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Water Quality of Sawaga River and the Relationship of Socio-Economic and Health Status of its Surrounding Communities

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ABSTRACT

Preserving Sawaga River is becoming a concern as various factors contribute to the pollution of its ecosystem. Specifically, this study aimed to assess the Socio-Demographic, Economic, Sanitation profile, and Health of people vis-à-vis its contribution to the water quality of the Sawaga River. A quantitative approach was utilized to examine various variables, and the Multiple Fermentation technique was employed to determine the water quality of the Sawaga River. There were three stations identified in three barangays, and a total of 109 respondents living near the river were purposively recruited to participate in the study. Validation of results was also initiated through an interview with selected Barangay Officials and Barangay Health Workers. The study results revealed that the source of water and age are significant variables related to the respondents' water-borne diseases. High total Coliform was also noted in the three Stations of Sawaga River, contributed by socio-demographic, sanitation, and Health profile of the residents living near Sawaga River.

Keywords*:* Sawaga River, Water quality, Socio-demographic, Sanitation and Health profile

INTRODUCTION

The River basin has been a significant source of water supply for many purposes, supporting the development of highly populated residential areas (Mouri, Takizawa, & Oki, 2011). Locally, one of the primary water sources in Bukidnon is the Sawaga River. The Sawaga is one of the tributaries of Pulangi River, located at Malaybalay City, Bukidnon that stretches 64.5 kilometers from its source-Mount Tuminungan, to its end-Pulangi River, with coordinates of 7° 58' 48.90" N and 125° 8' 49.13" E (Bertomen, Roa, Tubio, Vedra, & Dela Peña, 2017). However, due to its water supply, increasing human settlements and industries have blossomed meters near the River. These human settlements and industries' presence creates a threat as it may affect our Sawaga River's water quality.

Moreover, Yan, Zhang, Zhang, Liu, Deng, & Nie (2015) emphasized the need to conduct a continuous water quality assessment. The publication of water pollution findings will produce a detailed picture of water quality essential in identifying and eliminating factors causing pathogenic agents in water. Thus, it is fitting to conduct a study that looks into the various elements and the effects of communities on the water quality of the Sawaga River.

In another context, various factors were widely investigated to be associated with water quality. A study conducted by Hu (2011) observed that human settlements and industries concentrated along rivers, estuaries, and coastal zones cause the predominance of waterborne trade and waste disposal. Rivers constitute the main inland water body for domestic, industrial, and agricultural activities and often carry sizeable municipal sewage, industrial wastewater discharges, and seasonal runoff from an agricultural field (Singh, Malik, Mohan, & Sinha, 2004; Pradhan et al., 2009; Hue et al., 2011). These human and industrial activities have contributed significantly to water contamination & pollution in various rivers (Dimitrovska et al., 2012). Vittori (2010) also observed that river water pollution could be linked to the type of wastewater produced by urban, industrial, and agricultural activities that flows into surface and subsurface waters.

Different authors also conducted similar studies in observing water quality. Franczyk and Chang (2009) observed a negative relationship between income and water use. In contrast, Nahman and Antrobus (2005) witnessed wealthier areas have low water pollution as these areas invest more pollution control technology. Existing literature has seen the factors of education, ethnic composition, age structure, land use, population density, and water area as significant water quality indicators (Farzin, & Grogan, 2011). In terms of health, Li, Wang, Liu, Lin, Liu, and Hu (2014) observed that densely populated urban areas are more likely to be polluted from fecal sources and a source of waterborne pathogenic bacteria. Polluted water has caused common waterborne diseases and even death to children (Gomez, Perdiguero, & Sanz, 2019; WHO,2018).

