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Assessing the Correlation Between Basic Sanitation and Diarrhea Prevalence in Bulurejo Village, Gresilk: A Geographic Information System (GIS) Approach

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ABSTRACT In 2022, the number of diarrhea cases increased to 958 sufferers, with the highest incidence occurring in Bulurejo village. Physically, the sources of clean water still exhibit discoloration and unpleasant odor. The latrine construction lacks a roof, and the walls are made of cloth. The construction of waste bins lacks covers, and the wastewater disposal facilities (SPAL) are open. This research aims to determine the correlation between basic sanitation and the prevalence of diarrhea using the Geographic Information System (GIS) method. The study is descriptive-analytical through observations and a GIS approach in the form of a map. From the observations, bivariate and univariate analyses were conducted using the chi-square test. The results show that basic household sanitation is related to the prevalence of diarrhea in Bulurejo. Clean water facilities, with a p-value of 0.014, indicate a significant relationship. Toilet facilities, with a p-value of 0.347, show no significant relationship. SPAL facilities, with a p-value of 0.009, indicate a significant relationship. Waste disposal facilities, with a p-value of 0.029, indicate a significant relationship. After analysis, the results were represented in the form of a map. The Geographic Information System (GIS) approach was utilized to develop more effective mapping strategies for the improvement of sanitation and diarrhea control in the area. These findings indicate the necessity for enhancing basic sanitation facilities and implementing programs at community health centers to reduce diarrhea cases in Bulurejo.

INDEX TERMS Mapping, Diarrhea Disease, Basic Home Sanitation, Bulurejo Village

I. INTRODUCTION

Diarrhea is one of the Environmental-based diseases (PBL) which is related to the level of public health. Extraordinary Events (KLB) still occur frequently, and the case fatality rate (CFR) is still high. In Indonesia in 2018, it occurred in 8 provinces or cities, with 36 deaths (CFR 4.76%). In 2019, 2,546 people contracted diarrhea, with 34 deaths (CFR 1.97%). Even though the death rate has decreased, the increase in diarrhea cases is still high. Community-Based Total Sanitation (STBM) is one of the government's efforts to tackle diarrheal disease by creating a supportive environment and increasing the need for and provision of sanitation.

The environment is the dominant factor in the incidence of diarrheal diseases, which are included in environmental-based diseases. Polluted water sources carelessly disposed waste, and improper disposal of feces are examples of environments that have poor basic sanitation conditions, which can trigger diarrheal diseases [1]. Latrine construction that does not have ventilation and rubbish dumps are not watertight, and wastewater that flows in the open can cause diarrhea. Due to its deteriorating physical quality, the higher the likelihood of an increased presence of microorganisms within it. Additionally, the bacteria that cause diarrhea can also be transmitted through the fecal-oral route [2]. Diarrhea can be transmitted through water. When consuming drinking water that has been contaminated with E. coli bacteria because the water source with the source of contamination is < 10 meters [3]. In line with research by Marini and Ambarita (2020) showing that tap water is associated with diarrhea due to contaminated tap water pipe connections.

Latrine construction that is left open without a roof can trigger a strong odor, thereby attracting the attention of fly, cockroach, or rat vectors. If the disposal of feces is carried out haphazardly and the latrine construction does not meet the requirements, it can trigger diarrhea [4]. Not only that, apart from latrine construction, which can cause odors, odors can

also be generated from open wastewater disposal facilities because they can trigger odors that also attract disease vectors and become breeding grounds for vectors. Breeding vectors that spread diarrheal diseases [5]. Garbage is a breeding ground for diarrheal disease organisms, so the construction of waste disposal facilities must be strong, watertight, and have a cover. Garbage that is left piled up without processing can cause a dirty environment, trigger vector-borne diseases (diseases caused by pathogens and parasites), and cause diarrhea in humans [6].

