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Microbial Processing of Industrial Waste Made from Coconut for Sustainable Pangandaran Tourism

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Abstract

Pangandaran is one of the tourist destinations in West Java province. Therefore the development of the industry must pay attention to the environment for Pangandaran tourism to be sustainable. This study aims to analyze the influence of local microorganisms to treat coconut-based industrial waste so that the waste is not harmful to tourists who carry out activities in rivers and beaches. The method used is to conduct experiments by adding local microorganisms to the waste and then testing it in a credible laboratory. Based on laboratory test analysis of 4 samples, the results of 3 samples showed a decrease in COD and BOD levels based on coconut waste quality standards and were suitable for disposal into water bodies (rivers or beaches). The conclusion is that the use of local microorganisms has proven to be effective in treating industrial waste in Pangandaran.

Keywords: coconut industry waste; local microorganisms; Pangandaran tourism

Introduction

Pangandaran Regency is the expansion area of Ciamis Regency which is a leading tourist area in West Java. Pangandaran and its surroundings are prepared to be developed as a national and international tourist destination. This beach is still a favorite of local tourists with a figure reaching 3.9 million tourists at the end of 2018 (Viani, D; 2018). As a leading tourist destination in West Java, various facilities were also built to support the convenience of visitors, such as lodging, hotels, restaurants and others. Another potential of Pangandaran Regency is coconut plantations which are the third largest in the province of West Java. The potential of the coconut plantation can be developed into an agro-industry that is synergized with the tourism industry in Pangandaran.

The head-based food and beverage industry have great potential to improve the welfare of the people in Pangandaran. The industry is synergized with tourism which is the mainstay of this district's income. Coconuts can be used as food, drinks and crafts that can become typical souvenirs from Pangandaran. Coconut plants are multipurpose plants that almost all parts can be used by humans starting from the roots, stems, leaves and coconut fruit. The root of the head can

be used as decoration, the stem can be used for buildings, coconut leaves for the roof and the leaves for decoration, the fruit can be processed for food and drinks, coconut shells for charcoal and household appliances and coconut husks can be used as met and also a planting medium (cocopeat).

According to the Central Statistics Agency of West Java Province (2017), coconut plantations in Pangandaran Regency are people's plantations owned by 65,291 heads of families. Most of the people's coconut plantations are located in the coastal area of Pangandaran Regency. Various products can be produced from coconut plants in both small, medium and large industrial scales. These industries include copra, coconut oil, oleochemicals, grated coconut, coconut sugar, and industrial by-products such as cake, shell, coir, and nata de coco (Amin and Prabandano, 2014).

The coconut processing process carried out by small, medium and large industries will certainly produce waste. Waste generated from those generated from the coconut-based food and beverage industry must be handled properly and friendly to the environment. Recently, there were complaints from the people of Cikangkung Hamlet, Cikambulan Village, Sidamulih District, Pangandaran Regency that the company that produces nata de coco is suspected of having polluted the Citonjong River. Some people rely heavily on livelihoods from the river such as looking for fish and shrimp. Environmental conditions that are clean and not polluted by waste from industry must be considered not to disturb the comfort of tourists visiting Pangandaran.

Based on this, the purpose of this study is to identify the existence of the food and beverage industry made from coconut, analyze the waste treatment that has been carried out so far and analyze qualitatively the processing of industrial waste made from coconut using local microorganisms to support sustainable tourism in Pangandaran.

Research Method

The research method used is descriptive analysis, namely how to analyze, describe and explain the data that has been collected as it is without intending to make conclusions that apply to the public or generalizations (Sugiyono 2016). Descriptive analysis in this study is used to describe how the industrial waste management that developed in Pangandaran does not pollute the tourist area, in this case the rivers and beaches which are Pangandaran's tourist attractions. While the experimental method was carried out to analyze the effectiveness of using local microorganisms to treat coconut industrial waste before the waste was discharged into the river. The experimental method was carried out by taking samples of wastewater from a wastewater treatment plant at a large category coconut processing plant in Sidamulih District. Then laboratory tests were carried out on the waste samples before and after getting treatment with the addition of local microorganisms.

