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The analysis of the causes of flood disasters and their impacts in the perspective of environmental law

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Abstrak. The environment is a combination of two things: resources and hazards. One of the hazards that is a result of environmental changes is the occurrence of natural disasters. Floods are one of the disasters that is feared by people in society. Negative impact of floods is the affected quality of raw water in the flooded area. Polluted water will certainly have a negative impact on the health of the human body. From the explanation above, this article analyzes changes in water quality that occur in flood-affected areas. The utilized method is the empirical legal method, by describing the state of the research subject based on existing conditions and in relation to existing legal regulations. The results obtained from this study showed that irresponsible individuals had committed many violations by building factories on the riverbanks. This causes the river water to overflow and damage buildings, dikes, settlements, and so on. The advice that can be given is to give strict sanctions to people who intentionally or unintentionally violate legal regulations, as well as to build cooperation between society and the government to conserve nature and foster self-awareness to preserve the environment.

Keywords: flood disaster, water, law, environment.

1. Introduction

The environment is a combination of two things: resources and hazards. These are triggered because the environment changes, whether spontaneously or continuously. This change is influenced by many causative factors and the variety of resulting impacts. Environmental changes not only affect the environment itself, but can also cause changes in the components of the environment.

One of the hazards that results from environmental changes is the occurrence of natural disasters. Fundamentally, natural disasters have occurred since ancient times. Archaeologists say that humans in prehistoric times have faced the same risks and dangers as humans today, namely famine, crime from other humans, animal attacks, diseases, and so on [6]. Humans in that era had also tried to reduce or mitigate the risk of potential dangers by way of living in caves.



Starvation is just one kind of disaster; the risk of natural disasters includes the risk of flooding as one of its kinds. Floods are inundations of dry land such as agricultural fields, settlements, and city centers. Many factors cause flooding in downtown areas, including high rainfall, water discharge that exceeds drainage capacity, limited water catchment areas due to conversion into residential areas, people who throw garbage into rivers and cause the river flow to be blocked, illegal logging, drainage overflow, and many other factors.

A country that often experiences floods is Indonesia. From January to March 2019, 1,107 disasters resulted in 375 people dead or lost, 1,340 injured, and 850,772 displaced and affected. Sutopo also stated that the most deadly disasters in early 2019 were floods and landslides; the BNPB (National Disaster Management Agency) also estimated that material losses from the disasters that had taken place in Indonesia has reached billions of rupiahs [1]. The biggest losses are caused to the homes of people.

Floods are one of the disasters feared by people in society, because floods come with a high water discharge, inundate at a high level for a long time, and carry waste materials that interfere with activities in society. Flooding can also affect the quality of clean water in a region.

Water is a natural resource that is very important for all life on earth, especially humans. Almost all human activities on earth use water, such as basic sanitation, washing, food and drinking, and so on. The water sources that are mostly used by people in Indonesia are rivers, lakes, reservoirs, and wells. Therefore, water pollution that results from flooding will be very detrimental to people who live in the area.

Indonesian Government Regulation No. 82 of 2001 concerning the management of water quality and water pollution control [13] states that water pollution is the entry or deliberate insertion of living things, substances, energy, and/or other components into water and/or changes in water structure by human activities, which decrease water quality to a certain level and cause water to be unusable accordingly. If water pollution occurs, whether by germs (bacteria, viruses, parasites) or toxic and dangerous chemicals, health problems and ecosystem disturbances will be the results [18]. The characteristics of polluted water that can be identified directly by human senses are water that is dirty, has a smell, and changes in taste; polluted water will also leave stains on certain objects.

Polluted water will certainly have a negative impact on human health. Various types of diseases arise due to environmental pollution [16], including diarrhea, cholera, typhoid fever, hepatitis A, and amoebic dysentery.

An area in Indonesia that has recently experienced a clean water crisis due to flooding is the Province of Bengkulu. The floods that occurred from April 27 to May 4, 2019 in several cities in the Province of Bengkulu had killed at least 30 people while 6 were declared missing; 554 housing units were severely damaged, while 160 were moderately damaged and 511 were slightly damaged [1]. The damage to facilities that occurred due to flooding as well as debris washed up by the flooding makes clean water difficult to obtain. This is because the wells of the flood victims are smelly, muddy, and oily. Due to the high water demand, the Indonesian Red Cross (PMI) supplied 100,000 liters of water to areas affected by the floods, which could increase if the demand increased.

