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Risk level of domestic wastewater pollution in Kolaka regency: Natural break Jenks map model

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Abstract

Background: The clean water obtained by most of the people of Kolaka Regency comes from groundwater which is easily polluted and most of the feces storage facilities owned are plunge type, this type is not impermeable so that it allows soil contamination by feces, it can even reach the water source used. Daily. Likewise, the community-owned wastewater disposal system, in terms of construction, is still at risk of polluting the surrounding environment. Therefore the study aimed to determine the level of risk of household wastewater contaminating the surrounding environment.

Methods: This type of research is a quantitative research with a geographic information system approach. Data was collected by survey method using questionnaires and observation sheets. The sample in this study was 5,400.

Results: On the safety variable of the feces storage tank, 11 sub-districts are included in the very high risk category, namely Iwomendaa, Samaturu, Latambaga, Kolaka Wundulako, Baula Pomalaa, Tanggetada, Polinggona, Watubangga and Toari sub-districts, 1 sub-district is included in the high risk category, namely Wolo sub-district. as well as on the pollution variable due to the contents of the feces storage tank, but there are sub-districts experiencing risk changes in this variable, namely the Wolo sub-district is at very high risk while the Tanggetada sub-district is at high risk. In the variable of pollution due to the wastewater disposal system, the medium risk category is 3 sub-districts namely Wolo, Pomalaa, Polinggona, high risk 6 sub-districts namely Samaturu, Latambaga, Wundulako, Baula, Watubangga and Toari, very high risk 3 sub-districts namely Iwomendaa, Kolaka and Tanggetada sub-districts.

Conclusion: Kolaka District 91.67% of sub-districts have a high risk of pollution due to the safety of the feces collection tank and the contents of the feces collection tank, while the pollution caused by the wastewater disposal system is 50% including the high level of risk.

Keywords: Domestic Wastewater; Natural Break Jenks; Pollution; Risk level

1. Introduction

One of the serious waste problems in Indonesia is the problem of household waste. Some Indonesian people dispose of their waste in the surrounding environment, even the waste is disposed of into a drainage that is directly connected to the river. The rapid increase in population will have an impact on increasing the number of materials that pollute the environment [1].

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Kolaka Regency in 2021 has a population of 241,366 people. This amount will certainly increase the volume of household wastewater generated [2]. Household wastewater contains a lot of materials that can pollute the environment. In general, household wastewater comes from bathrooms, kitchens, used laundry, feces collection, and wastewater disposal systems that do not meet health requirements, mainly construction problems and downstream drainage, mostly in rivers and others.

Stool storage and household wastewater disposal systems allow pollution to the surrounding environment. The construction of the two facilities if they do not meet the requirements will have an impact on the environment. Construction that does not meet the requirements in accordance with the established standards allows pollutants to enter the soil or into clean water sources used by the community.

The habit of defecating in places that do not meet health requirements also allows pollution to the environment. Kolaka Regency of 135 villages, 54% have not stopped open defecation [3]. This situation will have an impact on environmental contamination originating from feces storage. Sanitation facilities that are very prone to contamination are water sources that come from ground water or springs, where the clean water obtained by most of the people of Kolaka Regency comes from these facilities. Most of the feces storage facilities owned by the people of Kolaka Regency are plunge type, this type is not impermeable so that it is possible to pollute the soil by feces, it can even reach water sources that are used daily. Likewise, the community-owned wastewater disposal system, in terms of construction, is still at risk of polluting the surrounding environment.

Based on the situation above, a research was conducted which aims to determine the level of risk of household wastewater polluting the surrounding environment, and display it in a risk map model of domestic wastewater pollution in Kolaka Regency.

2. Material and methods

This type of research is quantitative research with geographic information systems approach. Data was collected by survey method using questionnaires and observation sheets. The sample in this study was 5,400 respondents with residential observations as the object. Each village was represented by 40 respondents, so that a sample size of 12 sub-districts in Kolaka Regency was obtained. The number of respondents in each sub-district is different based on the number of villages. The sampling technique for each village is simple random sampling.

The variables included in the assessment are the safety of the fecal collection tank, pollution due to the contents of the feces collection tank, and pollution due to the waste water disposal system. This variable is taken from the environmental health risk assessment study (EHRA) variable [4].

The research was conducted in August 2021 in Kolaka Regency. Determining the level of risk using the natural break Jenks map model with 3 levels of risk, namely moderate risk, high risk, and very high risk. The application used in determining the risk level value in the natural break jenks model is the Quantum GIS version 3.26.0 [5].

