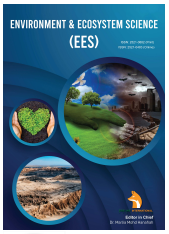
ZIBELINE INTERNATIONAL PUBLISHING

ISSN: 2521-0882 (Print)
ISSN: 2521-0483 (Online)
CODEN: EESND2

Environment & Ecosystem Science (EES)

DOI: http://doi.org/10.26480/ees.02.2020.55.61



RESEARCH ARTICLE

ENVIRONMENTAL QUALITY ANALYSIS DUE TO TIDAL FLOOD IN PASIRKRATONKRAMAT SUB-DISTRICT PEKALONGAN, INDONESIA

Eviana Rosida[1*], Sudrajat[2], and Muh Aris Marfai[2]

[1]Environmental Science, Graduate School of Universitas Gadjah Mada, Bulaksumur, Yogyakarta, 55281 Indonesia
[2]Department of Environmental Geography, Faculty of Geography, Universitas Gadjah Mada, Bulaksumur, Yogyakarta, 55281 Indonesia
**Corresponding Author Email: eviana.rosida@mail.ugm.ac.id*

This is an open access article distributed under the Creative Commons Attribution License CC BY 4.0, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

ARTICLE DETAILS

Article History:

Received 08 April 2020
Accepted 10 May 2020
Available online 22 May 2020

ABSTRACT

Pasirkratonkramat Sub-District is located in West Pekalongan District, Pekalongan City, Central Java, Indonesia. This location has been affected by tidal floods since 2016. Tidal floods have caused a decrease in environmental quality. The method used for this research is a descriptive survey research with an ecological approach. This paper presents the quality of the biophysical environment and social quality. The biophysical environment consists of water quality, soil quality, air quality. The water quality showed that Pollution Index (PI) of surface water is 5,15 (medium pollution), PI of Clean water (Residents' well waters) is 5,09 (medium pollution) and PI of Clean Water is 2,20 (light pollution). Water quality analyzed by parameters Electrical Conductivity, Salinity, BOD, COD, Total Phosphate as P, Chrome (Cr) (VI), Copper Cu, Nitrite as N, Free chlorine, Sulfur as H_2S, Oil and fat, Detergent as MBAS, Fecal Coliform, Total Coliform, Chloride, Total dissolved solids (TDS), Water hardness (CaCO3), and Organic substance ($KMnO_4$). The soil of quality decreased because of inundating sea water, the chemical and physical composition cannot support paddy or plants to grow, even they cannot survive because of salinity and decreasing minerals. The air quality showed that the average Temperature Humidity Index (THI) is 28.74 which mean that 100% of subjects feel uncomfortable. Meanwhile the social quality consists of various activities.

KEYWORDS

Tidal flood, Environmental Quality, Pekalongan, Indonesia.

1. INTRODUCTION

Environmental science is a study of environmental problems caused by humans wherein there is an interaction between humans and their environment (Enger and Smith, 2010; Boersema and Reijnders, 2009; Jorgensen and Johnsen, 1981). In addition, Cunningham and Cunningham (2012) define the environment as a condition that surrounds an organism or group of organisms as well as the complexity of social or cultural conditions that affect individuals or communities. Based on the Law of the Republic of Indonesia No. 32 of 2009 concerns on Protection and Management of the Environment, it is stated that the environment is the unity of space with all objects, powers, conditions, and living things, including humans and their behaviors, which affect nature, the survival of life, and the welfare of humans and other living beings. Protection and management of the environment is a systematic and integrated effort carried out to preserve environmental functions and prevent pollution and/or environmental damage which includes planning, utilization, control, maintenance, supervision and law enforcement.

The environment consists of components of biology, physics and chemistry which are the basis for studying processes in the environment (Boersema and Reijnders, 2009; Saravanan et al., 2005; Allaby, 2000; Alley, 2000; Jorgensen and Johnsen, 1981). Environment in the framework of ecosystem and ecology is a dynamic space with various kinds of interactions and a series of processes that take place in it. From an ecological and environmental perspective, environmental degradation is characterized by a decrease in the quality and quantity of land, water, air, soil and other physical aspects that can present crises and environmental problems and decrease environmental quality over time (Marfai, 2013).

Climate change gives impacts in various countries in the world. One of them is Indonesia. Indonesia is an archipelago which is one of the largest archipelagic countries in the world which ranks second with a coastline of 81,000 km (KKP, 2017). In Indonesia there are many cities located in the coastal areas. This is a problem in Indonesia because the effects of climate change make coastal areas risky to tidal flooding caused by rising sea levels and lack of mitigation preparedness for the arrival of tidal floods, both structural mitigation and non-structural mitigation.

Due of the climate change is the rising of sea levels. IPCC (2015) in the 2014 synthesis report stated that the world's sea level rise due to global warming during the period of 1901 to 2010, the average sea level rise was 0.19 m, which was between 0.17 m-0.21 m. At the end of the 21st century it is estimated that sea levels will rise by more than 95% of the ocean. Indonesia has the impact of rising sea levels. Brodjonegoro (2017) states that the North Java Coast region is now threatened with sinking due to global climate change. The condition of the North Java Coast has been very worrying. This makes the areas in northern Java are vulnerable to tidal flooding caused by the attachment of sea water and coastal erosion (Marfai, 2011; Marfai, 2014; Marfai et al., 2013).

Quick Response Code	Access this article online	
	Website: www. environecosystem.com	DOI: 10.26480/ees.02.2020.55.61

Cite the Article: EvianaRosida, Sudrajat and Muh Aris Marfai (2020). Environmental Quality Analysis Due To Tidal Flood In Pasirkratonkramat Sub-District Pekalongan, Indonesia. *Environment & Ecosystem Science, 4(2): 55-61.*

Tidal floods have inundated several areas in Java. Several studies have examined flooding in Java, among others, in Jakarta (Ramadhoan, 2017; Ward et al., 2012; Ward et al., 2011), in Semarang (Jatmiko, 2017; Manihuruk, 2017; Jatmiko, 2017; Sudjati, 2017; Suhardjono, 2017; Riasasi, 2014; Riasasi, 2014 ; Nugraha, 2013; Yuniartanti, 2013; Soedarsono, 2011; Marfai et al., 2008; Marfai and King, 2008a; Marfai and King, 2008b), in Demak (Alufi, 2017; Asrofi, 2017; Maulida, 2017; Ayunda, 2014; Rif'an, 2014; Ragil, 2013; Susanto, 2010), in Tegal (Septriayadi, 2012), in Cirebon (Widiyanto, 2017) and in Pekalongan (Artiningsih, 2018; Kurniawan, 2018; Wulandari, 2017; Hardianto, 2017; Gumanti, 2016; Akhmad, 2014; Hardoyo et al., 2014; Sitanggang and Sunarti, 2013; Marfai, 2013; Prihatno, 2011).

