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Assessment on Qualities of Drinking Water, Ambient Air, and River in Select Barangays in Mariveles, Bataan, Philippines

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ABSTRACT

This quantitative study, employing a Descriptive-Survey Design, investigates assessments on drinking water, ambient air, and river in three barangays - Alas-Asin, Baseco, and Sisiman - within Mariveles, Bataan. A survey-questionnaire instrument, divided into five sections, evaluates various aspects, including water quality, ambient air quality, their effects on health and community, barangay river quality, and respondents' awareness of environmental initiatives. With a sample size of 900 respondents, 300 from each barangay, statistical analysis reveals concerning findings regarding access to safe drinking water, air and water quality issues, and limited community awareness. Recommendations include enhancing access to safe drinking water, improving air quality monitoring, strengthening community engagement, fostering partnerships, and regularly monitoring environmental projects. This research stresses the urgent need for proactive measures to address environmental challenges and promote sustainability in Mariveles, Bataan, emphasizing collaboration among stakeholders for lasting positive change.

INTRODUCTION

Environmental degradation remains one of the most pressing global challenges of the 21st century, threatening both ecological systems and human well-being. The relentless pace of urbanization, industrialization, and climate change has led to significant deterioration of air and water quality in both developed and developing nations (Gonzalez et al., 2023; Zhang & Wang, 2022). According to the World Health Organization (WHO, 2021), over 90% of the world's population breathes air that exceeds recommended pollution levels, and nearly 2.2 billion people lack access to safely managed drinking water services (UNICEF & WHO, 2020). These environmental hazards are no longer distant threats; they manifest in the daily realities of communities, particularly in vulnerable and resource-constrained areas.

In Southeast Asia, the Philippines is experiencing the double burden of economic growth and environmental decline. Rapid urban sprawl, insufficient waste treatment, and poor enforcement of environmental laws have resulted in increasing pollution levels in urban and peri-urban areas (Santos-Borja, 2018; Cruz et al., 2021). For example, recent reports highlight the significant degradation of surface water bodies and worsening air quality in industrial zones (Carreon-Monterola et al., 2020; Balaria & Fernandez, 2019). Despite these challenges, limited research is focused on barangay-level assessments, the smallest administrative units in the Philippines, where environmental issues are often first observed and most strongly felt.

Several studies have stressed the importance of community-based environmental monitoring as a strategy to achieve localized sustainability (Yuan et al., 2021; Alibhai et al., 2022). In contexts like the Philippines, barangays play a pivotal role in frontline environmental management, yet their monitoring efforts remain under-supported, and data-driven assessments are often lacking (Ramos & Florido, 2022; Castillo et al., 2020). Without reliable baseline data, policy development and CSR initiatives remain reactive and fragmented (Lim et al., 2023).

The quality of drinking water in Philippine barangays continues to be a critical issue. While national data report increasing coverage of potable water sources, disparities persist, especially in rural and semi-urban regions (Espaldon et al., 2019). Contaminants such as nitrates, heavy metals, and microbial agents have been reported in local water sources near industrial hubs (Garcia et al., 2022; Da Silva et al., 2017). The lack of regular water quality testing at the barangay level further compounds the issue, leaving households exposed to waterborne diseases and other health risks (Kim et al., 2019; Miller et al., 2021).

Ambient air quality is another environmental concern that has worsened in recent years. The Philippines ranks among countries with high levels of PM2.5 exposure, particularly in industrial towns and port cities (Greenpeace Southeast Asia, 2020). Studies link poor air quality to increased cases of respiratory and cardiovascular diseases, especially in densely populated communities near coal-fired power plants and heavy industries (Liu et al., 2021; Torres et al., 2023). Despite this, citizen awareness of air quality issues remains low, and community participation in air quality monitoring is rare (Chakraborty & Maity, 2022; Park et al., 2020).