3. Results

3.1. Stool Storage Tank Safety

Based on the table below, out of 4,500 respondents 5,300 (98.15%) have unsafe feces storage tanks (prone to contamination in the soil). Only a small proportion of 100 (1.85%) respondents have safe feces storage tanks.

Table 1 Distribution of Respondents on the Safety of Stool Storage Tanks in Kolaka Regency

Code	Sub District	Stool Storage Tank Safety					
		Not Safe		Safe		Total	
		n	%	n	%	n	%
010	Watubangga	557	99.46	3	0.54	560	100
011	Tanggetada	542	96.79	18	3.21	560	100
012	Toari	392	98.00	8	2.00	400	100
013	Polinggona	278	99.29	2	0.71	280	100
014	Pomalaa	472	98.33	8	1.67	480	100
015	Wundulako	440	100.00	0	0.00	440	100
016	Baula	386	96.50	14	3.50	400	100
017	Kolaka	280	100.00	0	0.00	280	100
018	Latambaga	279	99.64	1	0.36	280	100
019	Wolo	517	92.32	43	7.68	560	100
020	Samaturu	757	99.61	3	0.39	760	100
021	Iwomendaa	400	100.00	0	0.00	400	100
Total		5,300	98.15	100	1.85	5,400	100

3.2. Pollution Due to the Contents of the Stool Storage Tank

Table 2 Distribution of Respondents on Pollution Due to the Contents of the Stool Storage Tank in Kolaka Regency

Code	Sub District	Pollution Due to the Contents of the Stool Storage Tank					
		Not Safe		Safe		Total	
		n	%	n	%	n	%
010	Watubangga	556	99.29	4	0.71	560	100
011	Tanggetada	542	96.79	18	3.21	560	100
012	Toari	400	100.00	0	0.00	400	100
013	Polinggona	280	100.00	0	0.00	280	100
014	Pomalaa	480	100.00	0	0.00	480	100
015	Wundulako	440	100.00	0	0.00	440	100
016	Baula	399	99.75	1	0.25	400	100
017	Kolaka	280	100.00	0	0.00	280	100
018	Latambaga	280	100.00	0	0.00	280	100
019	Wolo	560	100.00	0	0.00	560	100
020	Samaturu	760	100.00	0	0.00	760	100
021	Iwomendaa	400	100.00	0	0.00	400	100
Total		5,377	99.57	23	0.43	5,400	100

Based on the table above, from 4,500 respondents 5,377 (99.57%) disposal of feces into the holding tank pollutes the surrounding environment. Only a small part of 23 (0.43%) respondents did not pollute the surrounding environment.

Of the 22 sub-districts in Kolaka Regency, all respondents in 9 sub-districts were polluted due to the contents of the feces storage tank, namely Toari, Polinggona, Pomalaa, Wundulako, Kolaka, Latambaga, Wolo, Samaturu, and Iwomendaa sub-districts.

3.3. Pollution due to Wastewater Disposal System

Table 3 Distribution of Respondents on Pollution due to Wastewater Disposal System in Kolaka Regency

Code	Sub District	Pollution due to Wastewater Disposal System					
		Not Safe		Safe		Total	
		n	%	n	%	n	%
010	Watubangga	459	81.96	101	18.04	560	100
011	Tanggetada	542	96.79	18	3.21	560	100
012	Toari	313	78.25	87	21.75	400	100
013	Polinggona	207	73.93	73	26.07	280	100
014	Pomalaa	334	69.58	146	30.42	480	100
015	Wundulako	370	84.09	70	15.91	440	100
016	Baula	321	80.25	79	19.75	400	100
017	Kolaka	268	95.71	12	4.29	280	100
018	Latambaga	234	83.57	46	16.43	280	100
019	Wolo	411	73.39	149	26.61	560	100
020	Samaturu	613	80.66	147	19.34	760	100
021	Iwomendaa	364	91.00	36	9.00	400	100
Total		4,436	82.15	964	17.85	5,400	100

Based on the table above, from 4,500 respondents 5,436 (82.15%) there was pollution as a result of the waste water disposal system that did not meet health requirements. Only a small percentage of 964 (17.85%) respondents did not pollute the surrounding environment. From 22 sub-districts in Kolaka Regency, the sub-district with the highest number of respondents polluted as a result of the sewage system that does not meet health requirements is Tanggetada District, is 96.79% of respondents.