Pekalongan City has directly facing the Java Sea, lead to vulnerability due to tidal flood. Tidal floods in Pekalongan City have occurred since 2005. Since 2016, tidal floods have reached West Pekalongan District. Tidal flood is designated as a status of disaster emergency after the issuance of Pekalongan Mayor's decree number 362/287 year 2016, then followed by a natural disaster statement number 460/02002 which stipulates eight areas affected by the tidal flood disaster. One of the areas is Pasirkratonkramat Sub-Distric.

Pasirkratonkramat Sub-District is located in West Pekalongan District, Pekalongan City. This Village is an amalgamation of 3 regions, namely Pasirsari Sub-District, Kraton Kidul Sub-District and Kramatsari Sub-District. The merger of the region was stated in the Regional Regulation of Pekalongan City Number 8 of 2013 concerns on Merging of Village in Pekalongan City Government Environment which was then inaugurated on January 1, 2015.

The Pasirkratonkramat Sub-District area experienced land subsidence of 1.81 cm (Pramudyo and Wafid 2015). It gave result that this location becomes vulnerable to tidal floods. The tidal flood flood has a negative impact to the community and the flooded environment. Environmental quality conditions have decreased due to this disaster. This study examines the conditions of environmental quality caused by tidal floods including the biophysical quality and quality of the socio-economic environment.

2. METHOD

Pasirkratonkramat Sub-District is located at coordinates 6052 '39 "LS-6053'41" LS and 109038'50 "BT-109040'13" BT. This study focused on urban Sub-District affected by tidal flooding, namely Pasirkratonkramat Sub-District. Below is presented the map of research location along with map of tidal flood distribution in Figure 1.

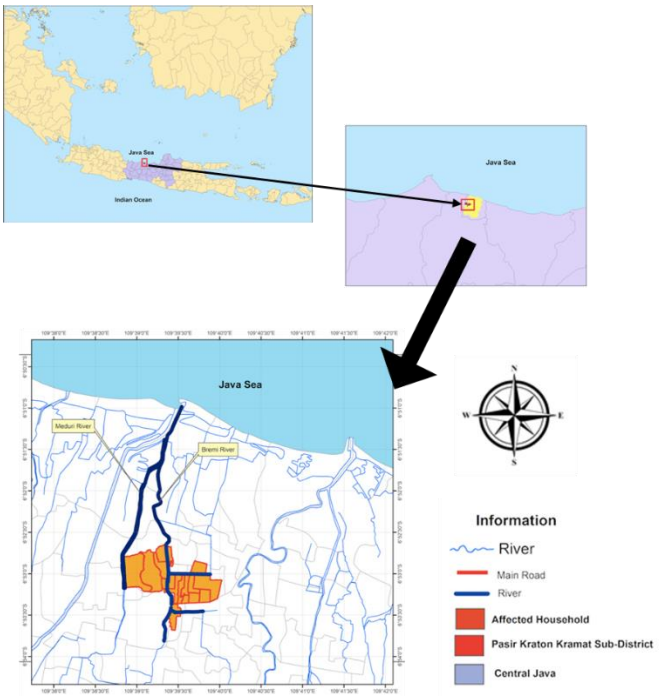


Figure 1: Research Location Map

The study was conducted in Pasirkratonkramat Sub-District, Pekalongan West District, Pekalongan City. The pre-research activity was conducted in January-March 2018. After that, the data collection was carried out since July-October 2018. Observations were made to determine the quality of the social environment in the research location. Meanwhile water samples and soil samples were selected by using purposive sampling. The researchers conducted laboratory tests to determine water quality and soil quality. Tests were carried out to determine the physical, chemical and biological content contained in water samples and soil samples affected by tidal flooding. The testing of water samples was carried out at the Central Java Testing Center and Environmental Laboratory and soil samples were tested at the Primary Chem-Mix Laboratory.

Water quality is calculated by using the Pollution Index. Pollution Index (PI) Based on the Decree of the Minister of Environment No.115 of 2003 concerns on Guidelines for Determining the Status of Water Quality, a calculation of the Pollution Index (PI) is carried out using the following formula:

$$P_{I_j} = \sqrt{\frac{(C_i/L_{ij})_M^2 + (C_i/L_{ij})_R^2}{2}} \quad (1)$$

Information:

Lij: concentration of water quality parameters listed in Water Allocation Standard (j)

Ci: concentration of water quality parameters (i) obtained from the analysis of water samples at a sampling location from a river channel

PIj: Pollution Index for designation (j) which is a function of Ci / Lij.

The PI calculation results are then evaluated as follows:

0 ≤PIj≤1,0 : meets the quality standard (good condition)

1,0<PIj≤ 5,0 : mild pollution

5,0 <PIj≤10 : moderate pollutant

PIj>10 : severe contamination

Soil quality is measured by using parameters of Water, Organic matter, pH, N, P, Ca, Fe, Na, Cl, K, Mg, and soil texture (Sand, Clay, Dust). In addition, indoor air quality was measured by using a barometer with a sample of 25 houses. How to determine the sample is by using the formula formulated by Yamane (1967) in Sukandarrumidi (2012) which explained as follows:

$$n = \frac{N}{Nd.d+1} \quad (2)$$

Information:

n = number of samples

N = population

d = precision

The population in this research was the number of families affected by tidal flooding in Pasirkratonkramat Sub-District, there are as many as 1435 people with a precision of 20%, a confidence level of 80%, so that a sample of as many people as possible could be taken:

$$n = \frac{1435}{1435\ (0{,}2x0{,}2) + 1}$$

$$n = 24{,}57$$

$$n \approx 25$$

3. RESULTS AND DISCUSSION

On 1 December 2016, the height of inundation of tidal flood is as high as 50-60 cm, as well as in May 2017. Since June 2017, the government has built electric pumps and fuel pumps to pump water that inundates residents' settlements and then dumps them into the river (Figure 2). These pumps play an important role in accelerating the decline in water inundation due to tidal flooding, but there are still points especially in

residential areas that are still flooded by tidal flooding because they cannot be reached by the pump.

