
| RESEARCH ARTICLE

Water Pollution Study and its Control Strategies in the Boentuka Sub-watershed, South Timor Regency, Timur Nusa Tenggara Province

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| ABSTRACT

A Watershed is a land area that is an integral part of the river and its tributaries, which functions to accommodate, store and drain water from rainfall to lakes or to the sea naturally, whose boundaries on land are topographical separators. And boundaries at sea up to water areas that are still affected by land activities. This study aims as follows: 1) To assess the current water quality in the Boentuka Sub-watershed, Timor Tengah Selatan Regency, 2) Identify the factors causing water pollution entering the Boentuka Sub-watershed, 3) Formulate Strategic Recommendations on Water Pollution Control to the District Government South Central Timor in water quality management and efforts to control water pollution in the Boentuka Sub-watershed. This research method is descriptive with a laboratory-based quantitative approach to describe the condition of river water quality status in the Boentuka Sub-watershed area and the pollution load originating from residential and agricultural activities of local residents. d. The results of the SWOT analysis state that the strategic recommendations that need to be made to control the level of water pollution in the Boentuka Sub-watershed area are (a) the need for a technical study on the determination of river water classes and the carrying capacity of river water pollution loads as the basis for river pollution control policies; and (b) Increasing the frequency of supervision and monitoring activities by the relevant agencies on settlement activities, agriculture and or other activities that contribute to increasing river water pollution.

| KEYWORDS

Water pollution, control strategy, sub and boentuka, south-central Timor district

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1. Introduction

Watershed (DAS) is an area bounded by mountain ridges where rainwater that falls on the area will be accommodated by the mountain ridge and will be channelled through small rivers to the main river (Asdak in Novita Sari, 2014; Bahri, 2014). et al., 2019). A watershed includes a land area that is an integral part of a river and its tributaries, which functions to accommodate, store and drain water from rainfall to a lake or to the sea naturally, where the land boundary is a topographical separator and the sea boundary to the sea, with water areas that are still affected by land activities. (PP No. 37 on Watershed Management, Article 1).

Rivers are open waters that flow all the time so that they get input from discharges from various human activities in the area where they live, agriculture and household industries in the vicinity. The input of waste into the river causes physical, chemical and microbiological changes in river waters. This change can have an impact on decreasing river water quality (Asdak, 2014).

The increasing pollutant load entering river waters is caused by the activities of communities around the river disposing of domestic waste, both liquid waste and solid waste, directly into river waters. The degradation of the river water environment is strongly influenced by the population subsystem, water resource population subsystem, industrial subsystem, pollution (pollution) subsystem, water quality subsystem, tourism subsystem and agricultural subsystem (Baherem et al., 2014; Kathon and Ariastita, 2017). Changes in land-use patterns into agricultural land, moor and settlements, and increased industrial activity will impact hydrological conditions in a watershed. Changes in land-use patterns mean that there has been a change in the amount and type

of ground cover vegetation (Asdak, 2014; Natsir, 2015).

The increasing population and economic development in Timor Tengah Selatan Regency today also increase activities that produce waste, such as agricultural activities, land clearing, disposal of organic waste from humans and livestock, and various other activities. Waste from these activities has the potential and has polluted the Noelmina river flow, especially the Boentuka Sub-watershed area, which is administratively located in five sub-districts, namely Soe City, Batu Putih District, North Mollo District, South Amanuban District, and West Amanuban District. The Boentuka sub-watershed has a length of 15 kilometres. The use of the Noelmina river water in the Boentuka sub-watershed serves irrigation, agriculture, flood control and tourism activities (BPDAS NTT, 2021).

Currently, there are 2 (two) main activities that are the biggest contributor to the pollution of the Boentuka Sub-watershed, namely residential and agricultural activities. Pollution caused by residential activities, namely the use of river flows in the Boentuka Sub-watershed for various activities such as disposal of organic and inorganic waste (remains of vegetables, fruits, and leaves, as well as livestock manure) into the river, as well as bathing and washing activities carried out by the community. Produce soap/detergent waste that is dumped into the river; Meanwhile, from agricultural activities, changes in land-use patterns, namely the excessive use of fertilizers and pesticides, bring in chemical waste that pollutes the Boentuka Sub-watershed (Balai Management of the NTT Watershed, 2021).

River pollution occurs when the quality of river water drops to a certain level so that it cannot function according to its designation. The benchmark used to determine whether water pollution has occurred the water quality standard according to river class based on Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management.

The objectives of this study are as follows: 1) To assess the current water quality in the Boentuka Sub-watershed, Timor Tengah Selatan Regency, 2) Identify the factors causing water pollution that enters the Boentuka Sub-watershed, 3) Formulate Strategic Recommendations regarding Water Pollution Control to the South Central Timor Regency Government in water quality management and efforts to control water pollution in the Boentuka Sub-watershed.

The benefits expected from this research are: 1) For science, as a scientific work that can be useful for the development of studies and further research by interested parties, 2) For the community, as information material regarding the condition of water quality in the Sub-District area. Boentuka Watershed, South Central Timor Regency, East Nusa Tenggara Province, 3) For the Government, it can be used as a material for determining the pollution load capacity of water sources in the Water Pollution Control Program and is useful for spatial planning in the Boentuka Sub-watershed area in order to maintain the quality of resources. Nature and environment.

2. Study of theory of water

2.1 Resources

Water has a very central position for human life; without adequate water for more than a week, humans will not be able to survive. In addition to survival in accordance with its central position, water also has a big role in supporting the success of agriculture—the role of law as a means of development and enforcement of justice/order in society. The role of law in development in the field of water resources must be able to guarantee changes in an orderly and orderly direction in accordance with what has been regulated (Arsyad in Mondal, 2016; Ardhani, 2014).

The hydrological cycle of water depends on the processes of evaporation and precipitation. Water found on the earth's surface turns into water vapour in the atmosphere through the process of evaporation (evaporation) of the river, lake, and seawater, as well as the process of evaporation or evaporation of water through plants. The evaporation process that takes place in the sea is more than the evaporation process in inland waters. In the sea, the evaporation process also exceeds the precipitation process, so the ocean is the main source of water for the precipitation process. On the other hand, there is more precipitation on land than evaporation. On land, about 50% of the water obtained through precipitation is evaporated, and the rest is stored in lakes, rivers, and groundwater (Effendi in Kurniawan, 2014; Wardiyah, 2016).

2.2 Water

Quality Quality is the quality characteristic required for a particular use of various water sources. Water quality criteria are a standard basis regarding the quality requirements of water that can be utilized. Water quality standard is a regulation prepared by a country or a region concerned. Water quality can be known by performing certain tests on the water. The tests carried out are chemical, physical, biological, or appearance tests (smell and colour).

2.3 Water Pollution

1. Source and Pollution

Pollution occurs when materials in the environment cause unexpected changes, whether physical, chemical, or biological. Water is one of the natural resources needed by living things to sustain their life. Therefore, if water is not managed properly, it can cause social conflict if the availability of water is reduced according to needs and has an impact on the occurrence of damage or destruction to other living things (Tchobanoglous, 2014; Singh, 2016).

Basically, environmental pollution can be divided into three levels, namely: (1) disturbance, which is the lightest form of pollution, (2) temporary pollution, which is short term because nature is able to digest it so that the environment can return to its original state, and (3) permanent pollution, which is permanent—fixed because nature is unable to digest it again, which is known as a change in natural resources (Hidayat in Devi, 2018; Binhar, 2020).

2. Pollution Indicators and Parameters

Common indicators used in water pollution inspections are pH or hydrogen ion concentration, dissolved oxygen (dissolved oxygen, DO) and chemical oxygen demand (COD). Indicators or signs that water has been polluted are changes or signs that can be observed through (Wardhana in Handriarti, 2018; Kumalajati, 2017):

- a. There is a change in water temperature.
- b. There is a change in pH or hydrogen ion concentration.
- c. There is a change in the water's colour, smell, and taste.
- d. The emergence of precipitates, colloids, solvents and suspended solids.
- e. The presence of microorganisms that live in the water.
- f. Increased radioactivity of water in the environment.

