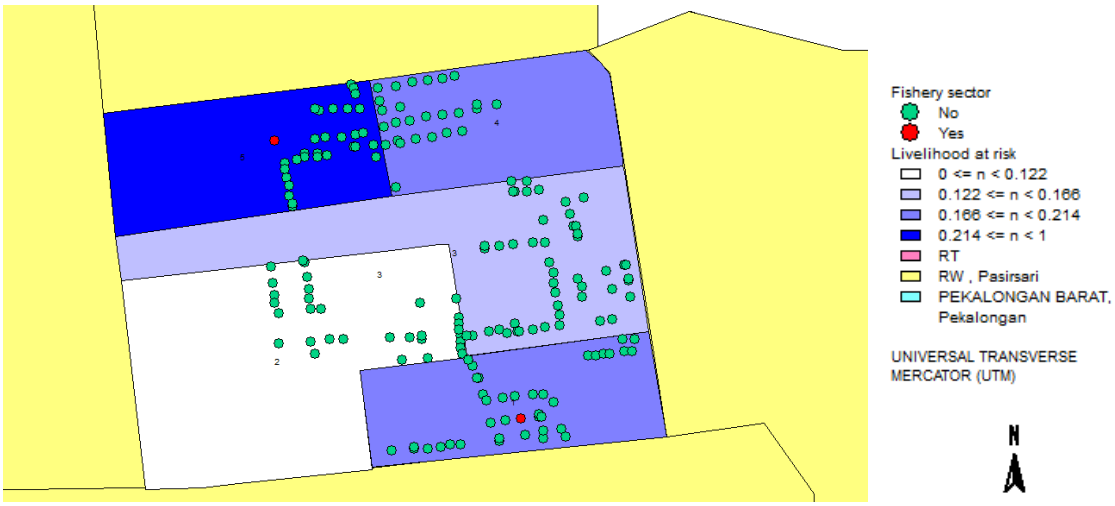


Figure 25. Households work in fishery sector at *RW* 3 of Pasirsari in Kota Pekalongan

Source: Authors calculation.

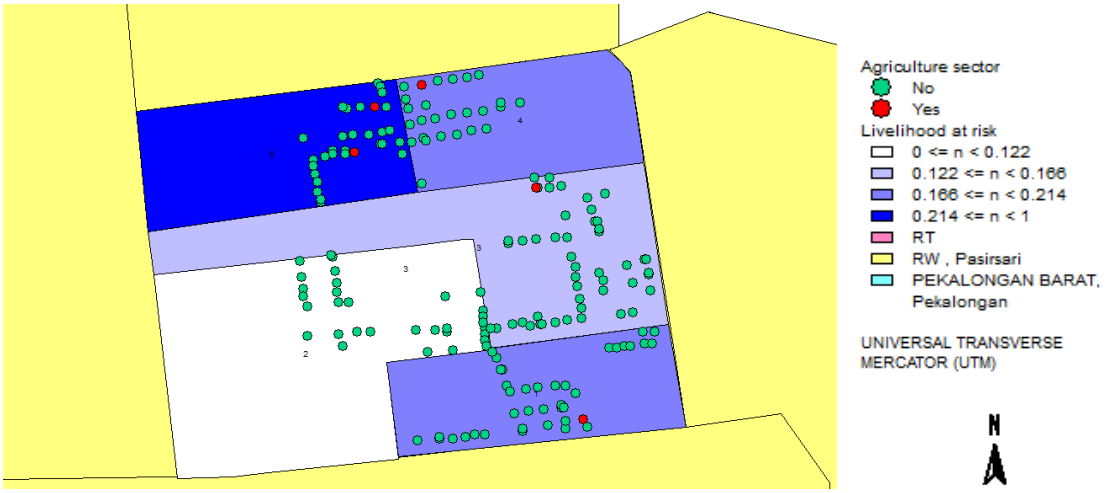


Figure 26. Households work in agriculture sector at *RW* 3 of Pasirsari in Kota Pekalongan

Source: Authors calculation.

Whilst in Panjang Wetan, most citizens are engaged in the fishing industry. Since 2006 fish catches in Kota Pekalongan have been decreasing (Figure 27). According to the FDG in Panjang Wetan, the fishers who are sailing out to sea are not affected by coastal inundation. Coastal inundation only affects people who are on land. However, the fishers admit that they now have to sail farther out to sea than before to find fish because of low fish catches. The low fish catches not only effect fishers but also the people employed in processing the catch and servicing the equipment used by the fishing industry. The porters who are employed to carry the fish from the boat to the fish market have now become unemployed. The manufacturing of ice, which is used to pack the fish for delivery to market are facing less demand for ice because of the low catches of fish. For those people engaged in fish farming, fishponds are often flooded and cause fish to drift out of the ponds during times of coastal inundation.

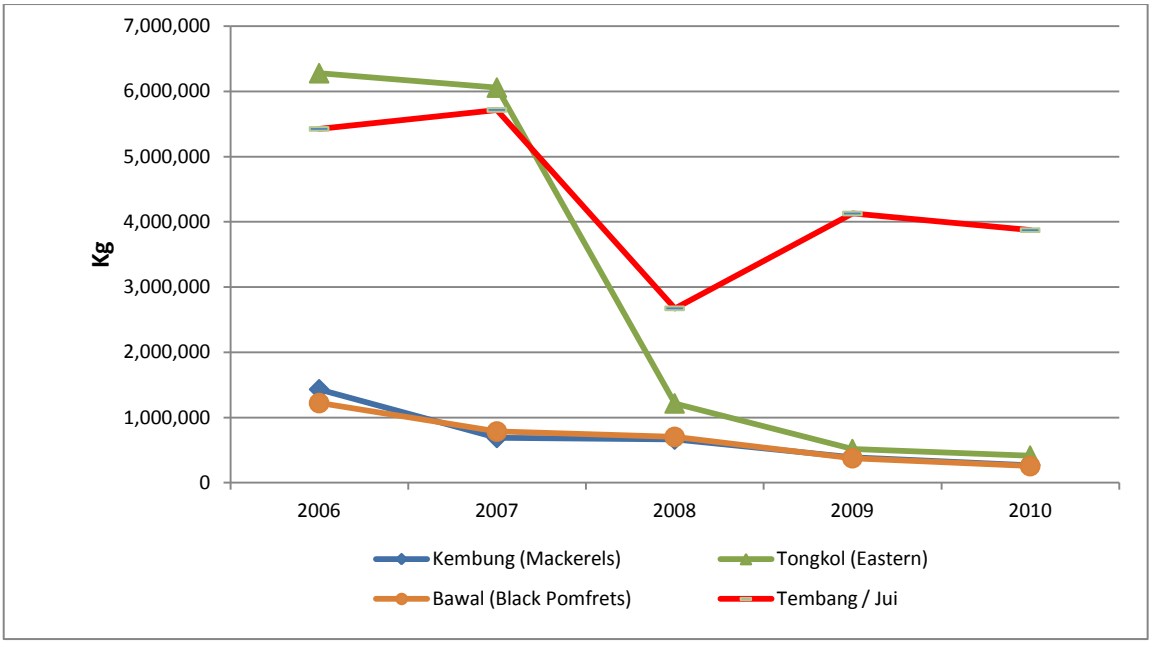


Figure 27. Fish catch in Kota Pekalongan

Source: DPPK.

The working sector map of household at *RW* 9 in Panjang wetan shows that most of households are working at fishery sector (Figure 29). The reason is because Panjang wetan located in north of Kota Pekalongan which is near to the Java sea. Only some of them are working at batik sector and none of them are working at agricultural sector.

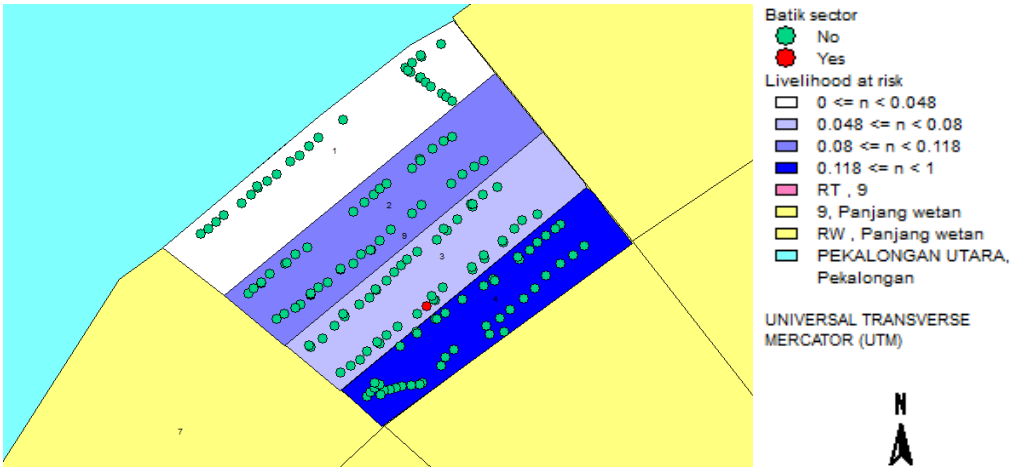


Figure 28. Households work in batik sector at *RW* 9 of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

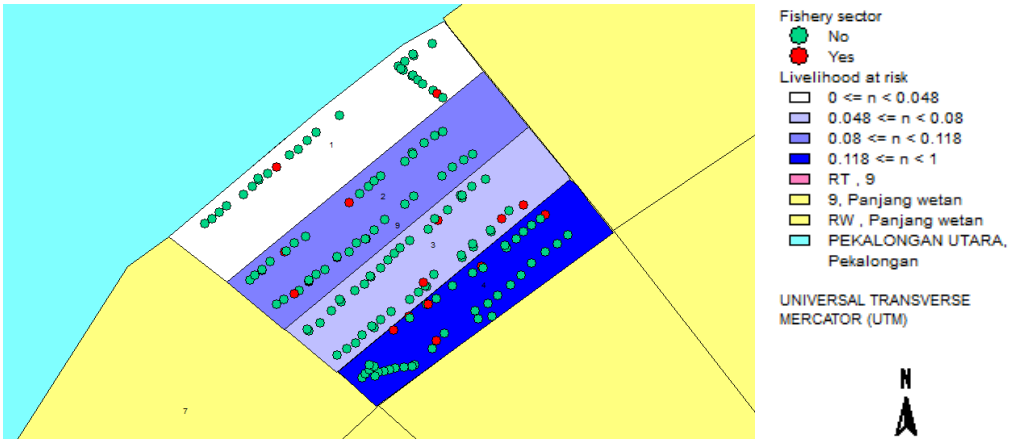


Figure 29. Households work in fishery sector at *RW* 9 of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

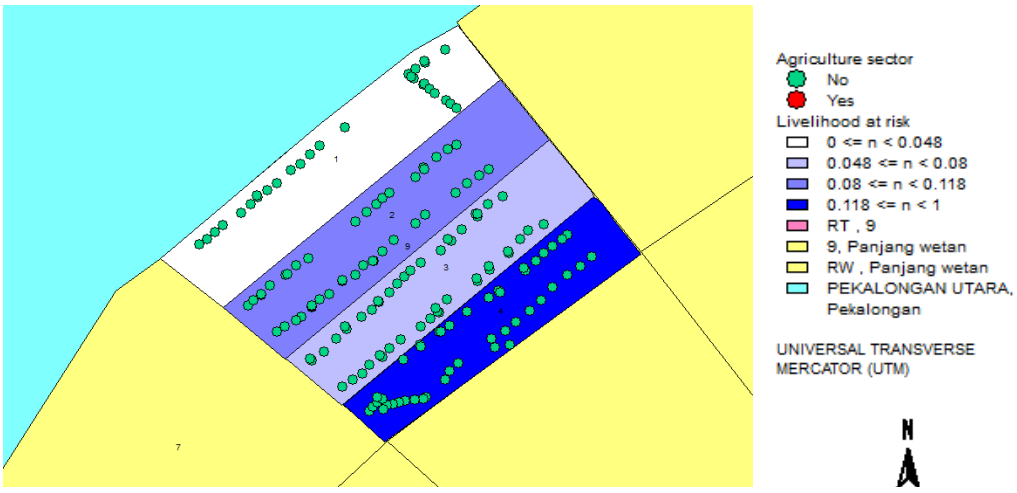


Figure 30. Households work in agriculture sector at *RW* 9 of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

4.4.2 Educational sector

Floods and coastal inundation affect school activities in Pasirsari and Panjang Wetan. Although the school buildings themselves are not effected by flood waters, the floods restrict access to the school and obstruct both teachers and students. Students are very likely not to attend school when access to their school is flooded. The school management usually postpones school activities during the flood until the water has subsided. Students whose houses are flooded cannot come to school and they often prefer to play with in the flood waters than go to school. As part of the FDG in Pasirsari, a teacher said that school activities would only be disturbed if floods and coastal inundation

occured at the same time because it has a greater impact than a separate flooding or coastal inundation incident.

According to the map of households who have schools student as household member, the existence of school students are scatter in almost everywhere (Figure 31 and Figure 32). The red dots in the map show that this condition is alarming because school students are vulnerable from climate change.

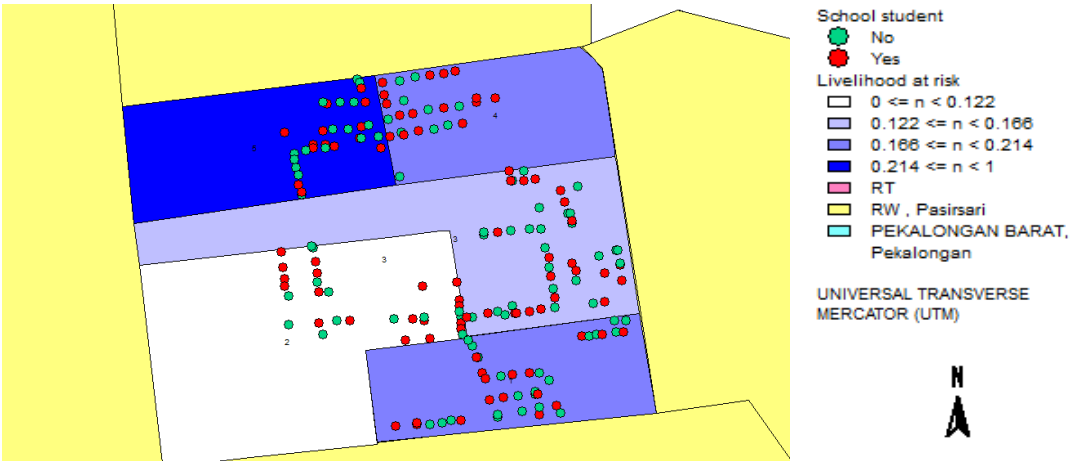


Figure 31. Households with school students at *RW* 3 of Pasirsari in Kota Pekalongan

Source: Authors calculation.

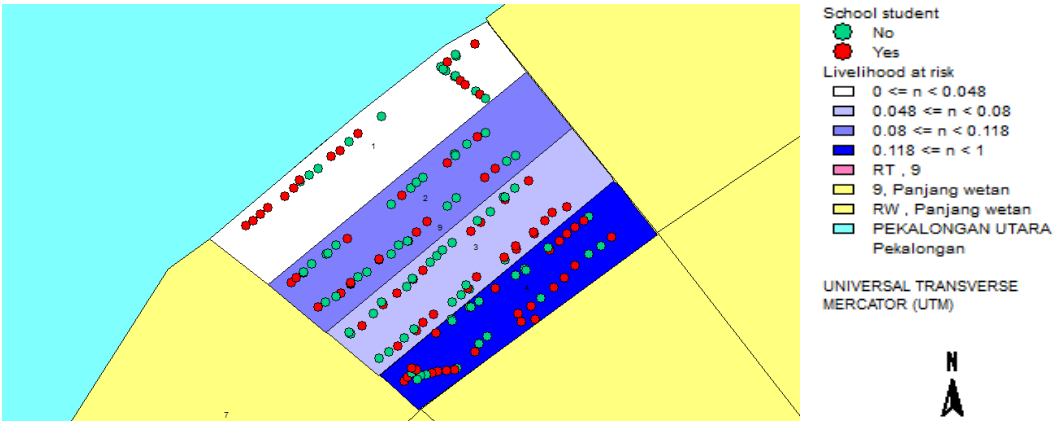


Figure 32. Households with school students at *RW* 9 of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

4.4.3 Health

Flooding and coastal inundation which caused the land to be underwater for hours or days can cause the prevalence of some types of disease. Based on FGD, people in Pasirsari and Panjang Wetan usually get sick during or after incidents of flooding and coastal inundation. The most common illnesses that infect people are skin irritations such as itchiness and small bumps on the skin, respiratory diseases such as coughing, dengue fever, diarrhea, and also parasitic diseases, namely filariasis. People in Pasirsari and Panjang Wetan who become sick usually present at the nearby community health center (Puskesmas) whether in their own *kelurahan* or at the Puskesmas in a neighboring *kelurahan* that has more complete medical facilities.

According to the map of heath officer at *RW*3 in Pasirsari, there is only one household who works as heatlh officer in there (Figure 33). The worse is the fact that there is none of health officer who live at *RW* 9 in Panjang Wetan (Figure 34).