The results of the laboratory tests are then compared with the quality standards of coconut industrial waste based on the Regulation of the Minister of Environment Number 5 of 2014. Based on the results of this comparison, conclusions are drawn about the effect of using local microorganisms to treat industrial waste made from coconut in Pangandaran. If the existence of industries that dispose of their waste into rivers that empties into the beach must be below the threshold of the quality standard of wastewater to ensure environmental conditions, especially rivers and beaches are not polluted by industrial waste, so that it can support sustainable Pangandaran tourism.

Results and Discussion

Industrial Development and Sustainable Tourism Areas in Pangandaran

Sustainable development is the development that carries a balance between economic, social and environmental dimensions (Fauzi, A., & Oxtavianus, A., 2014: 42-52). Based on this, the industrial development around the Pangandaran tourist area must be built with an environmentally sound industrial concept. Waste generated from industrial processes should not pollute and damage the environment because this will harm the tourism sector. Pangandaran Tourism Area with the main attraction in the form of beaches and rivers, of course, must be maintained not to be polluted by industrial waste in the area. Moreover, the Pangandaran tourist area has received the Sustainable Tourism Observatory (STO) certification and has become a mainstay of tourism in West Java Province. As an area that has received an award as an area that has been certified by the STO "Sustainable Tourism Observatory", Pangandaran Regency has become a reference for sustainable tourism observations. Based on this, the development of other industrial sectors must be based on the principle of sustainability.

Industrial development around the Pangandaran tourist area must of course be in accordance with Law Number 32 of 2009 concerning Environmental Protection and Management. Based on Article 68 of the law, it is stated that every person who carries out a business and/or activity is obliged to: (a) provide information related to environmental protection and management in a correct, accurate, open and timely manner; (b) maintaining the sustainability of environmental

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functions; and (c) comply with the provisions on environmental quality standards and/or standard criteria for environmental damage. Based on the article, all forms of industry located in a place must pay attention to their impact on the environment. The law also regulates sanctions on anyone who commits any form of pollution to the environment.

Furthermore, based on the Law of the Republic of Indonesia Number 10 of 2009 concerning Tourism, it has been stated that everyone is obliged to maintain and preserve tourist attractions. In addition, everyone is also obliged to participate in helping to create a safe, orderly, clean atmosphere, behave politely, and preserve the environment of tourism destinations. Based on the results of research from Abdillah, F., Damanik, J., Fandeli, C., & Sudarmadji, S. (2015: 339-350) it was stated that local communities in Pangandaran have realized that the environment is very important for the sustainability of fisheries and fisheries tourism, because both are representations of the main work of the community. They are aware that littering causes slums and maintaining good environmental conditions will cause tourists to want to come back one day.

Then in another case regarding the importance of protecting the environment from garbage or waste to support the tourism sector, especially beach tourism, is based on the results of research from Wildan, W., Sukardi, S., & Syuaeb, M. Z. (2016: 214-222) where complaints from tourists regarding the cleanliness of the beach in the tourist area of Sekotong, West Lombok. The conclusion is that the condition of a tourist attraction that is kept clean from waste or garbage supports sustainable tourism.

Pangandaran Regency has a relatively complete tourist attraction, both containing historical value and natural wealth of flora and fauna. Another potential of Pangandaran Regency is in the agricultural, fishery, livestock and forestry sectors. To support the tourism sector and based on the potential of natural resources, the industrial sector began to be developed. Based on data from the Central Statistics Agency in the report "Pangandaran Regency in Figures 2019", small industries dominate. The following is Table 1. regarding data on the number of small industries and their absorption of labor.

Table 1
Number of Small Industries and Manpower by Type of Industry in Pangandaran Regency

No	Industry Type	Business unit	Labor
1	Food industry	3958	8585
2	Textile industry	271	1144
3	Wood Goods Industry	341	1670
4	Paper Industry	-	-
5	Chemical Industry	-	-
6	Minerals Industry	8	25
7	Base Metal Industry	-	-
8	Transport Equipment/Machinery Industry	-	-
9	Other Goods Industry	234	925
Pangandaran Regency		4812	12349

Source: Pangandaran Regency in 2019 Figures

Based on Table 1., Pangandaran has 4,812 business units that absorb 12,349 workers. The food industry is the most dominating small industry compared to other small industries such as the textile industry, the wood goods industry and the basic metal industry which only has less than 37 business units with a workforce of fewer than 200 people. Meanwhile, for the food industry, there are 4,105 business units with a total workforce of 8,181 people.