3. Impact of Water Pollution

The impacts that occur due to water pollution are (Supriyantini et al., 2017; Putri, 2018):

- a. Water pollution has a wide impact,
- b. Can poison drinking water sources,
- c. Poisoning animal food,
- d. Imbalance of river and lake ecosystems,
- e. Destruction of forests due to acid rain,
- f. Health for humans and other living things.

2.4 Water Pollution Control Efforts for Watersheds (DAS)

Water can be polluted if its quality or composition, either directly or indirectly, is changed by human activities so that it no longer functions like drinking water, household use, agriculture, recreation or other purposes as before it was exposed to pollution. Water pollution is a deviation of the properties of water from normal conditions. The characteristics that are polluted vary greatly depending on the type and the pollutant or the components that cause pollution (Kumar in Devi, 2018; Sumengen, 2014).

As a primary need for survival, water should not be contaminated. Today's water pollution is heavily influenced by household waste and agricultural waste. Water, being the main resource that supports human survival, should be glorified. This natural resource is really present and presented in nature and cannot be renewed. All living things on earth, humans, animals, and plants, need water. If the water needed is polluted, it becomes a problem for all living things on earth; therefore, water pollution must be known how to overcome it (Asdak, 2014; Mondal et al., 2016).

3. Research Methods

3.1 Methods of research

The method is descriptive with a laboratory-based quantitative approach to describe the condition of river water quality status in the Boentuka Sub-watershed area and the pollution load originating from residential and agricultural activities of local residents. This research was carried out in several stages, namely site surveys, determination of the existing condition of the Boentuka Sub-watershed through physical-chemical and biological analysis of river water using the standard procedures of American Public Health Association methods (US APHA 1998), determining the status of river water quality using the Pollution Index method. (IP) and the STORET method (comparing water quality data with the quality standards that have been determined according to its designation), and developing a strategy for controlling water pollution in the Boentuka Sub-watershed as feedback and a follow-up to the study of pollution load and water quality using SWOT analysis.

3.2 Research Implementation Procedures

1. River Water Sampling Methods.

A sampling of river water was carried out for one day during the study in March 2021, or samples were taken 1 (one) time during the study, which represented the transition season (dry season to rainy season) from morning to noon. The total sampling is 9 (nine) times. The sampling procedure carried out was as follows:

- a. Samples were taken at the same depth of 50 cm from the surface of the river water by inserting the bottle into the river water until it was completely filled with each containing 1 litre of water per observation parameter.
- b. For the measurement of dissolved oxygen, a light bottle was used for sampling, a dark bottle for fecal coliform was used, and the measurement of other parameters except temperature and TSS has used an Aqua bottle.
- c. Sampling was first carried out in the upstream area of the Boentuka Sub-watershed, after that in the middle and downstream areas of the Boentuka Sub-watershed.
- d. Prior to initial sampling, stakes were installed at each sampling point location as a marker for sampling based on the population in the Boentuka Sub-watershed area that uses river water for domestic and agricultural activities. Furthermore, the water sample is stored in a coolbox to be brought to the laboratory.
- e. Sampling was carried out in 3 (three) parts of the Boentuka Sub-watershed, including upstream, middle and downstream. Each part is taken 1 point of sampling, and repetition is carried out 3 (three) times at each point. The water sample is then put into a 1-litre container; then, the water sample is preserved so that the water conditions do not change at the time of water sampling and will be analyzed in the laboratory.

2. Analysis of Sample Data The

Results of river water quality analysis were carried out at the BLHD Laboratory of East Nusa Tenggara Province; then, the results were analyzed using the Pollution Index method and the STORET method based on river water quality standards. From the analysis of the Pollution Index and Storet, it can be seen that the class of river water quality in the Boentuka sub-watershed is in accordance with its designation for domestic, industrial, livestock and agricultural irrigation needs.

- a. Pollution Index (IP) method.
The definition of the Pollution Index method is related to Attachment II to the Decree of the State Minister of the Environment proposing an index related to significant variable pollution compounds for a designation. Based on Attachment II to the said Decree of the State Minister of the Environment, this method was developed as a designation for the entire body of water or part of a river. Management of water quality based on the pollution index (IP) can provide input to decision-makers so that they can assess the quality of water bodies for a designation and take action to improve quality if there is a decrease in quality due to the presence of pollutant compounds entering river water.
- b. StoretThe Storet
The method is one of the methods commonly used to determine the status of water quality. Determination of quality status is carried out by comparing water quality data with quality standards that have been determined according to their designation. With this method, the parameters that have met or exceeded the water quality standards can be seen.

3. Respondent SamplingRespondent

Technique Sampling technique was carried out using the purposive sampling technique. Sampling by purposive sampling is carried out with certain objectives and considerations where the sample has certain characteristics, properties and characteristics. The population is the subject of research. If someone wants to examine all the elements that exist in the research area, then the research is a population study or population study or census. The research subject is the place of the variable; the research variable is the object of research (Arikunto in Fitri, 2018; Binhar et al., 2020).

4. Determination of River Water Pollution Control Efforts and Strategies

Strategy is a tool to achieve goals. Efforts to control water pollution in the Boentuka Sub-watershed area require strategic planning, which includes the process of analysis, formulation and evaluation of these strategies. One of the strategic planning models is a SWOT analysis (Strengths, Weaknesses, Opportunities, and Threats). This analysis can be used as a basis for designing strategies and work programs.

SWOT analysis is a strategic planning method used to evaluate strengths, weaknesses, opportunities, and threats in a project that aims to justify the internal and external factors that have been analyzed. The study includes the role and coordination of cross-sectoral institutions as well as an analysis of the effectiveness of the institutional success of water quality management in the Boentuka Sub-watershed. The interviewees were taken from various related fields, including the NTT Regional Environmental

Agency, the Water Resources Office from the provincial level, namely Balai PSDA for the NTT River Basin, and the central level, namely the Office of the River Basin Center (BBWS) East Nusa Tenggara II.

4. Results and Discussion

4.1 Results of Water Sample Analysis

1. Physical Properties

parameters measured and observed at the research site were temperature, total dissolved solids (TDS) and total suspended solids (TSS).

a. Temperature.

Temperature is an important physical parameter in river water bodies because it affects chemical reactions and reaction rates, aquatic life and the suitability of water use for certain purposes (Metcalf and Eddy, 1979). An increase in temperature causes an increase in viscosity, chemical reactions, evaporation, and volatilization. The results of measurements and observations of temperature at the research location from upstream to downstream can be seen in the following figure:

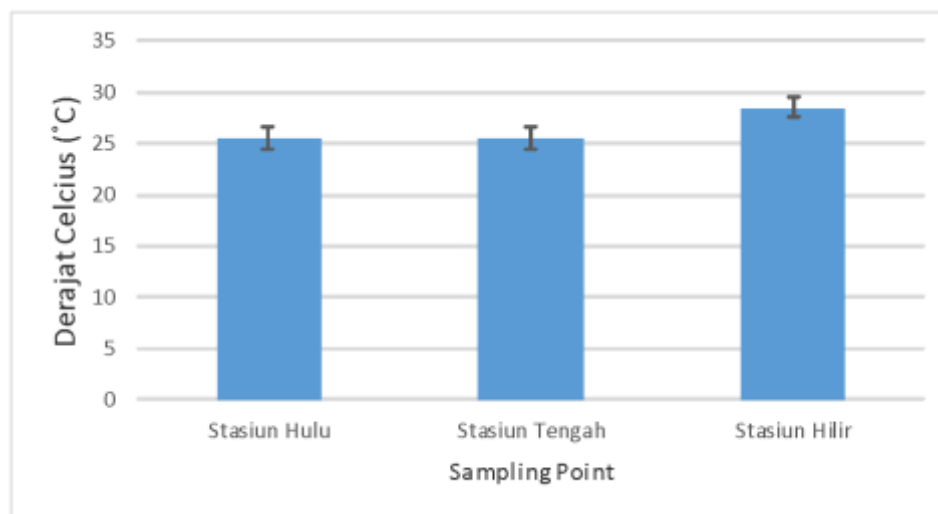


Figure 1 Concentration of River Water Temperature (Derajat Celsius) in the Boentuka

Sub-watershed. water temperature parameters in the upstream and middle areas are 25.5°C to 28.5°C. This temperature is within the water quality standard in accordance with Government Regulation No. 22 of 2021. The condition of river water quality in terms of temperature parameters is still within the water quality standard limit according to its designation. The water temperature of this study is also almost the same as the results of the Tukad Saba water quality study, which reached an average of 21.9 C - 31.5 C (Susanti, 2015).