According to Gresik City Health Service (Dinkes) profile data from 2020-2022, the Benjeng Community Health Center area experienced an increase in diarrhea cases every year. In 2020, 727 diarrhea sufferers were recorded, and this increased significantly in 2021, reaching 880 sufferers. Secondary data from Benjeng Community Health Center from January to November 2022 showed 958 diarrhea cases, of which 300 occurred in Bulurejo Village, with 109 further cases in July and November.

Gresik Regency is an industrial city known as the place where the first Indonesian cement factory was established. In connection with the development of information technology, it is necessary to carry out further research regarding mapping the distribution of risk factors for the occurrence of a disease using a geographic information system (GIS). GIS generally offers numerous benefits, such as facilitating the digital management of data and providing a clearer representation through maps [7].

GIS allows its users to choose various options related to geographic distribution and manipulation, enabling the determination of the relationship between disease distribution and the prevalence of diarrheal disease based on basic household sanitation facilities in a particular area [8]. Consistent with this research, geographic information is produced in the form of spatial data, which is geographically oriented data with coordinate information as a reference basis. Additionally, GIS is also applied to facilitate the storage of patient or individual data affected by the disease and the collection of patient data from health centers and other institutions [9].

This research contributes to advancing the application of GIS in the field of health, particularly in the context of diarrhea control programs. The utilization of GIS in this study is aimed at analyzing the precision and effectiveness of interventions, especially at the Community Health Center (Puskesmas) level. Previously, numerous studies on the incidence of diarrhea have been conducted, particularly related to basic household sanitation and clean and healthy living behaviors. However, these earlier studies primarily focused on explaining factors and risks associated with diarrhea without applying GIS, resulting in a lack of map representation. Therefore, this research introduces a new contribution by incorporating GIS to identify high-risk areas, implement targeted interventions, and optimize decision-making processes. This directly impacts the reduction of diarrhea prevalence, especially in Bulurejo Village.

II. METHODOLOGY

This research is descriptive and analytical through observation and a geographic information system (GIS) approach depicted in map form. This research design uses case-control, namely comparing the case and control groups to determine the proportion of history of exposure using a simple random sampling technique. Data obtained from observations were analyzed bivariate and univariately using the chi-square test and depicted in map form using GIS to determine the distribution pattern of diarrhea cases based on basic household sanitation. The population in this study was all 300 houses of diarrhea sufferers in Bulurejo Village.

The data used in this research is primary data, obtained directly by visiting respondents and recording the required data in an observation sheet regarding basic household sanitation facilities. Determine the coordinates of the location of diarrhea sufferers and non-diarrhea sufferers who are identified using the Global Positioning System (GPS) tool. The coordinate point data that has been obtained through observation is analyzed using GIS and depicted in the form of a map to determine the distribution pattern of diarrheal disease prevalence based on basic household sanitation. This research can be replicated similarly and can be expanded to include behavioral aspects.

III. RESULT

The results of the observational assessment of basic house sanitation in Bulurejo Village were included in the poor category, and the results of the analysis using chi-square stated that there was a relationship between basic house sanitation and the prevalence of diarrheal disease.

TABLE 1
Results of Diarrheal Disease Prevalence Analysis (Case-Control Study of Basic Sanitation of Houses in Bulurejo Village

No	Variable	Case	Control	*p-value*
		N=75	N=75	
1.	**Basic Home Sanitation**			0.044
	Good	15 (10%)	26 (17.3%)	
	Not enough	60 (40%)	49 (32.7%)	
2.	**Clean Water Facilities**			0.014
	Good	29 (19.3%)	44 (29.3%)	
	Not enough	46 (30.7%)	31 (20.7%)	
3.	**Toilet Facilities**			0.347
	Good	71 (47.3%)	68 (45.3%)	
	Not enough	4 (2.7%)	7 (4.7%)	
4.	**Waste Water Disposal Facilities (SPAL)**			0.009
	Good	9 (6%)	1 (0.7%)	
	Not enough	66 (44%)	74 (49.3%)	
5.	**Waste Disposal Facilities**			
	Good	7 (4.7%)	1 (0.7%)	0.029
	Not enough	68 (45.3%)	74 (49.3%)	

The lack of basic sanitation facilities at home in Bulurejo Village puts people at risk of diarrheal disease incidents if

environmental factors are unhealthy human behavior, namely food and drink (Ministry of Health of the Republic of Indonesia, 2019).