Likewise, river systems often vital sources of livelihood and water for domestic use, are under constant threat from industrial waste discharge, illegal settlements, and improper waste disposal (Hoang et al., 2019; Yusof et al., 2021). Barangay rivers in industrial municipalities are showing signs of eutrophication, declining biodiversity, and odor pollution, severely impacting nearby residents (Amoako et al., 2020; Sahin et al., 2022). Local residents often report changes in the water color and smell but lack formal platforms to raise environmental concerns or take part in mitigation efforts (Rahman et al., 2022).

Addressing these issues through a quantitative approach allows researchers to generate statistically significant insights into local residents' experiences, perceptions, and levels of awareness. Through structured survey data, it becomes possible to understand how environmental quality affects health, livelihood, and behavior across socio-demographic segments (Zhang et al., 2021; Al-Rawi & Abdullah, 2023).

This study, therefore, conducts a barangay-level assessment of environmental conditions in selected communities in Mariveles, Bataan, a coastal municipality with a rapidly expanding industrial base. Specifically, it evaluates: (1) the quality of drinking water at the household level, (2) the perceived and observable changes in ambient air quality, (3) the ecological and social functions of barangay rivers, and (4) the community's awareness and involvement in environmental monitoring. These assessments aim to inform long-term Corporate Social Responsibility (CSR) programs, especially for stakeholders like GNPower, and to contribute to the strengthening of grassroots environmental governance.

Aligned with Sustainable Development Goal (SDG) 11: Sustainable Cities and Communities, this study supports local actions that aim to ensure inclusive, safe, resilient, and sustainable settlements. Furthermore, it contributes empirical data that can support national and regional efforts toward SDG 6 (Clean Water and Sanitation) and SDG 13 (Climate Action) by spotlighting the local dimensions of global environmental issues.

MATERIALS AND METHODS

Method and Design

This study employed a quantitative research approach to assess environmental conditions in selected barangays in Mariveles, Bataan. Quantitative research is a systematic investigation that primarily deals with numerical data, enabling researchers to identify patterns, relationships, and trends within a population (Creswell & Creswell, 2018). It is particularly useful when aiming to generalize findings to a larger group through structured data collection tools and statistical analysis (Bryman, 2016; Apuke, 2017).

The adoption of a descriptive-survey design is grounded in the need to provide an accurate representation of the current environmental conditions experienced by residents. Descriptive research is concerned with observing and documenting the characteristics of a particular population without manipulating variables (Kabir, 2016). A survey method, in this context, is advantageous as it allows the collection of self-reported data on specific environmental issues, such as drinking water quality, ambient air condition, and river cleanliness, across a diverse demographic (Lavrakas, 2020).

In line with the study's objectives, the descriptive-survey design was selected to gather quantitative data on three core domains: (1) quality of household drinking water, (2) changes and perceptions regarding ambient air quality, and (3) the environmental and social roles of the barangay river. Additionally, the survey explored residents' awareness of barangay-level monitoring and their participation in local environmental initiatives. These domains were operationalized into measurable variables within the structured questionnaire, which was administered to a statistically selected sample from each target barangay.

According to Neuman (2014), descriptive surveys are instrumental in capturing a "snapshot" of attitudes, perceptions, and behaviors within a population, particularly in studies related to community-based environmental governance. This methodological design enables researchers to document current conditions and inform targeted policy interventions and CSR programs, especially in geographically defined communities like barangays (Bhattacherjee, 2019; Taherdoost, 2016).

The study used closed-ended questions with Likert-scale and multiple-choice formats to ensure the reliability and objectivity of responses. The structured nature of the instrument facilitated quantitative analysis using frequency distribution, percentages, and mean scores. These statistical tools are commonly employed in descriptive studies to summarize large datasets and draw general patterns from community responses (Sekaran & Bougie, 2019; McMillan & Schumacher, 2021).

Through a quantitative approach with a descriptive-survey design, this study aims to produce evidence-based insights into the environmental issues experienced at the grassroots level. This method not only highlights public perception but also provides empirical data necessary for informing policy recommendations, especially those concerning local governance, environmental monitoring, and community-led initiatives. Moreover, the generated data will serve as a foundation for a follow-up research that will propose a long-term Corporate Social Responsibility (CSR) plan and actionable community programs tailored to the barangay context in Mariveles.