If it is seen that the temperature of the wastewater entering the river water body is 23 - 33°C, then the temperature of the river water in the Boentuka Sub-watershed area does not have much effect on the temperature of the river water. This condition is in accordance with the optimum conditions for the growth of phytoplankton in the waters, which is between 20 – 30°C (Effendi, 2003).

b. Total Dissolved Solid (TDS)

The results of measurements and observations of the parameters of Total Dissolved Solid/dissolved solids at the research site from upstream to downstream and the distribution of the level of the TDS (Total Dissolved Solid) parameter to river water quality standards can be seen in the figure below this.

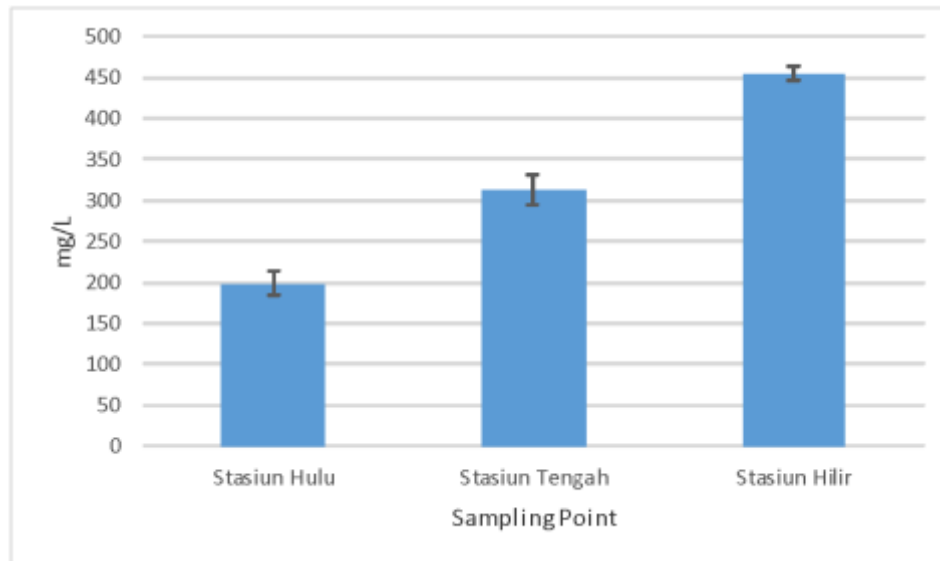


Figure 2 Concentration of Total Dissolved Solid (mg/L) in the Boentuka Sub-Watershed

A level of 455.5 mg/L. Meanwhile, the lowest TDS content was at the upstream location at 199 mg/L and the highest at the downstream location at 455.5 mg/L. The results of another study conducted by Ramadhawati et al. (2021) showed that the TDS concentration in the Cisadane River was 15 mg/L–100 mg/L. This shows that the quality standard in the river is still below the quality standard threshold, even though it is designated for agriculture and domestic waste treatment.

The results of this study can be concluded that the TDS parameter is still below the threshold for class III quality standards based on PP. No. 22 of 2021. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that the water quality remains below the quality standard.

c. Total Suspended Solid (TSS)

TSS is a physical property of a water body related to turbidity. The suspended solids content varies from upstream to downstream. The concentration of TSS in the dry season in May is 80 mg/L. This figure is within the class III water quality standard of 100 mg/L.

The following figure shows the measurement results of total suspended solids (TSS) at the research site.

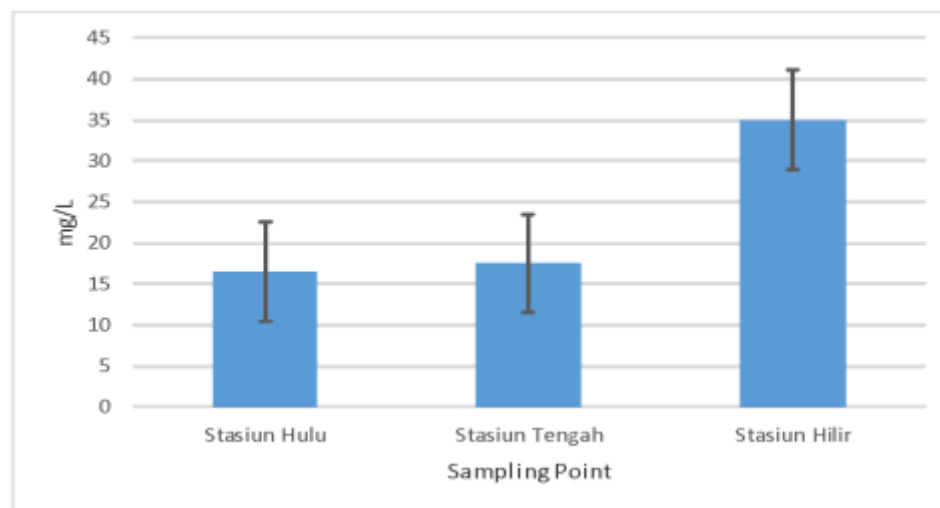


Figure 3 Concentration of Total Suspended Solid (mg/L) in the Boentuka Sub-watershed

The concentration of TSS in the upstream reaches 16.5 mg/L, in the middle area, it reaches 17.5 mg/L and in the downstream reaches 35 mg/L. Class III water quality standards based on PP no. 22 of 2021, which is 100 mg/L, therefore the condition of water quality in the Boentuka Sub-watershed seen from the concentration of TSS is still within the quality standard limits. The results of

research conducted by Nurhidayah et al. (2021) showed that the concentration of TSS in the Kebon Kongok Riverbank, West Lombok, West Nusa Tenggara was 5 mg/L – 30 mg/L. This shows that the quality standard in the river is still below the threshold, even though it is designated for agriculture, plantations and domestic waste treatment. The results of another study conducted by Sukiman et al. (2021) showed that the concentration of TSS in the Poooph River, Tombariri District, Minahasa Regency was 5 mg/L – 20 mg/L. This shows that the quality standard in the river is still below the threshold, even though it is designated for agriculture.

The results of this study can be concluded that the TSS parameter still shows below the threshold of class III quality standards based on PP. No. 22 of 2021. Therefore, the management of water resources (SDA) in the Boentuka Sub-watershed needs to be maintained, and research carried out continuously so that the water quality, especially the TSS parameter, remains below the quality standard.

2. Chemical Properties of Water

a. pH (Degree of Acidity).

The results of measurements and observations of pH at the research site from upstream to downstream can be seen in the image below.