TABLE 2
Results of Diarrheal Disease Prevalence Analysis

No	Variable	OR	95 % CI	
			Lower	Upper
1.	**Basic Home Sanitation**	2,122	1,014	4,445
2.	**Clean Water Facilities**	2,251	1,171	4,328
3.	**Toilet Facilities**	0.547	0.153	1,954
4.	**Waste Water Disposal Facilities (SPAL)**	0.099	0.012	0.803
5.	**Waste Disposal Facilities**	0.131	0.016	1,095

Based on TABLE 1, it is known that the basic sanitation of houses in which diarrhea sufferers live is in the deficient category in 60 houses, whereas in the houses of non-diarrhea sufferers, it is in the deficient category in 49 houses. From the results of the chi-square test, it can be interpreted that there is a significant relationship between basic household sanitation and the prevalence of diarrheal disease, with a p-value of 0.044 ($P < 0.05$). An increase in the prevalence of diarrheal disease due to poor basic sanitation at home, such as not having complete basic sanitation facilities at home and not meeting health requirements, can facilitate the occurrence of diarrheal disease [10].

MAP OF THE PREVALENCE OF DIARRHEA BASED ON BASIC HOME SANITATION

Bulurejo Village is a sub-district consisting of four hamlets, namely Bulurejo Hamlet, Nyanyat Hamlet, Balowangon Hamlet, and Rayung Hamlet. The population of Bulurejo Village is 4,367, with 2,184 men and 2,183 women. There are four maps of the prevalence of diarrhea disease based on basic household sanitation in Bulurejo Village, Benjeng Health Center Working Area, namely maps of clean water facilities, latrine facilities, SPAL, and waste disposal facilities. The following are the results of the basic sanitation mapping of the house, which has been processed using Q-GIS.

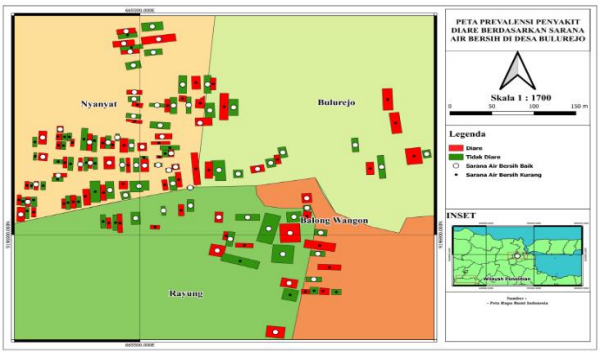

FIGURE 1. Map of clean water facilities on the prevalence of diarrheal diseases

The distribution pattern of diarrhea based on clean water facilities is divided into two categories: good and poor. In this picture, symbols representing diarrhea cases are depicted with red squares, while non-diarrhea cases are depicted with green squares. This helps visualize and understand how the distribution of diarrhea cases correlates with the quality of clean water facilities, with a specific focus on areas categorized as either good or poor. The image provides a visual insight into the relationship between water sanitation and the occurrence of diarrhea in various village or district areas.

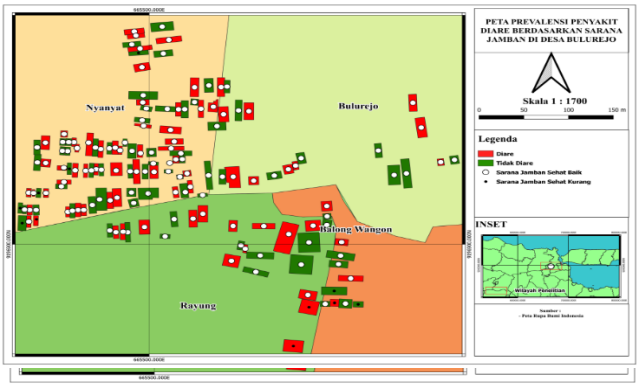

FIGURE 2. Map of latrine facilities on the prevalence of diarrheal diseases

The distribution pattern of diarrhea based on toilet facilities is divided into two categories: good and poor. In this picture, symbols representing individuals with diarrhea are depicted with red squares, while those without diarrhea are depicted with green squares. This helps visualize and understand how the distribution of diarrhea cases correlates with the quality of toilet facilities, with a specific focus on areas categorized as either good or poor.