Conceptual Framework

In this study, the Proposed Original Model (PMO) was considered in doing a descriptive-survey research:

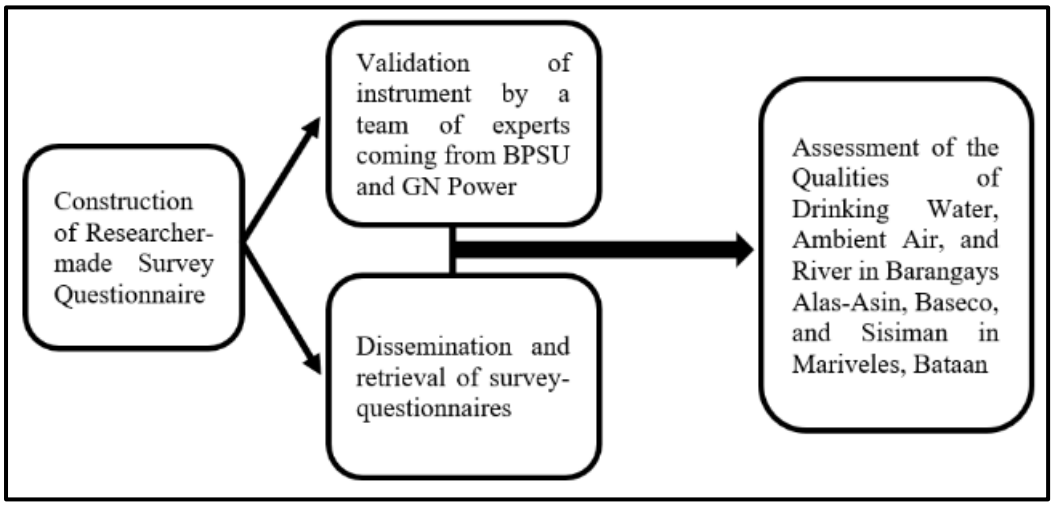

Figure 1. The POM Framework on the Assessment of Qualities of Drinking Water, Ambient Air, and River in Select Barangays in Mariveles, Bataan

In this study, the researcher adopted a Proposed Original Model (POM) to guide the data collection phases, revealing the assessment of environmental qualities in selected barangays. The model begins with the construction of a researcher-made survey questionnaire, specifically designed to gather quantitative data on drinking water, ambient air, and river quality.

Following the construction phase, the survey instrument underwent validation by a team of experts from Bataan Peninsula State University (BPSU) and GNPower. This validation process ensured that the questionnaire met the necessary

standards for reliability and relevance, addressing potential biases and enhancing the overall quality of data collection.

The next phase involved the dissemination and retrieval of survey questionnaires across three barangays in Mariveles, Bataan: Alas-Asin, Baseco, and Sisiman. A total of 900 questionnaires were distributed, with 300 respondents from each barangay participating in the study. This comprehensive approach aimed to capture a wide range of perceptions regarding environmental quality.

Finally, the last phase of the POM focuses on the assessment of the qualities of drinking water, ambient air, and river conditions based on the responses collected. The analysis utilized descriptive statistics to interpret respondents' perceptions quantitatively. It is crucial to note that this assessment relies on residents' perceptions rather than actual scientific testing of environmental qualities.

Through this structured approach, the findings from this quantitative study contribute valuable insights into environmental conditions in Mariveles, Bataan, potentially informing future initiatives aimed at improving local environmental quality.

Population and Sample

This study focused on the residents of three selected barangays in Mariveles, Bataan, as the target population for the environmental assessment. The barangays were chosen based on their proximity to industrial zones and residential communities, ensuring a relevant and context-rich setting for investigating local environmental concerns. To ensure the reliability and generalizability of the data, a probability sampling technique, specifically simple random sampling, was employed in selecting participants from each barangay.

Random sampling is one of the most robust techniques in survey research as it provides each individual in the population an equal chance of selection, thereby reducing selection bias and enhancing representativeness (Etikan & Bala, 2017; Acharya et al., 2013). In total, 900 respondents participated in the study, with 300 respondents per barangay. This equal distribution allowed for consistent and balanced data collection, making comparative analysis across barangays feasible and statistically valid.