Few studies have been conducted in the Sawaga River's local settings, but no comprehensive approach was made. Bertomen et al. (2017) observed that Sawaga is polluted; however, their study suggested a comprehensive analysis of water quality in several other parts of the River to determine coliform levels. Another study conducted by Opiso and Alburoa (2014) assessed the Sawaga River in terms of its hydro-geochemical characteristics to determine the degree of impairment. The study observed that the overall water quality of Sawaga River is attributed to the influence of land use and human activities along the River; thus, the authors recommended regular monitoring and strict implementation of environmental laws. However, there are limited to no comprehensive evaluations were conducted to assess if research recommendations were implemented at the grassroots level.

The identified gaps can be addressed by conducting a comprehensive evaluation of the condition of the Sawaga River. This study assesses the Socio-Demographic, Economic, Sanitation profile, and health of people living near Sawaga River. The study stands on its notion that community activities pose a threat to the water quality of the Sawaga River. Thus, understanding water quality starts in the evaluation of the community surrounding it.

FRAMEWORK

The study hinges on the environmental theory of Florence Nightingale (1860). The theory focuses on how external environmental factors affect the life and development of an individual. The theory considers every environmental situation an essential tool to promote people's optimum health and all life it influences. Nightingale believes in 13 cannons that can alter health. These are environmental factors such as ventilation, light, cleanliness of rooms and walls, houses' health, noise, bed and beddings, personal cleanliness, variety, chattering hopes, nutrition, cleanliness of rooms, petty management, and observation of sick. Of the identified cannons, there are three environmental factors used in this study: cleanliness of rooms, houses' health, and observation of sick.

Cleanliness of rooms, according to Nightingale, refers to preserving cleanliness (Udan, 2020). On the other hand, the health of houses refers to pure air, pure water, efficient drainage, cleanliness, and light. In this cannon, Nightingale noted that the cleanliness outside the house affected what is inside the house. This factor is still applicable in our time today as families are still affected by toxic wastes and contaminated water (Udan, 2020). Since humans are sources of cleanliness, it is just right to look at human-related factors influencing one's environment. Observation of the sick refers to what to observe, what symptoms indicate improvement, and vise versa, the critical evidence that needs attention, and what needs to be done. Nightingale urges every health practitioner to remember that observation is not an end in itself but a means to assure that appropriate actions are taken.

In application, the three dimensions, namely Sociodemographic, Economic, and Sanitation, emerge from Nightingale's environmental cannons. These dimensions serve as leverage to understand the water quality of the Sawaga River. Specifically, the sociodemographic dimension refers to human characteristics such as age, religion, and educational attainment. The economic dimension looks into the specific economic activities conducted by various residents living near the river. Lastly, the Sanitation dimension observes the waste and livestock disposal practices of communities. Looking into these dimensions would help us assess which factors contributed to health and water quality. Figure 1 shows the interplay of these dimensions in the study.

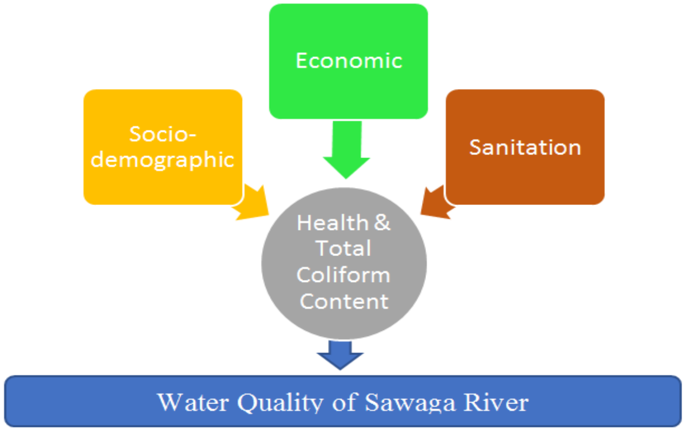

Figure 1. The interaction of multiple parameters influencing the quality of a river system.