Figure 2: (a) Water pumps to dispose of inundated water from floods into the Bremi River (b) Water pumps to dispose of inundated water flooding into the Meduri River (Rosida, October 13, 2018)

There was a tidal flood on May 23, 2018, below is presented the documentation of tidal flood water levels outside the house, in the house, in the community's garden and in the yard in Pasirkratonkramat Sub-District (Figure 3). Although the occurrence of tidal floods has emerged since May 2018, there are still many home yards and homes of people that are still inundated by tidal floods that have not receded. This is due to the poor drainage system at several points in Pasirkratonkramat Sub-District.

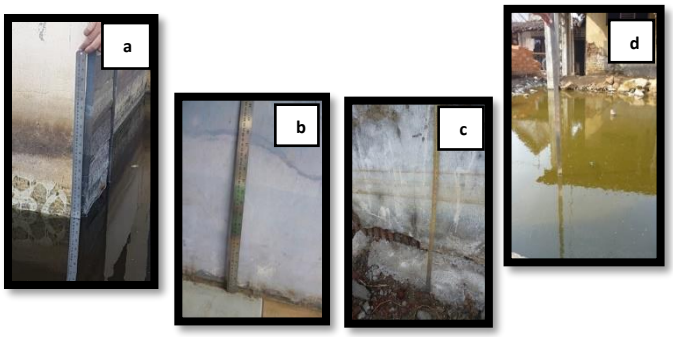


Figure 3: Inundation water level of tidal flood (a) 1 m outside the house (Marfai, July 1, 2018), (b) 40 cm in a house that has been raised 2x, (c) 66 cm in the garden, (d) 30 cm in home yard (Rosida, October 13, 2018)

3.1 Water quality

Tidal floods have influenced surface water (rivers) and ground water. In addition, the condition of river water contaminated with seawater, industrial and household waste lead to the decreasing the quality of surface water. Residents have been unable to use river water as for daily acitivities because the conditions are polluted, exceeding the quality standards of clean water. Likewise, the condition of the community wells can no longer be used for household needs or for industrial purposes because it is extruded by sea water.

Water samples were taken to determine the physical, chemical and biological content of water affected by tidal floods, including surface water samples in the Bremi River stream, at PAMSIMAS owned by residents affected by tidal floods and in the wells of residents affected by tidal floods in Pasirkratonkramat Sub-District.

3.1.1 Surface water

The surface water used as a sample is water from the Bremi River (X: 351507 mT and Y: 9239413 mU) which is taken from polluted water sources, namely locations that have undergone changes or downstream of pollutant sources (Figure 4).

3.1.2 Groundwater

The negative impact of (excessive) use of ground water can be divided into qualitative impacts (groundwater quality) and quantitative (groundwater supply) (Asdak, 2014). Pollution of groundwater quality is also found in areas on verge of the coast in the form of seawater intrusion into population wells. Impacts related to the quantity of groundwater are generally found during the dry season, which the groundwater level that is further away from the surface of the well. Land subsidies that occur along roads or buildings as well as the further the sea water intrusion can also be used as an indicator of the decreasing amount of groundwater (Asdak, 2014).

Groundwater taken as a sample is depressed groundwater, it is water from aquifers that are fully saturated with water, with the upper and lower parts limited by a water-resistant layer in the form of PAMSIMAS (Community-based Water and Sanitation) water owned by residents (Figure 4) and in the wells of residents affected by tidal flood .4). Water from land owned by residents has never been tested before either the well water or the PAMSIMAS water. There has never been any control over the use and quality of PAMSIMAS water and the quality of well water in the Pasirkratonkramat Sub-District area. The location for taking PAMSIMAS water samples was in RT 4 RW 3 Pasirkratonkramat Sub-District (X: 351441 mT and Y: 9239146 mU) and carried out at 09.41 WIB. Sampling of well water was located in RW 5 alley 5 Pasirkratonkramat Sub-District (X: 351138 mT and Y: 9238960 mU) and carried out at 10.12 WIB.

Figure 4: (a) River Bremi Samples (b) PAMSIMAS Water Samples (c) Well Water Samples (Rosida, August 1, 2018)

Water samples that have been taken from predetermined points are then tested at the Laboratory. The water samples were taken on August 1, 2018 and then taken to the Testing Center and Environmental Laboratory in Semarang. The BOD value of surface water is 44.2 mg / l which indicates that the BOD content exceeds the quality standard of water for clean water. The water condition of the Bremi River is polluted by sea water, batik wastewater and household wastewater. There are no fish in the river and the river water is in an odor condition. The greater the BOD index of a waters, the greater the level of pollution that occurs (Asdak, 2014).

Fecal coliform is a member of total coliform capable of fermenting lactose at a temperature of 44.5 0C. About 97% of the total content of human fecal coliform bacteria is fecal coliform, which consists mainly of Escherichia and several Klebsiella species. These fecal coliform bacteria are also found in animal feces, so as to determine the contamination of animal feces is by using fecal coliform (Effendi, 2003). The results of laboratory tests on samples showed that 5500 exceeds water quality standards. The results of laboratory tests on surface water samples showed that the total coliform of 19800 exceeded the quality standard for clean water. This condition is due to poor sanitation caused by tidal flooding, causing the MCK to be unable to function so that the residents discard feces on the Bremi River.

In laboratory testing, shows the chromium valence (Cr^{6+}). Chromium is more toxic than chromium valence III (Cr^{3+}) because Cr^{6+} is difficult to decompose and does not settle. Cr^{6+} levels in surface water exceed the quality standard for clean water, which is equal to 0.062. Chromium can be derived from batik waste (Supenah et al. 2015; Sari 2014; Puspita et al. 2011) which were directly thrown into the river because in the Pasirkratonkramat Sub-District there were many batik artisans but the government had not provided a WWTP (Waste Water Treatment Plant) so it caused the pollution to the river was very high. The impact on aquatic organisms is the disruption of the body's metabolism due to disturbed metabolism, namely the obstruction of the work of enzymes in physiological processes and if it continues to accumulate in the body of aquatic organisms it can cause death (Palar, 1994). The impact of the presence of Cr^{6+} in humans can cause nasal and skin ulcers, hyperpigmentation and cancer of the skin, and interfere with the work of the human kidney (Soemirat, 2009; Purwaningsih, 2008 in Puspita, 2011).