The decision to use 300 respondents per barangay is anchored in the principles of survey research, which suggest that larger sample sizes improve statistical power and reduce sampling error (Cochran, 2017; Creswell & Creswell, 2018). According to Israel (2016), a sample size of 300 from a barangay-level population provides sufficient confidence and margin of error for descriptive statistics in community-based environmental research. Furthermore, the large sample enhances the study's ability to capture a broad spectrum of resident experiences, perceptions, and levels of awareness regarding water, air, and river quality.

Participants were randomly selected from official barangay resident lists. Inclusion criteria consisted of: (1) being at least 18 years old, (2) residing in the barangay for at least two years, and (3) willingness to participate in the survey. This ensured that respondents had lived experience in the area and were aware of long-term environmental changes.

Simple random sampling was deemed appropriate for this study due to its neutrality and statistical validity in handling large populations (Kumar, 2019). It also facilitated impartial representation across gender, age, and socioeconomic status factors considered vital in assessing environmental perceptions and lived impacts. The strategy of using one instrument and method across barangays under the same sampling conditions contributes to the internal consistency of the data collection process.

Overall, the use of a large and randomly selected sample reflects the methodological rigor of the research and strengthens the reliability of the findings. This approach allows for a deeper and more accurate understanding of the current environmental conditions in the selected barangays, offering a solid empirical basis for developing local policy recommendations and CSR programs.

Research Instruments

To obtain relevant data aligned with the objectives of this quantitative study, the researchers employed a structured survey questionnaire as the primary data collection instrument. Survey questionnaires are widely recognized tools in descriptive research for gathering quantifiable information from large population groups in a standardized and efficient manner (Dillman et al.,

2014; Creswell & Creswell, 2018). This method is particularly suitable for studies involving environmental assessment, where perceptions, awareness, and observable phenomena must be evaluated across multiple domains.

The survey instrument was designed specifically for this study and was organized into five major sections, each targeting a specific variable group under investigation:

1. Assessment on Drinking Water Quality – focused on respondents' access to water, perceived cleanliness, and the presence of contaminants or irregularities in supply.
2. Assessment on Ambient Air Quality – explored changes in air quality over time and the extent to which these were observed or felt in daily life.
3. Effects on Health and Community – measured perceived health impacts and community-level consequences linked to water and air quality.
4. Assessment on Barangay River Quality– examined the use, cleanliness, and degradation of local rivers as observed by residents.
5. Awareness of Environmental Initiatives– assessed the respondents' knowledge and engagement with barangay-level environmental programs and monitoring activities.

Each section utilized a combination of dichotomous items (e.g., Yes, No, Not Sure) and five-point Likert scales (e.g., Excellent to Very Poor) to allow for both categorical and ordinal measurement of responses. These scale types were selected for their appropriateness in capturing community sentiment and enabling robust descriptive statistical analysis (Taherdoost, 2016; Apuke, 2017). Additionally, certain items included tailored response choices specific to the environmental context of the barangays, enabling deeper exploration of local nuances.

To ensure content validity, the draft questionnaire underwent expert review by environmental science educators, local government personnel familiar with barangay-level environmental policies, and seasoned social science researchers. Their feedback contributed to refining item wording, ensuring clarity and cultural appropriateness of terms, and aligning the items with the intended research objectives. According to Boateng et al. (2018), expert validation is a critical step in survey design that enhances the relevance and precision of instrument items in capturing complex variables.

The structured format of the instrument allowed for uniform administration and interpretation, essential for producing statistically meaningful results. Furthermore, the self-administered nature of the questionnaire minimized interviewer bias and facilitated the efficient collection of responses from a large and diverse population across three barangays.

Overall, the instrument was rigorously designed and validated to meet the analytical demands of the study and reflect the lived experiences and environmental awareness of the community members in Mariveles, Bataan.

Statistical and Data Analysis

To ensure the appropriateness and reliability of data interpretation, the researchers consulted with a professional statistician from the institution to identify the most suitable statistical technique for the study's descriptive research objectives. As the research aimed primarily to explore and report the perceptions of community members regarding the quality of drinking water, ambient air, and river systems in their barangays, descriptive statistics were determined to be the most appropriate analytical approach.