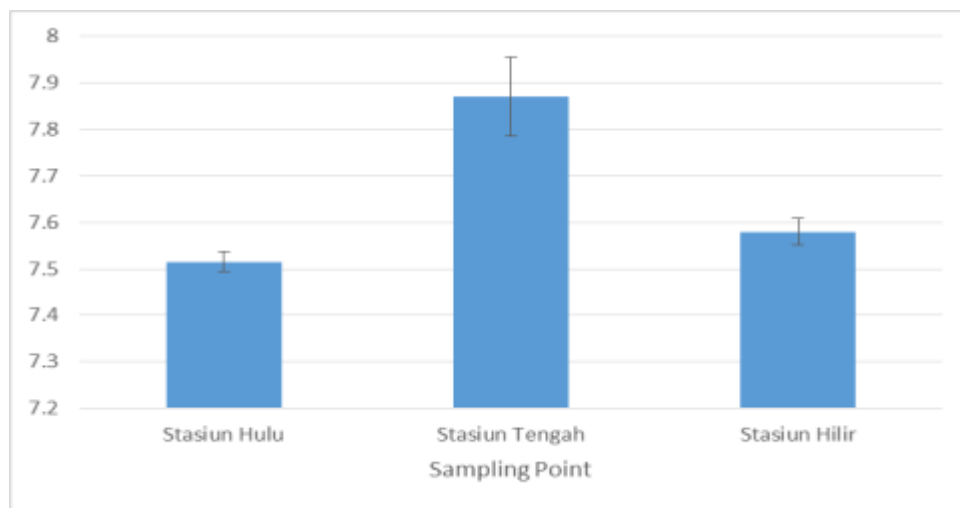


Figure 4 Concentration of Degree of Acidity (pH) in the Boentuka Sub-watershed

The results of the measurement of the pH of the water in the Boentuka Sub-watershed show that the pH of the water in the upstream to downstream areas is in normal condition, which has a pH value in the range of 7.51 – 7.87. The pH value is still within the class I water quality standard, which is in the value 6-9.

The increase in the pH value at the research location in the middle area of the Boentuka Sub-watershed reached 7.87 due to the activity of disposing of organic waste originating from domestic waste and waste originating from agricultural activities around the river that enter the river.



Figure 5 Boentuka Sub-watershed Central Station

According to Yuliasuti (2011), fluctuations in pH values are influenced by the discharge of organic and inorganic waste into the river. Normal water that meets the requirements for life has a pH of around 6.5-7.5 (Wardhana, 2004). The pH value of unpolluted water is usually close to neutral (pH 7) and fulfills the life of almost all aquatic organisms (Suharto, 2011). The results of research conducted by Putra and Yulis (2019) showed that the pH concentration in Teluk Nilap village Riau was 2.8–6.6. This shows that the quality standard in the river is still below the threshold, even though its designation is for the feasibility of clean water in the area. The results of this study can be concluded that the pH parameter is still below the threshold for class III quality standards based on PP. No. 22 of 2021. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that the water quality remains below the quality standard.

b. Dissolved Oxygen (DO)

Dissolved oxygen is an important parameter used to determine the quality of a body of water (Salmin, 2005). The following figure shows the results of Dissolved Oxygen (DO) measurements at the research site.

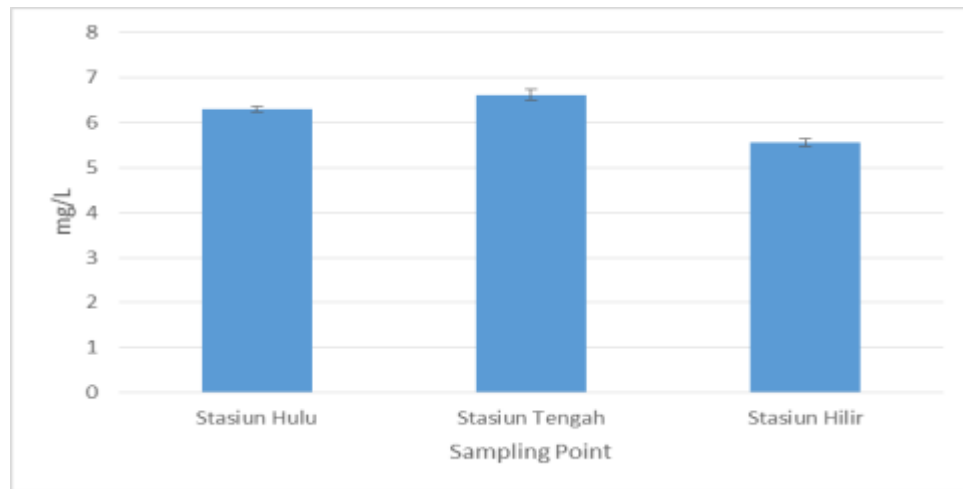


Figure 6 Concentration of Dissolved Oxygen (mg/L) in the Boentuka Sub-watershed

The results of monitoring the concentration of dissolved oxygen (DO) carried out in the upstream area were 6.30 mg/L, 6.62 mg/L in the middle region and in the downstream area of 5.56 mg/L. Water can be said to be good and have a low level of pollution if the dissolved oxygen level (DO) is greater than 5 mg/L (Salmin, 2005), while the dissolved oxygen concentration (DO) in unspoiled waters has a DO value of less than 10 mg. /L (Effendi, 2003). The results of this study can be concluded that the parameters of dissolved oxygen (DO) levels are still below the environmental quality standard threshold for class III. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that water quality, especially dissolved oxygen levels, remains below the environmental quality standard.

c. Biological Oxygen Demand (BOD) Biological Oxygen Demand (BOD)

The results of measurements and laboratory analysis and observations on the parameters of the research site from upstream to downstream and the distribution of BOD levels, can be seen in the figure below.

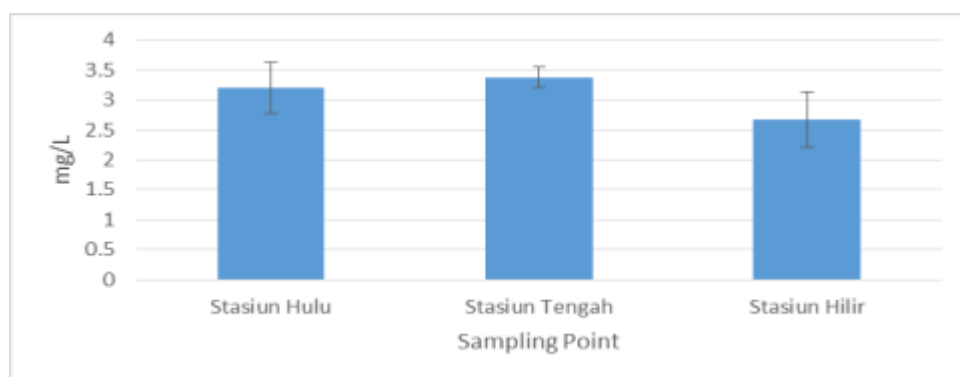


Figure 7 Concentration of Biological Oxygen Demand (mg/L) in the Boentuka Sub-watershed.

Based on the results of BOD measurements of river water in the Boentuka Sub-watershed, the highest BOD concentration value was found in the middle area, namely 3.38 mg/L and the lowest in the downstream area, namely 2,68 mg/L.

The results of monitoring BOD parameters in the upstream to downstream areas when compared with the class III water quality standard in accordance with PP No.22 of 2021 are still below the specified water quality standard of 6 mg/L. The increase in BOD affects the dissolved oxygen concentration decreases. The results of research conducted by Rozari (2021) showed that the concentration of BOD parameters in the Kali Dendeng sub-watershed, Kupang City was 1.5 – 6.3 mg/L. The results of this study can be concluded that the BOD parameter is still below the environmental quality standard threshold for class III. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that the water quality remains below the quality standard.

d. Chemical Oxygen Demand (COD)

Parameter Chemical Oxygen Demand (COD) indicates the amount of oxygen required to chemically oxidize organic matter, both those that can be degraded biologically (biodegradable) and those that are difficult to degrade biologically (non-biodegradable). The results of measurements and observations on the COD parameters of the Boentuka River water at the research location can be seen in the following figure.