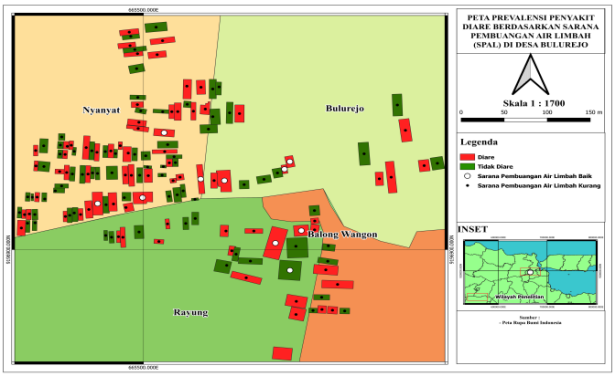

FIGURE 3. Map of SPAL facilities on the prevalence of diarrheal diseases

The distribution pattern of diarrhea based on wastewater disposal facilities is divided into two categories: good and poor. In this picture, symbols representing individuals with diarrhea are depicted with red squares, while those without diarrhea are depicted with green squares. This helps visualize and understand how the distribution of diarrhea cases correlates with the quality of wastewater disposal facilities, with a specific focus on areas categorized as either good or poor.

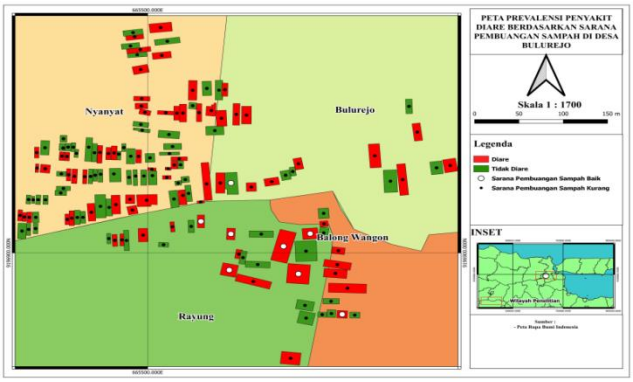

FIGURE 4. Map of waste disposal facilities on the prevalence of diarrheal diseases

The distribution pattern of diarrhea based on waste disposal facilities is divided into two categories: good and poor. In this picture, symbols representing individuals with diarrhea are depicted with red squares, while those without diarrhea are depicted with green squares. This helps visualize and understand how the distribution of diarrhea cases correlates with the quality of waste disposal facilities, with a specific focus on areas categorized as either good or poor.

IV. DISCUSSION

Based on Table 2, the calculation results are OR = 2.122 and CI = 1.014-4.445, so it can be concluded that basic home sanitation in the poor category has a 2.122 times higher risk of contracting diarrhea when compared to basic home sanitation in the good category. Therefore, having basic sanitation facilities at home, such as providing rubbish bins, using toilet facilities that are suitable for use, providing a distance of >10 meters from sources of pollution, and having SPAL facilities with a closed system, can prevent the occurrence of diarrheal diseases [11]. According to Permenkes Number 2 of 2023 concerning implementing regulations for government Regulation Number 66 of 2014 concerning environmental health, basic home sanitation includes clean water facilities, latrine facilities, waste disposal facilities, and wastewater disposal facilities.