The copper content in surface water was 0.024 mg / l exceeding the water quality standard. Excessive copper levels can cause water to taste if taken and can cause damage to the liver. High copper levels can also lead to corrosion of iron and aluminum (Effendi, 2003). Meanwhile the detergent levels in surface water samples were 269.7 µg / l exceeding the quality standard of clean water. The detergent content found in the Bremi River come from household waste which is immediately disposed into the river

because there is no IPAL available in Pasirkratonkramat Sub-District. Detergents contribute negatively to the environment because detergent has the ability to dissolve substances that are carcinogenic. In addition, the detergent content in water causes unpleasant odor and taste that can interfere with health (Judo, 2010).

In surface water samples there is a very high oil and fat content of 4470.9 µg / l beyond the quality standard of water, besides the content of organic substances including oil and fat in well water samples of 25.4 mg / l exceeding water quality standards. The real impact of the presence of fat and oil on the surface of the water is the obstruction of the penetration of sunlight which can inhibit the rate of photosynthesis in water. The lack of photosynthesis and the input of O_2 from the air will disrupt the growth and development of aquatic organisms.

The test results in the laboratory showed that the hardness value in the well water sample is equal to 816, exceeding the quality standard for clean water. Hardness ($CaCO_3$) is a divalent metal cation (valence two). These cations can react with soap to form deposit (precipitation) or with anions found in water to form deposit or rust on metal equipment. In freshwater, the most abundant divalent cations are calcium and magnesium. In hard waters, calcium, magnesium, carbonate and sulfate are usually high. If heated, hard water will form deposits (crust) (Effendi, 2003). Water with high hardness is difficult to dissolve soap.

Electrical conductivity measurement has been done in this research, aims to measure the ability of ions in water to conduct electricity and predict mineral content in water. Table 1 shows that there is a classification of water based on electrical conductivity, namely fresh water, slightly salty ground water, moderate level salty ground water, high level salty groundwater, very high level salty ground water and sea water. Laboratory test results showed that the value of electrical conductivity in surface water was 4.38 mS / cm = 4380 µmhos / cm, electrical conductivity in PAMSIMAS water was 0.390 mS / cm = 390 µm / cm and electrical conductivity in well water was 4.06 mS / cm = 4060 µm / cm. Surface water conditions are at a value exceeding the electrical conductivity level limit in natural waters and include a slightly salty groundwater class. The value of electrical conductivity in PAMSIMAS water is in the freshwater class and the condition of the residents' well water is in the medium level salty groundwater class. PAMSIMAS water residents have electrical conductivity of 390 µm / cm.

The sampling location is in RW III, where PAMSIMAS comes from one channel used by residents of RW III and RW IV. The value of electrical conductivity in well water is 4060 µm / cm in the medium level salty ground water class. This shows that the residents' well water located in RW VI has been contaminated by sea water. Sea water enters the residents' wells through sea water intrusion. Well water cannot be used as raw material for clean water. Before the tidal flood occurred, in 2013 the residents still used well water as a source of clean water for household needs and as a batik washing material. However, with the occurrence of tidal flooding since 2016, residents' wells have been polluted by sea water so that residents cannot use them anymore. This resulted in the community switching to use PAMSIMAS water and PDAM (Local Water Supply Utility) to fulfill clean water needs.

Table 1: Classification of Water based on Electrical Conductivity

Class	Electrical Conductivity (µm/cm)
Tasteless water	<700
Slightly salty ground water	700-2000
Moderate level salty ground water	2000-10.000
High level salty ground water	10.000-20.000
Very high levels salty ground water	20.000-45.000
Sea water	>45.000

(Rhoades et al. (1992) in Cahyadi et al. (2017))

Based on laboratory test results showed that the surface water salinity value is 2.4 ppt (2.4 0/00) and well water is 2.1 ppt (2.1 0/00) which exceeds the freshwater salinity value limit, so that it belongs to the brackish water category, while PAMSIMAS water has a salinity value of 0.2 ppt (0.2 0/00) which includes in the freshwater category. Salinity values in the Bremi River and well water indicate that the water conditions have been polluted by sea water so that it is in brackish water conditions.

COD value in surface water of 194.9 mg / l is in a condition that exceeds water quality standards. Chemical Oxygen Demand (COD) is the amount of oxygen (mgO_2) needed to oxidize organic substances in 1 liter of water sample, where oxidant $K_2Cr_2O_7$ is used as a source of oxygen (oxygen agent) (Alaerts and Santika, 1987; Effendi, 2003). The COD number is a measure of water pollution by organic substances which can naturally be oxidized through microbiological processes and can result in reduced oxygen dissolved in water.

The total value of phosphate as P in surface water is 0.90 mg / l in conditions in waters with high fertility because a lot of organic waste from households is directly discharged into the river without first processing. This value has an impact on the reduced number of aquatic algae so that fewer fish can survive in the river. In addition, high phosphate levels can be sedimentary deposits resulting in siltation of rivers.

The value of nitrite as N from the results of laboratory testing is 0.185 mg / l. This value is in a condition that exceeds the quality standard for clean water. Nitrite levels of more than 0.05 mg / liter can be toxic to highly sensitive aquatic organisms. In humans, excessive consumption of nitrite can result in disruption of the oxygen binding process by blood hemoglobin, which in turn it forms methoglobin which is unable to bind oxygen (Effendi, 2003).

The results of testing in the laboratory showed that there was sulfur content as H_2S of 0.024 mg / l which exceeds the quality standard of clean water. If there is no oxygen and nitrate in the waters, the sulfate acts as a source of oxygen in the oxidation process carried out by anaerobic bacteria. In this condition, sulfate ions are reduced to sulfite ions which form equilibrium with hydrogen ions to form hydrogen sulfide. H_2S is also considered as one of the causes of metal rust.