Specifically, the study utilized percentage computation, a widely accepted method in survey-based environmental studies that involve categorical or ordinal data (Sullivan et al., 2017; McMillan & Schumacher, 2014). Descriptive statistics, including frequency counts and percentages, are effective for summarizing and interpreting data collected from large populations, particularly in community health and environmental perception studies (Babbie, 2020; Creswell & Creswell, 2018).

Percentage computation was applied to all sections of the survey to determine the distribution of responses related to residents' access to clean water, perceived air quality, the health and environmental effects of pollution, river conditions, and awareness of local initiatives. This method allowed the researchers to quantify public sentiment in a format that is both easily interpretable and statistically meaningful for planning and policy-making.

According to Gravetter and Wallnau (2017), percentages provide an accessible way to describe how often certain conditions or perceptions occur

within a population. This technique also helps identify trends, common patterns, and disparities between communities, especially when analyzing comparative data from different barangays. The results from each survey item were expressed as a percentage of the total responses per question, thus enabling straightforward comparisons and insights.

In alignment with the study's descriptive-survey design, the use of non-inferential, summary-based statistical methods was justified due to the study's goal of documenting community realities rather than testing causal hypotheses or predictive models (Frey, 2018). This approach facilitated the systematic organization of quantitative findings and contributed to an evidence base that may guide local interventions and follow-up research on environmental management and sustainability.

RESULTS AND DISCUSSION

This section concentrates on the findings and results from the data collected. Part I (3.1) assesses the quality of water in terms of access to safe and trusted water sources at home, quality of water source at home, issues with the quality of water source at home, and awareness of the respondents on the barangay's monitoring activity in the quality of water source in the households. Part II (3.2) assesses the quality of ambient air in terms of respondents' perceptions of the change in the quality of ambient air in the barangay in the past years, concrete effects that are evident on ambient air quality, and respondents' awareness of the barangay's monitoring activity in the quality of ambient air. Part III (3.3) reveals the effects on health and community that are evident based on the results of the assessment of the water source and ambient air quality. Part IV (3.4) assesses the quality of barangay river in terms of use of the river to the residents' daily activities, cleanliness of the river based on respondents' perceptions, issues in the quality of the river, and evident causes and effects of the change in the quality of the river; and Part V (3.5) describes how aware are the respondents in terms of initiatives of the community in dealing with the environmental problems in the barangay.

On the Quality of Water/ Water Source at Home

Table 1. Access to a Safe and Trusted Water Source

Do you have a safe and reliable source of drinking water in your home?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	17	9	274	300
Baseco	0	3	297	300
Sisiman	0	6	294	300
TOTAL	1.89%	2%	96.11%	100%

The study reveals a critical insight into the perceived quality and reliability of drinking water in selected barangays of Mariveles, Bataan. A significant 96.11% of respondents expressed uncertainty about whether their household water source is safe and reliable. This overwhelming uncertainty reflects a broader pattern of water insecurity in low- to middle-income communities, particularly those situated in rapidly urbanizing or peri-urban regions (Sharma et al., 2020; WHO, 2019). The high rate of distrust signals a potential gap in infrastructure, public awareness, and government accountability in ensuring safe water delivery.

Table 2. Safe and Trusted Water Source

What is the safe and reliable source of drinking water in your home?						
Baran-gays	Tap Water	Shallow Well	Deep Well	Free Flow	Others	Total
Alas-Asin	98	92	3	15	92	300
Baseco	85	117	0	0	98	300
Sisiman	102	71	6	0	121	300
TOTAL	31.67%	31.11%	1%	1.67%	34.56%	100%

As reflected in Table 2, the most common water source identified by residents is bottled or commercially purchased water (34.56%), followed closely by tap water (31.67%). The preference for bottled water explains a widening trust deficit in public water utilities, consistent with findings from

Singh et al. (2018), who noted that rising consumer preference for packaged water is often a response to perceived threats in piped water systems. This also reflects trends in Southeast Asia, where reliance on commercial water is increasingly normalized, albeit creating financial burdens on low-income households (Jung et al., 2022).