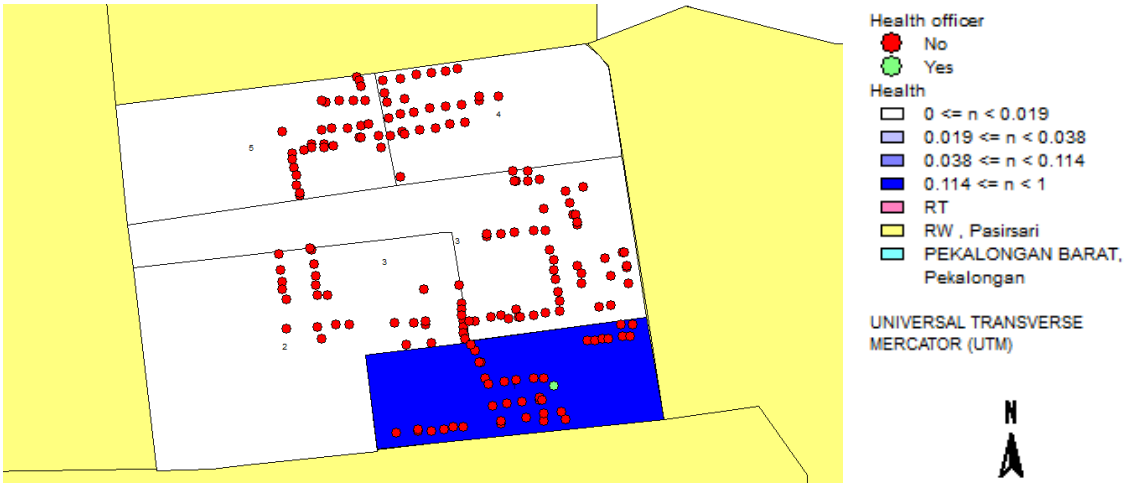


Figure 33. Households work as health officer at *RW* 3 of Pasirsari in Kota Pekalongan[5]

Source: Authors calculation.

[5] Health Officer is one of the adaptive capacity indicators.

Figure 34. Households work as health officer at *RW* 9 of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

4.4.4 Environment and ecological effect

In Pasirsari and Pajang Wetan, frequent coastal inundation has caused infrastructure damage to roads and buildings. The water is absorbed into the walls and foundations of houses making them more fragile. Often the flooded water is as high as two meters and this leaves unsightly marks on the walls of the buildings.

In Pasirsari there is a small mosque of historical significance for local people. This building was established around 1960s and it becomes flooded during times of coastal inundation or flooding. This building is privately owned so the local government is not responsible for its upkeep or repairs. In Panjang Wetan, there is a prison that was established in 1813 that also becomes flooded during times of coastal inundation and flooding. According to the FGD with people in Pajang Wetan, they do not know what happens if the prison becomes flooded but they do know that the flood usually reaches as high as 30cm inside the prison.

Coastal inundation also effects animal population. The beach at Panjang Wetan used to be a grazing place for buffalo. Every morning and evening, herds of buffalo would be taken to the beach to graze, however because of coastal inundation the grass growing near the beach has been lost. The owners of the buffalos admit that they can not afford to buy food for the buffalo anymore so they decided to sell them. Not only have animal population disappeared because of coastal inundation in Panjang Wetan, some jasmine gardens also vanished after frequent coastal inundation. In Pasirsari, some fruit growing areas such as a mango plantations are no longer producing fruit because the plants can not grow in the saline conditions produced after frequent coastal inundation.

In term of ground water, people in Pasirsari and Panjang Wetan are no longer using ground water as a source of drinking water. Since coastal inundation has occurred in their *kelurahan*, the ground water has become too salty due to saltwater intrusion. Some of the people still use the ground water for bathing or washing clothes. Almost all

people in both *kelurahan* now use bottled drinking water or PDAM tap water for their drinking water supply.

4.4.5 Effects on households

Based on the FGD in Pasirsari, most people identify themselves as being poor, 60% of people in Pasirsari are poor, 30% are in the middle income bracket and only 10% of them are considered wealthy. Most of the time, the floods and coastal inundation occuring in Pasirsari affects all people regardless of whether they are wealthy, middle income, or poor people. In Panjang Wetan, there are 15% wealthy households, 43% middle income, and 42% poor households. The effect of climate hazards on households in Panjang Wetan is the same as households in Pasir Sari.

This situation of frequent flooding and coastal inundation decreases people's productivity. Usually people do not go to work and prefer to stay at home during incidences of flooding. Transportation also becomes one of the causes of people staying at home as many types of public transport will stop operating during times of flooding and coastal inundation. Land flooded with sea water will cause corrosion in exposed equipment made from metal such as bicycles, motorcycles, and fences as well as to electronic goods and documents.

4.4.6 Climate change sensitivity map

The sensitivity index consists of values indicating risk associated with livelihood, ecology, and population. The map shows which *kecamatan* (subdistrict) are the most vulnerable in terms of livelihood, ecology, and population (Figure 35). Pekalongan Selatan is the most sensitive *kecamatan* and Pekalongan Barat is the least sensitive. Pekalongan Selatan is the most vulnerable because it is the center of the city's batik industry which is one of the most vulnerable industries to climate hazards. In terms of livelihood aspects, Pekalongan Selatan is the most sensitive region (Table 13). Pekalongan Timur has the most sensitive environment compared with other *kecamatan*. The population in Pekalongan Utara is the most sensitive *kecamatan* due to climate change compared to the others.

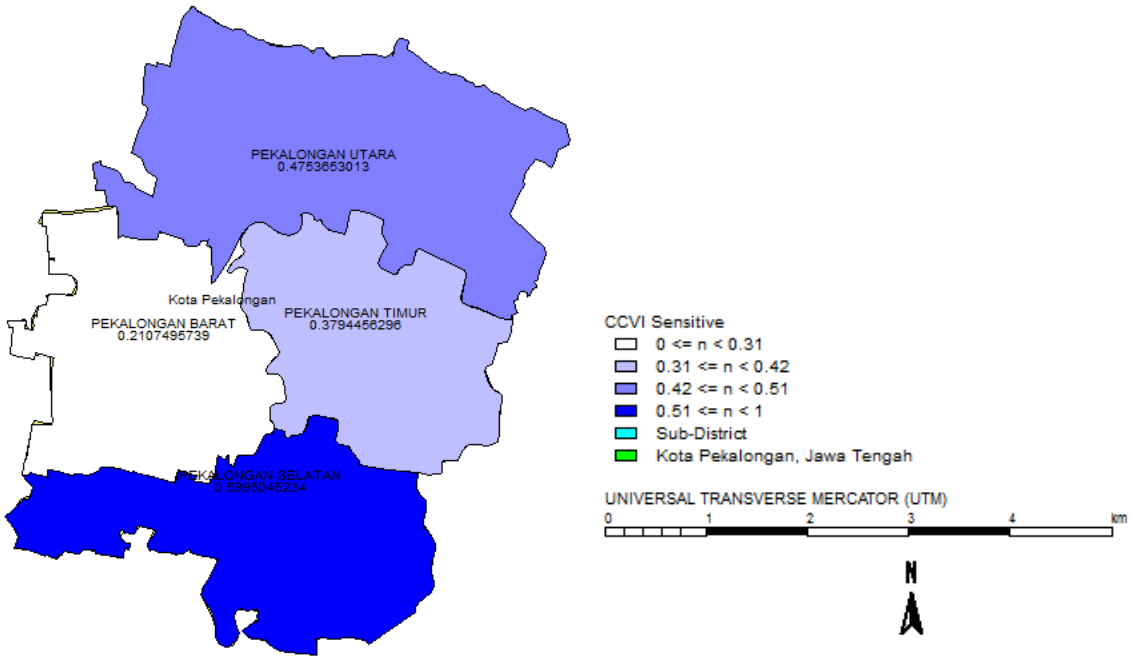


Figure 35. Climate change sensitivity map of Kota Pekalongan

Source: Authors calculation.

Table 13. Climate change sensitivity index of Kota Pekalongan

Kecamatan	**Livelihood at risk**	**Ecology at risk**	**Population at risk**	**Sensitivity Index**
Pekalongan Barat	0.06	0.00	0.16	0.21
Pekalongan Timur	0.02	0.14	0.22	0.38
Pekalongan Selatan	0.23	0.13	0.24	0.60
Pekalongan Utara	0.18	0.05	0.25	0.48

Source: Authors calculation.

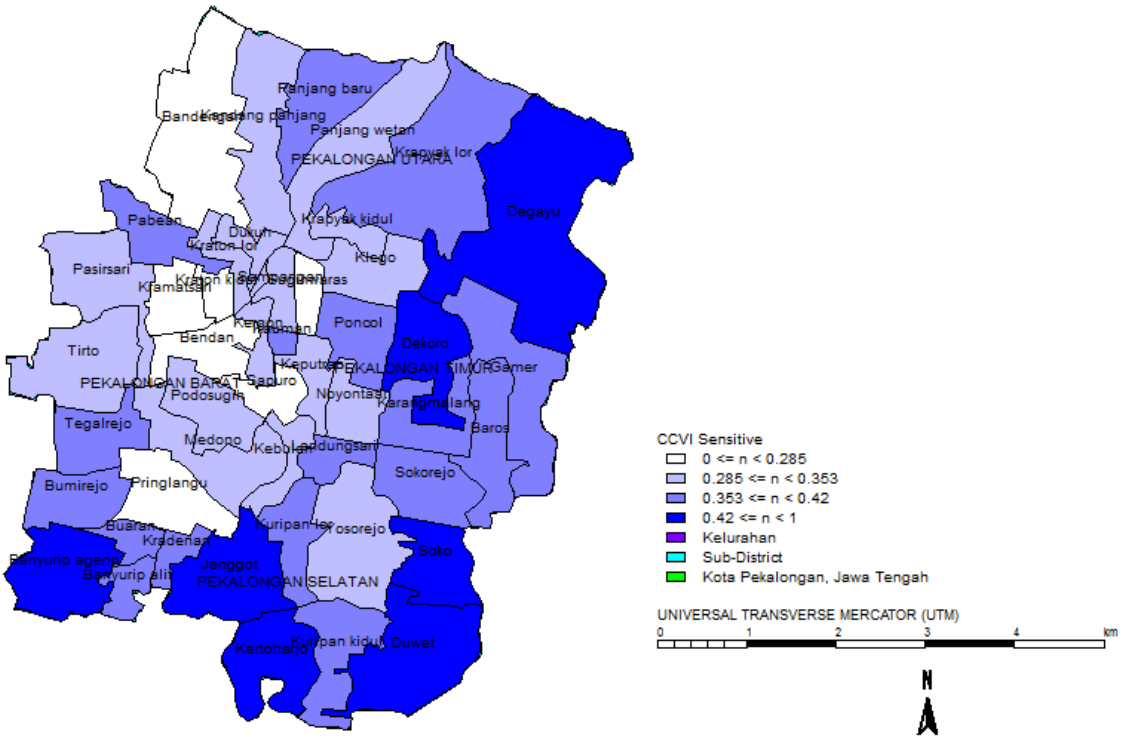


Figure 36. Climate change sensitivity map at *kelurahan* level in Kota Pekalongan

Source: Authors calculation.

According to the *kelurahan* level analysis, the white color in the climate change sensitivity map shows the most sensitive *kelurahan* (Figure 4.8). The *kelurahan* that are located in the south are the most sensitive to climate change. Although the map has different color ranges, the numbers used by the sensitivity index are only slightly different among the *kelurahan* (Table 14).

Table 14. Climate change sensitivity index at *kelurahan* level in Kota Pekalongan

Kecamatan	***Kelurahan***	**Livelihood at risk**	**Ecology at risk**	**Population at risk**	**Sensitivity Index**
Pekalongan Selatan	Jenggot	0.116	0.112	0.26	0.488
Pekalongan Selatan	Soko	0.118	0.111	0.231	0.46
Pekalongan Selatan	Kertoharjo	0.085	0.15	0.222	0.457
Pekalongan	Duwet	0.136	0.107	0.203	0.447

Selatan					
Pekalongan Selatan	Banyurip Ageng	0.126	0.088	0.22	0.434
Pekalongan Timur	Dekoro	0.082	0.1	0.242	0.425
Pekalongan Utara	Degayu	0.157	0.06	0.203	0.42
Pekalongan Utara	Pabean	0.12	0.099	0.199	0.418
Pekalongan Selatan	Kradenan	0.106	0.086	0.223	0.415
Pekalongan Timur	Gamer	0.127	0.077	0.21	0.414
Pekalongan Utara	Panjang Baru	0.119	0.034	0.258	0.411
Pekalongan Selatan	Buaran	0.076	0.101	0.226	0.404
Pekalongan Utara	Krapyak Lor	0.138	0.084	0.174	0.396
Pekalongan Selatan	Kuripan Lor	0.049	0.117	0.224	0.39
Pekalongan Timur	Sokorejo	0.076	0.122	0.191	0.389
Pekalongan Selatan	Banyurip Alit	0.113	0.061	0.211	0.385
Pekalongan Timur	Tegalrejo	0.118	0.11	0.149	0.377
Pekalongan Barat	Poncol	0.054	0.097	0.227	0.377
Pekalongan Timur	Kauman	0.068	0.068	0.233	0.368
Pekalongan	Bumirejo	0.141	0.079	0.147	0.367

Barat					
Pekalongan Timur	Landungsari	0.049	0.095	0.214	0.358
Pekalongan Timur	Baros	0.046	0.1	0.21	0.357
Pekalongan Selatan	Kuripan Kidul	0.1	0.036	0.219	0.355
Pekalongan Timur	Karangmalang	0.056	0.107	0.19	0.353
Pekalongan Timur	Keputran	0.05	0.112	0.19	0.352
Pekalongan Timur	Klego	0.049	0.087	0.212	0.347
Pekalongan Utara	Krapyak Kidul	0.053	0.119	0.172	0.344
Pekalongan Barat	Pasirsari	0.087	0.039	0.208	0.334
Pekalongan Barat	Medono	0.068	0.074	0.19	0.331
Pekalongan Utara	Sampangan	0.021	0.099	0.211	0.331
Pekalongan Timur	Panjang Wetan	0.094	0.053	0.185	0.331
Pekalongan Barat	Tirto	0.078	0.084	0.167	0.329
Pekalongan Utara	Kandang panjang	0.093	0.084	0.147	0.323
Pekalongan Timur	Noyontaan	0.029	0.081	0.21	0.32
Pekalongan Barat	Kebulen	0.045	0.083	0.188	0.316
Pekalongan	Yosorejo	0.062	0.051	0.199	0.312

Utara					
Pekalongan Selatan	Kraton Lor	0.048	0.113	0.151	0.312
Pekalongan Barat	Kergon	0.043	0.043	0.218	0.304
Pekalongan Barat	Podosugih	0.072	0.083	0.144	0.3
Pekalongan Utara	Dukuh	0.056	0.072	0.157	0.285
Pekalongan Barat	Sapuro	0.03	0.071	0.172	0.274
Pekalongan Barat	Pringlangu	0.062	0.085	0.118	0.265
Pekalongan Barat	Kraton Kidul	0.041	0.014	0.199	0.253
Pekalongan Timur	Sugihwaras	0.011	0.115	0.126	0.252
Pekalongan Utara	Bandengan	0.061	0.052	0.131	0.244
Pekalongan Barat	Kramatsari	0.054	0.056	0.129	0.238
Pekalongan Barat	Bendan	0.044	0.055	0.117	0.216

Source: Authors calculation.

In Pasirsari, according to the *RW* level sensitivity analysis, the most sensitive *RW* are *RW* 4, *RW* 6, and *RW* 7 (Figure 37). *RW* 7 is the most sensitive *RW* due to high population at risk of climate change. In Panjang Wetan *RW* 1, *RW* 6, *RW* 7 and *RW* 13 are the most sensitive area which are shown by the dark blue map (Figure 38).

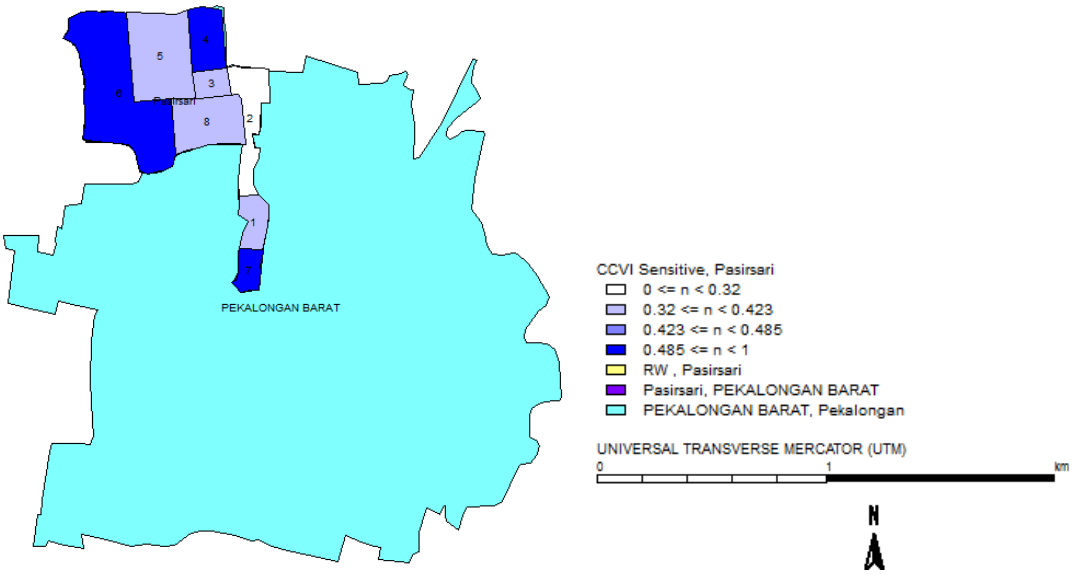


Figure 37. Climate change sensitivity index at *RW* level of Pasirsari in Kota Pekalongan

Source: Authors calculation.