Then the following is Table 2 which shows the distribution of small industries in Pangandaran Regency.

Table 2
Distribution of Small Industries Every District in Pangandaran Regency

No	Districts	Food industry		Textile industry		Wood Goods Industry	
		Business unit	Labor	Business unit	Labor	Business unit	Labor
1	Cimerak	983	1999	-	-	16	77
2	Cijulang	226	463	21	42	28	112
3	Cigugur	462	977	16	65	17	75
4	Langkaplancar	457	873	3	15	112	442
5	Parigi	260	434	2	9	8	24
6	Sidamulih	109	109	11	30	37	142
7	Pangandaran	211	577	47	188	27	86
8	Kalipucang	239	571	4	8	39	453
9	Padaherang	826	1411	114	463	43	204
10	Mangunjaya	332	634	53	324	14	14
	Total	4105	8181	271	1144	341	1629

Source: Pangandaran Regency in 2019 Figures

Based on Table 2, it can be concluded that the distribution of small industries in Pangandaran Regency is almost evenly distributed in every sub-district. Then it can be seen that only in Cimekar District there is no textile industry.

Based on data obtained from the Department of Manpower, Industry and Transmigration, Pangandaran Regency, it is known that there are two categories of coconut-based agro-industry, namely coconut sugar and non-coconut sugar. Coconut sugar agroindustry is spread in all sub-districts, with the largest number in Cimerak District. While the non-sugar coconut agroindustry is not too much, there are only four sub-districts that dominate the non-coconut sugar-based coconut agroindustry, namely Parigi District, Padaherang District, Cimerak District and Sidamulih District (Department of Industrial Manpower and Transmigration Pangandaran Regency, 2017).

Then for the development and arrangement of industry in Pangandaran Regency, the Pangandaran Regency Regional Regulation No. 3 of 2018 concerning the Regional Spatial Plan of Pangandaran Regency for 2018-2038. Based on the regulation, the allocation for medium and small industries is in all sub-districts. While the designation of large industries with an area of approximately 565 hectares is located in Cimerak District.

Coconut Raw Industrial Waste Treatment in Pangandaran

The waste generated from coconut processing is in the form of coconut coir. Coconut husk is the outermost part of the coconut that wraps around the coconut shell. In general, this waste is considered to have no economic value. In general, the results of observations in the field of waste in the form of coir and shells are only used as a substitute for firewood. Whereas coconut coir if processed with simple technology will increase the income of the farming community.

According to Palungkun (2004), the composition of coconut fruit consists of at least 25-32% coir, 12-13.1% shell, 28-34.9% coconut meat, and 19.2-25% water. Coconut coir has a thickness of 5-6 cm and consists of an outer layer and an inner layer. Its chemical composition includes cellulose, lignin, pyroligneous acid, gas, charcoal, tar, tannin, and potassium. Then previously, according to a report submitted by Rumokoi (1990) it was stated that coir was the largest weight component (38-44%) of coconut fruit, compared to other components such as shell (21-28%) and coconut water (29-35%).

Based on observations, the coconut coir processing business in the medium industry category was initiated in Parigi District where the Coconut Partners Producer Cooperative (KPMK) processes coconut coir waste into two superior products, namely cocopeat and cocofiber. Cocopeat is commonly used as a growing medium for organic plants and cocofiber (coconut tapas fiber) is used for the automotive industry, such as car seat cushions, lading belts, dampers, compressor replacements, to the manufacture of mattresses, ropes, mattresses and sofas. This cooperative business was started in 2016 and within 3-4 years this cooperative managed to penetrate the export market to China and Japan, with increasing demand.

Then if it is associated with Pangandaran as a leading tourist area of West Java, the presence of coconut waste can be a creative product for tourist souvenirs. Utilization of coconut waste as souvenirs will reduce environmental pollution which is in line with the concept of zero waste agroindustry. According to Zaman and Lehmann (2011) the concept of zero waste includes the

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utilization of all resources from waste materials and aims to recycle 100% of solid waste generated from a system.