The results of laboratory tests on PAMSIMAS water samples showed that the chloride content of 48.21 mg / l was still safe for domestic purposes, while the chloride content in well water samples was 1072.5 mg / l which meant that it had exceeded the standards of the RI Ministry of Health standards and the water becomes salty. The residents' well waters can no longer be used as raw material for clean water.

Water TDS values are strongly influenced by weathering of rocks, runoff from land, and anthropogenic influences (in the form of domestic and industrial waste). Laboratory test results on well water samples showed a TDS value of 2150 mg / l so that it could be included in the rather salty / brackish water category.

Table 2: Water Sample Pollution Index

No.	Name	Pollution Index	Quality Status
1.	Surface water (Bremi river)	5,15	medium pollution
2.	Clean water (Residents' well waters)	5,09	medium pollution
3.	Clean water (PAMSIMAS)	2,20	light pollution

Table 3 shows the results of the calculation of the pollution index of surface water (Bremi River) and Groundwater (PAMSIMAS and residents' well waters). It was found that the pollution index for surface water was 5.15 (medium pollution quality status), pollution index for clean water (residents' well) up to 5.09 (medium pollution quality standard) and pollution index for clean water (PAMSIMAS) of 2.20 (light pollution quality status).

3.2 Soil Quality

Soil samples in the form of paddy fields and samples of garden soil was carried out in RW 12 (X: 352138 mT and Y: 9238914 mU) and RW 4 (X: 351354 mT and Y: 9239403 mU) Pasirkratonkramat Sub-District. Total of 5 soil samples were tested in the laboratory. The first soil sample is a sample of 20 cm deep paddy field, the second soil sample is a sample of paddy soil with a depth of 40 cm, the third soil sample is a sample of paddy soil with a depth of 60 cm, the fourth soil sample is a soil sample of garden with a depth of 20 cm, and the fifth soil sample is a sample of garden soil with a depth of 40 cm.

Soil samples were tested at the Chem-Mix Pratama soil laboratory with several parameters, namely water, organic matter, pH, N, P, Ca, Fe, Na, Cl, K, Mg, and textures (Sand, Clay, Dust). Tests are conducted to determine the chemical and physical content of soil samples. The content can be used as a basis for determining soil quality. The following is shown the results of the laboratory test. Based on the results of testing, soil samples including sandy clay types where the proportion (%) of the soil fraction is 45% -62.5% (sand), <20% (dust) and 37, 5% -57.5% (clay). The soil particles feel smooth, sticky and can be made into rolls or continuous slabs, so the soil is textured clay (Hanafiah, 2013). Based on the results of the laboratory test, it showed that the pH value was 7.8, 7.9 and 7.7 which means that there could be deficiencies of P, B, Fe, Mn, Cu, Zn, Ca, and Mg, as well as poisoning B and Mo and with the pH level it cannot be optimally grown as a rice plant medium because the optimum pH range for rice is 5.5-6.5 (Hanafiah, 2003).

The nitrogen content in soil samples is very small (0.13%, 0.13%, 0.19%, 0.19%, and 0, 11%). Nitrogen has an important role for rice plants that is encouraging rapid plant growth and improving the level of yield and quality of grain through increasing the number of tillers, development of leaf area, grain formation, grain filling, and protein synthesis. Nitrogen-deficient rice plants have a small number of tillers and stunted growth. The leaves are yellowish green and start to die from the tip then spread to the middle of the leaf blade (Patty et al., 2013).

Sea water contains high salt (> 500 ml^{-1}), especially in the form of NaCl, a combination of base cations (K, Ca, Mg), sulfate, bicarbonate and chlorine (anions) (Brown et al., 2003). If this sea water inundates agricultural land, it will cause increased soil salinity. Based on the test results, it was found that the concentrations of Na and Cl in soil samples were at high concentrations (425.25 ppm, 419.31 ppm, 430.64 ppm, 321.64 ppm, and 312.80 ppm). The high concentration of Na ions in the soil will damage the soil structure, disrupt the balance of nutrients, and reduce the availability of water for plant growth.

The results of soil samples test showed that the soil had high levels of Chloride (Cl^-) (655.44 ppm, 646.29 ppm, 663.83 ppm, 495.74 ppm, and 482.12 ppm). Chloride (Cl^-) is one of the main elements in forming soil salinity followed by Sodium (Na). Chloride is highly soluble in the soil and is almost negligible in the amount fixed by clay particles. Therefore, chloride is easily washed into the soil under conditions where there is enough water and soil structure supports the washing process. In conditions where there is a layer of soil with very low hydraulic conductivity, the chloride will accumulate in that layer (Rachmani, 2008).

3.3 Air Quality

A sample of 25 houses was conducted to determine the air quality conditions in the house. The condition of the sample can be seen in Figure 6. The conditions of the air temperature and relative humidity are measured by using a barometer. Data on air temperature and relative humidity are used in determining THI (Temperature Humidity Index) so that the category of THI calculation results is obtained.

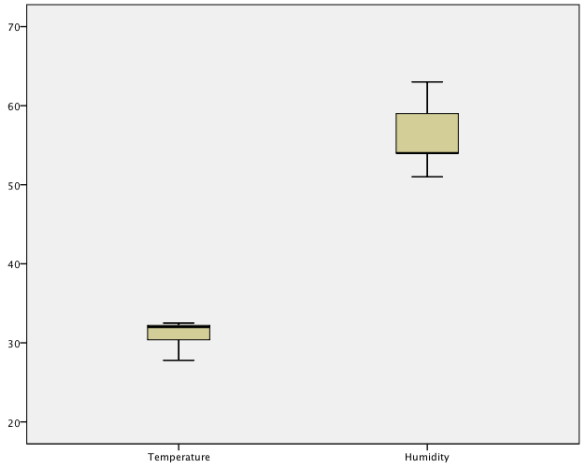


Figure 5: Boxplot temperature and humidity in the research sample

Figure 5 shows that Q_1 at a temperature is 30.39 ^{0}C, Q_2 is 32 ^{0}C, and Q_3 is 32.22 ^{0}C, the highest temperature is based on a sample of 32.5 ^{0}C, and the lowest is 27.78 ^{0}C. In the variable of relative humidity, the value of Q_1 is 54, Q_2 is 54, and Q_3 is 59, the highest humidity is 63 and the lowest is 51. The average THI is 28.74 which mean that 100% of subjects feel uncomfortable (Kakon et al., 2010; Sugiasih, 2013).