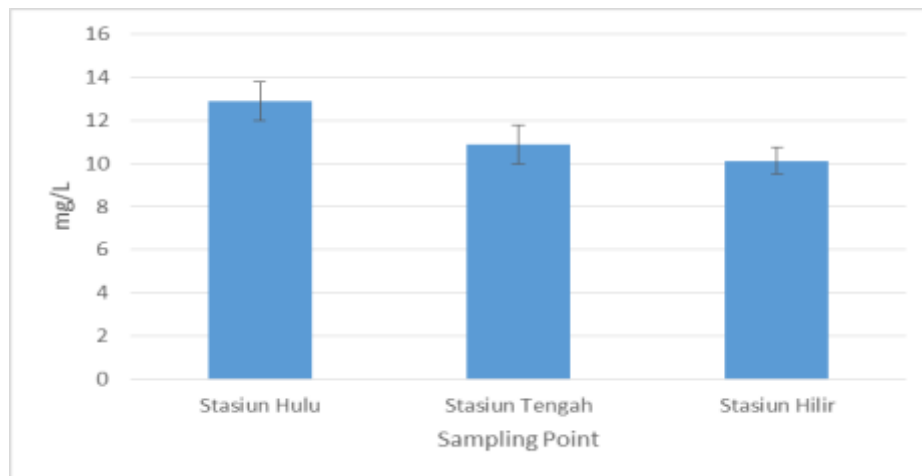


Figure 8 Concentration of Chemical Oxygen Demand (mg/L) in the Boentuka Sub-watershed

Measurement results COD concentration of river water in the Boentuka Sub-watershed in the upstream area of 12.89 mg/L, the Central area of 10.89 mg/L and the downstream area of 10.13 mg/L (below the class III water quality standard, which is 40 mg/L).

In general, the COD value obtained from the measurement results is greater than the BOD value because the number of chemical compounds oxidized chemically is smaller than those of biological compounds. The results of research conducted by Rozari (2021) showed that the concentration of COD parameters in the Kali Dendeng sub-watershed, Kupang City was 2.5 – 12.1 mg/L. The results of this study can be concluded that the COD parameter is still below the quality standard threshold. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that the water quality remains below the quality standard.

3. Microbiological Properties of water

a. Fecal Coliform.

Coliform bacteria are a group of microorganisms that are commonly used as indicators, where these bacteria can be a signal to determine whether a water source has been contaminated by pathogens or not. These coliform bacteria can produce methionine which can cause cancer; besides that, these spoilage bacteria also produce various kinds of toxins such as indole and skatole, which can cause disease if the amount is in excess in the body. Bacterial density indicators of e-coli contamination in developing countries, especially tropical countries, are generally much higher than in subtropical waters. The concentration of bacteria can range from 2×10^2 MPN/100 ml to 19×10^3 MPN/100 ml. The strength of pollution is also influenced by seasonal factors and the intensity of waste from activities on land.

The results of measurements and observations of fecal coliform (FC) at the research site from upstream to downstream can be seen in the following figure.

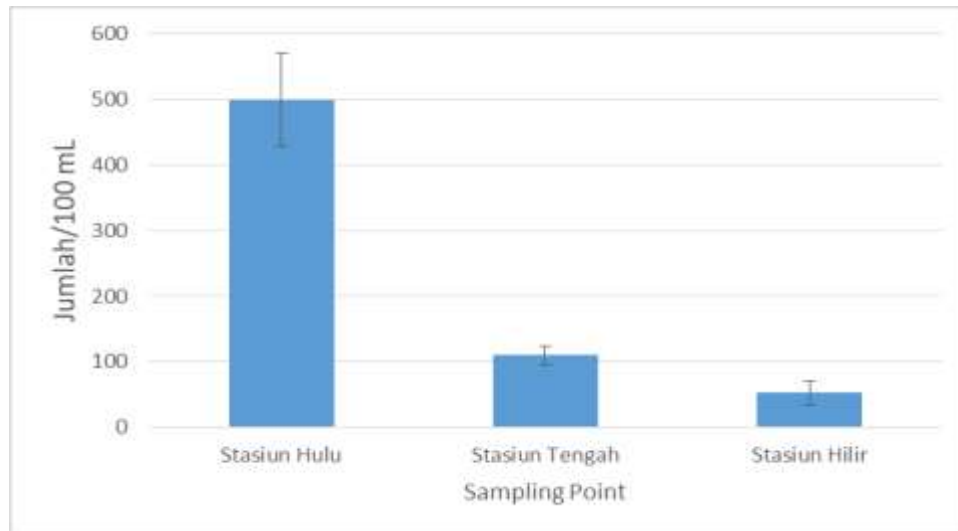


Figure 9 Fecal Coliform Concentration (amount/mL) in the Boentuka Sub-watershed

The fecal coliform concentration of river water in the Boentuka Sub-watershed at the upstream station is 500 amounts/ml, the middle station is 110 meters/ml, and the downstream station is 52.5 meters/ml. The parameters of fecal coliform bacteria in the Boentuka sub-watershed at the upstream, middle and downstream sampling points are still below the class III river water quality standard according to PP No.22 of 2021, which is set, namely: 2000 amount/ml.

The results of research conducted by Rosmeiliyana and Wardhani (2021) showed that the concentration of fecal coliform in the transition season in the Cisangkan River, Cimahi City was 460 – 1100 total/ml. This shows that the quality standard in the river is still below the Class III quality standard in accordance with PP No.22 of 2021, which is set at 200 quantities/ml, even though the allocation is for domestic, agricultural and industrial waste. The results of this study can be concluded that the concentration of fecal coliform still shows below the quality standard threshold. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that the water quality, especially the concentration of fecal coliform, remains below the quality standard.

b. Total Coliform

The following figure shows the measurement results of Total Coliform at the study site.

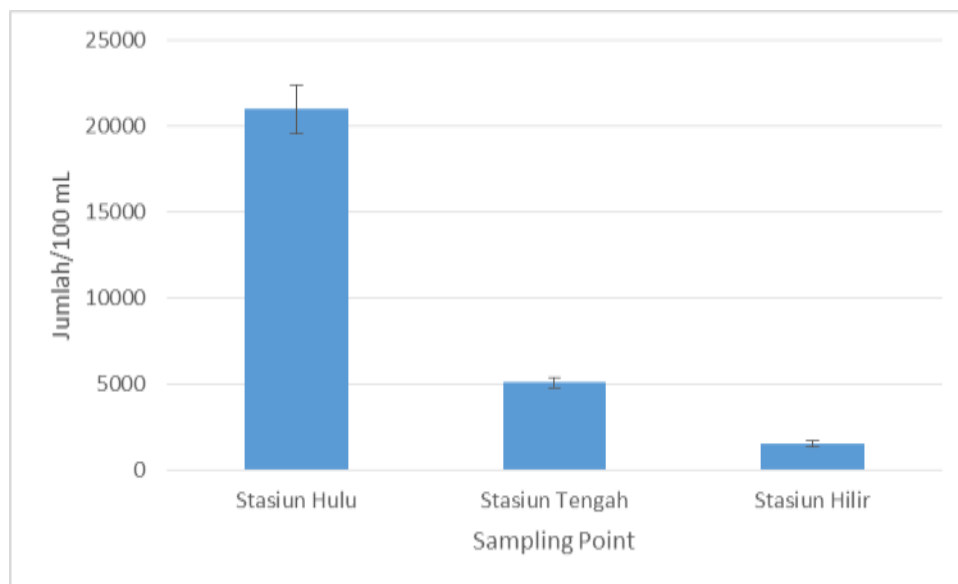


Figure 10 Total Coliform Concentration (amount/mL) in the Boentuka Sub-watershed

The total coliform concentration of river water in the Boentuka Sub-watershed carried out in the upstream to downstream areas ranged from 1525 - 21000 jml/100 ml; in the upstream area, the highest was 21000 jml /100 ml while the lowest in the downstream area was 1525 ml/100 ml.