OBJECTIVES OF THE STUDY

The study aimed to evaluate the water quality and the Socio-demographic, Economic, Health, and Sanitation profile of communities living near Sawaga River. Specifically, it sought to: (1) Assess the socio-demographic profile of the identified residents living in three stations near Sawaga river in terms of: Age; Religion; and Educational attainment. (2) Identify economic characteristics of respondents living near the three stations of Sawaga river in terms of: Income; and Occupation. (3) Determine the sanitation profile of respondents in terms of: Type of toilet; Source of water; Livestock raising; and Waste disposal.(4) Analyze common water/environment-related diseases encountered per station; (5) Explore the relationship between socio-demographic, economic, and sanitation profile to common water-related diseases. 6. Evaluate total coliform content in Sawaga river per area: Station 1; Station 2; and Station 3.

METHODS

This descriptive study utilizes a quantitative approach. Specifically, it evaluates the residents' sociodemographic, economic, and sanitation profiles using available data from the barangay integrated survey system. The respondents of the study are limited to those residing near the Sawaga River. For the health profile, Barangay Midwife and Barangay Health workers were utilized, as recommended by the Barangay Captain, to assess the common waterborne disease incidences per identified respondents.

In detail, researchers seek a letter of approval from three Barangay Captains. Data gathering restrictions were identified by the barangay due to COVID-19; thus, the documentary analysis was recommended by the barangay officials and employed in this study. After the approval, consultation with Barangay Secretary was initiated to gather and consolidate the data needed. It only covers the age, religion, and educational qualifications of residents residing near the Sawaga river for the sociodemographic profile. The economic profile looks into the income and occupation of the barangay residents living near the river. On the other hand, the sanitation profile evaluates the type of toilet, source of water used by the residents, the livestock raising, and waste disposal of identified residents. The health profile assesses the common waterborne or environment-related diseases encountered by residents per identified areas for the past three years. The study includes data validation where various interviews with Barangay health workers and Barangay Officials of the three stations confirm the study's findings. Moreover, the verification process includes documentary analysis found in barangay annual reports.

In terms of research locale, the study was conducted in Malaybalay City, Bukidnon. The study establishes three sampling stations in Sawaga River. The first station is situated near the diversion road bridge at Barangay Sumpong within the geographical coordinates of 8.1616 latitudes and 125.1180 longitudes, where there is the presence of human settlements. The second station was near the City Slaughterhouse at Barangay 9 with 8.1426 latitudes and 125.1294 longitudes. This area is densely populated, and there is a presence of industrial establishments nearby. The third station is near City Health Office at Barangay 3, Fortich Street, within the geographical coordinates of 8.1558 latitudes and 125.1229 longitudes, where there is a presence of households. The third station was near the City Slaughterhouse at Barangay 9 within the 8.1426 latitudes and 125.1294 longitudes. Generally, gathering data specific to every parameter will be done in the three identified sampling sites for three months to note climatic or seasonal variations in the Sawaga River system's conditions.

In evaluating the total coliform content of the water in the Sawaga river, water sample collection was done at the three identified stations. Collection of water samples used a sterile bag purchased at the Department of Science and Technology, Cagayan de Oro City. In gathering samples, the researchers used protective and appropriate personal protective equipment (PPE). There is also sterilization of samples for 15-20 minutes. The sterile container is placed 50 cm away from the river bank and 10 cm below the water surface to prevent the surface's collection. According to DOST, the container must not be overfilled, and it should be a 1-inch minimum.

The samples were taken to the laboratory within 6 hours as stipulated by DOST. Traveling of samples was executed adequately by using an appropriate ice bucket. The collected samples were stored in the ice bucket with a temperature within negative 4 degrees Celcius. A portable thermometer was used to ensure the appropriate temperature is maintained. DOST used multiple Tube Fermentation Technique to analyze the water sample qualitatively. This three-stage procedure would determine the Most Probable Number (MPN) of total coliform seen in the samples. For samples' accuracy, the sampling spot has markers secured in a rick. The gathering of data was done three times every second Saturday of September, October, and November, at the same time, around 7:00 in the morning.