3.4 Social environment

The social environment focuses on the continuity of interactions within the social environment itself and with related environments. Communities in Pasirkratonkramat Sub-District have high mutual cooperation in community namely *gotong royong*. It is a part of the help system in conditions of joy and sorrow, which in Javanese culture means that a person will not refuse to help various activities between neighbors (Koentjaraningrat, 1985). *Gotong royong* is rooted in rural Javanese culture and refers to the principle of mutual assistance between neighbors in society. *Gotong royong* comes from the spirit of respect, responsibility, and redistribution of collective works, solidarity, strengthening and *teposeliro* (tolerance) (Baiquni, 2009). *Gotong royong* is basically a voluntary process of sharing ideas, organizing society, gathering materials, financial contributions, and mobilizing workers to carry out social and cultural activities (Bintarto, 1983 in Rijanta et al., 2014).

Gotong royong is one of the social capitals. Social capital according to Coleman (1990) in Field (2003) represents a resource because it involves the expectation of reciprocity, and goes beyond any individual so that it involves a broader network which relationship is governed by high levels of trust and shared values. The strength of social capital lies in the context and socio-cultural dynamics that still exist and are practiced by the community. Communities that have social capital will be quicker in handling emergency conditions and the restoration of their lives and livelihoods (Rijanta et al., 2014).

Communities in the Pasirkratonkramat Sub-District still have very good social relations among its members even though the tidal flood has inundated their homes and damaged public facilities (Figure 6). Residents still maintain harmony between neighbors by attending community gatherings such as *slametan, kenduren, tahlilan*, RT and RW associations and weddings. In line with the research conducted by Akhmad (2014) that social capital is one of the main capitals in forming a resilient society. The strength of social capital lies in the context and dynamics of socio-culture that are still alive and practiced in the community (Rijanta et al., 2014).

Figure 6: (a) Residents work together to repair the tomb (b) Residents continue to attend community gatherings (Rosida, August 3, 2018)

The tidal flood has inundated the residents' yard, the condition of the residents' yard is still flooded by tidal floods until now (Fig 3d). The people's home yard is usually used as a gathering place between neighbors as a place to relax in the afternoon to communicate things about life. However, with the tidal flood, residents can no longer have chit-chat in the yard because they are always flooded.

4. Conclusions

The biophysical consist of water quality, soil quality and air quality. The water quality showed that the groundwater class is slightly salty to medium salty, salinity is brackish waters, BOD, COD, Total Phosphate as P, Chrome (Cr) (VI), Copper (Cu), Nitrite as N, Free chlorine, Sulfur as H_2S, Oil and fat, Detergent as MBAS, Fecal Coliform, Total Coliform, Chloride, Total Dissolved Solids (TDS), Water hardness ($CaCO_3$) and Organic substance ($KMnO_4$) are over quality standard. Soil quality showed that the soil is textured clay, the pH value was 7.8, 7.9 and 7.7, The nitrogen content in soil samples is very small (0.13%, 0.13%, 0.19%, 0.19%, and 0, 11%), the concentrations of Na in soil samples were at high concentrations (425.25 ppm, 419.31 ppm, 430.64 ppm, 321.64 ppm, and 312.80 ppm), The results

of soil samples test showed that the soil had high levels of Chloride (Cl-) (655.44 ppm, 646.29 ppm, 663.83 ppm, 495.74 ppm, and 482.12 ppm). The physical and chemical in soil cannot support paddy and plants to grow even they cannot survive in that condition. The air quality measured from Temperature Humidity Index (THI). The average THI is 28.74 which mean that 100% of subjects feel uncomfortable. The Quality of the Socio-Economic Environment consist of gotong royong, concord, sport activities. Communities in Pasirkratonkramat Subdistrict have high mutual cooperation in community namely *gotong royong*. Communities in the Pasirkratonkramat Subdistrict still have very good social relations among its members even though the tidal flood has inundated their homes and damaged public facilities.

ACKNOWLEDGEMENTS

This research was supported by Research Grant Graduate School Universitas Gadjah Mada Number 1422/H1.SPs/PL/2018.

REFERENCES

Akhmad, G.R. 2014. Resilience of Coastal Communities in North Pekalongan District Against Tidal Flood (in Indonesian). MSc Thesis, MSc Program on Planning and Management of Coastal Area and Watershed, Faculty of Geography Universitas Gadjah Mada.

Alaerts, G., Santika, S.S. 1987. Metoda Penelitian Air. Usaha Nasional, Surabaya.

Allaby, M. 2000. Basics of Environmental Science 2nd Edition. Routledge, USA.

Alley, E.R. 2000. Water Quality Control Handbook. McGraw-Hill, New York.

Alufi, A.M. 2017. The Effect of Sea Tidal Flood on Environmental Quality of Settlements in Bedono Village, Sayung District, Demak Regency (in Indonesian). MSc Thesis, Faculty of Geography Universitas Gadjah Mada.

Artiningsih. 2018. Household Ecological Spatial Cognition Pattern on the Vulnerability of the area Due to Tidal Flooding on Coastal landscapes (Case Study of Pekalongan Utara District) (in Indonesian). Dissertation, Environmental Science Universitas Gadjah Mada.

Asdak, C. 2014. Hidrologi dan Pengelolaan Daerah Aliran Sungai. Yogyakarta, UGM Press.

Asrofi, A. 2017. Strategies for Adaptation of Coastal Communities in Disaster Management of Rob Floods and Their Implications for Regional Resilience (Study in Bedono Village, Sayung District, Demak District, Central Java) (in Indonesian). Master Thesis. Sekolah Pascasarjana Universitas Gadjah Mada.

Ayunda, T.P. 2014. Community Resilience in Coastal Areas Affected by Tidal Flood (Case: Timbulsloko Village, Sayung District, Demak Regency) (in Indonesian). MSc Thesis, Faculty of Geography Universitas Gadjah Mada.

Baiquni, M. 2009. Social Affairs: Gotong royong as Local Wisdom. An article in the Yogyakarta and Central Java Earthquake 2006. Recovery Status Report Vol.1.