From the explanation above, this article concerns the analysis of changes in water quality in flood-affected areas, in the perspective of environmental law.

2. Materials and methods

a. Flood Disasters

Flood is inundation of land due to river overflow, which is caused by heavy rain or torrents of water from other areas in higher places. Indonesia has very high rainfall, which ranges from 2,000-3,000 mm/year, and thus flooding easily occurs during the rainy season, which lasts from October to January. There are 600 large rivers spread throughout Indonesia that are in poor condition and not well managed, which then cause floods [1].

Flooding can inundate land that is usually dry, such as agricultural lands, settlements, and city centers. Flooding can also occur due to a volume of water or discharge that flows in a river or through

a drainage channel that exceeds beyond its drainage capacity. Water overflow is usually not a problem if it does not cause losses, deaths, or injuries, and does not remain in settlements for a long time or cause other problems in daily life. But on the contrary, if water is pooled with a high enough, and occurs in a long time of course this can complicate human activity. In the last ten years, the area and frequency of floods have expanded and losses have increased [2].

In Indonesia, floods have occurred for a long time and often. In the Jakarta area, for example, floods have occurred in modern times since 1959, when the population was still relatively small. Earlier floods in Jakarta have occurred since 1621, which was followed by floods in 1878, 1909, 1918, 1923, and 1932 that inundated settlements due to the overflowing of water from the Ciliwung, Cisadane, and Angke rivers. Floods have occurred several times in the territory of Indonesia, especially the capital city of Jakarta since Indonesia's independence. Namely in 1976, 1996, 1999, 2002 and 2007. [11]

b. Causes of Floods

Floods are caused by natural conditions and phenomena (topography, rainfall), regional geographical conditions, and human activities that result in changes in land use in an area. Floods in parts of Indonesia, which usually occur in January and February, are caused by very high rainfall intensities, for example in DKI Jakarta with a rainfall intensity greater than 500 mm [2]

Kodoatie and Syarief explained that the factors that cause floods include changes in land use, waste management, erosion and sedimentation, slums along rivers, improper flood control systems, high rainfall, river physiography, inadequate river capacity, effects of high tides, land subsidence, water structures, and damage to flood control structures [10]. Based on their geographical conditions, areas located on floodplains have a high risk of being flooded. Besides Jakarta, several major cities in Indonesia are located on floodplains and thus are at a high risk of being flooded. Many of the recent floods have occurred in many floodplain areas. The 13 rivers in Jakarta have the potential to cause floods [4]

Occurrences of flooding are also influenced by human activities or development that does not consider the principles of environmental conservation. Spaces are often utilized without consideration of their capabilities and in ways that exceed their carrying capacities. In urban areas, green open spaces and urban parks have sizes that are less than ideal for cities, and are now increasingly becoming reduced due to pressure from settlements or other uses that are considered capable of providing greater economic benefits.

Because of reduced open green spaces in cities, the level of infiltration in city regions decreases, resulting in increased surface flow velocity and discharge. When heavy rains fall for a long time, most of the rainwater will flow over the soil or land surface with great velocity and volume, subsequently accumulating into a flood. Many areas or streets in Bandung have experienced this phenomenon, which resembles a river in the middle of the city. Regarding people and their behavior or awareness of the environment, many are still unaware that their daily behavior or activities can be a detriment to others, whether in their area or the areas of other people.

c. Flood Impact

In general, the impact of flooding can be direct or indirect. Direct impacts are relatively easier to predict than indirect impacts. The impacts toward urban areas that are dominated by human settlements are also different from the impacts toward rural areas that are dominated by agricultural lands. Floods that occur in different areas can damage and wash away homes, causing injuries and deaths, as those that occurred in Wasipor and Bahorok. Flooding can also cripple public transportation (microbuses, trucks) or result in longer routes to certain destinations in order to avoid flooded areas, as is often the case along the north coast roads of Java. Flooding disrupts schedules of railroads and flight transportation. Residents often have to evacuate temporarily to safer or non-flooded places, such as in what happens each year in Cienteung, South Bandung. Flooding in Jakarta has also caused more than 84,000 Jakarta residents to be evacuated to other safer places because their homes are submerged

in water [2]. Many fish farmers on the coast are under threat of bankruptcy because their ponds are damaged by flooding, such as by floods on the northern coast of Java. Many flood victims, both in their own homes and in flood shelters, have been afflicted by skin diseases, diarrhea, respiratory problems, and other illnesses. Floods that inundate agricultural lands can also cause crop failure in some areas.

d. Water pollution

Water pollution is the intrusion of living things, substances, energies, or other components into water that drops water quality to a certain level, making it not usable as intended. According to [12], water pollution is the deviating of water properties from normal conditions.