The results of research conducted by Rosmeilina and Wardhani (2021) showed that the concentration of fecal coliform in the transition season in the Cisangkan River, Cimahi City was 460 – 1100 total/ml. This shows that the quality standard in the river is still below the Class III quality standard in accordance with PP No.22 of 2021, which is set at 10,000 quantities/ml, even though the allocation is for domestic, agricultural and industrial waste. The results of this study can be concluded that the total coliform concentration is still below the quality standard threshold. Therefore, the management of water resources (SDA) in the Boentuka sub-watershed needs to be maintained, and research carried out continuously so that the water quality, especially the total coliform concentration, remains below the quality standard.

4.2 Water Pollution Level Analysis of Boentuka Sub-watershed

Determination of water quality status in the Boentuka Sub-watershed River is based on the pollution index method. A river is said to be polluted if it cannot be used according to its normal designation (Azwir, 2006). In this study, the parameters used to analyze the status of water quality were pH, TSS, DO, BOD, COD, phosphate, fecal coliform and total coliform, which were compared with PP. Number 22 of 2021 concerning Water Quality Management and Water Pollution Control.

1. Status of River Water Quality with Pollution Index (IP) Method The calculation of the pollution index (IP) is also applied to water quality in the Boentuka Sub-watershed area in this study, then based on the results of the pollution index (IP), it will determine the status of water quality for each point of collection. Water samples in the Boentuka Sub-watershed.

The results of the calculation of the Pollution Index (IP) value according to the Decree of the Minister of Environment Number 115 of 2003 concerning Guidelines for Determining the Status of Water Quality are as follows:

Table 5 Results of the Pollution Index Analysis in the Boentuka Sub-Watershed Area

Parameter	Unit of	Station		
		Upstream	Middle	Downstream
Temperature	C	0.17	0,17	1.17
TDS	mg/L	0.20	0.31	0.46
TSS	mg/L	0.33	0.35	0.70
pH	-	0.01	0.25	0.05
DO	mg/L	0.06	0.03	0.12
BOD	mg/L	1.14	1.26	0.89
COD	mg/L	0.52	0.44	0.41
Fecal Coliform	amount/100 ml	0.50	0.11	0.05
Total Coliform	amount/100 ml	4.12	1.04	0.31

Based on the results of the analysis of the pollution index (IP) of the Boentuka sub-watershed from upstream to downstream for parameters TDS, TSS, COD, and Fecal Coliform meets water quality standards; the river is in good condition. Meanwhile, the parameters of pH, DO, BOD has exceeded the river water quality standard with lightly polluted conditions.

2. Water Pollution Index in the Boentuka Sub-watershed

The results of the analysis of water quality status using the Pollution Index method show that the condition of water quality in the Boentuka Sub-watershed in April 2021 can be categorized as lightly polluted with a pollution index value between 1 and 5. increased but still included in the category of lightly polluted. The insignificant change in the level of pollution is due to the calculation of the pollution index by taking into account the values of other parameters besides BOD, namely TDS, TSS, COD, Phosphate (PO4) Fecal Coliform and Total Coliform. The magnitude of the pollution index value and the status of water quality in the Boentuka Sub-watershed can be seen in the following table:

Table 6 Status of River Water Quality in the Boentuka Sub-watershed

No	Location	Time	Pollution Index	Water Quality Status
1	Upstream Station	April 2021	2.857	Lightly polluted
2	Central Station	April 2021	0.834	Good
3	Downstream Stations	April 2021	0.757	Good

Based on the table above, the pollution index (IP), it can be seen that the water quality status of the Boentuka Sub-watershed from upstream to downstream has decreased. The status of water quality with a value of 2.857 in the upstream area indicates a lightly polluted condition because there is a continuous flow of river water which will have an effect on water conditions, while for the Middle and Downstream areas with a value of 0.834 and 0.757 indicates a good condition, due to plantations, agriculture, not yet there are settlements or human, industrial and livestock activities that affect river water.

The results of this study can be concluded that the pollution index in the Boentuka Sub-watershed is in good to lightly polluted conditions (at the upstream station), while for the Mahap River and Dendeng River, the conditions are mild to heavily polluted.

3. Water Quality Status based on STORET Method

Determination of water quality status in the Boentuka sub-watershed uses the STORET method. The Storet index can provide an overall picture of the general condition of water quality in the Boentuka sub-watershed. In this method, the physical, chemical and biological water parameter data from observations of the average, maximum and minimum values of each parameter are compared with class II water quality standards according to Government Regulation No. 22 of 2021. The values obtained are given a score according to the level of pollution so that good or bad water quality can be known by looking at what parameters do not meet the specified quality standards. The table below shows the results of the evaluation of water quality in the Boentuka sub-watershed using the STORET method.

Table 7 Status of Water Quality subzone Boentuka Upstream Stations Using STORET Value Systems

Parameter	Unit	Quality Standards	Measurement Result			Score
			Max	Min	Average	
Temperature	° C	22-28	26	25	25.5	0
TDS	mg / L	1000	210	188	199	0
TSS	mg / L	50	17	16	16.5	0
pH	-	6-9	7.53	7.50	7.52	0
DO	mg/L	4	6.35	6.25	6.3	0
BOD	mg/L	3	3.5	2.9	3.2	-8
COD	mg/L	25	13.52	12.25	12.89	0
Focal Coliform	amount/100 ml	1000	550	450	500	0
Total Coliform number	/100 ml	5000	22000	20000	21000	0
Total Score						-8

Table 8 Status of Water Quality in Boentuka Sub-watershed Central Station Using the STORED Value System

Parameter	Unit	Quality Standard	Measurement Result			Score
			Max	Min	Average	
Temperature	C	22-28	26	25	25.5	0
TDS	mg/L	1000	326	300	313	0
TSS	mg/L	50	19	16	17.5	0
pH	-	6-9	7.93	7.81	7.87	0

DO	mg/L	4	6.7	6.53	6.62	0
BOD	mg/L	3	3.5	3.26	3.38	-10
COD	mg/ L	25	11.53	10.24	10.89	0
Focal Coliform	quantity/100 ml	1000	120	100	110	0
Total Coliform	quantity/100 ml	5000	5300	4900	5100	0
Total						-10

Table 9 Status of Water Quality in Boentuka Sub-watershed Downstream Station Using the S Value System TORET

Parameter	Unit	Quality Standards	Measurement Result			Score
			Max	Min	Average	
Temperature	° C	22-28	29	28	28.5	0
TDS	mg / L	1000	461	450	455.5	0
TSS	mg / L	50	36	34	35	0
pH	-	6-9	7.60	7:56	7:58	0
DO	mg /L	4	5.62	5.5	5.56	0
BOD	mg/L	3	3	2.35	2.68	-2
COD	mg/L	25	10.56	9.69	10.13	0
Focal Coliform	amount/100 ml	1000	65	40	52.5	0
Total Coliform	amount/100 ml	5000	1650	1400	1525	0
Quantity						- 2 The

The quality standard used refers to the class II water quality criteria in Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management. The results of the STORET calculation at the 3 sampling locations are presented in the following table.

Table 10 Results of Calculation of Water Quality Status in Boentuka Sub-watershed based on the STORET Method

Sampling Location	Value for	Criteria
Upstream Station	-8	Light Polluted
Central Station	-10	Lightly Polluted
Downstream Station	-2	Lightly Polluted

The results of calculating water quality status in Boentuka Sub-watershed using the STORET method indicate water quality in the Boentuka Sub-watershed from upstream to downstream; it is categorized as lightly polluted.