Boersema, J. J., Reijnders, L. 2009. Principles of Environmental Sciences. Springer Science + Business Media, United Kingdom.

Azzura 2017. Bos Bappenas: Kawasan Pantai Utara Jawa terancam tenggelam. Available at: http://www.merdeka.com/uang/bos-bappenas-kawasan-pantai-utara-jawa-terancam-tenggelam.html (last access: 18/02/2018)

Brown, E., Colling, A., Park, D., Phillips, J., Rothery, D., Wright, J. 2004. Seawater: Its Composition, Properties and Behavior Second Edition. Open University Course, UK.

Cunningham, W. P., Cunningham, M. A. 2012. Environmental Science a Global Concern. The McGraw-Hill Companies, New York.

Decree of the Minister of Environment No.115 of 2003 concerns on Guidelines for Determining the Status of Water Quality

Effendi, H. 2003. Telaah Kualitas Air. PT Kanisius, Sleman.

Enger, E.D., Smith, B.F. 2010. Environmental Science: A Study of Interrelationships Twelfth Edition. McGraw-Hill Companies, New York.

Field, J. 2003. Social Capital (Translator: Nurhadi, 2010). Kreasi Wacana, Bantul.

Gumanti, P.L. 2016. Resiliency of Aquaculture Community Against Tidal Flooding in Pekalongan Municipality. A Case Study of Krapyak Lor and Degayu Subdistricts. Master Thesis. Graduate Program Faculty of Engineering Universitas Gadjah Mada.

Hanafiah, K. A. 2013. Dasar-dasar ilmu tanah. Rajawali Pers, Jakarta.

Hardianto, Y. 2017. Policy Analysis of Countermeasures for Marine Tidal Floods (Rob) in Pekalongan City (In Indonesian). Master Thesis. Graduate School Universitas Gadjah Mada.

Hardoyo, Su. R., Sudrajat, Kurniawan, A. 2014. Aspek Sosial Banjir Genangan (Rob) di Kawasan Pesisir. Gadjah Mada University Press, Yogyakarta.

IPCC (Intergovernmental Panel on Climate Change), 2015, Climate Change 2014 Synthesis Report.

Jatmiko, D.W. 2017. Kajian Pengendalian Banjir dan Rob Kawasan Madukoro Kota Semarang (in Indonesian), Master Thesis, Civil engineering and environment department, Faculty of Engineering, Universitas Gadjah Mada.

Jorgensen, S.E. and Johsen, I. 1981. Principles of Environmental Science and Technology. Elsevier Scientific Publishing Company, Amsterdam.

Kakon, A.N., Nobuo, M., Kojima S., Yoko T. 2010. Assessment of Thermal Comfort in Respect to Building Height in a High-Density City in the Tropics, American J. of Engineering and Applied Sciences 3 (3): 545-551, 2010.

Ocha 2017. Langkah Indonesia Menjadi Poros Maritim Dunia Demi Impian RI. Available at: http://kkp.go.id/artikel/2228-langkah-indonesia-menjadi-poros-maritim-dunia-demi-impian-ri (last access: 18/02/2018).

Koentjaraningrat. 1985. Javanese Culture. Oxford University Press, Oxford.

Kurniawan R. 2005. Environmental Quality Evaluation Around Household Wastewater Treatment Plants (Case Study of Environment Around Centralized Household Wastewater Treatment Plants in Cepit Hamlet Pendowoharjo Village Sewon District, Bantul Regency, DIY Province) (in Indonesian). Thesis, Universitas Gadjah Mada.

Law of the Republic of Indonesia No. 32 of 2009 concerns on Protection and Management of the Environment

Manihuruk, A. 2017. Effectiveness of Adaptation and Hazard Mitigation Strategies for Floods in the Coastal Areas of Semarang (in Indonesian). MSc Thesis, Faculty of Geography Universitas Gadjah Mada.

Marfai, M.A., dan King, L. 2008a. Potential Vulnerability Implications of Coastal Inundation due to Sea Level Rise for the Coastal Zone of Semarang City, Indonesia ". Environ Geol, 54:1235-1245.

Marfai, M.A., King, L. 2008b. Tidal inundation mapping under enhanced land subsidence in Semarang, Central Java Indonesia, Nat Hazards (2008) 44:93–109, DOI 10.1007/s11069-007-9144-z.

Marfai, M.A., King, L., Sartohadi, J., Sudrajat, Budiani, S.R., Yulianto, F. 2008. The impact of tidal flooding on a coastal community in Semarang, Indonesia. Environmentalist (2008) 28:237–248.

Marfai, M.A., Mardiatno, D., Cahyadi, A., Nucifera, F., Prihatno, H., 2013, Pemodelan Spasial Bahaya Banjir Rob Berdasarkan Skenario Perubahan Iklim dan Dampaknya Di Pesisir Pekalongan, Jurnal Bumi Lestari, Volume 13 No. 2, Agustus 2013, 244-256.

Marfai, M.A. 2013. Introduction to Environmental Ethics and Local Wisdom (in Indonesian). Gadjah Mada University Press, Yogyakarta.

Marfai, M.A. 2011. The hazard of coastal erosion in Central Java Indonesia: an overview. GEOGRAFIA, Malaysia Journal of Society and Space, 7(3), 1 – 9.

Marfai, M.A. 2014. Impact of Sea Level Rise to Coastal Ecology: A Case Study on The Northern Part of Java Island, Indonesia". Quaestiones Geographicae 33(1).

Marfai, M.A. 2014. Banjir Pesisir Kajian Dinamika Pesisir Semarang. UGM Press, Yogyakarta.

Maulida. A. 2017. Dimensions of Resilience of Coastal Communities in Facing Rob Floods in Sayung District, Demak Regency (in Indonesian). Master Thesis, Graduate Management and Public Policy Faculty of Social and Political Sciences Universitas Gadjah Mada.

Nugraha, A.L. 2013. Preparation and Presentation of Online Maps of Rob Flood Risk in Semarang City (in Indonesian). Master Thesis, Program Pascasarjana Universitas Gadjah Mada.

Palar. 1994. Pencemaran dan toksikologi logam berat. Rineka Cipta, Jakarta.