It is known in Table 1 above that the clean water facilities for diarrhea sufferers are in the poor category in 46 houses, whereas for non-diarrhea sufferers, the clean water facilities are in the good category in 44 houses. From the results of the chi-square test, it can be interpreted that there is a significant relationship between clean water facilities and the prevalence of diarrhea, with a p-value of 0.014 (p 0.05). The results of this research are different from the results of Fitria Eka Putri (2021) research, which found that clean water facilities do not have a significant relationship with the incidence of diarrhea. In this research, 50% of the clean water sources used were PDAM, 11.9% were dug wells or tap water, and 2.4% were protected springs. The distance from the dug well to the source of pollution is > 10 meters and is not adjacent to latrine facilities [12].

Based on Table 2 above the calculation results indicate that OR = 2.251 and CI = 1.171-4.328, so it can be concluded that clean water facilities in the poor category have a 2.251 times higher risk of contracting diarrhea when compared with clean water facilities in the good facility. The majority of people in Bulurejo Village get clean water from dug wells. There are families who get clean water from the same well and use it for household purposes. There are components that still do not meet the requirements, such as the construction of the well not having cover and the condition of the floor around the well being cracked so that infiltration into the well water occurs. It is possible that this infiltration could contaminate the water in the dug well, supported by the research results of Hanan Lanang (2020), dug well water comes from a layer of soil that is relatively close to the ground surface, therefore it is easily exposed to contamination through seepage from human, animal, or domestic household activities. Dug wells as a source of clean water must be supported by construction requirements and location requirements for the construction of a dug well. This is necessary so that the water quality of the dug well is safe in accordance with established regulations [13].

Toilet facilities that do not meet the requirement will cause soil pollution, and unsanitary disposal of feces can cause harm to humans both in terms of aesthetics and health. Latrines can be divided into several types, including plunge latrines where a stool reservoir is built under the footing. Pond latrine or overhung latrine where a latrine is built on a pond, river, or swamp. Chemical toilets are toilets that are usually found in transportation facilities (trains, airplanes) where the feces are disinfected with chemical substances and cleaned using toilet paper. A swan neck latrine is a latrine with a curved toilet hole neck. The behavior of humans who dispose of feces carelessly instead of in latrines will provide opportunities for transmission of infection through water and soil. This will affect environmental conditions so that the incidence of diarrhea increases [14].

Results of a bivariate analysis of latrine facilities in Bulurejo Village 71 houses and 68 houses are in the good category, from the results, it can be interpreted that there is no significant relationship between latrine facilities and the prevalence of diarrheal disease, with a p-value of 0.347 (p 0.05). Based on Table 2, the calculation results are OR = 0.547 and CI = 0.153-1.954, so it can be concluded that latrine facilities do not increase the prevalence of diarrheal disease. The construction conditions of the latrine facilities in Bulurejo Village meet the requirements, such as having adequate ventilation in the bathroom, a suitable latrine that has a septic tank, and a distance from pollution sources of > 10 meters. Supported by the research results of Halimah (2023) there is no significant relationship between latrine ownership and the incidence of diarrhea with a p-value = 0.18 > 0.05. However, it is different from the research results of Sri Maywati (2023) that there is a relationship between latrine facilities and the incidence of diarrhea with a p-value of 0.000 and OR of 6,231. The condition of latrine facilities that do not comply with health requirements is indicated by the conditions of direct final disposal, which is not in a septic tank but is discharged into ditches, rivers, and ponds. Apart from that, the cleanliness

of latrines is very important to maintain and prevent latrines from becoming breeding vectors. The conditions of latrines that are not clean allow latrines to become a transmission medium for the transmission of diarrheal diseases. The final disposal of feces in ditches, ponds, or other open places can be touched by vectors such as flies, causing contamination of food [15]. According to the results of Widyaningrum's research (2023), it can be concluded that the distance of a latrine that is < 10 meters from a clean water source, the conditions of the floor where the latrine hole enters, the size of the latrine house's area, and the condition of the latrine house that does not meet health requirements can be factors in diarrheal disease [16].