For statistical treatment, frequency and percentage distribution were used to analyze the respondents' sociodemographic, economic, sanitation, and health profile. In determining the relationship between multivariate nominal variables, Wilks' Lambda was used. For ordinal variables, Chi-Square Test was utilized. Both tests have a critical value set at 0.05; if data falls below 0.05, it is considered significant in this paper.

RESULTS AND DISCUSSION

Socio-demographic profile of residents per station

The residents' sociodemographic profile in Sawaga River is categorized in terms of age, sex, civil status, religion, and educational attainment. Table 1 showed the age distribution of 106 respondents in the three stations. The results suggest that most respondents in Station 1 and 2 belong to the age bracket of 25-34 years old (Station 1:f=10, %=33.3; Station 2: f=19, %=38). On the other hand, most of the respondents in Station 3 belong to 45-54 years old (f=8;%=30.8). This data shows that majority of the respondents are young but of legal age.

Table 1

Frequency and Percentage Distribution of Three Stations' Age

Range	Station 1 N = 30		Station 2 N = 50		Station 3 N = 26	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
15-24	6	20.0	2	4.0	7	26.9
25-34	10	33.3	19	38.0	6	23.1
35-44	6	20.0	7	14.0	4	15.4
45-54	6	20.0	5	10.0	8	30.8
55-64	2	6.7	12	24.0	1	3.8
65-74	0	0	5	10.0	0	0
$\bar{x}$	34.8		44.08		35.08	

These findings are consistent with Sandberg's (n.d.) observations that low age increases the possibility to leave a survey incomplete, and a high age increases the interaction while doing the study. An increasing number of legal age respondents is beneficial to ensure complete and comprehensive data retrieved in the study. Furthermore, Raudsepp (2001) claimed that environmental friendliness increases with advancing age. The peak of environmental concern is in the age group 40–54. The peak of everyday pro-environmental habits is in the age group 65 89. Also, the same study found out that young age groups tend to be more passive in environmentalism.

Table 2 displayed the frequency and percentage distributed in terms of religion. Most of the respondents in the three identified stations are Roman Catholic with a frequency of 20 (%=66.7) in station 1; 39 (%=78) in station 2, and 20 (%=76.9) in station 3. Al-Khatib et al. (2008) further observed that increasing moral and religious convictions effectively decrease littering. The same study illustrated that having religious affiliations increases citizens' tendency to consciously and subconsciously associate good citizenry with higher religious standards, thereby decreasing littering practices. It can be surmised that religion can be a factor in determining the pro-environmental ways of residents.

Table 2

Frequency and Percentage Distribution of Three Stations' Religion

		Station 1 N = 30		Station 2 N = 50		Station 3 N = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Religion	Roman Catholic	20	66.7	39	78.0	20	76.9
	SDA	2	6.7	0	0	0	0
	Baptist	8	26.7	2	4.0	4	15.4
	INC	0	0	4	8.0	0	0
	Islam	0	0	3	6.0	2	7.7
	Jehova's Witness	0	0	2	4.0	0	0

In terms of educational attainment, table 3 illustrates a varied level of education among respondents. In station 1, most of the respondents attained high school graduate level and college graduate level, each comprising 26.7% (f=8) in the said area. Station 2, on the other hand, shows that most of the respondents have elementary level education (f=14; %=28%). While station three displays a large percentage (30.8%) of respondents have college level and college graduate levels. It can be recalled that high educational attainment provides individuals with the knowledge and skills to enhance their performance and promotes growth and improvement of one's social capital (Vera-Toscano, Rodrigues, Costa, 2017). This finding showed that educational attainment is critical to residents' water quality preservation practices.