Table 15. Climate change sensitivity index at *RW* level of Pasirsari in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Livelihood at risk**	**Ecology at risk**	**Population at risk**	**Sensitivity Index**
Pekalongan barat	Pasirsari	1	0.128	0.000	0.281	0.409
Pekalongan barat	Pasirsari	2	0.030	0.067	0.120	0.217
Pekalongan barat	Pasirsari	3	0.194	0.030	0.184	0.408
Pekalongan barat	Pasirsari	4	0.147	0.014	0.334	0.494
Pekalongan barat	Pasirsari	5	0.093	0.095	0.203	0.392
Pekalongan barat	Pasirsari	6	0.148	0.150	0.198	0.496
Pekalongan barat	Pasirsari	7	0.140	0.092	0.316	0.547
Pekalongan barat	Pasirsari	8	0.129	0.082	0.211	0.422

Source: Authors calculation.

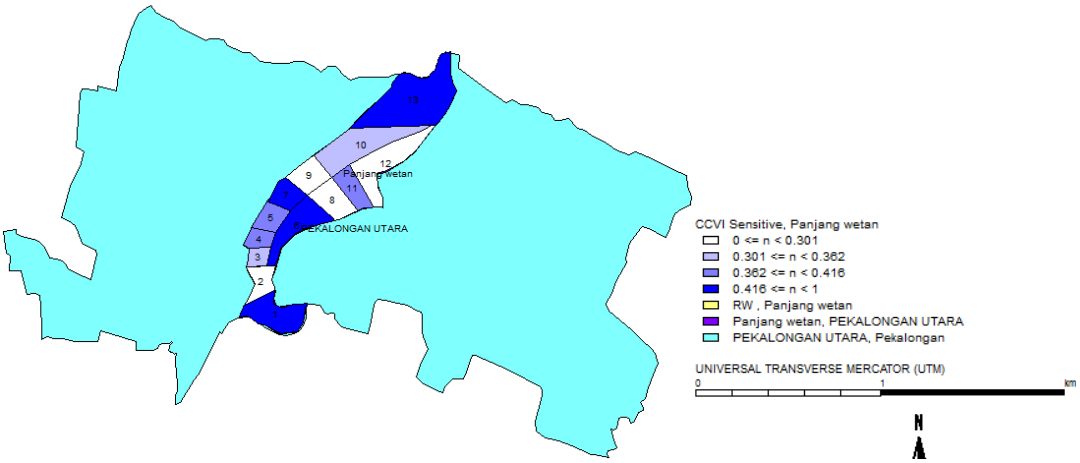


Figure 38. Climate change sensitivity index at *RW* level of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

Table 16. Climate change sensitivity index at *RW* level of Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Livelihood at risk**	**Ecology at risk**	**Population at risk**	**Sensitivity Index**
Pekalongan utara	Panjang wetan	1	0.153	0.119	0.160	0.432
Pekalongan utara	Panjang wetan	2	0.039	0.056	0.146	0.240
Pekalongan utara	Panjang wetan	3	0.082	0.150	0.091	0.323
Pekalongan utara	Panjang wetan	4	0.113	0.130	0.130	0.373
Pekalongan utara	Panjang wetan	5	0.201	0.032	0.145	0.378
Pekalongan utara	Panjang wetan	6	0.151	0.063	0.256	0.470
Pekalongan utara	Panjang wetan	7	0.168	0.044	0.235	0.447
Pekalongan utara	Panjang wetan	8	0.096	0.010	0.192	0.298
Pekalongan utara	Panjang wetan	9	0.122	0.000	0.164	0.287
Pekalongan utara	Panjang wetan	10	0.126	0.041	0.152	0.318
Pekalongan utara	Panjang wetan	11	0.153	0.044	0.202	0.399
Pekalongan utara	Panjang wetan	12	0.067	0.052	0.167	0.286

Pekalongan utara	Panjang wetan	13	0.202	0.044	0.210	0.456

Source: Authors calculation.

At the *RT* level analysis, *RT* 4 and *RT* 5 at *RW* 3 in Pasirsari is the most sensitive area due to high population at risk index and livelihood at risk index (Table 17). Whilst *RT* 4 is the most sensitive areas at *RW* 9 in Panjang Wetan due to high population at risk.

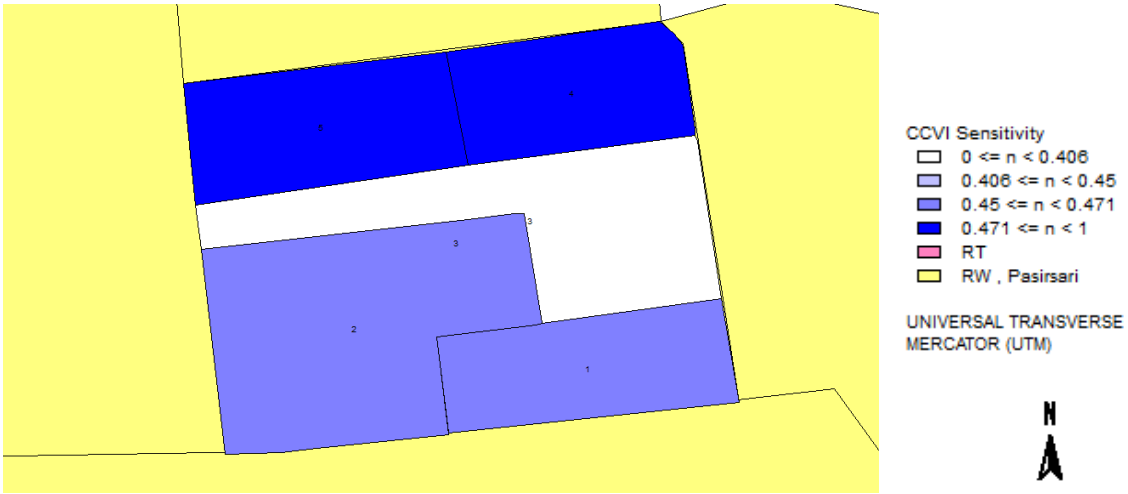


Figure 39. Climate change sensitivity index at *RT* level in *RW* 3 Pasirsari Kota Pekalongan

Source: Authors calculation.

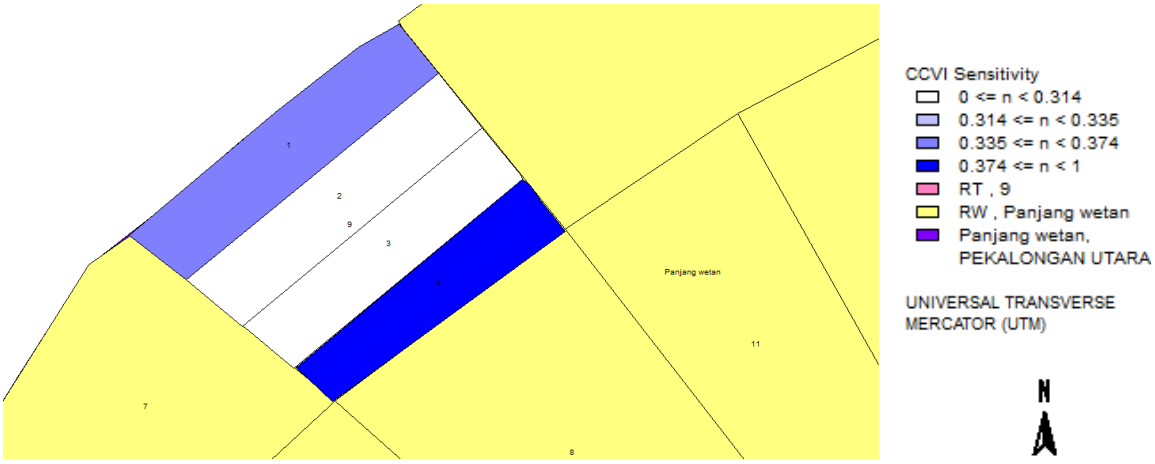


Figure 40. Climate change sensitivity index at *RT* level in *RW* 9 Panjang Wetan Kota Pekalongan

Source: Authors calculation.

Table 17. Climate change sensitivity index at *RT* level of Pasirsari and Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	***RT***	**Livelihood at risk**	**Ecology at risk**	**Population at risk**	**Sensitivity Index**
Pekalongan utara	Panjang wetan	9	1	0.016	0.150	0.172	0.338
Pekalongan utara	Panjang wetan	9	2	0.096	0.000	0.201	0.298
Pekalongan utara	Panjang wetan	9	3	0.055	0.010	0.227	0.292
Pekalongan utara	Panjang wetan	9	4	0.155	0.043	0.215	0.412
Pekalongan barat	Pasirsari	3	1	0.171	0.150	0.130	0.451
Pekalongan barat	Pasirsari	3	2	0.078	0.000	0.392	0.469
Pekalongan barat	Pasirsari	3	3	0.146	0.022	0.194	0.362
Pekalongan barat	Pasirsari	3	4	0.170	0.065	0.258	0.492
Pekalongan barat	Pasirsari	3	5	0.263	0.092	0.120	0.475

Source: Authors calculation.

4.5 Adaptive Capacity

The frequent coastal inundation in Panjang Wetan has forced households to raise the levels of their floors, particularly for those who live near the sea. The effect of this is that the living space between the floor and the ceiling becomes smaller. In terms of moving to a better place to live, people in both Pekalongan Utara and Pekalongan Barat do not want to move due to their economic situation. These residents prefer to stay at their current house even though they know it will continue to be flooded during high tide or heavy rain because they do not have the financial ability to buy a new house. Most of the community will chose to stay with their homes if there is a flood.

Fortunately most of houses' condition of households in Pasirsari dan Panjang Wetan is in good condition. The houses condition in Pasirsari is better than in Panjang Wetan. It is shown by the bigger numbers of bad condition of houses in Panjang Wetan.

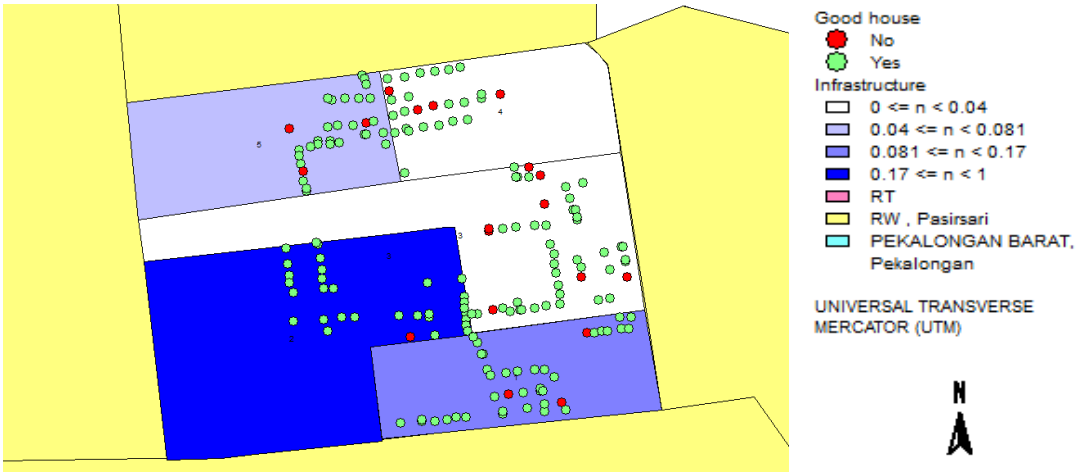


Figure 41. Households live in good house condition health officer at *RW* 3 of Pasirsari in Kota Pekalongan

Source: Authors calculation.

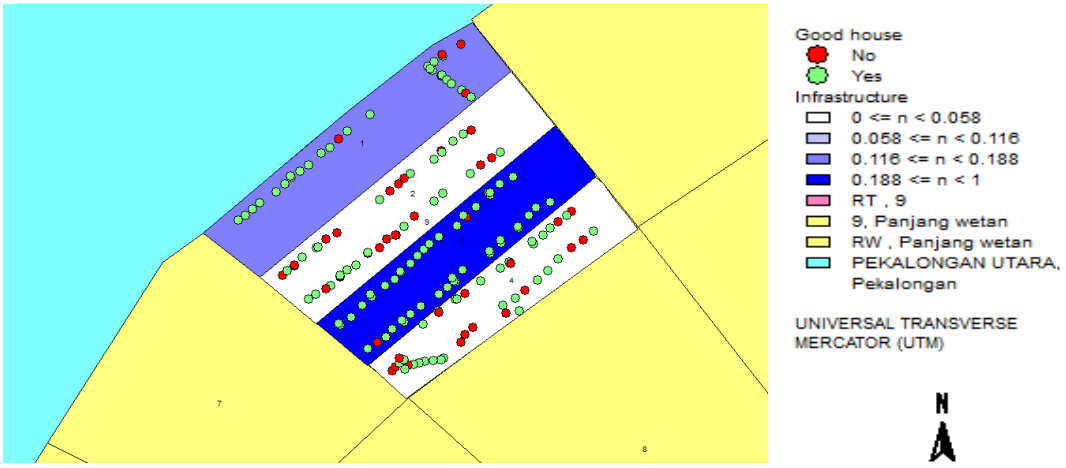


Figure 42. Households live in good house condition health officer at *RW* 9 of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

According to agricultural, fishery, and forestry agency in Kota Pekalongan, the floods and coastal inundation do not only produce a negative effect but also a positive effect to the local economy. The farm that has become worthless because of flooding can produce a large profit for the farmer if they change the utilization of the land into a new land function such as fish farming of carp or shrimp. Farmers admitted that the profit from fish farming was actually larger than from normal agricultural farming.

People have also begun conducting activities to make necessary changes to address climate change. People in Pasir Sari are working together to clean the river that runs through their *kelurahan*. They clean the river of mud and water plants so the water

can flow uninhibited. During the flood or coastal inundation, people in Pasirsari will stay in their houses. The local government of Pasir Sari or *kelurahan* head have searched for assistance from the relevant government agencies for their citizens. The assistance received was in the form of some instant noodles and rice. Although only some of the people are genuine victims of these climate hazard, the *kelurahan* head distributed the instant noodles and rice to all the households in Pasirsari. A similar experience occurred in Panjang Wetan, a large flood there caused people to move to the *Sekolah Tinggi Akuntansi Negara (*STAIN) building which had been identified as an evacuation building, once the *kelurahan* head had managed to obtain assistance he distributed it to all the households even though some of the recipients were in areas free from the floods.

Although some flood mitigation activities are carried out by the community they mostly rely on the government. Most people tend to wait for the government program to be implemented without having made significant local efforts to cope with climate change effects. In Panjang Wetan the study found that most water canal systems were in poor condition meaning that they were not flowing optimally due to a build-up of garbage, but local people wer reluctant to become involved in the solution, even with the canal system and the problem right in front of their houses.

4.5.1 Climate change adaptive map

The adaptive index of climate change consists of information on: infrastructure, technology, health facilities, institutions, and economic conditions. The map describes which kecamatan are the most adaptive to climate hazards (Figure 43) The darker colored areas on the map indicates a higher level of adaptation in an area, whilst the lighter the map color indicates a lower adaptation in an area. As the vulnerability index indicates the negative value of something, the higher adaptation index indicate the worse adaptation capacity in an area and the lower adaptation index indicates better adapatation capacity. Pekalongan Barat is the most adaptive kecamatan among others and Pekalongan Timur and Pekalongan selatan are the less adaptive kecamatan.

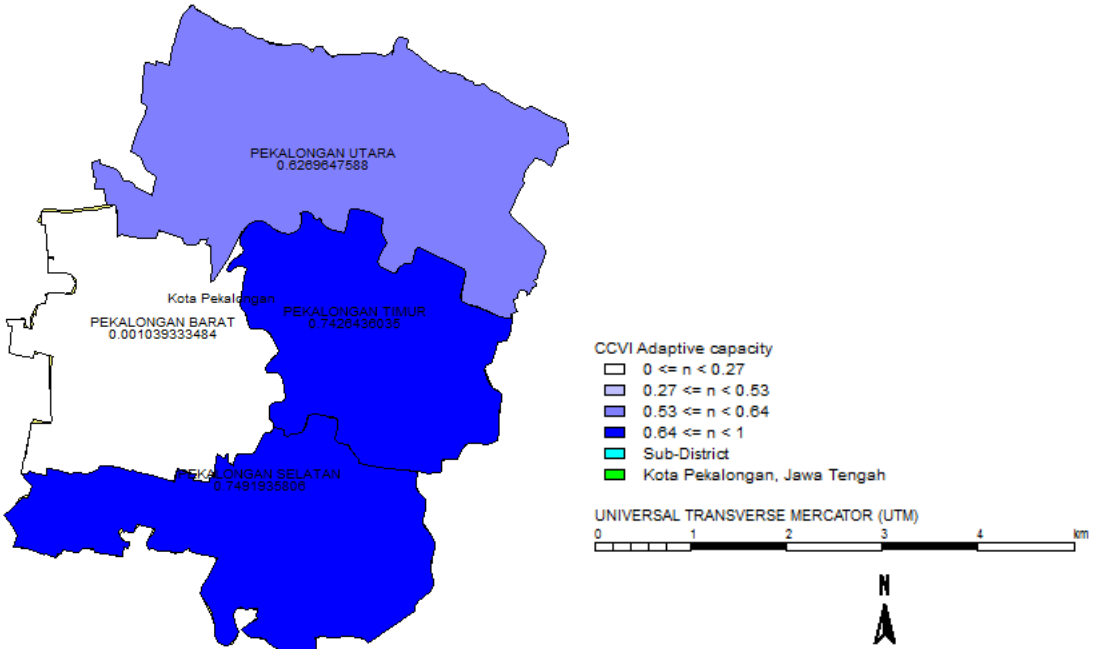


Figure 43. Climate change adaptive capacity of Kota Pekalongan

Source: Author's calculation.