Sources of water pollution include community waste, industrial waste, agricultural waste and domestic waste. There are several types of pollutants that can contaminate water: substances infected by germs, substances that decompose with oxygen, organic chemical substances from industrial or agricultural fertilizer waste, and substances containing radioactivity and heat.

Waste disposal can cause the level of dissolved oxygen in water to decrease as it becomes consumed by decomposing bacteria. Continuous disposal of organic and inorganic waste that into rivers will cause flooding, in addition to polluting water and especially in the rainy season. Water is an important natural substance for living things due to its flowing and absorbent characteristics. If water flow is blocked, flooding will result. Water pollution occurs because of a lack of discipline among people, for example regarding environmental cleanliness and littering.

There are two kinds of flood disasters: flash floods and pluvial (ponding) floods. Flash floods occur because of water overflowing from streams or rivers in large volumes, while pluvial or ponding floods occur due to inundation from rainwater in an area because of blocked waterways and limited infiltration.

The method use in this research is empirical legal research, where the research problem being studied is examined by describing the state of the research subject(s) based on available facts, which is then associated with existing legal regulations. Here, the study pertains to laws related to water pollution and environmental health.

The materials for research originated from field survey and literature study. Field survey was conducted to obtain primary data, while literature study was conducted to obtain secondary data. The utilized primary law materials consist of legislation related to water pollution and the environment. Secondary law materials consist of materials in the form of literature, as in books, magazines, research journals, papers, and other documents related to the research.

3. RESULT AND DISCUSSION

a. General Description of the Problems of Flooding

From the results of identification carried out by the BNPB, flood disaster that occurred at 2019 in the nine regencies/cities of the City of Bengkulu, Bengkulu Tengah Regency, Bengkulu Utara Regency, Kepahiang Regency, Rejang Lebong Regency, Lebong Regency, Seluma Regency, South Bengkulu Regency, and Kaur Regency is a disaster that not only caused material losses but also lose a life. From the results of their identification, the Meteorology, Climatology, and Geophysics Agency [2] explained that the flood that struck the Province of Bengkulu was related to the activity from the Madden-Julian Oscillation (MJO). The MJO is a natural phenomenon that, by its scientific workings, increases the supply of wet air mass in most parts of Indonesia.

The flood that occurred this time was only a manifestation of small part of the damage to the landscape in Bengkulu, and was the worst by far [3]. This is due to damage to the Bengkulu Watershed. In the Bengkulu Watershed, there are two CPO factories and two rubber factories that certainly change the landscape conditions.

In addition, the increase in river water discharge was also caused by mining activities carried out in the upper reaches of the river, particularly by PT. Inti Bara Perdana, PT. Bukit Sunur, PT. Fetro Rejang, PT. Sirat Unggul Permai, PT. Kusuma Raya Utama, PT. Danau Mas Hitam, and PT. Bara

Mega Quantum. The six mining companies operate in the forest area of the Bukit Daun Protected Forest and the Semidang Bukit Kabu Hunting Park. Along the Air Bengkulu River, there are the two CPO factories of PT. Cahaya Sawit Lestari and PT. Palma Mas Sejahtera, and the two rubber factories of PT. Batang Hari Bengkulu and PT. Bengkulu Angkasa Makmur.