Table 3

Frequency and Percentage Distribution of Three Stations' Educational Attainment

		Station 1 N = 30		Station 2 N = 50		Station 3 N = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Educational Attainment	Elementary Level	7	23.3	14	28.0	4	15.4
	Elementary Graduate	0	0	4	8.0	0	0
	High School Level	4	13.3	9	18.0	3	11.5
	High School Graduate	8	26.7	12	24.0	3	11.5
	College Level	3	10.0	3	6.0	8	30.8
	College Graduate	8	26.7	8	16.0	8	30.8

Economic characteristics of respondents living near the three stations of Sawaga river

The economic characteristics of respondents living near Sawaga River are divided into income and occupation. Table 4 illustrates that most of the respondents in the three stations have an income range of 3,000 to 7,000 months. According to Albert, Santos, Vizmanos (2018), an income less than 9,520 pesos belong to the poor classification/ cluster.

Table 4

Frequency and Percentage Distribution of three Stations' Income

Range	Station 1 $N = 30$		Station 2 $N = 50$		Station 3 $N = 26$	
	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
No Income	4	13.3	3	6.0	5	19.2
3000-7999	19	63.3	35	70.0	13	50.0
8000-12999	5	16.7	10	20.0	6	23.1
13000-17999	0	0	0	0	2	7.7
18000-22999	2	6.7	1	2.0	0	0
23000-27999	0	0	0	0	0	0
28000-above	0	0	1	2.0	0	0
$\bar{x}$	6350.0		6390.0		6346.2	

This data illustrated that most of the respondents living near the Sawaga River belong to the poor sector. Various studies observed that littering is higher in the area occupied by people with a lower average annual income and literacy (Santos, Friedrich, Wallner-Kersanach, Fillmann, 2005; Rhodes, 2008). Similarly, Al-Khatib et al. (2008) sees that high income is usually associated with higher social and educational status contributing to litter reduction. Another study found out that small water supplies, particularly those that serve low-income and minority communities, may have poorer source water quality due to closer proximity to pollution sources (Schaider, Swetschinski, Campbell, & Rudel, 2019). It can be surmised that low-income sectors are prone to contribute to waste disposal in river sources and are likely to be affected by water pollution.

Table 5 showcases the frequency and percentage distribution of respondents' occupation in three stations. A large number of respondents in three stations are skilled workers (Station 1: f=11, %=36.7; Station 2: f=30; %=60; Station 3: f=9, %=34.6). This data explains why mostrespondents have low income, considering that most of them belong to the said occupation category. According to Kagan (2020), unskilled labor is a workforce segment associated with a limited skill set or minimal economic value for the work performed. Unskilled labor is generally characterized by lower educational attainment, such as a high school diploma and typically smaller wages. Work that requires no specific education level or specialized experience is often available to the unskilled labor force like construction laborers, service laborers, vendors, janitors, fast-food workers, and the like (Laurence, n.d.). However, Zelezny et al. (2000) observe that occupation has weak and inconsistent relationships with environmentalism. Also, unemployment will decrease the extent of pro-environmental behaviors (Meyer, 2016). These observations need to be thoroughly examined to understand the relationship of occupation to water quality.

Table 5

Frequency and Percentage Distribution of three Stations' Occupation

		Station 1 $N = 30$		Station 2 $N = 50$		Station 3 $N = 26$	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Occupation	No work	4	13.3	0	0	0	0
	Government Employee	6	20.0	8	16.0	6	23.1
	Private Employee	9	30.0	12	24.0	6	23.1
	Unskilled Worker	11	36.7	30	60.0	9	34.6
	Student	0	0	0	0	5	19.2

Sanitation profile

The sanitation profile of the three stations in Sawaga river is categorized according to the type of toilet, source of water, livestock raising, and waste disposal. In terms of toilet type, 100% of residents in Station 1 and 3 use water-sealed toilets. It is interesting to note that in Station 2, there is still 12% of the household that does not have toilets. United Nations Children's Fund (2017) reported that approximately six percent of Filipinos, mostly in rural areas, still do not have sanitary toilets. World Health Organization (2019) observed that people who defecate in the open fields and waterways are more likely to experience frequent diarrhea and worm infections.