Table 18. Climate change adaptive capacity index of Kota Pekalongan

Kecamatan	**Infrastructure**	**Technological Information**	**Health**	**Institution**	**Economic**	**Adaptive Capacity Index**
Pekalongan Barat	0.26	0.14	0.19	0.2	0.21	0.001
Pekalongan Timur	0	0.09	0.04	0.036	0.095	0.74
Pekalongan Selatan	0.047	0.007	0	0.056	0.141	0.745
Pekalongan Utara	0.24	0.03	0.03	0.066978	0	0.63

Source: Authors calculation.

At the *kelurahan* level analysis, *kelurahan* which are located in Pekalongan Barat have more adaptive capacity (Figure 44). *Kelurahan* in Pekalongan Utara and Pekalongan Selatan are less adaptive. It shows by the dark blue map. *Kelurahan* Klego in Pekalongan

Timur is the least adaptive *kelurahan* and *Kelurahan* Pasirsari in Pekalongan Barat is the most adaptive *kelurahan* in term of climate change.

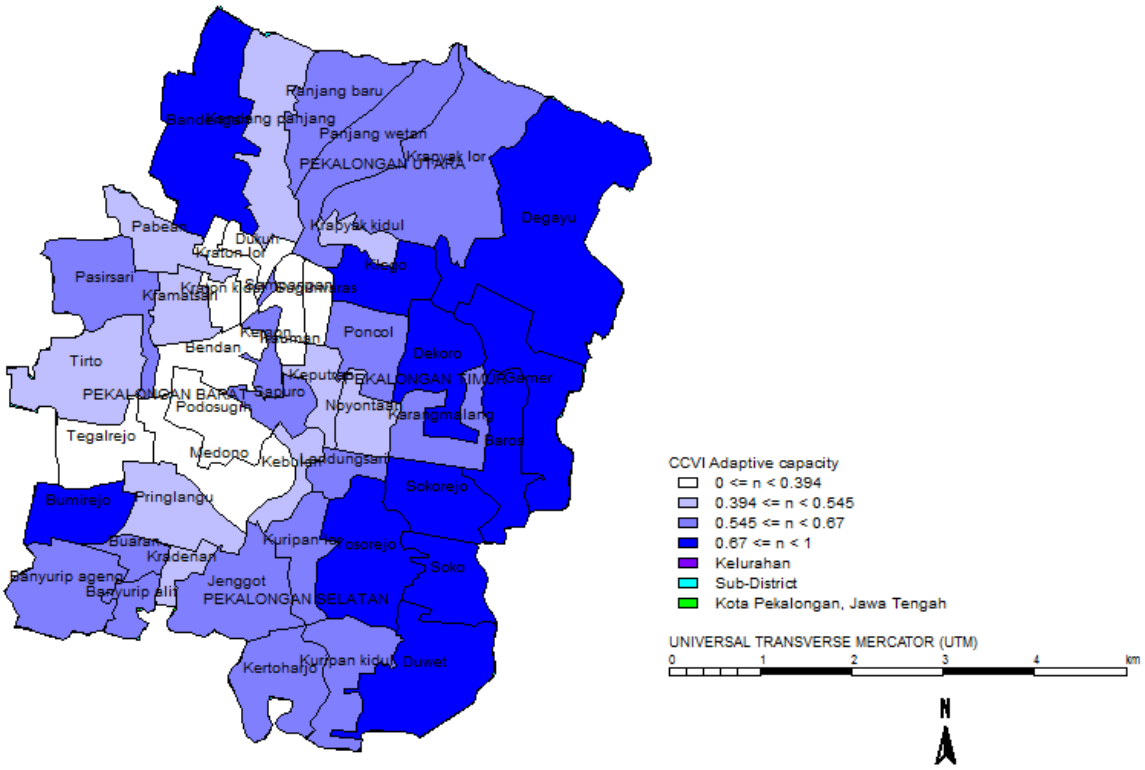


Figure 44. Climate change adaptive map at *kelurahan* level in Kota Pekalongan

Source: Author's calculation.

Table 19. Climate change adaptive index at *kelurahan* level in Kota Pekalongan

Kecamatan	***Kelurahan***	**Infra structure**	**Technological Information**	**Health**	**Institution**	**Economic**	**Adaptive Capacity Index**
Pekalongan Timur	Klego	0.063	0.029	0.045	0.031	0.037	0.794
Pekalongan Selatan	Soko	0.077	0.016	0.047	0.067	0.020	0.773
Pekalongan Timur	Sokorejo	0.064	0.028	0.059	0.040	0.065	0.744
Pekalongan	Duwet	0.093	0.013	0.000	0.086	0.069	0.739

Selatan							
Pekalongan Timur	Dekoro	0.034	0.028	0.061	0.086	0.053	0.739
Pekalongan Timur	Baros	0.090	0.026	0.000	0.080	0.072	0.732
Pekalongan Utara	Degayu	0.144	0.012	0.037	0.063	0.013	0.730
Pekalongan Utara	Bandeng an	0.191	0.008	0.054	0.023	0.000	0.724
Pekalongan Selatan	Yosorejo	0.100	0.031	0.013	0.071	0.068	0.717
Pekalongan Timur	Gamer	0.114	0.029	0.047	0.033	0.081	0.695
Pekalongan Barat	Bumirejo	0.143	0.043	0.034	0.034	0.050	0.695
Pekalongan Timur	Poncol	0.046	0.061	0.070	0.067	0.087	0.668
Pekalongan Selatan	Kertohar jo	0.086	0.040	0.059	0.081	0.070	0.664
Pekalongan Timur	Karangm alang	0.000	0.045	0.186	0.023	0.089	0.657
Pekalongan Selatan	Jenggot	0.128	0.037	0.040	0.033	0.106	0.657
Pekalongan Selatan	Banyurip Ageng	0.064	0.035	0.084	0.099	0.072	0.647
Pekalongan Barat	Pasirsari	0.153	0.027	0.071	0.089	0.031	0.630
Pekalongan Utara	Panjang Wetan	0.156	0.047	0.055	0.082	0.056	0.604
Pekalongan Selatan	Banyurip Alit	0.106	0.071	0.050	0.054	0.114	0.604
Pekalongan	Kuripan	0.129	0.046	0.058	0.094	0.083	0.589

Selatan	Kidul						
Pekalongan Selatan	Kuripan Lor	0.092	0.056	0.055	0.086	0.122	0.589
Pekalongan Timur	Landung sari	0.115	0.060	0.049	0.115	0.072	0.589
Pekalongan Barat	Sapuro	0.170	0.053	0.062	0.069	0.062	0.585
Pekalongan Utara	Krapyak Lor	0.204	0.051	0.044	0.062	0.055	0.584
Pekalongan Selatan	Buaran	0.140	0.060	0.074	0.057	0.102	0.566
Pekalongan Utara	Panjang Baru	0.138	0.037	0.061	0.154	0.055	0.556
Pekalongan Barat	Kergon	0.167	0.055	0.100	0.068	0.063	0.548
Pekalongan Utara	Krapyak Kidul	0.211	0.056	0.065	0.068	0.077	0.523
Pekalongan Timur	Noyonta an	0.128	0.074	0.069	0.112	0.095	0.522
Pekalongan Selatan	Kradena n	0.145	0.069	0.076	0.058	0.132	0.520
Pekalongan Utara	Pabean	0.232	0.011	0.166	0.061	0.017	0.514
Pekalongan Barat	Kramats ari	0.171	0.063	0.064	0.128	0.080	0.494
Pekalongan Timur	Keputran	0.114	0.092	0.091	0.096	0.138	0.469
Pekalongan Barat	Kebulen	0.224	0.064	0.068	0.074	0.103	0.468
Pekalongan Utara	Kandang Panjang	0.185	0.079	0.077	0.108	0.126	0.424
Pekalongan	Pringlan	0.248	0.076	0.032	0.087	0.135	0.423

Barat	gu						
Pekalongan Barat	Tirto	0.151	0.071	0.147	0.133	0.095	0.403
Pekalongan Timur	Sugihwa ras	0.228	0.116	0.080	0.061	0.148	0.368
Pekalongan Barat	Podosugi h	0.209	0.099	0.076	0.103	0.156	0.356
Pekalongan Barat	Medono	0.219	0.081	0.101	0.140	0.140	0.319
Pekalongan Barat	Tegalrej o	0.183	0.088	0.088	0.116	0.210	0.314
Pekalongan Timur	Kauman	0.179	0.114	0.153	0.102	0.148	0.304
Pekalongan Utara	Kraton Lor	0.242	0.099	0.131	0.112	0.116	0.300
Pekalongan Barat	Bendan	0.206	0.103	0.124	0.143	0.125	0.300
Pekalongan Utara	Dukuh	0.229	0.097	0.123	0.126	0.135	0.290
Pekalongan Barat	Kraton Kidul	0.260	0.087	0.134	0.142	0.125	0.251
Pekalongan Timur	Sampang an	0.214	0.103	0.190	0.102	0.148	0.243

Source: Authors calculation.

In Pasirsari the least adaptive *RW* are *RW* 1 (Figure 45). This condition is influence by the low insitution capacity of people who live in this area. The institution capacity indicates the society involvement into society activities. According to interviews and FGD in Pasirsari, the society involvment in term of environment activity is low. Although every month Pasirsari has such an environment activity called “Clean Friday”, only few of people get involve on it.

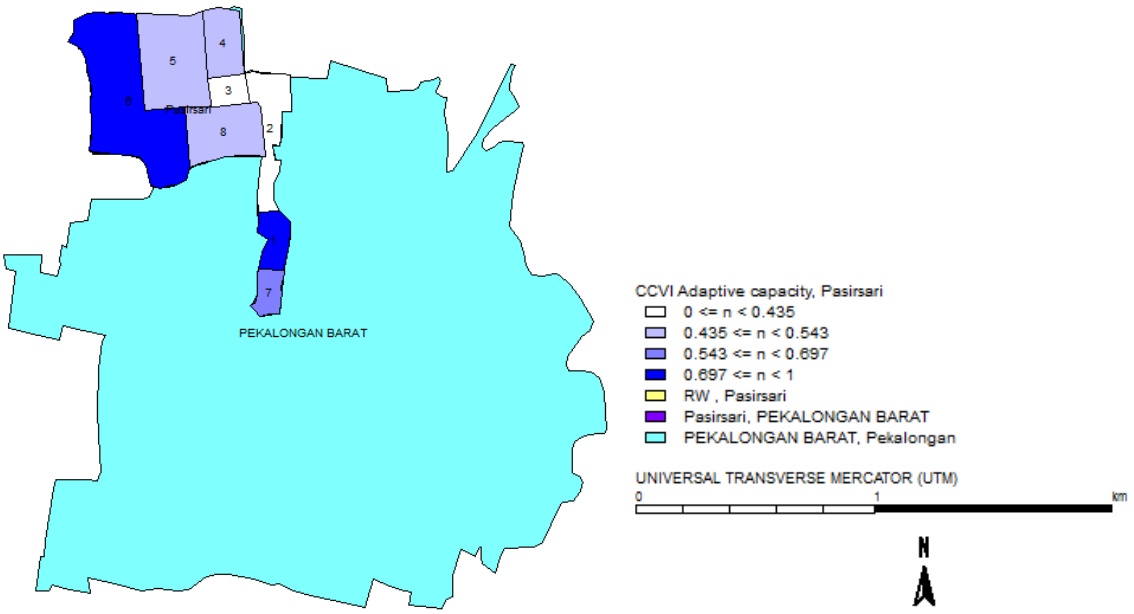


Figure 45. Climate change adaptive capacity index at *RW* level in Pasirsari Kota Pekalongan

Source: Authors calculation.

Table 20. Climate change adaptive capacity index at *RW* level of *Kelurahan* Pasirsari in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Infrastructure**	**Technological Information**	**Health**	**Institution**	**Economic**	**Adaptive Capacity Index**
Pekalongan barat	Pasirsari	1	0	0.038	0	0.111	0.000	0.852
Pekalongan barat	Pasirsari	2	0.171	0.116	0	0.177	0.210	0.326
Pekalongan barat	Pasirsari	3	0.243	0.021	0.074	0.173	0.086	0.405
Pekalongan barat	Pasirsari	4	0.199	0.058	0.025	0.129	0.091	0.497
Pekalongan barat	Pasirsari	5	0.260	0.043	0.0	0.088	0.146	0.463
Pekalongan barat	Pasirsari	6	0.122	0.013	0.0	0.058	0.082	0.724

Pekalongan barat	Pasirsari	7	0.126	0.033	0.0	0.045	0.174	0.622
Pekalongan barat	Pasirsari	8	0.124	0.058	0.0	0.184	0.176	0.458

Source: Authors calculation.

In Panjang wetan, *RW* 8 is the least adaptive in term of climate change (Figure 46). The most influence thing is the high infrastructure index. It indicates that most of houses in this area are in bad condition.

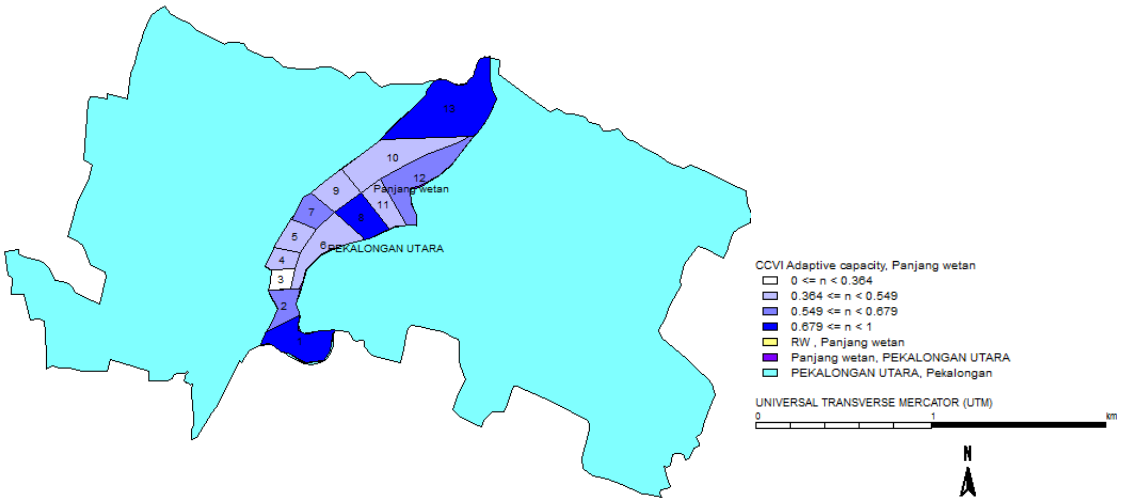


Figure 46. Climate change adaptive capacity index at *RW* level in Panjang Wetan Kota Pekalongan

Source: Authors calculation.

Table 21. Climate change adaptive capacity index at *RW* level of *Kelurahan* Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Infrastructure**	**Technological Information**	**Health**	**Institution**	**Economic**	**Adaptive Capacity Index**
Pekalongan utara	Panjang wetan	1	0.115	0.015	0.000	0.048	0.119	0.704

Pekalongan utara	Panjang wetan	2	0.000	0.130	0.000	0.016	0.200	0.655
Pekalongan utara	Panjang wetan	3	0.250	0.129	0.095	0.171	0.177	0.179
Pekalongan utara	Panjang wetan	4	0.077	0.079	0.052	0.115	0.150	0.527
Pekalongan utara	Panjang wetan	5	0.227	0.064	0.054	0.103	0.164	0.387
Pekalongan utara	Panjang wetan	6	0.260	0.086	0.000	0.048	0.210	0.396
Pekalongan utara	Panjang wetan	7	0.188	0.016	0.000	0.042	0.129	0.625
Pekalongan utara	Panjang wetan	8	0.163	0.008	0.000	0.021	0.000	0.808
Pekalongan utara	Panjang wetan	9	0.158	0.019	0.000	0.185	0.113	0.525
Pekalongan utara	Panjang wetan	10	0.239	0.050	0.000	0.064	0.138	0.510
Pekalongan utara	Panjang wetan	11	0.210	0.072	0.000	0.105	0.138	0.475
Pekalongan utara	Panjang wetan	12	0.155	0.065	0.000	0.003	0.162	0.616
Pekalongan utara	Panjang wetan	13	0.038	0.034	0.000	0.070	0.124	0.734

Source: Authors calculation.

Inline with the finding at *RW* level analysis in each *kelurahan*, the least sensitive *RT* in *RW* 3 Pasirsari is *RT* 5 and it is caused by the low institutional capacity of society in there (Table 22). Whilst the least sensitive *RT* in *RW* 9 Panjang Wetan is *RT* 4 which is caused by the low infrastructure capacity.

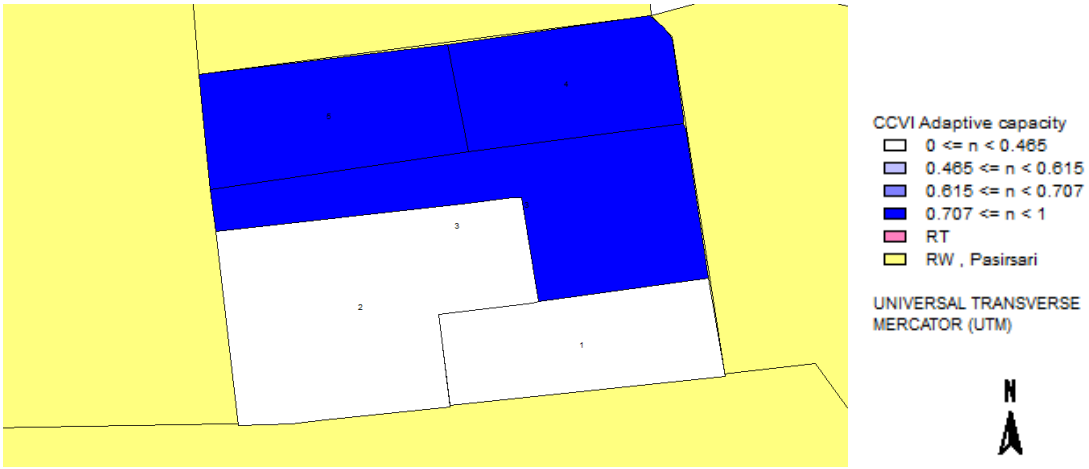


Figure 47. Climate change adaptive capacity index at *RT* level in *RW* 3 Pasirsari Kota Pekalongan

Source: Authors calculation.