For the sample of the coconut processing industry in the large industrial category, based on information from the Department of Industrial Manpower and Transmigration, Pangandaran Regency is located in Sidamulih Pangandaran District. This company produces 4 types of products, namely Coconut Water (Cocoday) is natural coconut water, Coconut Cream (Klatu) is liquid coconut milk, Coconut Cream Powder (Klatu) is coconut milk in the form of flour, and Desiccated Coconut is dried grated coconut meat. This factory already has a wastewater treatment plant (WWTP) to treat the waste generated from the production process.

Industrial waste is all types of waste materials or waste materials originating from by-products of an industrial process. The Industrial waste can be very dangerous waste for the environment and humans (Palar, 2004). Furthermore, according to Chandra (2006), industrial waste is liquid waste that can come from factories which usually use a lot of water in the production process. In addition, liquid waste can also come from raw materials that contain water so that in the processing process, the water must be disposed of.

The wastewater treatment process is generally divided into four groups, namely (Soeparman and Soeparmin, 2002), namely: Pre-treatment is used to separate coarse solids, reduce solids size, separate fat/oil, and equalize fluctuating flow of waste in the reservoir. Then the first stage of processing aims to reduce the content of suspended solids through a sedimentation process. In the deposition process, solid particles are allowed to settle to the bottom of the tank. Chemicals are usually added to neutralize and increase the ability to reduce suspended solids. BOD can reach 35% while TSS is reduced to 60%. The reduction of BOD and solids at this initial stage will further reduce the burden of processing the second stage.

The second stage of processing, namely in the form of a biological process that aims to reduce organic substances through biological oxidation mechanisms. The selected biological process is based on consideration of the quantity of liquid waste entering the processing unit, the ability to reduce the organic matter present in the waste (biodegradability of wastes), and the availability of land. In this unit, it is estimated that there will be a reduction in BOD content in the range of 35-95% depending on the capacity of the processing unit. The second stage of treatment using high rate treatment is able to reduce BOD with efficiency ranging from 50-85%. The units commonly used in the second stage of treatment are trickling filters, activated sludge units, and stabilization ponds.

Furthermore, in the third stage of processing, the stages are to remove certain contaminants or prepare the liquid waste for reuse. Processing at this stage is more functioned as an effort to improve the quality of liquid waste from the second stage of treatment so that it can be discharged into receiving water bodies and reuse the effluent.

Based on the research findings, the wastewater treatment plant (WWTP) at the coconut processing plant in Sidamulih Pangandaran District, in general is (1) the process of deposition of solids and separation of fat/oil and equalization of wastewater fluctuations, (2) the process of further sedimentation and addition of coagulant material, (3) aeration process, (4) clear waste ready to be discharged into water bodies. After being processed at the wastewater treatment plant (WWTP), the condition of the wastewater is clear and ready to be discharged into water bodies or reused. The coconut processing factory in Sidamulih District is located on the edge of the Citonjong river estuary. The condition of river water in the estuary is strongly influenced by the tidal conditions of seawater.

Effectiveness of Local Microorganisms to Treat Industrial Waste to Support Sustainable Pangandaran Tourism.

Based on the survey results, there is one large coconut processing factory in Sidamulih District, Pangandaran Regency which is at the mouth of the Citonjong River. This factory already has a wastewater treatment plant as required by applicable regulations. This study was conducted to see how local microorganisms (MOL) are able to treat waste so that it complies with the quality standards of wastewater based on the Regulation of the Minister of the Environment of the Republic of Indonesia Number 5 of 2014.

The use of microorganisms in wastewater treatment plants (WWTP) has been widely studied and has become an integrated part of the WWTP system. As done by Muhimmatin, I. (2019: 106-115) processing batik liquid waste using indigenous microorganisms with the activated sludge method, there was a decrease in both pH (to 7), DO (7.6 mg/L), and color. waste that was

originally pitch black becomes brighter in color. Then the research conducted by Veronika, N., Dhora, A., & Wahyuni, S. (2019:154-161) who succeeded in processing palm oil trunk waste by using local microorganism decomposers (MOL) from banana weevil into compost according to standards. Minister of Agriculture Regulation No. 70 in 2011.