Table 3. Rating on the Quality of Water Used by Residents for Drinking

If yes, please rate the quality of your drinking water at home						
Barangays	Excellent	Good	Fair	Poor	Very Poor	Total
Alas-Asin	23	96	71	0	0	190
Baseco	32	73	90	7	0	202
Sisiman	28	114	118	13	0	273
TOTAL	9.22%	31.44%	31%	2.22%	0%	73.88%

Regarding the perceived quality of drinking water, 31.44% rated it as "good," while an almost equal number (31%) considered it only "fair." This polarization implies that even where piped or bottled sources are available, concerns about safety, taste, and clarity remain unresolved. Recent studies corroborate this, emphasizing that microbial contamination, aging pipelines, and lack of filtration contribute to mixed perceptions of household water quality (Jamwal et al., 2021; Caruso et al., 2019; Alfaro et al., 2020).

Table 4. Issues with the Quality of the Water Source at Home

Have you experienced any issues with the quality of your home's water source?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	184	8	108	300
Baseco	198	4	98	300
Sisiman	190	17	93	300
TOTAL	63.56%	3.22%	33.22%	100%

Table 4 further indicates that 63.56% of respondents reported experiencing issues related to water quality. This finding parallels Rahman et al. (2020), who documented that urban water systems in developing countries often suffer from inconsistency, poor maintenance, and inadequate monitoring, leading to significant user dissatisfaction.

Table 5. Signs Pertaining to Issues with the Quality of the Water Source at Home

If yes, what water quality issues have you experienced?				
Barangays	With color	Unpleasant Odor	Others	Total
Alas-Asin	104	55	141	300
Baseco	138	33	129	300
Sisiman	126	30	144	300
TOTAL	40.88%	13.11%	46%	100%

Specifically, 46% of respondents described their water as tasting "rusty," while 40.88% observed discoloration. These sensory indicators are critical markers of contamination and have strong psychological effects on users' trust, even in the absence of visible pathogens (UNICEF, 2020; WHO, 2019). Rusty taste and discolored water are often associated with iron content, bacterial presence, or pipeline corrosion issues common in aging water infrastructure in coastal and industrial municipalities (Okullo et al., 2021; Chouhan et al., 2022).

Table 6. Awareness of the Respondents on the Barangay's Monitoring Activity for Water Quality

Do you have knowledge of any water quality testing conducted in our barangay by relevant authorities or organizations?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	78	124	98	300
Baseco	65	118	117	300
Sisiman	51	156	93	300
TOTAL	21.56%	44.22%	34.22%	100%

When asked about barangay-level monitoring, 44.22% of respondents claimed they were unaware of any water testing activities conducted by local authorities or partner organizations. Only 21.56% had knowledge of such initiatives. This lack of awareness suggests either a lack of active monitoring or a deficiency in public information dissemination, both of which hinder participatory environmental management. Khan et al. (2018) emphasize the need for community-inclusive water governance, particularly through barangay-led awareness campaigns and visible public testing results.

Table 7. Respondents' Shared Information on Barangay's Monitoring Activity

If yes, please provide information about the results and any actions taken as a result of the testing: (You may choose one or more)			
Barangays	Through a warning on an unsafe water source	Testing & Cleaning of Water	Others
Alas-Asin	12	9	57
Baseco	21	7	37
Sisiman	18	7	26
TOTAL	5.67%	2.56%	13.33%

Finally, Table 7 highlights that a mere 5.67% of respondents acknowledged having received any warning or information from the barangay regarding unsafe water sources. This low percentage underscores the pressing need for proactive risk communication and transparency in environmental governance. UNDP (2020) and Uddin et al. (2021) advocate for integrating early warning systems, citizen science approaches, and localized health advisories to ensure that residents are informed and protected.