Table 6

Frequency and Percentage Distribution of Three Stations' Type of Toilet

		Station 1 N = 30		Station 2 N = 50		Station 3 N = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Type of Toilet	None	0	0	6	12.0	0	0
	Water Sealed	30	100.0	41	82.0	26	100.0
	Closed Pit	0	0	3	6.0	0	0

A similar study conducted by UNICEF about children's feces disposal: there is a widespread fallacy that feces of infants and young children are not harmful. There is evidence that children's wastes could be riskier than adult feces due to a higher prevalence of diarrhea and pathogens—such as hepatitis A, rotavirus, and E. coli—in children than in adults (UNICEF & World Bank, 2015). Children's feces should be treated with the same concern as adults' feces, using safe disposal methods that ensure separation from human contact and household contamination. In particular, the unsafe disposal of children's feces may be an essential contaminant in household environments, posing a high risk of exposure to young infants (Gil, Lanata, Kleinau, & Penny, 2004). United Nations Children's Fund and World Bank (2015) observed that 73% of households with improved sanitation have unsafe child feces disposal behaviors. The same study further emphasized that poor sanitation can substantially impact children, including a higher prevalence of diarrheal disease, intestinal worms, enteropathy, malnutrition, and death. Therefore, the type of toilet and its disposal-sewage system can be a factor that affects the quality of the Sawaga river.

Table 7 displays the frequency and percentage distribution of water sources in three identified stations. Most of the respondents in Station 1 and Station 3 have level 3 water sources. According to the Department of Health, a level 3 home has its waterworks system or individual water connections. Most of the residents are connected to the Malaybalay City Water District. However, during the interview with the barangay health workers, they revealed that sometimes residents use Sawaga water for washing activities.

Table 7

Frequency and Percentage Distribution of Three Stations' Source of Water

		Station 1 *N* = 30		Station 2 *N* = 50		Station 3 *N* = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Source of Water	Level 1	8	26.7	8	16.0	0	0
	Level 2	10	33.3	31	62.0	10	38.5
	Level 3	12	40.0	11	22.0	16	61.5

On the other hand, data further revealed that most of the Station 2 have a level 2 water source. According to DOH, this type of water source uses a communal faucet system that can serve 4 to 6 households. According to the barangay health workers, most of the residents share a water system since most of them are informal settlers in the barangay. In a study conducted by Barroso and Alava (2012), residents who do not have potable water and use waters from nearby rivers, creeks, and springs are prone to water-borne diarrheal diseases.

Table 8, on the other hand, displays the frequency and distribution of three stations' livestock raising. Data showed that most do not have animals in their household; however, several residents have raised pigs (Station 1: f=10, %=33.3; Station 3: f=5, %=19.2) and chicken (f=13, %= 26.0) in their backyard. A similar study was conducted by Barroso and Alava (2012), stating that presence of piggery and livestock can be a source of water pollution through contaminating the water system with the chemicals and waste they release. With rivers, creeks, and other water supply sources contaminated, residents are at risk of having diarrheal diseases.

Table 8

Frequency and Percentage Distribution of Three Stations' Livestock Raising

		Station 1 *N* = 30		Station 2 *N* = 50		Station 3 *N* = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Livestock raising	None	10	33.3	33	66.0	21	80.8
	Pig	10	33.3	2	4.0	5	19.2
	Chicken	9	30.0	13	26.0	0	0
	Duck	1	3.3	0	0	0	0
	Pig & Chicken	0	0	2	4.0	0	0

Another study conducted by Hubbard, Newton, and Hill (2004) observed that major surface water quality problems associated with pathogens had been linked to grazing animals/ livestock population, particularly when they are not fenced out from streams and farm ponds. The same study illustrated that the major water quality concern with grazing animals is the presence of pathogens, which may move from the wastes into surface water bodies or groundwater, making water dangerous for usage (Hubbard et al., 2004).