Other research regarding the use of microbes for waste treatment was carried out by Lopes, M., et al (2020) using microbes to decompose cooking oil waste into other industrial raw materials. Then research from Kale, S. K., et al (2015) and Taghavi, N., et al (2021) used microbes to reduce plastic waste. Next is research from Febrianti, F., et al (2017) which uses microbes to treat tofu waste to produce bioethanol and Pant,D et al (2010) microbes for sustainable fuel. Hassen, A et al (2001), Colombo, B., et al (2017) and Sarkar, P., & Chourasia, R. (2017) treatment of municipal organic waste with microbes. Then the research of Cohen, R.R. (2006) who used microbes to reduce industrial mining waste. Another study in the mining industry by Kalin, M., et al (2005) and Pedersen, K. (2000) used microbes to reduce uranium waste or radioactive waste disposal.

Traditionally, microorganisms are used in the secondary treatment stage to remove organic matter. Microbes used in aeration tanks or lagoons will be able to remove organic matter in wastewater more quickly, which usually takes months to completely decompose waste. The addition of bacteria at the initial stage (primary treatment) can help decompose solid waste at the bottom and on the surface of the wastewater, thereby reducing sludge production.

Bacteria assist in the process of treating and disposing of sludge by decomposing organic matter and reducing sludge volume, while reducing the smell of sludge. Not surprisingly, many WWTPs use bacteria. In addition to the benefits in the form of increased capacity, increased efficiency and reduced operational costs. Bacterial supplementation also keeps the sewage treatment process as natural as possible, which is the ultimate goal of the WWTP itself. So that the existence of the industry does not pollute the rivers and beaches which are tourist attractions in Pangandaran.

The existence of the coconut processing industry in Pangandaran must of course pay attention to the waste disposal that is safe for the environment. Coconut processing industrial waste before being discharged into waterways or rivers must first meet the level of wastewater quality standards according to applicable regulations, namely the Regulation of the Minister of the Environment of the Republic of Indonesia Number 5 of 2014 concerning Wastewater Quality Standards. Based on the definition of the Permen LH, what is meant by the quality standard of wastewater is the limit size or level of pollutant elements and/or the acceptable amount of pollutant elements in wastewater that will be discharged or released into the water medium from a business or activity.

The quality standards for wastewater for each industry are of course different for each parameter and its requirements. With regard to the potential for the coconut industry in Pangandaran Regency, the following is a table for the quality standards for industrial or coconut processing business activities based on Minister of Environment Regulation No. 5 of 2014.

Table 3
Wastewater Quality Standards for Coconut Processing Businesses or Activities

Parameter	Highest Rate (mg/L)	Highest Pollution Load (kg/Ton)
BOD	75	1,1
COD	150	2,2
TSS	100	1,5
Fat Oil	15	0,2
pH	6-9	
Highest Wastewater Quantity	15 M^3	

Source: Minister of Environment Regulation No. 5 of 2014

The experiment was carried out by researchers by adding local microorganisms to liquid waste at a coconut processing plant in Sidamulih District, Pangandaran Regency. Local microorganisms (MOL) are microorganisms derived from local raw materials such as leaves, spices, whole milk, water and other biological materials. The manufacturing process is by fermentation for one to two weeks to produce MOL liquid. Based on the results of laboratory tests of PT. Biopharma in MOL fluid contained aerobic bacteria consisting of: Pseudomonas putida, Bacillus cereus and Bacillus badius, and anaerobic bacteria, namely Clostridium clostrioforme and Eggethia catenaformis (Report on the Implementation of UKL-UPL PT. UPBS, 2018). Based on the research of Kastolani, W., Setiawan, I., & Paramida, I. (2019, March) local microorganisms are able to process organic waste quickly, without causing odor and heat. Another research is from Elella, M. H. A et al, (2021) which uses

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modified bacteria to treat liquid waste. It is also supported by research from Nguyen, H. T., Kakarla, R., & Min, B. (2017) regarding microbes for leachate removal power plants in liquid waste. Next is the research of Chaturvedi, V., & Verma, P. (2016) about microbial fuel cells and Cecconet, D., et al (2018) and Jatoi, A. S., et al (2021). which uses microbial fuel cells for wastewater treatment.

The procedure for testing samples from coconut processing factory waste in Sidamulih is carried out in the following stages: (1) taking waste samples (2) checking waste in the laboratory, (3) adding waste samples with MOL, (4) checking waste that has been added MOL, (5) results and conclusions. The samples taken were then treated by adding local microorganisms (MOL) which were then checked in a credible laboratory. Laboratory trials carried out by PT. Sucofindo conducted from 20-27 August 2021. The following are the results of laboratory samples after receiving treatment (mixed with local microorganisms/MOL) with the comparison being the wastewater quality standard based on the Minister of Environment Regulation No. 5 of 2014.