On the Quality of Ambient Air

Table 8. Respondents' Perceptions on the Change in the Quality of Ambient Air in Barangay for the Past Years

Have you noticed any changes in air quality in your barangay in recent years?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	89	55	156	300
Baseco	101	61	138	300
Sisiman	136	22	142	300
TOTAL	36.22%	15.33%	48.44%	100%

Air quality perception among the residents of selected barangays in Mariveles, Bataan, reflects a prevailing sense of uncertainty. As shown in Table 8, 48.44% of respondents reported being unsure whether there had been any change in the quality of ambient air over the past few years. While 36.22% acknowledged that there were changes, this was still counterbalanced by a significant portion of the population unable to discern such environmental shifts. This finding corresponds with studies by Zhang et al. (2020) and the United Nations Environment Programme (UNEP, 2019), which emphasize that public perception of air pollution is often hindered by a lack of environmental literacy, the absence of clear monitoring indicators, and delayed symptom visibility.

Table 9. Concrete Effects that are Evident on Ambient Air Quality

If yes, please describe the changes observed: (You may choose one or more)				
Barangays	Unpleasant Odor	Warm feeling	Having particles	Others
Alas-Asin	23	10	33	23
Baseco	10	13	24	54
Sisiman	67	11	41	17
TOTAL	11.11%	3.78%	10.89%	10.44%

Moreover, the physical indicators of air pollution appear subtle yet impactful. Table 9 indicates that 11.11% of respondents reported experiencing unpleasant odors, while 10.89% observed dirty or dusty air particles. These sensory observations, though reported by a minority, should not be underestimated. Research by Patel et al. (2018) and Zhang et al. (2020) shows that persistent exposure to particulate matter (PM2.5 and PM10), volatile organic compounds (VOCs), and sulfur compounds can contribute to respiratory irritation, cardiovascular disease, and psychological stress, particularly in communities located near industrial zones or transport corridors, conditions similar to some barangays in Mariveles.

Table 10. Respondents' Awareness of Barangay's Monitoring Activity in Air Quality

Do you have knowledge of any air quality monitoring or testing systems conducted in your barangay?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	2	115	183	300
Baseco	0	144	156	300
Sisiman	4	128	172	300
TOTAL	0.67%	43%	56.78%	100%

The level of awareness regarding ambient air monitoring remains notably low. Table 10 reveals that 56.78% of respondents were unsure whether any monitoring or testing activities had been conducted in their barangays, and 43% answered outright "no". This highlights a fundamental gap in public communication and environmental transparency. According to UNEP (2019), access to environmental information, especially air quality data, is critical in empowering communities to demand action and take precautionary measures. The absence of visible, localized air quality monitoring tools such as real-time air quality index displays or mobile air sensors limits residents' ability to correlate environmental changes with health symptoms and lifestyle decisions (Ghosh et al., 2021).

Table 11. Respondents' Shared Information on Barangay's Monitoring Activity for Ambient Air Quality

If yes, please provide information about the results and any actions taken as a result of the testing:				
Barangays	Banning of Cigarettes	Infrequent burning of trashes	Others	Total
Alas-Asin	0	2	0	2
Baseco	0	0	0	0
Sisiman	1	3	0	4
TOTAL	0.11%	0.56%	0%	0.67%

Table 11 further reveals the lack of observable community actions to mitigate air pollution. Only 0.56% of respondents noted infrequent trash burning as an effort by the barangay to preserve air quality. This minuscule percentage highlights a critical weakness in grassroots-level environmental governance. Burning of household waste remains a significant contributor to localized air pollution in rural and peri-urban Philippines, releasing harmful pollutants such as dioxins, furans, and fine particulate matter into the atmosphere (DENR-EMB, 2021; World Bank, 2020).

Taken together, the results from this section emphasize the need for stronger barangay-led

environmental management frameworks, which should include community education campaigns, regular monitoring of ambient air conditions, and policy enforcement on waste management practices. Capacity-building programs and partnerships with environmental NGOs and academic institutions can further equip local governments with the tools to develop air quality interventions rooted in science and community participation. As Zhang et al. (2020) note, citizen involvement in air quality discourse not just as beneficiaries but as informed participants, remains essential in achieving environmental resilience and sustainability.