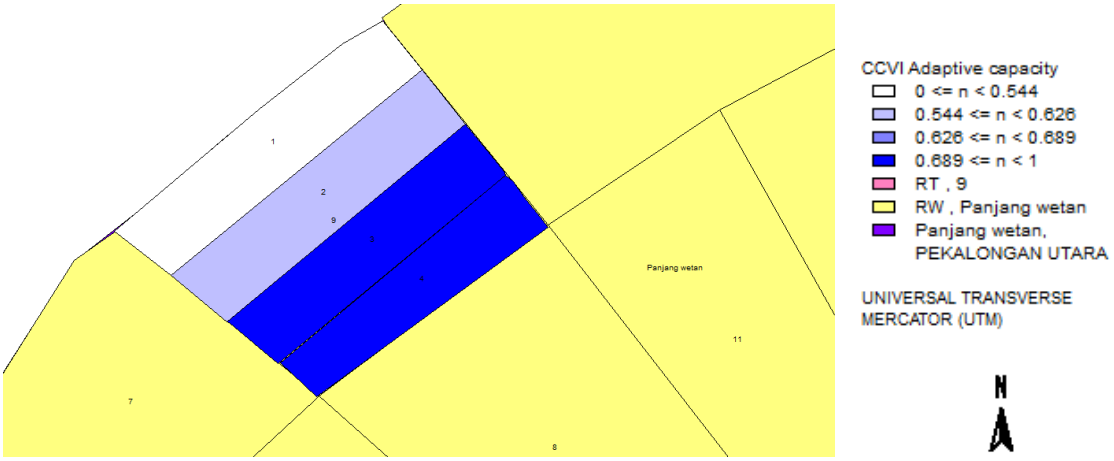


Figure 48. Climate change sensitivity index at *RT* level in *RW* 9 Panjang Wetan Kota Pekalongan

Source: Authors calculation.

Table 22. Climate change adaptive capacity index at *RT* level in *Kelurahan* Pasirsari and Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	***RT***	**Infrastructure**	**Technological Information**	**Health**	**Institution**	**Economic**	**Adaptive Capacity Index**
Pekalongan	Panjang	9	1	0.176	0.084	0.000	0.123	0.156	0.462

Utara	Wetan								
Pekalongan Utara	Panjang Wetan	9	2	0.000	0.092	0.000	0.105	0.210	0.592
Pekalongan Utara	Panjang Wetan	9	3	0.260	0.004	0.000	0.038	0.000	0.698
Pekalongan Utara	Panjang Wetan	9	4	0.029	0.053	0.000	0.062	0.105	0.752
Pekalongan Barat	Pasirsari	3	1	0.092	0.126	0.190	0.162	0.114	0.316
Pekalongan Barat	Pasirsari	3	2	0.260	0.114	0.000	0.031	0.210	0.384
Pekalongan Barat	Pasirsari	3	3	0.000	0.015	0.000	0.000	0.192	0.793
Pekalongan Barat	Pasirsari	3	4	0.004	0.068	0.000	0.102	0.043	0.783
Pekalongan Barat	Pasirsari	3	5	0.047	0.041	0.000	0.113	0.000	0.799

Source: Authors calculation.

4.6 Vulnerability Index of Climate Change

The vulnerability index of climate change is constructed using an exposure index, sensitivity index, and vulnerability index in Kota Pekalongan. The map of the index indicates the *kecamatan* that is the most vulnerable to climate change in Kota Pekalongan (Figure 49). Pekalongan Utara is the most vulnerable *kecamatan*. Pekalongan Utara is the most vulnerable area because its high exposure to climate change especially coastal

inundation. Pekalongan Selatan is the second most vulnerable *kecamatan* due to its high sensitivity and low adaptive capacity.

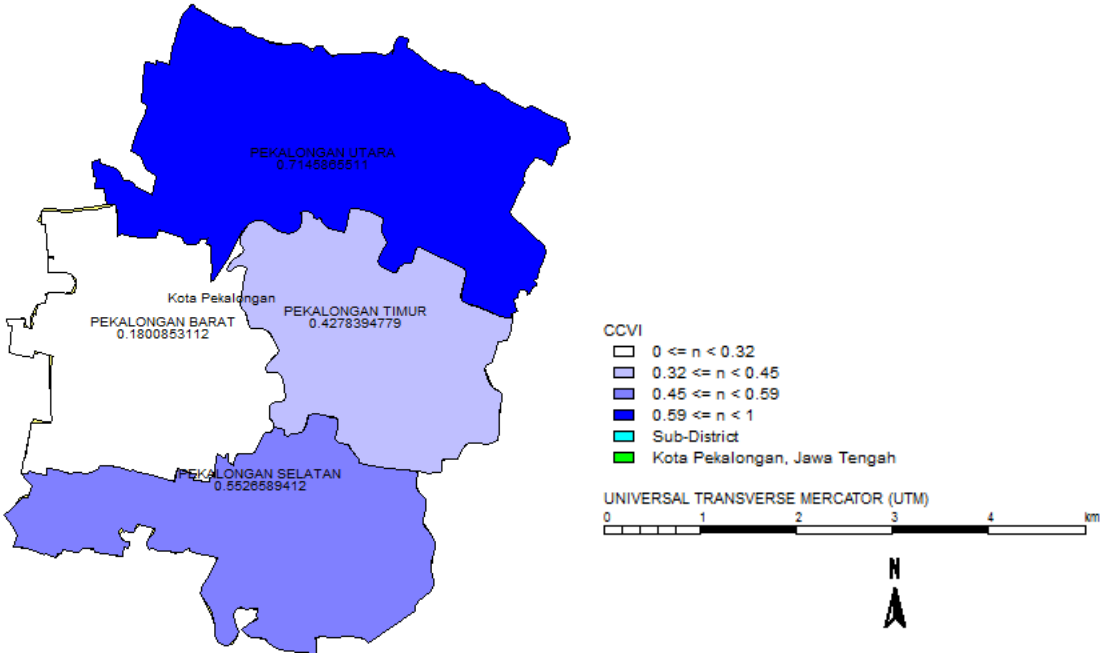


Figure 49. Climate change vulnerability map Kota Pekalongan

Source: Authors calculation

Table 23. Climate change vulnerability index Kota Pekalongan

Kecamatan	**Exposure**	**Sensitivity**	**Adaptive Capacity**	**CCVI**
Pekalongan Barat	0.342576	0.21	0.001039	0.180085
Pekalongan Timur	0.115375	0.38	0.742644	0.427839
Pekalongan Selatan	0.281194	0.60	0.749194	0.552659
Pekalongan Utara	1	0.48	0.626965	0.714587

Source: Author's calculation.

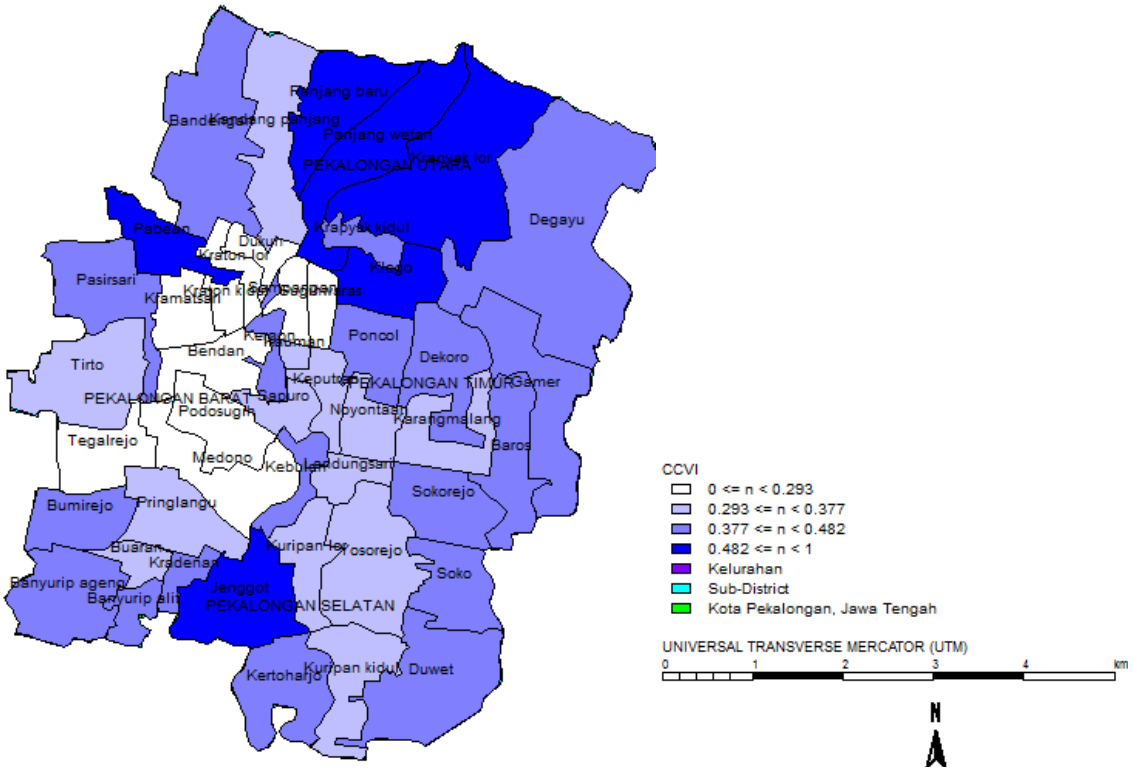


Figure 50. Climate change vulnerability map at *kelurahan* level in Kota Pekalongan

Source: Author's calculation.

In line with vulnerability at the *kecamatan* level, the climate change vulnerability at *kelurahan* level also indicates that the most vulnerable *kelurahan* are located in the north and south of Kota Pekalongan, this is shown by the blue colored areas on the map (Figure 50). Pabean is the most vulnerable *kelurahan* in Kota Pekalongan. Panjang Wetan is high vulnerable and Pasirsari is in the middle high vulnerability category.

Table 24. Climate change vulnerability index at *kelurahan* level in Kota Pekalongan

Kecamatan	***Kelurahan***	**Exposure**	**Sensitivity**	**Adaptive Capacity**	**CCVI**
Pekalongan Utara	Pabean	73.791	28.171	0.514	0.588
Pekalongan Utara	Krapyak Lor	67.041	25.759	0.584	0.561
Pekalongan Utara	Panjang Baru	73.596	26.622	0.556	0.554

Pekalongan Timur	Klego	30.134	26.609	0.794	0.551
Pekalongan Selatan	Jenggot	3.874	28.330	0.657	0.533
Pekalongan Utara	Panjang Wetan	42.974	25.758	0.604	0.510
Pekalongan Barat	Pasirsari	14.458	27.100	0.630	0.479
Pekalongan Timur	Baros	0.168	26.081	0.732	0.465
Pekalongan Selatan	Soko	0.460	26.910	0.773	0.444
Pekalongan Utara	Krapyak Kidul	19.643	24.074	0.523	0.434
Pekalongan Utara	Degayu	5.331	27.274	0.730	0.434
Pekalongan Timur	Dekoro	0.637	25.622	0.739	0.432
Pekalongan Barat	Kergon	2.551	25.045	0.548	0.423
Pekalongan Timur	Sokorejo	0.131	27.467	0.744	0.418
Pekalongan Selatan	Banyurip Alit	1.209	25.942	0.604	0.409
Pekalongan Selatan	Duwet	0.117	29.420	0.739	0.409
Pekalongan Barat	Bumirejo	0.217	29.511	0.695	0.406
Pekalongan Selatan	Banyurip Ageng	0.355	25.551	0.647	0.402
Pekalongan Barat	Kebulen	0.586	25.940	0.468	0.397

Pekalongan Selatan	Kertoharjo	0.132	28.562	0.664	0.390
Pekalongan Utara	Bandengan	3.798	26.920	0.724	0.386
Pekalongan Timur	Poncol	0.721	25.344	0.668	0.385
Pekalongan Selatan	Kradenan	1.049	26.862	0.520	0.385
Pekalongan Timur	Gamer	0.000	28.371	0.695	0.384
Pekalongan Selatan	Yosorejo	0.265	26.706	0.717	0.371
Pekalongan Selatan	Kuripan Lor	0.751	26.546	0.589	0.369
Pekalongan Timur	Karangmalang	0.412	28.615	0.657	0.367
Pekalongan Barat	Tirto	0.745	25.545	0.403	0.365
Pekalongan Timur	Landungsari	0.367	24.347	0.589	0.364
Pekalongan Timur	Keputran	1.377	22.601	0.469	0.361
Pekalongan Selatan	Buaran	0.348	26.956	0.566	0.354
Pekalongan Barat	Sapuro	0.316	24.822	0.585	0.352
Pekalongan Timur	Kauman	0.390	22.826	0.304	0.348
Pekalongan Utara	Kandang Panjang	17.440	24.904	0.424	0.345
Pekalongan Selatan	Kuripan Kidul	0.000	27.986	0.589	0.333

Pekalongan Timur	Noyontaan	0.178	22.289	0.522	0.306
Pekalongan Barat	Pringlangu	0.406	23.419	0.423	0.295
Pekalongan Barat	Kramatsari	0.202	24.537	0.494	0.275
Pekalongan Timur	Sugihwaras	0.497	19.511	0.368	0.251
Pekalongan Barat	Tegalrejo	0.071	24.741	0.314	0.247
Pekalongan Barat	Podosugih	0.226	22.957	0.356	0.246
Pekalongan Barat	Medono	0.668	24.996	0.319	0.242
Pekalongan Timur	Sampangan	0.396	19.243	0.243	0.240
Pekalongan Barat	Bendan	0.594	22.668	0.300	0.239
Pekalongan Utara	Kraton Lor	0.336	22.930	0.300	0.230
Pekalongan Utara	Dukuh	0.210	25.421	0.290	0.221
Pekalongan Barat	Kraton Kidul	0.197	22.179	0.251	0.209

Source: Authors calculation.

In Pasirsari, *RW* 4 is the most vulnerable *RW* due to high climate exposure and low adaptive capacity (Figure 51). In Panjang Wetan the most vulnerable *RW* are *RW* 1 and *RW* 13 (Figure 52). Both areas have high exposure and low adaptive capacity.

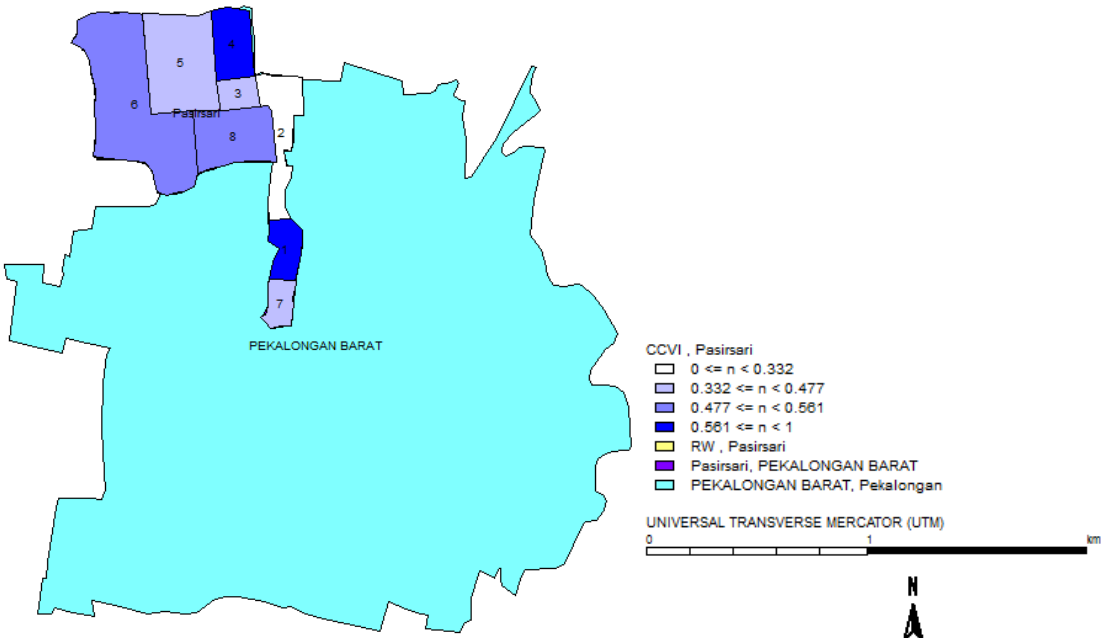


Figure 51. Climate change vulnerability index at *RW* level of Pasirsari in Kota Pekalongan

Source: Authors calculation.