3.4. Domestic Wastewater Pollution Risk Level

To assess the level of pollution risk, the percentage of each parameter that indicates the risk of polluting the surrounding environment is taken. The first parameter is an unsafe feces storage tank, the second parameter is an unsafe condition for pollution due to the contents of the feces storage tank, and the third parameter is an unsafe condition for pollution due to the waste water disposal system. Details can be seen in the following table:

Based on the values in the table below, data processing and analysis were carried out using the quantum GIS application version 3.26.0 by giving color gradations on the map using the natural break jenks map model available in the quantum GIS application. The value obtained from each variable is above 50%, so the number of risk levels is divided into 3 levels, namely moderate risk, high risk and very high risk. From the results of data analysis obtained a map of the risk of domestic wastewater pollution as shown in the following map image.

Table 4 Percentage of Respondents at Risk of Pollution due to Domestic Waste in Kolaka Regency

Code	Sub District	Unsafe Stool Storage Tank (%)	Not Safe from Pollution Because of the Contents of the Stool Storage Tank (%)	Not Safe from Pollution due to Wastewater Disposal System (%)
010	Watubangga	99.46	99.29	81.96
011	Tanggetada	96.79	96.79	96.79
012	Toari	98.00	100.00	78.25
013	Polinggona	99.29	100.00	73.93
014	Pomalaa	98.33	100.00	69.58
015	Wundulako	100.00	100.00	84.09
016	Baula	96.50	99.75	80.25
017	Kolaka	100.00	100.00	95.71
018	Latambaga	99.64	100.00	83.57
019	Wolo	92.32	100.00	73.39
020	Samaturu	99.61	100.00	80.66
021	Iwomendaa	100.00	100.00	91.00

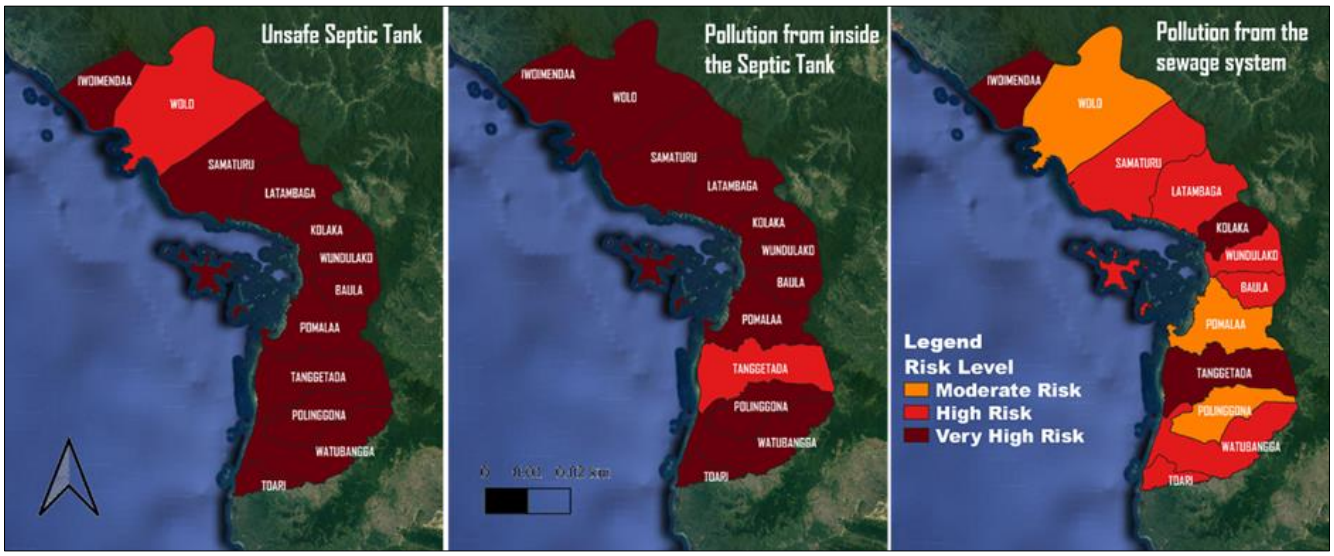

Figure 1 Map of Domestic Wastewater Pollution Risk Level Model Natural Breaks Jenks in Kolaka Regency

Based on the map image above, on the safety parameters of the feces storage tank, 11 sub-districts are included in the very high risk category, namely Iwomendaa, Samaturu, Latambaga, Kolaka Wundulako, Baula Pomalaa, Tanggetada, Polinggona, Watubangga and Toari sub-districts, 1 sub-district is included in the high risk category, namely Wolo. as well as on the pollution parameters due to the contents of the feces storage tank but there are sub-districts experiencing risk changes in this parameter, namely Wolo sub-district very high risk while Tanggetada sub-district has high risk. On the parameters of pollution due to the wastewater disposal system which is included in the moderate risk category, 3 sub-districts namely Wolo, Pomalaa, Polinggona, high risk 6 sub-districts namely Samaturu, Latambaga, Wundulako, Baula, Watubangga and Toari, very high risk 3 sub-districts namely Iwomendaa, Kolaka and Tanggetada.