SPAL is a facility in the form of excavated soil or pipes made from cement or even paralon that functions to dispose of remaining household liquid waste, such as water left over from washing, bathing, or other dirty activities in the household. In general, liquid waste contains materials or substances that are dangerous to human health and can disrupt environmental conditions. However, the volume of wastewater produced is large because less than 80% of the amount of water used for daily activities is disposed of in the form of dirty water. Waste management is aimed at avoiding water and soil pollution, so waste processing must produce non-hazardous waste [17].

The results of this research show that SPAL facilities for diarrhea sufferers and non-diarrhea sufferers are in the poor category, namely 66 houses and 74 houses. From the results of the chi-square test, it is interpreted that there is a significant relationship between SPAL facilities and the prevalence of diarrhea, with a p-value of 0.009 (p 0.05). The calculation results of OR mean SPAL = 0.099 and CI = 0.012–0.803, so it can be concluded that the SPAL facility in Bulurejo Village has a risk of 0.099 times in the low category for contracting diarrhea. This research is in line with the research results of Henny Arwina (2020), with a p-value of 0.015 (p 0.05), which means there is a significant relationship between SPAL facilities and the incidence of diarrhea. This is supported by the condition of the SPAL used, which is clogged [18].

The condition of Bulurejo Village SPAL facilities with an open system can spread unpleasant odors so that they can attract the attention of vector animals such as mosquitoes, flies, and cockroaches. SPAL facilities with an open system during the rainy season can cause flooding because the water in the gutter can overflow out onto the road, causing flooding and becoming a breeding ground for mosquitoes. This could pose a risk of diarrheal disease. To prevent or reduce wastewater contamination of the environment, waste must be managed properly so that wastewater does not become a breeding ground for disease germs such as flies, does not contaminate water sources or soil, and does not cause odors [19].

Waste is all substances or objects that are no longer used, whether from the household or the result of industrial processes. Types of waste include inorganic and organic waste. Usually, organic waste decomposes more easily and pollutes the environment. Therefore, action needs to be taken so that waste does not become a source of disease, especially diseases that can cause diarrhea. One of the conditions of trash cans that do not meet the requirements is that they do not separate wet and dry waste [20]. Not only does it separate wet and dry waste, but trash bin construction that is not strong and leaks easily can attract vectors such as flies and/or cockroaches, which can transmit diarrheal diseases. Trash bins that do not meet the requirements will provide a good place for disease vectors to find food and reproduce quickly, increasing the incidence of environmental-based diseases, one of which is diarrhea, in the community. Good waste management is very important to prevent the spread of disease, one of which is by providing trash bins that meet the requirements [21]

The results of this research show that the waste disposal facilities for diarrhea sufferers and non-diarrhea sufferers are in the deficient category, namely 68 houses and 74 houses. From the results of the chi-square test, it is interpreted that there is a significant relationship between waste disposal facilities and the prevalence of diarrheal disease, with a p-value of 0.029 (p 0.05). OR calculation results for waste disposal facilities = 0.131; CI = 0.016–1.095, so it can be concluded that waste disposal facilities in Bulurejo Village have a risk of 0.131 times in the good category for contracting diarrhea. In line with the results of Nurhaedah's (2019) research, there is a significant relationship between household waste management and the incidence of diarrhea in the elderly. This is because the majority of respondents do not have trash bins and throw trash anywhere [22]. The results of this research are not in line with the research by Monica (2020), which shows that there is no significant relationship between protecting waste and the incidence of diarrhea, with a p-value of 0.471 (p-0.05). There is no relationship between protecting household waste and This diarrhea incident occurs because, even though almost all households do not protect their waste properly, not all of them suffer from diarrhea. Many households have poor waste management but do not experience diarrhea in their family members [23]

DESCRIPTION OF THE PREVALENCE OF DIARRHEA BASED ON BASIC HOME SANITATION.

The results of mapping the distribution of clean water facilities in the homes of respondents with diarrhea and non-sufferers, it was found that the highest number was found among diarrhea sufferers. There is a tendency in the Nyanyat hamlet area to have fewer clean water facilities compared to the other 3 areas. This can explain why the variable clean water facilities used by Nyanyat Hamlet for diarrhea sufferers and non-sufferers are lacking or do not meet the physical quality requirements of water. It can be concluded that maps can identify patterns of disease spread based on geographic information systems [24].