The STORET value from upstream to midstream tends to increase even though at some sampling points it fluctuates. This shows that the condition of river water quality in the Boentuka Sub-watershed area is closely related to the activities of the community around the river disposing of waste. At the upstream and middle stations, the STORET value is greater than the STORET value at the downstream station; this may be due to the fact that the river's ability to recover itself from water pollution sources in the downstream area is not significant compared to the upstream and middle areas. The organic matter content in the upstream area has decreased, as indicated by the decreased BOD levels when compared to the sampling location at the downstream station, which is the downstream area of the Boentuka Sub-watershed.

The results of this study can be concluded for the value of the STORET method in the Boentuka Sub-watershed with mildly polluted conditions, while for the Palangan Reservoir with good conditions and for Dendeng River itself with moderately polluted conditions. Therefore, the management of water resources (SDA) in the Boentuka Sub-watershed needs synergy between the government and the community to rehabilitate the condition of the Boentuka Sub-watershed so that the level of pollution in the river remains in good condition.

4.3 Factors Causing River Water Pollution in the Boentuka Sub-watershed

From the author's observations at the research site, the cause of pollution in river water in the Boentuka Sub-watershed is the existence of community activities that use land in the river area so that the area is polluted due to the use of inorganic fertilizers. . The excessive and uncontrolled use of fertilizers is one of the factors that cause a decrease in the quality of river water in the Boentuka Sub-watershed area.

1. Characteristics of Land Use and Pollution in the Boentuka Sub-Watershed Bentuk

a. Area, Sub-Watershed Upstream Station Area.

The upstream station areas are located in the Villages of Health, Biloto, and Benluta. The coordinates are 9°54'12.93' South Latitude and 124°12'21.43' East Longitude. There are 3,920 residents in this area, with a total of 616 households (KK). The number of cattle and pig farmers in this location is 37 farmers with a total of 800 - 4200 livestock (BPS TTS, 2021). Meanwhile, the land use in the Boentuka Sub-watershed until 2021 is divided into plantation forests, settlements, plantations, dryland agriculture, rice fields and ponds. Identification of land use types in the upstream area of the Boentuka Sub-watershed is carried out by interpreting satellite imagery and checking conditions on the ground, the last of which was in 2019 (BPDAS NTT, 2021).

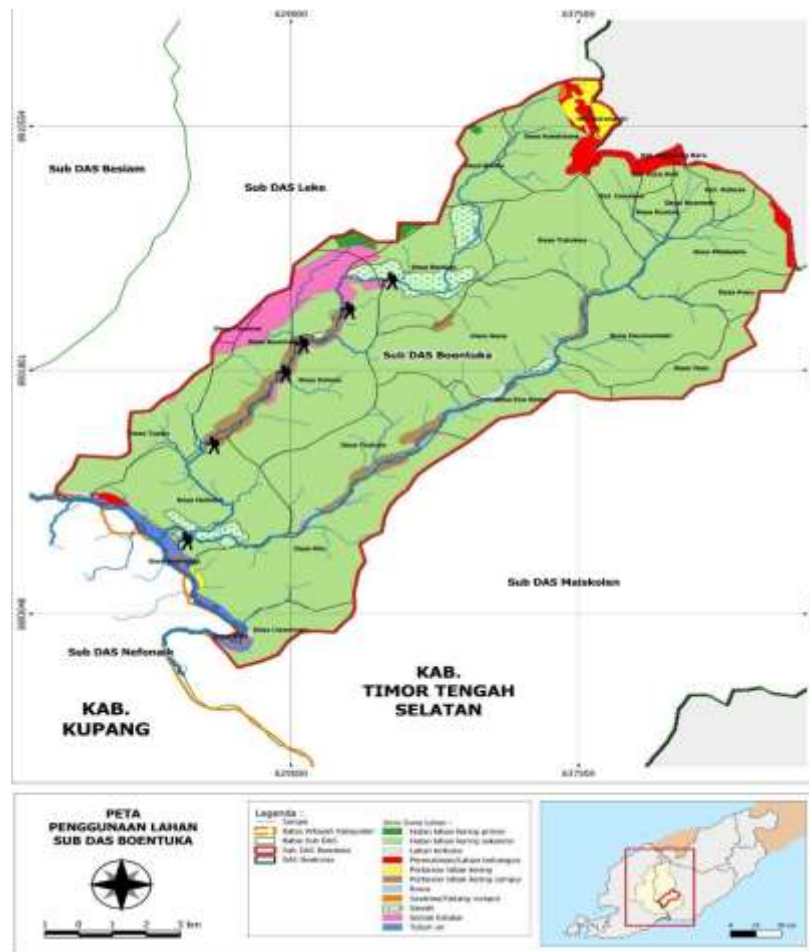


Figure 11 Land Use Map of Boentuka Sub-watershed.

Characteristics of pollutant sources in this area are residential activities, cattle and pig farming, and community bathing and washing activities. Pollution is caused by the use of the Boentuka river as a place to wash and dispose of solid waste such as plastic and garbage, and this is indicated by the change in colour of the river water and the accumulation of garbage carried by river water along the watershed (DAS).

b. Boentuka Sub-watershed Central Station Area.

The central station area is located on the rivers of Biloto and Boentuka Villages. Point II has coordinates 9°55'28.04"S South Latitude and 124°10'46.73"E East Longitude. The total population in this area is recorded as 3,512 residents, with a total of 551 households. The number of pigs dominates in this area, with a total of 600 - 3000 heads (BPS TTS, 2021).

The characteristics of the pollutant sources in this area are the residential activities of the people who live in this area, having pig farms, cattle breeding, and community bathing and washing activities. Pollution is caused by the use of the Boentuka river as a place to wash, as a place to drink water for livestock and dispose of garbage, this is marked by a change in colour, changes in high temperature in the watershed, besides that along the river there is garbage carried by the water.

c. Downstream Station Boentuka Sub-watershed Bentuk

Area in The downstream area of Sub-watershed is dominated by agricultural activities such as paddy fields, dry land, savanna/grasslands and residential areas, household-scale livestock and various activities/businesses to support the living needs of the surrounding community. The highest population is located in So'e City District, Batu Putih District, South Amanuban District, and West Amanuban District. The increase in population is followed by the conversion of land used as a place for community settlements (BPDAS NTT, 2021).

The characteristics of pollutant sources in this area are domestic waste from residential areas, livestock and agricultural activities. Pollution is caused by the use of rivers as disposal of liquid waste, organic and inorganic waste; this is characterized by high-temperature changes and changes in watercolour and the accumulation of garbage both in river flows and river banks.

4.4 Water Pollution Control Strategy in the Boentuka Sub-watershed Area

Water pollution control efforts are one of the efforts to implement environmental protection and management from the aspect of control in accordance with Law Number 32 of 2009 concerning Environmental Protection and Management. Control of pollution and/or environmental damage is carried out in the context of preserving environmental functions to ensure safety, health and human life, guarantee the survival of living creatures and ecosystem conservation, ensure the fulfilment of justice for present and future generations, and guarantee the fulfilment and protection of the right to the environment—life as part of human rights. The strategy for controlling water pollution is an effort made in the context of preventing and overcoming the occurrence of water pollution and restoring water quality according to its natural conditions so that the quality of river water is maintained according to its designation.