Patti, P.S., Kaya E. dan Silahooy, Ch. 2013. Analisis Status Nitrogen Tanah dalam Kaitannya dengan Serapan N oleh Tanaman Padi Sawah di Desa Waimital, Kecamatan Kairatu, Kabupaten Seram Bagian Barat. Agrologia, Vol. 2, No. 1, 2013, 51-58.

Prihatno, H. 2011. Identification and Impact Mapping of Coastal Floods Case Study of Pekalongan Coastal Area, Central Java (in Indonesian). Master Thesis, Graduate Program Faculty of Geography Universitas Gadjah Mada Yogyakarta.

Puspita, U., R., Siregar, A.S., Hidayati, N.V. 2011. Kemampuan Tumbuhan air sebagai agen fitoremidiator logam berat kromium (Cr) yang terdapat pada limbah cair industri batik, Berkala Perikanan Terubuk Vol 39 No.1 Februari 2011.

Rachmani, A., Erfandi, D., dan Ali, M. N. 2008. Dampak Tsunami Terhadap Sifat-Sifat Tanah Pertanian di NAD dan Strategi Rehabilitasinya, Jurnal Tanah dan Iklim No.28/2008.

Ragil, C. 2013. Livelihood Strategy of the Bedono Coastal Community in Sayung Subdistrict, Demak District In the face of Abrasion and Tidal Flood (in Indonesian). MSc Thesis, MSc Program on Planning and Management of Coastal Area and Watershed, Faculty of Geography Universitas Gadjah Mada.

Ramadhoan, F.2017. Analysis of the Impact of Inundation Floods on Social Accessibility and Infrastructure in Jakarta Coastal Areas Before Reclamation (in Indonesian). MSc Thesis, Faculty of Geography Universitas Gadjah Mada.

Riasasi, W. 2014. Adaptasi masyarakat pesisir Terhadap pemenuhan kebutuhan Air Domestik akibat Dampak Banjir Rob di Semarang Utara (in Indonesian). MSc Thesis, MSc Program on Planning and Management of Coastal Area and Watershed, Faculty of Geography Universitas Gadjah Mada.

Rif'an, A.A. 2014. Pemilihan lokasi pengembangan permukiman sebagai upaya adaptasi terhadap banjir pasang dan perubahan garis pantai (kasus wilayah pesisir kecamatan Sayung Kabupaten Demak) (in Indonesian). MSc Thesis, Faculty of Geography Universitas Gadjah Mada.

Rijanta, R., Hizbaron, D.R., Baiquni, M. 2014. Modal Sosial dalam Manajemen Bencana. Gadjah Mada University Press, Yogyakarta.

Saravanan, K., Ramachandran, S., Baskar, R. 2005. Principles of Environmental Science & Technology. New Age International (P) Limited, New Delhi.

Sari, A. M., Rachmadiarti, F., Fitrihidayati, H. 2014. Pengaruh Cekaman Kromium pada Limbah Cair Batik terhadap Pertumbuhan Eichornia crassipes dan Salvinia molesta, LenteraBio Vol. 3 No. 1, Januari 2014: 67–71.

Septriayadi, R. 2012. Coastal Community Adaptation to Tidal Flood Inundation (Case Study in Tegal Municipality) Master Thesis, Faculty of Geography Gadjah Mada University Yogyakarta.

Sitanggang, W., and Sunarti. 2013. Upaya Masyarakat dalam penanganan tempat bermukim di lingkungan pesisir di Kelurahan Bandengan Pekalongan Utara, Jurnal Teknik PWK Volume 2 Nomor 4.

Soedarsono. 2011. The Effect of Land Subsidence on the Environment of Settlements in the Alluvial Plains of Some of the City of Semarang (in Indonesian). Dissertation, Environmental Science, Graduate School Universitas Gadjah Mada.

Soemirat, J. 2009. Kesehatan Lingkungan. UGM Press, Yogyakarta.

Sujati, S. 2017. Active Alert Village Program Study As a strategy to build community resilience in dealing with tidal floods in the North Semarang sub-district (in Indonesian). Master Thesis, Disaster Management, Graduate School Gadjah Mada University.

Sugiasih. 2013. Rumus Indeks Ketidaknyamanan Suatu Wilayah. Jurnal Fourier April 2013, Vol. 2, No. 1, 19-25.

Suhardjono. 2017. Integration Simulation of Hydrological and Hydraulics Models Based on Geographic Information Systems to Evaluate Polder System Performance in reducing flood and tidal flood (in Indonesian). Dissertation, Faculty of Geography Universitas Gadjah Mada.

Sukandarrumidi. 2012. Metodologi Penelitian. Gadjah Mada University Press, Yogyakarta.

Supenah, P., Widyastuti, E., Priyono, R.E. 2015. Kajian Kualitas Air Sungai Condong yang terkena Buangan Limbah Cair Industri Batik Trusmi Cirebon. Biosfera 32 (2) Mei 2015.

Susanto, K.E. 2010. Projections of Sea Level Rise and Their Impacts on Coastal Zone Floods (Case Study: Demak Coastal Area, Central Java Province) (in Indonesian). MSc Thesis, MSc Program on Planning and Management of Coastal Area and Watershed, Faculty of Geography Universitas Gadjah Mada.

Ward, P. J., Marfai, M.A., Yulianto, F., Hizbaron, D.R., Aerts, J.C.J.H. 2011. Coastal inundation and damage exposure estimation: a case study for Jakarta, Nat Hazards (2011) 56:899–916.

Ward, P.J., Marfai, M.A., Poerbandono and Aldrian, E. 2012. Climate Adaptation in the City of Jakarta. Earthscan, USA and Canada.

Widiyanto, K. 2017. Analysis of Inundation Floods Due to Increase in Sea Water Levels in the Coastal City of Cirebon (in Indonesian). Master Thesis, Faculty of Geography Universitas Gadjah Mada.

Wulandari, I. 2017. Perceptions and strategies for community livelihoods in the face of tidal floods in Pekalongan Utara District, Pekalongan City (in Indonesian). Tesis: MSc Thesis, Faculty of Geography Universitas Gadjah Mada.

Yuniartanti, R.K. 2013. Community Capacity in Reducing the Risk of Rob Floods in the Coastal Area of Semarang City (in Indonesian). MSc Thesis, Faculty of Geography Universitas Gadjah Mada.