The waste disposal of the three stations is illustrated in Table 9. It is interesting to note that majority of the residents (f= 33, %=66) in Station 2 dispose of their waste through Dumping. These practices were further validated by the barangay health workers stating that most informal settlers threw their garbage in nearby Sawaga River. This data is evident in their annual report stating that waste disposal is a problem in their barangay. Data further revealed that in Station 1, 33.3% (f=10) of the respondents dump and burn their wastes. In contrast, Station 3 practices segregation of waste as most of them are near the main road where garbage trucks can pass.

In the study of Sankoh, Yan, Tran (2013), uncollected solid waste can obstruct the flow of water in the river and may cause the breeding ground of diseases such as Malaria, Diarrhea, and Cholera. Also, direct Dumping of untreated waste in rivers, seas, and lakes resulted in the accumulation of toxic substances affecting the ecosystem (BDerraik, 2002). It can be deduced that waste disposal is a primary factor for water quality and may cause health effects among residents.

Table 9

Frequency and Percentage Distribution of Three Stations' Waste Disposal

		Station 1 N = 30		Station 2 N = 50		Station 3 N = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Waste disposal	Dumping	10	33.3	33	66.0	5	19.2
	Burning	10	33.3	5	10.0	0	0
	Composting	3	10.0	0	0	0	0
	Segregation	7	23.3	12	24.0	19	73.1
	Dumping & Burning	0	0	0	0	2	7.7

Health profile of respondents in three stations in Sawaga River

Table 10 illustrated the common diseases encountered by residents in three stations. Most of the respondents claimed that they had not experienced water-borne infections for the past three years living in Sawaga River. Nonetheless, data further illustrated that several residents in Station 1 and 3 have diarrhea (Station 2: f=14, %=28, Station 3: f=6, %=23.1), and in Station 1, residents experienced both skin rashes and diarrhea (f=9, %=30.0). CDC (2014) observed that drinking water sources are subject to contamination and require appropriate treatment to remove disease-causing contaminants, leading to adverse health effects, including gastrointestinal illness, reproductive problems, and neurological disorders.

Table 10

Common water/environment related diseases encountered per station

		Station 1 *N* = 30		Station 2 *N* = 50		Station 3 *N* = 26	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Common Diseases	None	11	36.7	18	30.0	13	50.0
	Skin Rashes	4	13.3	9	18.0	4	15.4
	Diarrhea	6	20.0	14	28.0	6	23.1
	Skin Rashes & Diarrhea	9	30.0	9	18.0	3	11.5

In addition, Levallois and Villanueva (2019) observed that among other diseases, water-borne infections cause diarrhea, which kills nearly one million people every year. Also, direct or indirect exposure to contaminated water has been reported to cause a wide range of health–related problems, including dermatological and gastrointestinal issues (Sweileh, Zyoud, Al-Jabi, Sawalha, & Shraim, 2016). Although various studies have confirmed health effects on humans, there is no outbreak reported regarding water-borne diseases in three stations. This data was confirmed by the Barangay Health Workers and officials of the three stations near Sawaga River, stating that there are few cases of water-borne diseases reported but does not warrant any concern. Most of the residents' complaints were associated with their prolonged use of water in the said River.

Relationship between socio-demographic, economic, and sanitation profile to common water-related diseases per station.

The tabular value displayed the Lambda test of association for nominal variables such as sex, civil status, religion, occupation, educational attainment, type of toilet, water source, livestock raising, and waste disposal. It is interesting to note that only the source of water is significant, with a p-value of 0.024 in relation to the reported water-borne diseases of residents in the three stations. These findings mean that by improving the water source, there would be a decrease in water-borne conditions. This scenario is evident in the data gathered where most of the respondents have a Level 3 water source, and most of the residents have not experienced any water-borne diseases.