Table 4
Test Results of Samples Before Mixing MOL

Parameter	Highest Rate (mg/L) Permen LH	Laboratory Results (sample mixed MOL)			
		A1	B1	C1	D1
BOD	75	303	554	42,30	10,95
COD	150	757,9	1845	140,9	36,51
TSS	100	96	1760	158	3
Fat Oil	15	< 2	10	< 2	< 2
pH	6-9	6,53	4,28	2,75	8,46
Highest Wastewater Quantity		15 M^3			

Source: Lab. PT. Sucofindo, 2021

Table 5
Sample Test Results After Mixing MOL

Parameter	Highest Rate (mg/L) Permen LH	Laboratory Results (sample mixed MOL)			
		A2	B2	C2	D2
BOD	75	63,76	805,6	43,47	9,05
COD	150	140,9	1738	103,2	20,63
TSS	100	124	1070	70	5
Fat Oil	15	< 2	8	< 2	< 2
pH	6-9	8,42	6,14	8,06	8,38
Highest Wastewater Quantity	15 M^3				

Source: Lab. PT. Sucofindo, 2021

Based on the laboratory results, it can be concluded in general that all samples A, B, C and D for Chemical Oxygen Demand (COD) have decreased even though there is still one sample (sample B2) which is above the waste quality standard according to the Minister of Environment Regulation No. 5 of 2014. Then the levels of Biological Oxygen Demand (BOD) decreased in samples A2 and D2 and increased in samples B2 and C2. For the levels of Total Suspended Solid (TSS) there was a decrease in samples B2 and C2 and an increase in samples A2 and D2. Then for indicators of pH and fatty oil levels before and after adding local microorganisms (MOL) there was no significant change and was still below the quality standard threshold set by Minister of Environment Regulation No. 5 of 2014.

Based on the findings of the laboratory results, samples of liquid waste from the coconut processing industry after being treated (plus local microorganisms) experienced good changes, especially for Chemical Oxygen Demand (COD) levels decreased even though there was still one sample (sample B2) which was above the limit. quality standards. Several more trials are needed to establish the number of local microorganism mixtures (MOL) with the conditions when the amount of waste is greatest (peak load). In general, the use of local microorganisms has been proven to be able to treat liquid waste from industries made from coconut in Pangandaran. This is certainly a guarantee that the Pangandaran Tourism Area is safe from pollution from coconut processing factories around the area.

Conclusions

Based on the results of the study, it can be concluded that in Pangandaran Regency there are 4,812 business units that absorb a workforce of 12,349 people. The food industry is the largest small industry with 4,105 business units with a total workforce of 8,181 people. In small and medium industries that process coconut, the results of observations in the field of waste in the form of coir and shells are only used as a substitute for firewood. Whereas coconut coir if processed with simple technology will increase people's income. Then based on the trial of the use of local microorganisms (MOL) for coconut processing factory waste in Sidamulih qualitatively it can be concluded that local microorganisms based on the laboratory results of PT. Sucofindo showed a positive effect, where in all samples the COD indicator decreased. As for other indicators in accordance with the Ministry of Environment Regulation No. 5 of 2014 the results vary. The success of the sample trial in the laboratory was then carried out directly in the field by adding local microorganisms (MOL) to the wastewater treatment plant (WWTP). Based on the results of observations, it can be concluded that local microorganisms function very well when the production load is normal, namely when production is for 3 days, but when the peak load or when waste is continuously produced for 6 days, the microbial condition collapses. This is a note for researchers to suggest to parties in the field that when the peak load has doubled, the local microorganisms used should also be doubled so that their function is not reduced.

Then based on the results of the study in this study, the researchers gave suggestions that large industries developing in Pangandaran Regency must have a wastewater treatment plant (WWTP) that functions according to applicable regulations. Not only in industries that produce goods, but also in the field of tourism services such as hotels and restaurants. Liquid waste from hotels and restaurants that is dumped directly into waterways leading to the beach will certainly be harmful to the health of tourists visiting Pangandaran Beach.

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