The waters of the Air Kungkai Watershed in the regencies of Rejang Lebong and Kepahiyang flow into the Musi River in South Sumatra, which also has the operations of the Musi Hydroelectric Power Plant and PT. Pertamina Geothermal Energy in the Bukit Daun forest area. In addition, the forest areas that are used as agricultural cultivation zones and for non-forestry activities decreased water catchment areas as a result.

b. Impact of Flooding

The examples of flood impacts or losses, including loss of life or injury, loss of property, damage to settlements, damage to trade areas, damage to industrial areas, damage to agricultural areas, damage to drainage and irrigation systems, damage to roads/highways and railroads, damage to bridges and airports, damage to telecommunications systems, and so on [10]. The following is the data on losses in the flood-affected areas of the Province of Bengkulu:

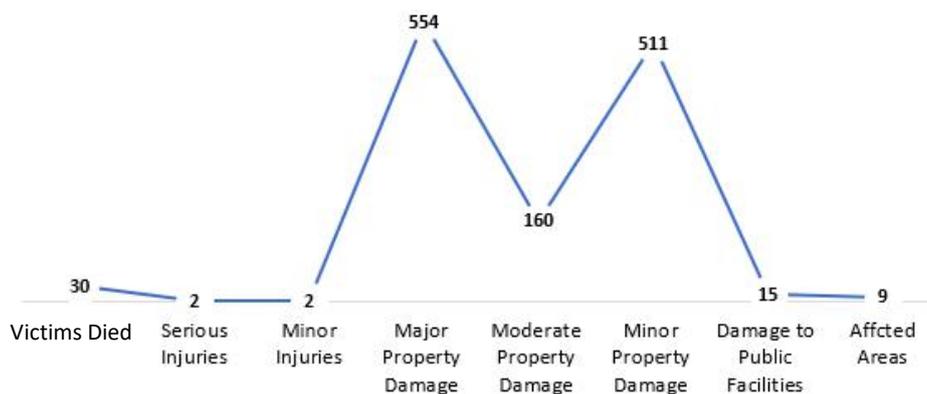


Figure 1. Bengkulu Flood Impact Data

Source: <http://dibi.bnpb.go.id/>

From the above data, it can be seen that the highest impact was on residential areas damaged by the flood. In addition, many victims died due to the flood disaster, numbering to 30 people.

c. Compliance Analysis with Legislation

Based on the results of the analysis carried out in the field, there were many discrepancies regarding the existing spatial planning, according to Minister of Public Works Regulation Number 63/PRT/1993 that concerns Riparian Zone Borders and Control of River and Ex-River Areas. Several things can happen if this regulation is not implemented, including:

- a. Dam bursts or failures
- b. Landslides on the riverbanks
- c. Washing away of settlements on the riverbanks
- d. Damage to the embankment
- e. Collapse of supporting pillars of bridges

The factory that was built next to the river certainly violated the regulation because it violated the protected area of the watershed. This condition also indicates a decrease in the quality of the environment that society should maintain and protect. This contradicts Article 7 of the Law on

Environmental Management, which states, “Society has the greatest equal opportunity in its role in environmental management.”

d. Health Impact of Polluted Water in the Perspective of Environmental Law

Increased development activities bring the risk of causing pollution and damage to the environment. This can also affect the availability of water resources, which are decreasing in quality. As previously explained, water is a vital natural resource for the survival of all living things on earth; therefore, it must be utilized for the greatest prosperity of the people, in accordance with the contents of Amended Article 33 of the 1945 Constitution. With the destruction of water catchment areas, water resources decrease; further, the abiotic, biotic, and social environment in the vicinity will also degrade in function. The following are some things that can cause a decline in the quality of health in society:

- a. A health gap, which commonly occurs particularly between urban and rural areas.
- b. Burden of disease.
- c. Behavior of people that does not support a healthy and clean lifestyle.
- d. Low quality of health of poor people, as well limited and unequal distribution of health personnel.

4. CONCLUSION

Based on the analysis and discussion of the research as described above, it can be said that the Province of Bengkulu has experienced a decrease in the quality of the environment, and the following conclusions can be made:

1. Flooding in the Province of Bengkulu is caused by the damage to the Bengkulu River Basin. In the Bengkulu Watershed, there are two CPO factories and two rubber factories that change the natural landscape conditions. Flooding is also caused by an increase in river water discharge as well as mining activities carried out in the upper reaches of the river, namely by PT. Inti Bara Perdana, PT. Bukit Sunur, PT. Fetro Rejang, PT. Sirat Unggul Permai, PT. Kusuma Raya Utama, PT. Danau Mas Hitam, and PT. Bara Mega Quantum. The six mining companies operate in the area of the Bukit Daun Protected Forest and Semidang Bukit Kabu Buru Park. Along the Air Bengkulu River, there are the two CPO factories owned by PT. Cahaya Sawit Lestari and PT. Palma Mas Sejahtera, and the two rubber factories owned by PT. Batang Hari Bengkulu and PT. Bengkulu Angkasa Makmur.
2. There is a discrepancy regarding existing spatial planning, according to Minister of Public Works Regulation Number 63/PRT/1993 that concerns Riparian Zone Borders and Control of River and Ex-River Areas. The factory areas built around the river are certainly in violation of regulations because they exist in the watershed areas that are classified as protected areas because they are prone to disasters.
3. The decrease in the availability of water resources is due to the depletion of watershed areas, making it difficult to obtain clean water.