Table 25. Climate change vulnerability index at *RW* level of *Kelurahan* Pasirsari in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Exposure**	**Sensitivity**	**Adaptive Capacity**	**CCVI**
Pekalongan Barat	Pasirsari	1	0.519	0.409	0.852	0.614
Pekalongan Barat	Pasirsari	2	0.004	0.217	0.326	0.187
Pekalongan Barat	Pasirsari	3	0.585	0.408	0.405	0.471
Pekalongan Barat	Pasirsari	4	0.919	0.494	0.497	0.645
Pekalongan Barat	Pasirsari	5	0.437	0.392	0.463	0.437
Pekalongan Barat	Pasirsari	6	0.195	0.496	0.724	0.483
Pekalongan Barat	Pasirsari	7	0.095	0.547	0.622	0.427
Pekalongan Barat	Pasirsari	8	0.753	0.422	0.458	0.552

Source: Authors calculation.

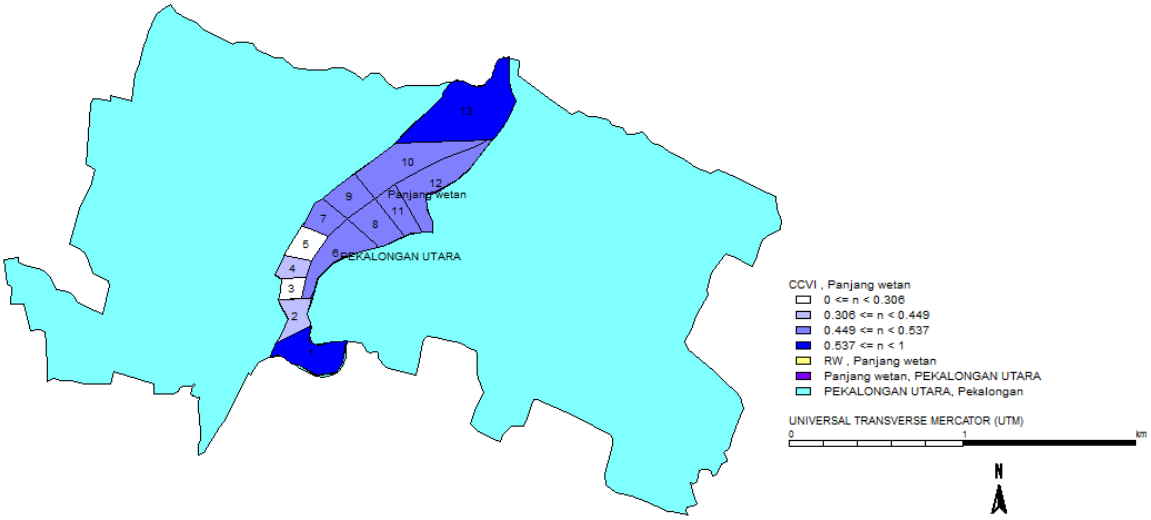


Figure 52. Climate change vulnerability index at *RW* level of Panjang Wetan in Kota Pekalongan

Source: Authors calculation.

Table 26. Climate change vulnerability index at *RW* level of *Kelurahan* Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	**Exposure**	**Sensitivity**	**Adaptive Capacity**	**CCVI**
Pekalongan Utara	Panjang Wetan	1	0.694	0.432	0.704	0.626
Pekalongan Utara	Panjang Wetan	2	0.016	0.240	0.655	0.320
Pekalongan Utara	Panjang Wetan	3	0.000	0.323	0.179	0.163
Pekalongan Utara	Panjang Wetan	4	0.000	0.373	0.527	0.307
Pekalongan Utara	Panjang Wetan	5	0.110	0.378	0.387	0.294
Pekalongan Utara	Panjang Wetan	6	0.546	0.470	0.396	0.473
Pekalongan Utara	Panjang Wetan	7	0.420	0.447	0.625	0.508
Pekalongan	Panjang Wetan	8	0.363	0.298	0.808	0.512

Utara						
Pekalongan Utara	Panjang Wetan	9	0.565	0.287	0.525	0.472
Pekalongan Utara	Panjang Wetan	10	0.591	0.318	0.510	0.485
Pekalongan Utara	Panjang Wetan	11	0.685	0.399	0.475	0.529
Pekalongan Utara	Panjang Wetan	12	0.594	0.286	0.616	0.516
Pekalongan Utara	Panjang Wetan	13	0.639	0.456	0.734	0.626

Source: Authors calculation.

At the *RT* level analysis, only two *RT* in *RW* 3 Pasirsari are high vulnerable to climate change (Figure 53). In *RW* 9 Panjang Wetan half of total *RT* are high vulnerable to climate change (Figure 54). In Pasirsari and Panjang Wetan the high vulnerability index at *RT* level is influenced by the low adaptive capacity in that area. It is indicated that at the lowest administrative level, the role of society which support the adaptive capacity indicator is significant to determine vulnerability of climate change.

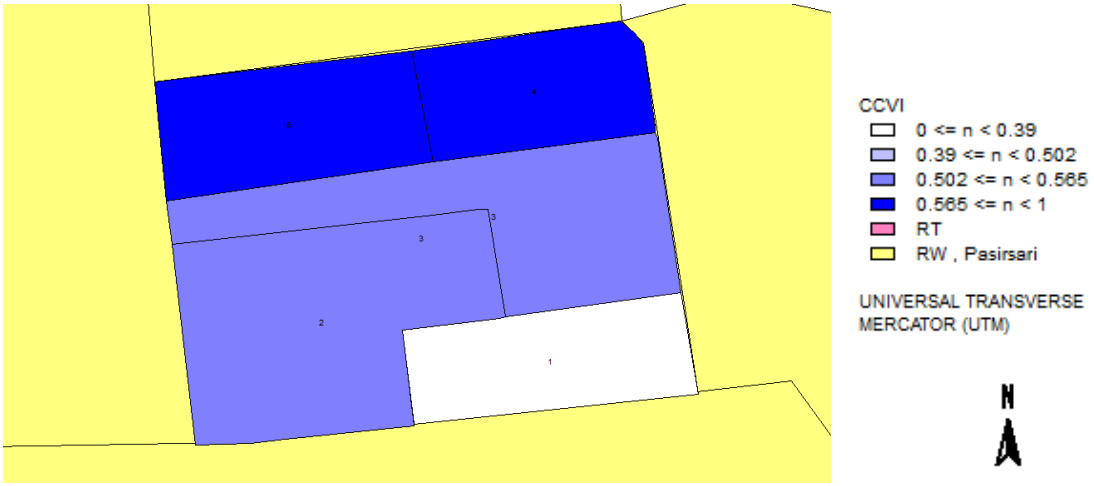


Figure 53. Climate change vulnerability index at *RT* level in *RW* 3 Pasirsari Kota Pekalongan

Source: Authors calculation.

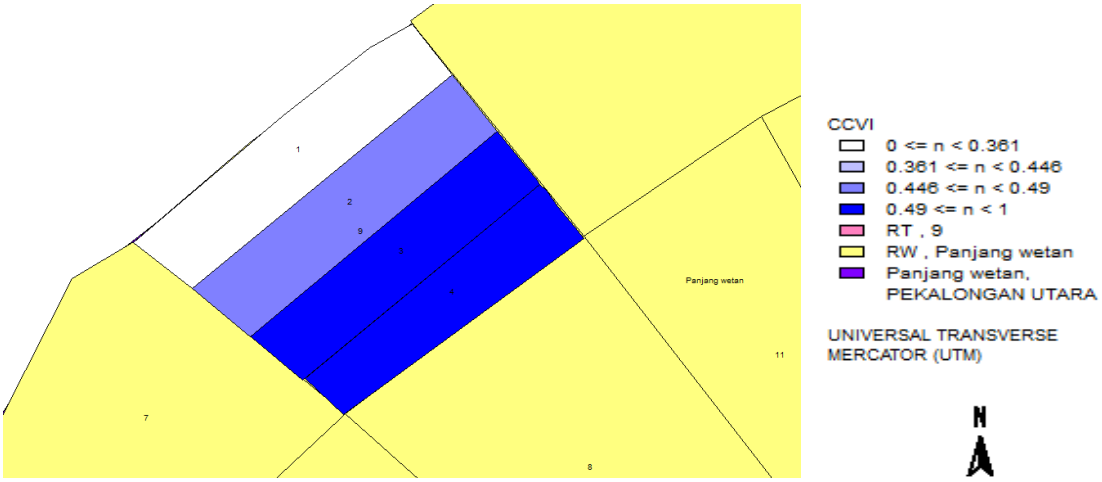


Figure 54. Climate change vulnerability index at *RT* level in *RW* 9 Panjang Wetan Kota Pekalongan

Source: Authors calculation.

Table 27. Climate change vulnerability index at *RT* level in *Kelurahan* Pasirsari and Panjang Wetan in Kota Pekalongan

Kecamatan	***Kelurahan***	***RW***	***RT***	**Exposure**	**Sensitivity**	**Adaptive Capacity**	**CCVI**
Pekalongan Utara	Panjang Wetan	9	1	0.014	0.338	0.462	0.277
Pekalongan Utara	Panjang Wetan	9	2	0.423	0.298	0.592	0.452
Pekalongan Utara	Panjang Wetan	9	3	0.509	0.292	0.698	0.519
Pekalongan Utara	Panjang Wetan	9	4	0.390	0.412	0.752	0.534
Pekalongan Barat	Pasirsari	3	1	0.075	0.451	0.316	0.278
Pekalongan Barat	Pasirsari	3	2	0.649	0.469	0.384	0.504
Pekalongan Barat	Pasirsari	3	3	0.377	0.362	0.793	0.530
Pekalongan Barat	Pasirsari	3	4	0.558	0.492	0.783	0.627
Pekalongan Barat	Pasirsari	3	5	0.390	0.475	0.799	0.571

Source: Authors calculation.

5.0 GOVERNMENT ROLE IN CLIMATE CHANGE (MITIGATION AND ADAPTATION)

5.1 Central Government Role

The commitment by the Government of Indonesia (GoI) to become involved in the mitigation and adaptation of climate change began with the ratification of the United Nations Framework Convention on Climate Change in Law No.6/1994 and continued with the ratification of the Kyoto Protocol in Law No.17/2004. The formulation of an integrative national action plan to face climate change started in 2007 with the integration of a development strategy focusing on economic growth (pro-growth), reducing poverty (pro-poor) and expanding employment opportunities (pro-job), combined with consideration of the natural environment (pro-environment).

In the 2007 National Action Plan Addressing Climate Change (RAN-PI), it is stated that climate change mitigation is aimed at reducing Global Greenhouse Gases with a focus on the energy sector and LULUCF (Land-Use, Land-Use Change and Forestry). Whereas climate change adaptation is focused on the ability to overcome the risks of climate change categorized generally as natural disasters. Natural disasters can take the form of; floods, landslides, erosion, tropical storms and drought. Therefore, the framing of the adaptation agenda needs to be connected with the National Action Plan for Disaster Reduction (RAN-PRB).

The RAN-PRB tries to change the focus of current practices in disaster management from a responsive to a preventive approach. The objective of the RAN-PRB is supporting policymaking and monitoring of disaster-risk reduction. The Hyogo Framework for Action 2005–2015 is used in RAN-PRB and prescribes the responsibilities of all stakeholders. There are three strategic goals being adopted: (1) to integrate disaster risk consideration into sustainable development policies, planning and programming at all levels, (2) to develop and to strengthen institutions, mechanisms and capacities at all levels that can contribute to building resilience to a hazard, and (3) to incorporate systematic risk reduction approaches into the design and implementation of emergency preparedness, response and recovery programs in the reconstruction of affected communities.

In 2007, the GoI enacted Law No.24/2007 on Disaster Reduction. In this law disaster was defined as:

> *An event or series of events that threaten lives and the livelihoods of society caused by both natural factors and/or unnatural factors as well as human factors that result in death, destruction of the environment, loss of property and psychological trauma (article 1).*

Generally, the risk of disaster in Indonesia is caused by five factors, namely: (1) geological (earthquakes, tsunami, volcanic eruptions), (2) hydro-meteorological (flooding, landslides, drought, hurricanes), (3) biological (epidemics, plant diseases, livestock diseases, plagues of pests), (4) technological failures (industrial and transportation accidents, nuclear radiation leaks, chemical pollution), and (5) socio-political (community conflict, terrorism, ideology, religion) (BNPB 2011).

By enacting Law 24/2007, in 2008 the National Disaster Management Agency (BNPB) was established through Presidential Decree 8/2008. The existence of the BNPB replaced the National Coordinating Agency for Disaster Management and was expected to improve on aspects of weakness concerning the law and implementation of disaster management. From a legal basis, BNPB was established with national legislation, while at the local level (provincial and *kabupaten/kota*) a Regional Disaster Management Agency was established and set up using local regulations[6]. At both the central and regional levels, the implementation of disaster management was based on principles of planning, integration, coordination and comprehensiveness. These principles are to be implemented in three stages, namely pre-disaster, the emergency response and post-disaster[7].

Up until February 2012, there were 104 *kabuputen/kota*[8] in Indonesia that had yet to establish a BPBD (Menkokesra 2012). In the Province of Central Java, there are four cities[9] that have not yet established a BPBD, one of which is Pekalongan.

Data on disaster occurrence provided by the BNPB has been available online since July 29, 2008 under the title: Indonesian Disaster Data and Information Database (DIBI). This data consists of information about disasters in Indonesia over the last 30 years. This disaster history is then used to identify risk areas throughout Indonesia. The result of this is the Disaster Prone Indonesia Index (IRBI) which is an analytical tool in the form of a disaster index showing the actual history of disasters that have occurred and the resulting loss to the *kabupaten/kota*. The IRBI is published every two years. The IRBI results for Pekalongan include the city in the high-risk category with a score of 52, and at 272 in terms of the national ranking (BNPB, 2011: 84).

In 2008, the Government of Indonesia formed the National Council on Climate Change (DNPI) through Presidential Regulation No.46/2008 in an effort to respond to institutional problems handling climate change. The main duties of the DNPI are to: (1) formulate national policy related to climate change, (2) coordinate climate change mitigation activities consisting of adaptation, mitigation, technology transfer and funding, (3) formulate a policy mechanism for carbon trading, (4) perform monitoring and evaluation of climate control policy, (5) strengthen Indonesia's position in encouraging developed counties to be more responsible for climate change control.

The DNPI is chaired by the President and two deputies, both being coordinating ministers: the Coordinating Minister for the People's Welfare and the Coordinating Minister for the Economy. In its daily running, the DNPI is lead by a chairperson and includes eighteen members of ministries including; the National Development Planning Board (Bappenas), the State Minister for the Environment, and the head of the Metrological and Geophysics Bureau.

In relation to funding, the Indonesian Government, through Bappenas formed the Indonesia Climate Change Trust Fund (ICCTF) in September 2009[10] and began funding

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[6] Law 24/2007 article 25.
[7] Law 24/2007 article 16.
[8] Based on BPS data, until June 2011, Indonesia consists of 33 provinces, 497 *kabupaten/kota* (399 *kabupaten* & 98 *kota*), 6,747 subdistricts and 78,198 villages (BPS 2011: 31).
[9] The Province of Central Java consists of 29 *kabupaten* and 6 *kota*.

three pilot projects in September 2010 (Bappenas 2011:5). The funding focus was toward efforts to reduce greenhouse gas emissions through three priority areas: land-based mitigation, energy, and, adaptation and resilience. The ICCTF fully supported the work of Bappenas in the coordinating forum Climate Change Policy Coordination Forum (CCPF) which consisted of representatives from government, civil society organizations, developments partners and professional experts.

In 2010, Bappenas published the Indonesia Climate Change Sectoral Roadmap (ICCSR) with the aim of mainstreaming climate change into the five year medium-term plan (RPJMN) 2010–14 and moving forward until the target year of 2029. The policy suggestions contained in the sectoral roadmap were adapted to Indonesian characteristics, where they were divided-up based on the regions: Sumatera, Jamali (Java, Madura, Bali), Kalimantan, Sulawesi, Nusa Tenggara, Maluku and Papua.

The ICCSR integrated several sectors into the two types of responses; mitigation and adaptation. The sectors which were included in mitigation were; forestry, energy, industry, transportation, and waste management. The aim of the mitigation response was to carry out potential emission reduction and mitigation strategies. Whereas sectors included in adaptation were; agriculture, oceans and fisheries, health, and water resources. The aim of the adaptation response was to identify vulnerability components, potential impacts, or the risks of climate change for each sector, and formulate an adaptation strategy.

On 20 September 2011, the National Action Plan to Reduce Greenhouse Gases (RAN-GRK) through Presidential Instruction No.61/2011 was adopted, as a sign of the President of Indonesia's commitment to reduce greenhouse gas emissions by 26% through domestic efforts and by as much as 41% when international assistance is received in 2020. The RAN-GRK was established as the main guidelines for ministries/institutions at the central level, regional governments (governors and regents/mayors), society and business people in carrying out the planning and implementation of GRK emission reductions.

The RAN-GRK is a part of the climate change mitigation, and covers five main sectors, which are: (1) agriculture, (2) forestry and peat forests, (3) energy and transportation, (4) industry, and (5) waste management. Aside from the five main sectors, there are supporting activities both for the five main sectors as well as several ministries or agencies connected to them which include: BMKG, the Ministry of Oceans and Fisheries and the Ministry for the Environment.

5.1.1 Mitigation and adaptation for flooding, land slides and coastal inundation (*ROB*)

According to the ICCSR for Water Resource Sector (2010b), climate change hazards for the water sector consist of; decreasing water availability, flood, landslide and saltwater intrusion. Flooding can be caused by some major factors namely: extreme rainfall of up to 400/mm/month, overloaded surface water or water reservoirs, such as

[10] ICCTF was established by Bappenas Ministerial Decree No.44/M.PPN/HK/09/2009 September 2009 and it was revised by No.59/M.PPN/HK/09/2010.

rivers, ponds, and dams; and certain land characteristics and conditions in the upper reaches of catchment areas (p.10).