Areas with very high risk must be prioritized for intervention targets in improving the quality of domestic waste management in Kolaka Regency. Therefore it is necessary to monitor water quality, with targeted observations and examination of the relationship between risk and water quality, it is important to identify priority interventions to be

carried out [6]. An economical and feasible solution to overcome the pollution of antibiotics contained in household waste to the aquatic environment is urgently needed [7].

4. Discussion

4.1. Stool Storage Tank Safety

Stool storage is useful for the disposal of human waste commonly called feces. This waste should not be distributed in any place, especially in public places, with the aim of maintaining environmental cleanliness and preventing environmental pollution from feces. The construction of the feces shelters used by the people of Kolaka Regency is mostly plunge type construction, this type is very prone to contaminating the soil because there are still pores or parts around the shelter that are not impermeable, so it can be in direct contact with the surrounding soil layer.

The construction of the plunge type tank is mostly only impermeable around the reservoir, but not tight at the bottom. The purpose of people choosing this type is because it can be used for a long time without routine draining. In addition to not being impermeable at the bottom, the walls of the storage tank also have gaps in the contents of the tank to seep into the ground, the material in the housing area of the tank wall only uses a ring well, so that between the rings there is a gap in the water in the tank seeping into the ground. The type of plunge is very at risk of soil contamination, even water sources consumed by the people who are around it by waste water originating from the feces storage tank, so that the feces storage tank owned by most of the people of Kolaka Regency is classified as unsafe for the environment.

Shelters without soaking pits and uncemented bottoms have environmental and health impacts. Sewage pipes connected to waterways contaminate freshwater sources leading to fecal contamination of water supplies, and disease outbreaks. Likewise, the open disposal of feces by some people still considers it normal [8].

4.2. Pollution Due to the Contents of the Stool Storage Tank

Human feces that enter the holding tank contain bacteria that can cause infectious diseases such as diarrhea. In addition, there is also the possibility of containing chemicals that come from soap if the user cleans using soap over the feces disposal area. Other chemicals can come from floor cleaners commonly used by people to clean closets. These materials will become the ingredients contained in the contents of the feces storage tank. This relates to the type of construction of the storage tank used, so that the contaminants contained in the contents of the tank are at risk of seeping into the ground causing pollution.

Transformational changes in the community environment may be required before significant impacts occur feces contamination [9]. Socialization to the community about the importance of building a fecal shelter that meets the requirements so as not to pollute the soil, even ground water used by the community.

4.3. Pollution due to Wastewater Disposal System

Most of the waste water disposal channels owned by the community in Kolaka Regency are open channels. There are channels that end (downstream) in rivers, public sewers, ponds/swamps/puddles, and there are also those that drain into plunge type fecal shelters. Even some of the channels are blocked, causing puddles. This situation is at risk of environmental pollution around the waste water disposal system, besides being able to pollute the soil, water sources, it can also pollute the air. In addition, it can cause an unfavorable aesthetic impact and cause an unpleasant odor. Community behavior also plays an important role in preventing environmental pollution.

Residents who deviate from healthy lifestyles, ownership of a sewerage system and ownership of latrines, as well as high levels of open defecation can contribute to the risk of environmental pollution [10]. This situation can be minimized with the treatment of domestic wastewater, simply in a simple way.

One way of treating domestic wastewater that is quite simple is with an artificial wetland. The results show that artificial wetlands in the short term can be relied on in treating domestic wastewater with characteristics of high organic and nutrient concentrations [11].

Long-term treatment of domestic effluent has a high risk of contamination of shallow groundwater in wetlands. This study provides suggestions for the management of the construction and operation of artificial wetlands i.e. anti-seepage layers should be constructed to reduce risks to groundwater, and management should be strengthened [12] [13].

Wetlands are sometimes accidentally formed naturally and can function to remove pollutants in the long term with more appropriate strategies [14]. For conditions of open waste water disposal, there should be no stagnant water. Sewers are built so that water flows smoothly. In dry conditions the downstream pollutant concentrations decrease [15]

5. Conclusion

Kolaka Regency 91.67% of the sub-districts are at high risk of pollution due to the safety of the fecal collection tank and the contents of the fecal collection tank, while the pollution due to the waste water disposal system is 50% including the high level of risk. Subdistricts with very high risk should be prioritized for intervention by the government in collaboration with the community.

Compliance with ethical standards

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Disclosure of conflict of interest

All authors state that this research was conducted without any conflict of interest.

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