5. SUGGESTIONS

Based on these conclusions, the author gave suggestions that could be used for improvements in the future, and the following suggestions can be made :

1. It is expected that, in the future, authorized institutions will impose sanctions in accordance with the violations committed by irresponsible parties who create structures on protected areas.
2. Synergy should be created between society and the government to jointly preserve the surrounding environment.
3. There should be growing self-awareness of the importance of environmental sustainability.

REFERENCES

- [1] Badan Meteorologi Klimatologi Geofisika (2013): Analisis Hujan Bulan Januari 2013 [Analysis of Rain, January 2013]. Buletin BMKG.
- [2] Badan Nasional Penanggulangan Bencana (2013): Bencana di Indonesia 2012 [Disasters in Indonesia, 2012].
- [3] Beni Ardiansyah. 2019. Banjir dan Longsor Bengkulu : Jalur Hukum Ditempuh Demi Bencana Menjauh. Buletin BMKG
- [4] Berpotensi Banjir [Flood Potentials]. November 21 2012
- [5] Bisnis Indonesia (2012): 13 Sungai di Jakarta [13 Rivers in Jakarta]
- [6] Chandra, B. 2007. Pengantar Kesehatan Lingkungan [Introduction to Environmental Health]. Penerbit Buku Kedokteran. Jakarta.
- [7] Coppola, Damon P (2007): Introduction to International Disaster Management. Elsevier, Oxford.
- [8] Djambur. W. Sukarno. 1993. Biologi 1 untuk Sekolah Menengan Umum [Biology 1 for High School]. Jakarta: Departemen Pendidikan dan Kebudayaan, pusat perbukuan.
- [9] Fitriindrawardhono (2012): Sejarah Banjir Jakarta [History of Jakarta Floods]. Cakrawala. Accessed from <http://fitriwardhono.wordpress.com/2012/04/06/sejarah-banjir-dijakarta/>
- [10] Online News. Accessed from <https://www.antaraneews.com/berita/873833/pmi-pasok-air-bersih-untuk-korban-banjir-bengkulu>
- [11] Kodoatie, Robert, J dan Roestam Sjarief (2006): Pengelolaan Bencana Terpadu [Integrated Disaster Management]. Penerbit Yarsif Watampone, Jakarta
- [12] Kompas.com dengan judul "BNPB Bencana Alam di Indonesia Meningkatkan pada Tahun 2019. [BNPB: Natural Disasters in Indonesia Increased in 2019]" Accessed from <https://nasional.kompas.com/read/2019/03/29/17293031/bnpb-bencana-alam-di-indonesia-meningkat-pada-tahun-2019>
- [13] Kristianto, P. 2002. Ekologi Industri [Industrial Ecology]. Penerbit ANDI. Yogyakarta.
- [14] Mulia, R. M. 2005. Kesehatan Lingkungan [Environmental Health]. Penerbit Graha Ilmu. Yogyakarta.
- [15] Pomalingo, N. dan I. Ali. 2002. Pengetahuan Lingkungan [Environmental Knowledge]. Penerbit BKS-PTNINTIM. Makassar.
- [16] Regulation of the Government of the Republic of Indonesia Number 82 of Year 2001 on the Management of Water Quality and Water Contamination.
- [17] Saragih, J. P. N. dan S. Sitorus. 1983. Bunga Rampai Lingkungan Hidup [Environmental Anthology]. Penerbit Usaha Nasional Surabaya
- [18] Slamet, J. S. 2000. Kesehatan Lingkungan [Environmental Health]. Gadjah Mada University Press. Yogyakarta
- [19] Wardhana, W. A. 1995. Dampak Pencemaran Lingkungan [Effects of Environmental Pollution]. Penerbit Andi Offset. Yogyakarta.