Whereas the cause of landslides can include: rain, steep slopes, soil that is not compact and thick, fragile rock type, type of landscaping, tremors, loss of lake or dam surface water, increases in pressure, erosion, a buildup of material on slopes, remnants of past landslides, the presence of discontinuity or permeable/impermeable soil junction, deforestation in disposal areas and rubbish (VSI, 2011). Mitigation efforts are carried out by the Centre for Volcanology and Disaster Mitigation (PVMBG)[11] with the national distribution of information about the areas that are frequently subject to landslides. The PVMG is one of the working units of the Geology Department at the Ministry of Energy and Mineral Resources.

The responsibility for protection of the community from destructive water disasters has been given to the Directorate General of Water Resources in the Ministry of Public Works. The technical expertise for controlling destructive water in river regions is the Central Office of River Regions (BBWS) that has six regional offices[12]. Management of the river region that runs through the city of Pekalongan is carried out by the Pemali-Juana River Region Office which manages sixteen *kabupaten* and four *kota* in the Province of Central Java. The Pemali-Juana BBWS has a working area that includes the Pemail-Comal River Region and the Jratunseluna River Region. Several rivers in the City of Pekalongan that are included under the management of Pemali-Comal River Region are the Kupang/Pagerukir River, the Banger and Gabus Rivers. The number of rainfall stations in the Pemali-Comal River Region is 89 (1990–2004) with an average rainfall of between 1,700mm and 3,000mm per year (Dirjen SDA, 2011).

Actions taken by the BBWS to mitigate flooding caused by overflowing rivers is to build river canals where ever the river splits in two, so that the discharge of water causing the height of the river to rise is able to fall, and not overflow and cause a flood. Other measures included within the maintenance program are cleaning the river of rubbish and dredging the bottom of the river to reduce the build-up of sediment.

In the ICCSR for the Marine and Fisheries Sector (2010c), discussion concerning coastal inundation (ROB) is included in the category of rising sea levels where the causes can influence many areas not only caused by ice melting at the poles, but also by the fluctuations of the ocean surface (rises and falls) at various time scales such as in the cases of; ocean waves (sea and swell) generated by ocean surface wind, tides caused by the gravitational forces of the moon and sun, storm surges and storm waves that arise due to cyclones or storms at sea. One of the nine priority activities of marine and fisheries sector is elevation adjustment and strengthening the structures of buildings and vital facilities in coastal zones. Furthermore, one of sub-priority activities is making assessments and the dissemination of elevated house (*rumah panggung*) construction in coastal zones.

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[11] Information about "Early Warning for Potential Land Movement" can be accessed at http://pvmbg.bgl.esdm.go.id

[12] Minister of Public Works regulation No.12/PRT/M/2006 on Organisation and Work Methods Main Offcie Regional Rivers

5.2 Local Government Role

Efforts by the City of Pekalongan government to carry out integrated mitigation and adaptation to face climate change to cross a new sector began in 2010 through the formation of a climate change working group[13]. This early initiative to from a working group originated from an offer by GiZ to address problems of mitigation and adaptation to climate change. This was in-line with a commitment by GiZ in 2009 to assist the Indonesian Government to carry out reductions in greenhouse gas emissions in eight *kota/kabupaten* in the provinces of Central and East Java[14]. Parties involved in the City of Pekalongan Climate Change Working Group included 25 representatives from 8 offices[15], one representative from Pekalongan University, and one representative from an NGO.

However, NGOs involved in the Working Group on Climate Change find it difficult to maintain their presence in the meetings. This is due to the strained relationship between the NGOs and Bappeda. The NGOs want a mutual relationship with the government. If the NGOs are called in to attend government meetings, it is expected that the government of the City of Pekalongan grant them access to obtain relevant data. But the process of accessing this data is hampered by bureaucratic procedures or ethics.

The final result reached by the climate change working group over the three year time-frame (2009–2012) is the City of Pekalongan Integrated Action Plan to Face Climate Change for the next 20 years. The content of the plan is a collection of several mitigation action choices in the form of an emissions scenario as well as the adoptation of a risk profile. One of the mitigation actions that has already been carried out is primary school children bringing a light bulb to school to exchange for an energy saving light bulb from Osram, a lightbulb producing company. The future direction for reducing emissions is to focus on electricity and fuel expenditure which is paid for with APBD funds. A saving of APBD funds, which is the people's money, is expected as a result of reducing greenhouse gases.

On 17 December 2011 public consultations were held for the Integrated City Climate Strategy. This event was one of the final steps to engage stakeholders in clarifying, giving input to, and being involved in the decisions of climate change public policy process. At the end of public consultation, the City of Pekalongan government committed to increase the city's resilience to climate change through adaptation to practices in the water, health, agriculture and fisheries sectors as well as reducing GHG emissions. The GHG emission reduction target became 15% for the whole city and up to 20% for government operations (PAKLIM, 2011).

The City of Pekalongan government is concentrating on the impacts associated with flooding and coastal inundation (ROB). The rivers that most often overflow and casue flooding are the Pekalongan River (Banger River) and the Bremi River. The agency acting in carrying out river regulation is the Pemali-Juana BBWS located in

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[13] Decision of Mayor of Pekalongan No: 050.05/112 / 2010 on Formation of Working Group on Climate Change – City of Pekalongan

[14] For further information about the cooperation of GiZ with the Indonesian Government on climate change can be found at http://www.paklim.org

[15] Agencies involved in the climate change working group are Dindikpora, Bappeda, Dinas Kesehatan, DPUPT, Dishubkominfoparbud, DPPK, Disperindagkop, and Kesbanglinmas.

Semarang, whereas the City of Pekalongan government has authority over the regulation of drainage channels that flow into the rivers. Efforts to overcome the overflows of water coming from the Banger River have been made with the construction of canals, namely the Banger Hilir canal which was constructed in 2002.

The occurrence of coastal inundation has become worse since 2006, so that a revetment and wave dissipater have been constructed under the supervision of the DPPK (Agriculture, Fisheries and Marine Office). Other measures to reduce ROB are the fitting of water gates to a number of estuary channels so that in the event of ROB these gates can be closed and prevent rising water to enter into residential areas. These water gates are automatic (in the Gabus River) and manual in the other rivers.

From the point of view of planning, the Bappeda in the City of Pekalongan coordinated with Bakosurtanal (Geospatial Information Agency) to produce the Regional Spatial Plan (*RTRW*) 2009–2029 using a scale of 1:20,000. A derivative of the *RTRW* is a detailed plan of strategic cultural regions, coastal regions or zoned as coastal. Connected to ROB and flood mitigation efforts, in the *RTRW* there is a plan to develop a system of polders in the form of long storage[16] and remove the water to the sea using a system of pumps and automatic gates. The plan is to have five drainage channels that will be used as long storage, they are; Bandengan drain, Kandang Panjang drain, the left Salam Manis drain, Panjang Wetan Kanan drain and Krematorium drain. From these five long storages a connection can be made to the three main drains: Bandengan drain, the Kandang Panjang drain and the Krematorium drain.

Fresh water can be obtained from PDAM who has water supply sources in Kabupaten Batang and Kabupaten Pekalongan. When there is a flood or ROB disaster, the supply of fresh water for residents needs to be maintained. For those *kelurahan* not serviced by PDAM, supplies of fresh water can be obtained from the Community Based Supply of Drinking Water and Sanitation (Pamsimas). At the moment, there are 47 *kelurahan* served by Pamsimas.

Other mitigation efforts connected to planning are: fulfilling the goal of 30% green open space, a by-law concerning the compulsory planting of another tree to replace a fallen tree, and the creation of city forests (in Yoso Rejo, Poncol, Krapyak, Landung Sari).

The City of Pekalongan *RTRW* is synchronized with the *RTRW* of Central Java Province[17]. In the Central Java Province *RTRW*, the City of Pekalongan is acknowledged as a Regional Center of Activity[18] (PKW) for the Petanglong zone system which consists of Kabupaten Pekalongan, Kabupaten Batang and the City of Pekalongan with the function of developing as a local and provincial service center. In reality, the area around the City of Pekalongan is hinterland which serves the needs of the City of Pekalongan because the economic center of the region is located in the city. More broadly, flood management

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[16] In the City of Pekalongan RTRW 2009–2029, it is explained at length the long storage which will be built is around 20–30 meter including an inspection path that is wide enough so that it can be used as a drainage channel (p. 4–15).

[17] Regional Regulation Central Java Province No.6/ 2010 on Spatial Plan Central Java Province 2009–2029.

[18] Regional Center of Activity (PKW) is urban area which has function on giving services for activities at provincial scale or some *kabupaten/kota*.

governance should be integrated with Kabupaten Batang and Kabupaten Pekalongan, however its implementation is in fact not like this. The main obstacle is regional autonomy that causes *kabupaten*–level policies to not be able to be intervened with.

The Regional Reduction of Disasters Agency (BPBD) of the City of Pekalongan has yet to form and is still rolled into one function with the Civil Service Police Unit (SATPOL PP) as a section of the Community Protection and Disaster Mitigation (Linmas & PB). Previously, the office that handled disasters was Kesbangpolinmas (Office of National Unity, Politics, and Community Protection). The transfer of task responsibilities occurred sometime in October 2011, and was carried out based on the new Organizational Structure and Work (SOTK) under the auspices of the City of Pekalongan government.

The reason given by Bappeda of why they have not formed the BPBD is: disasters in the City of Pekalongan are not yet critical, and administratively the budget for the BPBD is still handled by one office being *Kesbangpolimas*, in addition to the fact that the regional area of the City of Pekalongan is relatively small. The decision to not form a BPBD for the City of Pekalongan is facilitated by the Permendagri No.46/2008 on Organizational Guidelines and Work Procedures BPBD where the formation of a BPBD in every *kabupaten/kota* is an optional choice[19]. Whereas in Article 18, Law No.24/2007 on Disaster Reduction it firmly states that regional governments assumed the duty of forming a BPBD both at the provincial and *kabupaten/kota* level.

On the other hand, community-based disaster reduction strategies presented by the Ministry of Social Affairs since 2002 appear more successful in recruiting numbers of community members as disaster reduction volunteers in the area of social assistance or they are also known *Tagana* (disaster response cadets). The number of *Tagana* across Indonesia from 2004 until 2010 numbered 30,796 volunteers[20]. In the Province of Central Java, the total membership of *Tagana* from 2005–2009 was 1,438 volunteers. In the case of the City of Pekalongan, the establishment of *Tagana* only began in 2006 and continued until 2009, with only 18 members spread out at the *kelurahan* level.

In normal circumstances, the people of Pekalongan will have recourse to the Department of Social Welfare when there is a flood. The standard assistance provided by the Department of Social Welfare is 400 grams of rice per head for 3–4 days, and one carton of instant noodles for a family. If averaged out this means that each family will receive as much as 10 kg of rice and one carton of instant noodles. But in practice, relief supplies are smaller than the number of requests. The problem faced is the institution of the Department of Social Welfare does not operate alone, but is joined with other agencies, namely the Department of Labor (since 2009). The impact of this is that the ability of an institution is reduced due to a lower status than it held previously as a separate office in only one field, so now it has a severely reduced capacity to handle the 27 types of social welfare problems (PMKS) among the elderly, poor, disabled, drug abuse and commercial sex workers (PSK).

Although formally the inauguration of *Tagana* was only carried out on 14 December 2006 through regulation by the Ministry of Social Affairs No.82/HUK/2006

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[19] In article 2 paragraph 1, it is mention: "Provincial BPBD is formed in every province and BPBD of *kabupaten/kota* ***can be*** formed in every *kabupaten/kota*"

[20] For further information see website: http://tagana.depsos.go.id

on Disaster Response Cadets, recruitment had been carried out since 2004 through the Social Affairs Office at the *kabupaten/kota* level.

Procedurally, the handling of disasters by the City of Pekalongan is carried out through the Mayor's SK which contains the guidelines to declare a disaster and the formation of the team to respond to it. This team then coordinates the actions taken to handle the disaster. Before changing to SATPOL PP, all actions undertaken by the team come under the activities of *Kesbangpolinmas* as the administrative underwriter. As a result of the FGD at *Kelurahan* Panjang Wetan and *Kelurahan* Pasir Sari (4 November 2011), it is known that the community felt the amount of assistance given by the government was very small and far from enough, so that *kelurahan* institutional parties themselves had to secure additional assistance from other groups.

The handling of disasters by the City of Pekalongan in the middle of 2011 expanded with the formation of community organizations in each *kelurahan* called Community Emergency Response Teams (Pokmas Darat). Their goal was to increase the effectiveness of the role of the Public Protection and Disaster Management section. Therefore, their formation started at the *kelurahan* level, then *kabupaten*, then finally the municipal level. However, the formation of this organization did not appear to answer the problem of engaging the community to work together to clean up the sewers (to prevent flooding) or to assist close neighbors to realign roof tiles (due to high winds causing them to shift or fly off).

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The Government of Indonesia (GoI) has stipulated several laws/regulations and set up institutions related to climate change mitigation and adaptation. Implementing agencies at the national level (several ministries and agencies) have provided open access information about potential disaster areas with maps, such as: a map of potential flood areas and landslide areas. The lowest level of map is at the *kabupaten* level.

The mitigation effort is more intensive due to the President of Indonesia's commitment to reduce greenhouse gas emissions by 26% through domestic efforts and by as much as 41% when international assistance is received in 2020.

Using the CBMS database for Kota Pekalongan, the identification of climate hazards consists of floods, coastal inundation (ROB), and landslides. The two most vulnerable *kecamatan* which have high number of incidence of flood, coastal inundation and landslide are located in Kecamatan Pekalongan Barat and Kecamatan Pekalongan Utara. However, this CBMS database is categorized as exposure data.

This study has shown that it is not enough to use exposure data only in giving responses to climate change mitigation and adaptation. We should include sensitive and adaptive capacity category in it so we can get the most vulnerable area. Using this method, we can describe until household location. The results show that Kecamatan Pekalongan Utara is the most vulnerable area because of high climate exposure especially

to coastal inundation. Kecamatan Pekalongan Selatan is the second most vulnerable *kecamatan* due to its sensitivity and low adaptive capacity. The third position of vulnerable *kecamatan* is Kecamatan Pekalongan Timur and the fourth position is Kecamatan Pekalongan Barat.

This study also shown that at the higher administrative level, the exposure of climate hazard and sensitivity of climate hazard in an area has significanlty determine the level of vulnerability. At the lower administrative level analysis, the role of society which is represent by the adaptive capacity is significalty determine the level of vulnerability.

6.2 Gaps

- The local government of Kota Pekalongan still uses exposure data as the main consideration in its mitigation and adaptation strategies.
- The local government strategy to mitigate the impact of flooding and coastal inundation creates a uniform treatment for all *kecamatan* areas.
- In Regional Spatial Planning (*RTRW*) document, the sensitivity and adaptive capacity which is owned by each *kelurahan*, *RW*, *RT*, and household become invisible.
- Low pacticipation of society in social activities which support environment livelihood.

6.3 Recommendations

- Local government should use this vulnerability method in order to know in detail the level of vulnerability of each household. After knowing the details, the local government can used it to create programs that are concerned with differentiation ability (particularity) at the household level.
- Regional Spatial Planning (*RTRW*) should recognize the special conditions or problems at the *RT* level especially for areas which are continuously affected by flood water so that local governments recognize them, and give priority to solving their problems, and not leave them unassisted.
- This vulnerability method can be used by the residents of Kota Pekalongan (as an objective measurement tool) to evaluate the priority area for development. Regardless of who the head of the *kabupaten* government is they will aloocate priorities based on an objective calculation.
- The public needs to know their own level of vulnerability. It is possible to explore some actions which can be carried out by the households themselves i.e. (a) as a means of awareness for every family, so every citizen is willing to do voluntary work because they know a climate disaster would personaly affect them, (b) if there is any assistance or help, then assistance will not be divided equally, because through vulnerability maps, it can be ascertained the location of the households which are most in need and the different kinds of assistance that is required.