Based on the results of field observations, the results of river water quality testing, interviews, and literature studies, a description of the aspects of river water pollution control indicators in the Boentuka Sub-watershed is made as presented in the following:

table table 11 Analysis of River Water Pollution Control Efforts in the Boentuka Sub-watershed

No	Aspects of River Water Pollution Control Efforts	Indicator
1	River conditions in the Boentuka sub-watershed	<p>In general, the quality of river water in the Boentuka sub-watershed does not meet the quality standards based on class II criteria, but several parameters such as BOD, COD, DO, TSS, fecal coliform and total coliform have exceeded water quality standards.</p> <ul style="list-style-type: none"> ✓ The status of river water quality in the Boentuka Sub-watershed area is slight to moderately polluted. ✓ At a certain point during the dry season, the capacity of the river in the Boentuka Sub-watershed for parameters BOD COD has exceeded the water quality standard. ✓ In the upstream area, it is influenced by domestic activities, and there are parameters that have exceeded the class II water quality standard
2	Role of the Government	<ul style="list-style-type: none"> ✓ There are regulations regarding quality standards and permits for waste disposal, ✓ There are efforts to monitor domestic and agricultural, activities There are river water quality monitoring activities, although not periodically, ✓ The existence of a complaint center for pollution cases at environmental agencies,

		<ul style="list-style-type: none"> ✓ Coordination between agencies in controlling river water pollution is still lacking, ✓ Information and supporting data relating to rivers in the Boentuka Sub-watershed area and pollution control are still incomplete, ✓ The granting of industrial permits is based on the RTRW but not based on the capacity and carrying capacity of river water.
3	The role of the community	<ul style="list-style-type: none"> ✓ There is a forum for environmental care at the local district and district level. ✓ People still throw garbage at the Boentuka river border.

From the description above, a SWOT analysis is then carried out on each indicator as presented in the table below:

Table 12 SWOT analysis for River Water Pollution Control in the area Boentuka Sub-watershed

No	Strength – Strength (S)	Weight	Value	Total
1	There is conservation in the water catchment area/upstream in the Boentuka Sub-watershed.	0.33	2	0.66
2	Utilization of the river for crop irrigation so that the quality standard requirements are more open	0.33	2	0.66
3	Existence of IPAL for domestic waste treatment	0.33	2	0.66
4	Government agencies overseeing the management of river water quality in the Boentuka sub-watershed governing river	0.33	2	0.66
5	River water quality is in classes I and II	0.33	2	0.66
6	Laws Water quality	0.33	2	0.66
		1.98	12	3.96
Weaknesses – Weakness (W)		Weight	Value	Total
1	Water quality has met the criteria for freshwater river class I	0.25	3	0.75
2	In the upstream area, before being influenced by domestic activities, there are several parameters that exceed the water quality standard class I	0.17	2	0.22
3	In the dry season, the river's capacity for BOD parameters has exceeded the water quality standard	0.17	2	0.22
4	Quality status water has been lightly polluted	0.17	2	0.22
5	number of monitoring points for water quality is only two but The not periodically	0.25	3	0.75
		1.00	12	2.49
Opportunity – Opportunity (O)		Weight	Value	Total
1	There is a regulation on water quality standards	0.27	3	0.82
2	There is a participation forum for the community through environmental care forums and pollution complaint centres at the BLHD NTT Province	0.18	2	0.36
3	The existence of a program for monitoring and monitoring domestic and agricultural activities by the BLHD	0.18	2	0.82
4	There is a need for non-government parties to participate in managing river water quality, both from the business world, academics and society itself.	0.27	3	0.82
		0.86	10	2.82
Threat – Threat (T)		Weight	Value	Total
1	Incomplete database regarding pollution sources and river profile	0.20	2	0.40
2	In certain locations, there are still people who throw garbage in river bodies in Boentuka Sub-watershed	0.20	2	0.40

3	Lack of coordination between stakeholders	0.20	2	0.40
4	Institutions are currently not optimal in managing rivers in the Boentuka sub-watershed	0.20	2	0.40
		0.80	8	1.80

Based on the above analysis results, obtained $S < W$ and $O > T$ (quadrant III). This shows that the policy for controlling river water pollution in the Boentuka Sub-watershed is carried out by taking advantage of the existing opportunities (O) to overcome the weaknesses (W) in controlling river water pollution in the Boentuka Sub-watershed.

To determine the water pollution control policy strategy, the SWOT matrix is used as shown in the following table:

Table 13 SWOT Matrix for Water Pollution Control in the Boentuka Sub-watershed

	Strength – Strength (S)	Weakness – Weakness (W)
Internal	<p>There is conservation in the catchment area/ upstream in the Boentuka Sub-watershed.</p>	<p>Water quality does not meet the water quality criteria for class I In the upstream area, there is no domestic activity, but the BOD parameter has exceeded the class II water quality standard In the dry season, the river's capacity for the BOD parameter has exceeded the water quality standard with river water quality status lightly to moderately polluted. The number of monitoring points the water was only two and not periodically</p>
Factors External Factors		
Opportunity - Opportunity (O)	<p>Existence of regulations on water quality standards The existence of forums for environmental care organizations in sub-districts and districts and a water pollution complaint center at the BLH and BWS agencies the participation of the community in protecting the river Monitoring and monitoring program activities for the existence of the NTT BLHD</p> <p>Increasing community participation through environmental care forums and water pollution control activities Increasing conservation efforts from upstream and along the river so that water can be well maintained There is a</p>	<p>need for a study on determining river water classes and river water capacity in Sub-watersheds Boentuka Increasing the frequency of internal monitoring activities from domestic activities, etc., It is necessary to increase the number of monitoring points and the frequency of monitoring river water quality. There are law enforcement sanctions in environmental management.</p>
Threats (T)	<p>At certain locations, there are people who still throw garbage at river borders. Incomplete database regarding sources of pollution and river profile data Lack of coordination between stakeholders</p> <p>Formation of a coordination team for water pollution control policies from upstream to downstream involving <i>stakeholders</i> related to socialization of laws and regulations on water pollution control and waste management to stakeholders</p>	<p>Implementation of activities in river areas their <i>master plan</i> for the management and control of water pollution of the river in the subzone Boentuka</p>

From the analysis of the strategy (S - T), there are several strategies that support efforts to control pollution of the river water in Subwatershed Boentuka, namely:

1. Need for a technical study on the determination of the class of river water and power to accommodate the burden of river water pollution as the basis for river pollution control policies.
2. Studies on pollution load and water capacity can be used to regulate policies for granting location permits for an industry or other business activity, management of water and water sources, determination of spatial plans, issuance of permits for wastewater disposal, and determination of water quality standards with the aim of controlling pollution. River water.
3. Increasing the frequency of supervision and monitoring activities on settlement activities, agriculture, and other activities that increase river water pollution.

5. Conclusion

Based on the results of the analysis and discussion of water pollution and its control strategy in the Boentuka Sub-watershed, South Central Timor Regency, East Nusa Tenggara Province; The author can draw several conclusions as follows:

- a. The quality of river water in the Boentuka Sub-watershed area, in general, has decreased in quality, which is based on an analysis of the level of water pollution using the Pollution Index (IP) method for the upstream station being lightly polluted while the middle and downstream stations are good. Meanwhile, for the STORET method at stations upstream to downstream, the results are Light Polluted.
- b. The status of moderate water pollution that occurs in the Boentuka Sub-watershed area is specifically shown in the results of the analysis of water samples in the laboratory, which indicate that chemical parameters (BOD and COD) and biological parameters (fecal coliform and total coliform) have exceeded the Class III River Water Quality Standard according to the provisions of Government Regulation of the Republic of Indonesia Number 22 of 2021 concerning Implementation of Environmental Protection and Management (Appendix VI Roman Class 3).
- c. There are 3 (three) main factors that cause river water pollution in the Boentuka Sub-watershed from upstream to downstream stations, namely (a) domestic activities that dispose of solid or liquid waste into streams and riverbanks, (b) agricultural activities with the increasing use of inorganic fertilizers, and (c) livestock activities that contribute to the disposal of waste in the form of livestock manure into rivers. Have an influence on the decline in water quality in the Sub D . area AS Boentuka.
- d. The results of the SWOT analysis state that the strategic recommendations that need to be made to control the level of water pollution in the Boentuka Sub-watershed area are (a) the need for a technical study on the determination of river water classes and the carrying capacity of river water pollution loads as the basis for river pollution control policies; and (b) Increasing the frequency of supervision and monitoring activities by the relevant agencies on settlement activities, agriculture and or other activities that contribute to increasing river water pollution.

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