Table 11

Lambda test of association for nominal variables

Variable	Lambda	p-value
Religion	.016	.654
Occupation	.095	.271
Educational Attainment	.063	.504
Type of Toilet	.048	.176
Source of Water	.206	.024
Livestock	.016	.841
Waste Disposal	.111	.234

* Cannot be computed because the asymptotic standard error equals zero.
Critical Value set @ 0.05

Table 12, on the other hand, displayed the relationship between ordinal variables to the presence of water-borne diseases of the three stations. It showed that age is significant in relation to the water-borne diseases experienced by the residents living near Sawaga River. This data confirms the move to conduct health teachings to adult residents to reduce or eliminate water-borne diseases.

Table 12

Chi-Square Test for ordinal variables

Variable	Pearson Chi-Square	p-value
Income	25.833	.171
Age	39.933	.030

Critical Value set @ 0.05

Total coliform content in Sawaga river per station

The tabular value showed the total coliform content in three stations located near Sawaga River. Data exposed that all stations in three water collection revealed the high total coliform result. According to the Environmental Protection Agency (EPA) in their Revised Total Coliform Rule (RTCR), the Maximum Contaminant Level Goal is set at zero. Meaning the normal coliform that is safe for human consumption and usage is zero. Any number beyond zero may cause waterborne disease outbreaks (EPA, 2013). In a similar study by Seo, Lee, and Kim (2019), the presence of coliform bacteria is found to cause serious illnesses, such as gastroenteritis and diarrhea.

Table 13

Total coliform content in three Sawaga River Station

Station	Test Result 1	Test Result 2	Test Result 3
1	900 MPN/100ml	500 MPN/100ml	240 MPN/100ml
2	1000 MPN/100ml	760 MPN/100ml	350 MPN/100ml
3	680 MPN/100ml	700 MPN/100ml	350 MPN/100ml

The acceptable concentration per 100ml in testing Total Coliform should be NONE detectable per 100ml

Looking back at the three stations' different variables, educational attainment, waste disposal, and livestock raising are common among the three stations. These contributory factors could explain why there is high total coliform content in the Sawaga River. In terms of educational attainment, most of the residents residing near Sawaga are in elementary and high school levels. As Vera-Toscano, Rodrigues, Costa (2017) explained, educational attainment provides individuals with the knowledge and skills to enhance their performance. Education also promotes growth and improvement of one's social capital, including their understanding of water quality practices.

The presence of inappropriate waste disposal is seen in the study. The majority of the residents practice dumping wastes in the nearby Sawaga River. Marques, Silva, Rodrigues, and Coelho (2012) revealed that improper disposal of solid waste leads to contamination of water, thereby altering physical, chemical, and biological characteristics of the environment, which places human health at risk. This practice is highly evident in Stations 1 & 2, where their total coliform result also revealed more than the required MPN.

The last factor seen as contributory to Total Coliform content is the livestock raising practice. The majority of the respondents raise pigs and chickens in their backyard. Wastes of these animals are dumped in open sewage that can flow to the nearby river. According to Hooda, Edwards, Anderson, and Miller (2000), livestock waste, particularly untreated slurry and feces of grazing animals, can carry various bacterial and protozoan pathogens. These practices can contribute to water pollution and affects the water quality of the Sawaga River.

The result of the total coliform of Sawaga river can contribute to residents' water-borne diseases near the river. The high Total Coliform content in the river is an indication that the water is not safe for usage. As confirmed by CDC (2013), the presence of coliform in water not only increases the risk of contracting a water-borne illness but an indication of water pollution.

CONCLUSIONS

Based on the findings of the study, the Sawaga river is polluted and unsafe for human use and consumption. Factors like educational attainment, inappropriate waste disposal, and livestock raising contribute to the high total coliform content of the Sawaga river. Also, the source of water and age are significant variables related to the respondents' water-borne diseases.

RECOMMENDATIONS

The study would like to recommend the following; First, to Higher Education Institutions to conduct similar studies to determine other parameters such as fecal coliform, Heavy metals, and the like in the Sawaga river. Second, to the Local Government to create strategies or initiatives that will preserve the Sawaga River. Third, to the other researchers to conduct in-depth studies of other variables that might contribute to the water quality of the Sawaga River.

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