The results of mapping the distribution of latrine facilities in the homes of respondents with diarrhea and non-sufferers, it was found that the highest number was found among diarrhea sufferers. There is a tendency in the Nyanyat and Rayung hamlets to have good latrine facilities. Judging from

the latrine facilities that are in the good category, only 11 latrine facilities were found that did not meet the health requirements for both diarrhea sufferers and non-diarrhea sufferers. This can explain why the latrine facility variables used by the respondents are not related. Through GIS, it is easier to see the picture or distribution of diseases that occur and conclude what risk factors are problematic [25].

The results of mapping SPAL distribution facilities to the homes of respondents with diarrhea and non-sufferers, it was found that the highest number was found among diarrhea sufferers. There is a tendency in the Nyanyat hamlet area to have fewer SPAL facilities. Judging from the SPAL system, the majority of respondents do not meet the health requirements. It can be concluded that SPAL facilities need improvement with a closed system. Thus, using spatial analysis methods with GIS applications can help analyze health data to see disease phenomena in an area [26].

The results of mapping the distribution of homes between respondents suffering from diarrhea and non-sufferers showed that the highest number was found among non-diarrhea sufferers. Judging from the waste disposal facilities in the deficient category, the largest number is in Nyanyat Hamlet, compared to 3 other hamlet areas. It can be seen from Figure 4 that only 8 waste disposal facilities are in a good category or meet health requirements. Insufficient waste disposal facilities do not rule out the possibility that waste management is not good or that waste is not separated between wet and dry waste. These maps help to analyze the distribution of statistical data and in particular to show areas with a higher density of objects or phenomena and their activity clusters [27].

The results of the mapping that has been processed by Q-GIS with basic house sanitation variables, it can be concluded that basic house sanitation in Bulurejo Village is in the deficient category with the majority of people suffering from diarrhea. The image pattern of the distribution of diarrheal diseases can visualize a map of the spread of the disease and can display information including the area where the disease spreads, the number of times the disease spreads, and the level of susceptibility to diarrheal disease in each region. In line with research by Tria Saras (2021) that the use of a geographic information system can be implemented to map regional vulnerability based on risk factors for diarrhea in toddlers in Kendari City, where the Puuwatu sub-district is an area that is very vulnerable to diarrhea [28].

Regional vulnerability according to risk factors for diarrhea incidents using GIS, namely by carrying out an overlay technique between the map of the distribution of diarrhea incidents in Bulurejo Village and the basic sanitation of houses in good and poor categories. Distribution of cases according to the prevalence of diarrheal disease based on basic household sanitation. The highest number of cases was in Nyanyat Hamlet with clean water facilities, SPAL facilities, and waste disposal facilities in the deficient category. Only toilet facilities are in the good category.

The implementation of GIS in this research can provide convenience for institutions such as Community Health Centers, particularly in the diarrhea program, as a step in providing solutions related to diarrheal diseases through environmental disease control programs [29]. It is hoped that this can effectively prevent cases of diarrhea, especially in Bulurejo Village. The existence of this system allows for swift and precise interventions to support decision-making in efforts to control and address diarrheal diseases. The research also highlights the need for education and increased awareness in the community regarding proper sanitation practices. Providing knowledge to individuals about the impact of behavior on household sanitation is expected to lead to positive changes in their daily activities.

V. CONCLUSION

This research concludes that there is a significant relationship between basic household sanitation and the prevalence of diarrheal disease. Basic sanitation facilities at home that do not meet the requirements can be caused by other risk factors, such as the behavior of throwing rubbish carelessly and flowing wastewater in front of the house. This can explain why the basic sanitation variables at home are related. Therefore, further research on societal behavior factors is needed and would be an interesting variable for future studies. These suggestions can help subsequent researchers develop more comprehensive studies and make a greater contribution to understanding the relationship between household sanitation and public health.

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