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APPENDICES

Appendix 1 Climate change vulnerability index of Philippines

Weight	Category	Weight	Category	Weight	Label	Variable Name
0.30	**Sensitivity**	0.15	**Ecological Sensitivty**	0.73	**Proportion of Protected areas**	proc_areas
				0.27	**Number of Local Heritage sites**	heri_sites
		0.31	**Livelihood at Risk**	0.47	**Percentage of agricultural lands**	%_agriland
				0.19	**Percentage of industrial lands and commercial lands**	%_indusland
				0.34	**Proportion HHs engaged in fishing**	%_ff
		0.53	**Population at Risk**	0.23	**Population density (Land area/population)**	popden
				0.22	**Proportion of elders (60 and above)**	%_eldrs
				0.25	**Proportion of children (below 15)**	%_childrn
				0.29	**Proportion of persons with disability**	%_PWDs
0.37	**Adaptive Capacity**	0.21	**Economic Resource and Distribution**	0.21	**Average Income per capita**	pci
				0.11	**Average number of Assets per HH**	assets
				0.17	**Financial resources for disaster risk reduction (peso per person)**	fundsDRR_ppp
				0.18	**Poverty gap**	povgap
				0.21	**Proportion of population below the poverty threshold**	pov_hc
				0.12	**Income inequality (Gini coefficient)**	ineq
		0.19	**Skills**	0.32	**Number of Trained persons on DRR per 100 population**	#DDRskills
				0.12	**Average Number of years in school (15 years old and above)**	sch_yrs
				0.19	**Proportion of employed persons with skills**	%skilledwkrs
				0.22	**Number of health workers per 100 population**	#hw
				0.15	**Literacy rate**	%lit
		0.14	**Information and Technology**	0.37	**Proportion of households with access to landline or mobile phone**	%Hhsphone
				0.63	**Number of DRR communication equipment**	#DRRcomeqpt s
		0.26	**Infrastructure and Service Facilities**	0.18	**Number of health facilities**	#hf
				0.20	**Number of buildings for evacuations (except health facilities)**	#bldgecav
				0.13	**Length of dikes**	lgdikes
				0.09	**Number of dams**	#dams
				0.27	**Number of DRR equipment (except communication equipment)**	#DRReqpt
				0.13	**Length of good quality road in km**	lggdrds
		0.20	**Institutions**	0.14	**Proportion of population who are members of community organizations**	%assoc
				0.15	**Number of regulations on**	regCC

					Climate Change	
				0.34	**Presence of early warning system**	EWS
				0.19	**Presence of Disaster Risk Reduction plans**	DRRplans
				0.08	**Proportion of Voters**	%voters
				0.10	**Proportion of adult population (15-59 years old)**	%adultpop
0.34	**Exposure**	0.39	**Number of typhoons**	1.00	**Total number of typhoons per year which crossed the LGU from 1948-2009**	Typhoon
		0.31	**Susceptibility to Landslides**	0.50	**High Susceptibility Area**	HSA
				0.33	**Moderate Susceptibility Area**	MSA
				0.17	**Low Susceptibility Area**	LSA
		0.30	**Susceptibility to Flood**	0.50	**High Susceptibility Area**	HSA
				0.33	**Moderate Susceptibility Area**	MSA
				0.17	**Low Susceptibility Area**	LSA

Appendix 2 Focus group discussion and interviews guidelines

FGD Guide – *Kelurahan* level

The point that needs to be emphasized in CBMS FGD on Climate Change is the concept of the family, because the unit used in SPKOM data collection is the family (see questionnaire). Even though the focus of climate change is on the impact on flooding and coastal inundation (ROB) it is not, however, limited to these two events.

The impact of flooding and coastal inundation will be different depending on what is most affected by the disaster. Consequently, the grouping of welfare needs to come first (questioning the grouping of welfare needs does not need to be lengthy, but must include the type of occupation, income, etc)

Aims

Identify welfare criteria across *RW*/*RT*
Compare the level (rank) of welfare across *RW*/*RT*/family groups
Assess the impact of climate change on regions/families
Evaluate the measures that have already, are in the process of, and will be, carried out by the government, the private sector and the community.

Participants

Numbering 10-12 people
A combination of males and females
Consisting of: local authorities, community figures, religious leaders, teachers, midwives, LPP, PKK.

Stage I: Classification of Welfare

Sequence:

Facilitator opens the FGB (aims, itinerary)
General overview of welfare criteria → not to be used, but from the community's vision
Question: "What indicators or characteristics can be used to see the different welfare levels across *RW*/*RT*/families in this area?"
Participants are requested to write a brief in cards (not a sentence), attach it to *sticky cloth*. Group together responses that are the same. There should be indicators that are agreed on (maximum of 6 indicators)

Participants are asked to make and assessment (ranking) of welfare across *RW*/*RT*/families by allocating a score of between 1 (very bad) and 5 (very good). Average out the score of each indicator, then add them up and obtain the final result.

Make a sequence of *RW*/*RT*/families from those with highest score (most prosperous). Discuss the results with the participants until agreement is reached.

Is there a change in community welfare if compared with several years ago?

What is the cause of the change in community welfare? (example: because of climate change)

Stage II: Impact of Climate Change

1. Explain about climate change
2. What are the types of impacts of climate change (i.e. flooding and ROB)
3. Timeline (year and month) from two types of impacts of global warming (flooding/ROB)

1990 2000 2011

4. Has there been a change in welfare based on the length of time shown on the timeline?
5. What are the impacts from the types of climate change mentioned above? (point 2)
   a. People (according to their welfare category)
   b. Sector (agriculture, fisheries, education, transportation)
   c. Surroundings/region

Housing and road conditions

What is the effect of climate change on historic buildings?

6. Who has been negatively impacted on from every type of climate change mentioned?
   a. According to categories of welfare (what are the continuing effects? For example; for education, health)
   b. According to employment (what are the continuing effects? For example, for education, family health)

7. Where are the areas that will be most affected by these types of climate change?

What are the characteristics of these areas

Why are these areas greatly affected (the comparison of previously with now)

8. What are the causes of these differences? (points 4&5)

Stage III: Identification of Government/Private Sector Programs

The program at the time of being effected by climate change (flooding/ROB, etc)
For the community
Infrastructure

Stage IV: Identification of Community Efforts in Facing the Effects of Climate Change

Individual efforts
What is being done?
What are the resources? (Funding, equipment, etc)

Collective efforts
What is being done?
What are the resources? (Funding, equipment, etc)

Efforts in partnership with the government/private sector
What is being done?
What are the resources? (Funding, equipment, etc)

EXPLANATION OF GUIDELINES

I. Instructions

These indepth interview guidelines consist of open-ended questions that require a reasonable amount of time to complete (approximately one hour), so make sure that respondents have the time to complete the interview. If necessary, the interview can be continued at another time. Preferably, the interview should take place in a comfortable setting, preferably not at the office.

Researchers are expected to develop questions that are relevant to the objectives of the interview. Be sure that all respondents have completed their answers before leaving the location.

The researcher should ensure that respondent's contact details are fully recorded.

II. General Questions

The general questions are addressed to climatology institution (BMKG Tegal & BMKG Semarang), disaster reduction agency (BPBD Central Java Province), university (P5 UNDIP), and regional coordination agency at the provincial level (Bakorwil III Provincial Government of Central Java).

General

When did climate change happen on earth? What are the causes?
What are the impacts of climate change?
In regard to the types and frequency of natural disasters in Indonesia, who is responsible for watching/collecting information, data, etc?
How do these institutions (BMKG, BNPB, Bakorsutanal) cooperate with each other?
What fields or sectors are observed by *BMKG?* Which directorates or sections are involved? Is there any institution outside *BMKG* involved in natural disaster observation?
What is the categorization of potential flood-prone areas (high, medium, low)? What criterion is used?
Are there any regulations related to natural disasters? If there are regulations, please mention and explain their content.

Flood

How to categorize an area as being potentially flood-prone? What criterion is used?
Notes: flood-prone potentiality is divided into high, medium and low. The making of flood potentiality forecasting is conducted by cooperation among three institutions namely: *Meteorology, Climatology and Geophysics Agency* (BMKG); Directorate General of Water Resource Development at Ministry of Public Works

(PSDA PU); and Geospatial Information Agency (Bakosurtanal). In general, the role of each institution are describe as follows: BMKG is a provider of monthly rainfall forecast information, PSDA PU provide information about flood-prone area, and Bakosurtanal provide country's basic map (topographical map or RBI, land system map, and land cover map). Flood potentiality forecasting consist of high, medium, low flood potentiality and safe from flood risk.

What indicators can be used to determine potentially flood-prone areas?

How is the data collection processes conducted? (who collects the data, what methods are used, how long the period, how recording system proceed?, etc)

Can floods be predicted? What conditions does a flood happen?

Are there any certain times during the year when flood disasters are more likely to happen? Has this certain time changed along with changes in climate?

What are the impacts of floods?

How do you cope with floods? What should the government, the community and households do?

Are there any regulations either from the central or local government to cope with a flood disaster? Please explain.

Which institution/parties have significant roles in flood measurement and flood mitigation? (the name or title of a resource person who can be asked about flood determining factors)

Sea Level Rises

What factors cause sea levels to rise?

Is there any categorization of sea level rise? How high is the upper limit of sea level rise to be deemed as a natural disaster?

What indicators can be used to determine *ROB* (flood due to high tide)-prone area?

Are there any certain times during the year when *ROB* are more likely to happen? Has this certain time changed along with changes in climate?

What are the impacts of sea level rise?

How do you cope with sea level rise? What should government, community and household do?

Is there any regulation either from the central or local government to cope or mitigate rising sea levels? Please explain.

Which institutions/parties play a significant role in ROB's measurement and ROB mitigation? (the name or title of a resource person who can be asked about ROB determining factors)

Solution

How to cope with various emerging natural disasters in certain areas?

Flood disaster

ROB

Other disaster

How to prevent or anticipate various natural disasters in certain areas?

Flood disaster

ROB

Other disaster

Data
Rainfall, flood-prone area in Indonesia by province
Flood-prone area in Central Java by *kabupaten/kota* (district/city)
Flood-prone area in Kota Pekalongan by *kecamatan* (subdistricts) or *kelurahan*[21]
Sea level elevation in Indonesia by province
Sea level elevation in Central Java by *kabupaten/kota* (district/city)
Sea level elevation in Kota Pekalongan by *kecamatan* (subdistricts) or *kelurahan*

III. Question for Local Institutions or Organizations in Kota Pekalongan

The questions are addressed to Regional Development and Planning Board (*Bappeda*), climate change working group (*Radpaklim*), spatial planning office (*Pemda Tata Ruang*), public work office (*Dinas PU*), social office (*Dinas Sosial*), and Indonesian red cross office (PMI).

General

When did climate change begin happening in Pekalongan? What are the causes?
What are the impacts of climate change in Pekalongan?
What types of natural disasters in Pekalongan are caused by climate change?
Who is responsible for watching/collecting information or data related with climate change in Pekalongan?
How are these institutions (*BMKG, BPBD, Bakorsutanal*) cooperating with each other?
Which section has the task of addressing climate change? What are their duties?
How is the categorization of potential flood-prone area (high, medium, low)? What criterion is used?
Are there any regulations related to natural disasters? If there are regulations, please mention and explain their content?

Flooding

Where are the flood-prone areas in Kota Pekalongan?
What indicators can be used to determine potential flood-prone areas?
Is there any data collection related to floods? How is the data collection process conducted? (who collects the data, what method is used, how long was the data collection period, how did the recording system proceed?, etc)
Can floods be predicted? What conditions cause a flood to occur?
Is there any particular time of the year for a flood disaster to happen? Has that particular time changed along with climate changes? How often does flooding occur in Kota Pekalongan?
What are the impacts of floods?

[21] A ***kelurahan*** is a village level administrative area located in an urban center.

Who is the most effected by floods?
How do you cope flood? What should government, community and household do?
Are there any regulations either from the central or local government to cope with a flood disaster? Please explain.
Which institutions/parties play a significant role in flood measurement?
Which institutions/parties play a significant role in flood mitigation? (a resource person who can be asked about flood-determining factors)

Sea Level Rises

Where are the *ROB* (flood due to high tide)-prone areas in Kota Pekalongan?
What factors cause sea levels to rise?
Is there any categorization of rising sea levels? How far is the upper limit of sea level rise could be regarded as a natural disaster?
What indicators can be used to determine *ROB*-prone areas?
Is there any particular time of the year for a *ROB* to occur? Has that particular time changed along with climate changes?
What are the impacts of rising sea levels?
Who is the most effected by *ROB*?
How do you cope with rising sea levels?
Is there any regulation either from the central or local government to cope or mitigate rising sea levels? Please explain.
Which institutions/parties have a significant role in ROB's measurement and ROB mitigation? (a resource person who can be asked about ROB determining factors)

Solution
How to cope with various emerging disasters in certain areas?
Flood disaster
ROB
Other disaster
How to prevent or anticipate various disasters in certain areas?
Flood disaster
ROB
Other disaster

Data
Rainfall, flood-prone area in Indonesia by province
Flood-prone area in Central Java by *kabupaten/kota* (district/city)
Flood-prone area in Kota Pekalongan by *kecamatan* (subdistricts) or *kelurahan*[22]
Sea level elevation in Indonesia by province
Sea level elevation in Central Java by *kabupaten/kota* (district/city)
Sea level elevation in Kota Pekalongan by *kecamatan* (subdistricts) or *kelurahan*

[22] A ***kelurahan*** is a village level administrative area located in an urban center.

IV. Question for *Camat*[23]/ *RW*[24]/*RT*[25] in Kota Pekalongan

1. If we made acomparison with the previous year's situation, how do you feel about the climate conditionw in this area?
2. Do climate change impactw occur in this area i.e. flood and *ROB*?
3. Which area is the most effected by those disasters?
4. To what extent is the area more vulnerable than others? Please explain.
5. Who is most effected by those disasters?
6. What is the biggest impact felt by the community relating to when a disaster happens in their area?
7. What did or will government do in coping with disaster?
    a. To community
    b. To city spatial planning
8. How local government makes prevention or anticipation in disaster mitigation?

[23] Camat is head of subdistrict.
[24] RW is a unit of local administration consisting of several RT (neighborhood units) within a *kelurahan*.
[25] RT, or neighborhood unit, is the smallest unit of local admistration consisting of a number of households.

Guidelines for In-depth Interview at Household Level

Respondent Identity

Name	:	……
Gender	:	……
Age	:	……
Address	:	……
Mobile Phone Number	:	……

General

Hong long have you lived in this neighborhood?

Do you think the weather has change? Please explain why you think so! What kinds of changes have occurred? Since when did you notice these changes?

What are the impacts of these climate changes on your family?

What types of natural disaster occur in your *RT*[26]*/RW*[27]*/Kelurahan*[28]? When did the last natural disaster occur? What are the factors causing the natural disasters? Which area is the most effected? What about your neighborhood area?

Flood

Is your house in a flood zone? How often does it flood?

How high was the residual flood/tidal water this year? When does the flood water enter your house/yard? When does the highest residual flood water occur?

Can that flood be predicted? Are there any floods occurring outside of the wet (rainy) season?

Can you describe any actions directed to you during the flood (for example: stay at home, go to the *RT*'s house, go to the *kelurahan* offices, go to an evacuation center). What action becomes the main priority? What do you think is the reason for this?

What does the neighborhood do during a flood? Is there any flood warning signs or signals (e.g. sound of *kentongan*[29], sirens, bell, etc)?

When do you or your family have to go to an evacuation center? Who provides the information or makes the decision to go to the evacuation center?

Do all family members know the evacuation routes to go to the evacuation center?

Have you or your family stayed in an evacuation center? What do you or your family do in an evacuation center? How long have you and your family stayed there? What are the flood impacts on:

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[26] RT, or neighborhood unit is the smallest unit of local administration consisting of a number of households.

[27] RW is a unit of local administration consisting of several RT (neighborhood unit) within a *kelurahan*.

[28] A *kelurahan* is a village level administrative area located in an urban center.

[29] A drum made from bamboo or wood which is used to sound an alarm.

source of income
children absenteeism from school
family health conditions (drinking & eating; bathing/ablution, washing (clothes) activities; and health issues)
assets (livestock, valuable goods)
Which institutions/groups were involved in the evacuation process for flood victims and in the evacuation center?
What do you do after the flood has subsided? What are the major difficulties? What kind of support do you need? What can be done by the surrounding communities to help? Which government office/section can help you the most during the flood or after it occurs (*RT/RW/Kelurahan/Kecamatan/Office of* Kota Pekalongan/Office of Central Java Province)?
What do you think is the best way to prevent or anticipate flood disaster?
What are your coping strategies for a flood disaster? What can be done by your family, neighborhood, and local government?
What institutions or groups have the biggest roles in measuring the flood and have a solution for it? (informant will be asked about his/her opinion on the determining factors for flood)

Recommendation

What is your suggestion for the *kelurahan/kecamata*n government in coping with floods?
What is your suggestion for the *kota* government in coping with floods?
What is your suggestion for the provincial government in coping with floods?
What is your suggestion for the central government in coping with floods?

The same questions will be asked for sea inundation disaster and landslide.

Questionnaire for the Government of Kecamatan Pekalongan Barat and Kecamatan Pekalongan Utara

- CBMS Climate Change Study -

Name : ……..
Organization : ……..
Position : ……..

No	Question	*Kelurahan*[1]	*Kelurahan*[2]	*Kelurahan*[...]	*Kelurahan*[n]
Exposure to Flood, Sea inundation, and Landslide					
1	The *kelurahan* area experiences a flood almost every year. (Yes/No)				
2	How many times on average does a flood occur in one year?				
3	The *kelurahan* area experiences sea inundation almost every year. (Yes/No)				
4	How many times does sea inundation occur in one year?				
5	The *kelurahan* area experiences landslide almost every year. (Yes/No)				
6	How many times on average does a landslide occur in one year?				
7	The *kelurahan* area experiences flood almost every month. (Yes/No)				
8	The *kelurahan* area experiences sea inundation almost every month. (Yes/No)				
9	The *kelurahan* area experiences a landslide almost every month. (Yes/No)				
10	Which areas are vulnerable to flood? (Yes/No)				
11	Which areas are				

	vulnerable to sea inundation? (Yes/No)				
12	Which areas are vulnerable to landslide? (Yes/No)				

No	Question	*Kelurahan*[1]	*Kelurahan*[2]	*Kelurahan*[...]	*Kelurahan*[n]
Sensitivity of Flood, Sea inundation, and Landslide					
13	Does the *kelurahan* have a river/s passing through it? (Yes/No)				
14	How many rivers pass through the *kelurahan* area?				
15	Is the *kelurahan* area directly adjacent to the sea? (Yes/No)				
16	Are there inhabitants who live along the riverbank within the *kelurahan* area? (Yes/No)				
17	What percentage of area is categorized as a protected area?				
18	How many heritage buildings are in the *kelurahan*?				
19	What percentage of road area in comparison to the total *kelurahan* land area?				
Adaptive Capacity in mitigating Flood, Sea inundation, and Landslide					
20	The *kelurahan* area has an organization/task force for disaster management. (Yes/No)				
21	Number of elevated houses (disaster resistant houses).				
22	Number of formal health facilities (hospitals, community health centers, clinics, village maternity polyclinics, secondary community health centers)				
23	Number of health staff				

	(doctors, nurses, midwives, paramedics (*mantri*))				