On the Effects on Health and Community

Table 12. Issues on Health Experienced by the Respondents Based on the Assessed Quality of the Water Source

Have you or any members of your family experienced any health issues that you attribute to the quality of water in our barangay?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	99	17	184	300
Baseco	115	8	177	300
Sisiman	107	21	172	300
TOTAL	25.67%	5.11%	59.22%	100%

Environmental health risks in the barangays studied are underscored by a notable uncertainty among residents regarding the link between their environment and health outcomes. As shown in Table 12, 59.22% of respondents were unsure whether they or their family members had experienced health issues related to water quality. While 25.67% affirmed that such issues had occurred, the dominant uncertainty highlights a potential lack of health literacy and environmental health education. This trend supports the findings of Prüss-Ustün et al. (2019), who emphasize that communities exposed to poor water quality often remain unaware of the long-term health risks, particularly in areas without formal monitoring and public health reporting mechanisms.

Table 13. Specific Issues on Health Experienced by the Respondents Based on the Assessed Quality of Water Source

If yes, what health issues have you experienced? (You may choose one or more)				
Issues	Alas-Asin	Baseco	Sisiman	Total
Poisoned	0	0	0	0%
Stomach Ache	48	63	56	18.56%
Amoebiasis	3	5	4	1.33%
Allergies	18	22	16	6.22%
Skin Disease	4	7	9	2.22%
Others	26	18	85	14.33%

When respondents were asked to specify the health issues they experienced (Table 13), 18.56% reported stomach ache as the most prevalent symptom. This symptom is commonly associated with gastrointestinal infections caused by microbial contaminants such as E. coli, Giardia, and rotavirus, especially in contexts where the primary water sources are not tested regularly. Howard et al. (2018) affirm this pattern, noting that waterborne illnesses often go underreported in rural and peri-urban areas due to weak diagnostic access and fragmented healthcare systems.

Table 14. Issues on Health Experienced by the Respondents Based on the Assessed Quality of Ambient Air

Have you or any members of your family experienced any health issues that you attribute to the quality of air in our barangay?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	101	37	162	300
Baseco	98	44	158	300
Sisiman	86	37	177	300
TOTAL	31.67%	13.11%	55.22%	100%

Similar concerns arise in relation to air quality. Table 14 reveals that 55.22% of respondents were unsure whether air quality had contributed to any health problems, while 31.67% confirmed such experiences. This high level of uncertainty again signals a gap in environmental awareness and public health communication, underscoring the need for active education programs that bridge the connection between environmental degradation and physical well-being. Dockery and Pope (2018) advocate for localized air quality indices, early-warning systems, and integrative health-environment campaigns to increase public awareness, particularly in low-income and industrially exposed communities.

Table 15. Specific Issues on Health Experienced by the Respondents Based on the Assessed Quality of Ambient Air

If yes, what health issues have you experienced? (You may choose one or more)				
Issues	Alas-Asin	Baseco	Sisiman	Total
Asthma	13	10	3	4%
Allergies	6	11	14	3.44%
Cardiovascular Disease	3	4	2	1%
Cough and Colds	72	64	43	19.89%
Skin Disease	7	5	11	2.56%
Others	0	4	3	0.78%

Specific respiratory symptoms were further detailed in Table 15, where 19.89% of respondents reported experiencing cough and colds in relation to air quality deterioration. While these may appear as common illnesses, their persistence or recurrence in polluted environments signals more serious health risks, such as chronic bronchitis, asthma, and reduced lung function, especially in children and the elderly. The findings are consistent with the research of Lim et al. (2018), which connects short-term exposure to airborne pollutants like PM2.5 and nitrogen dioxide to increased respiratory morbidity in both urban and rural settings.

In summary, the results reveal that community health outcomes in the selected barangays are deeply intertwined with environmental conditions, yet awareness remains low. The uncertainty in self-reported health issues points to a critical need for integrating environmental health surveillance systems, barangay-level health education, and collaborative reporting mechanisms between local government units and healthcare providers. Improving diagnostic and information pathways can help communities recognize the health consequences of poor water and air quality, while empowering them to demand cleaner, safer environments.

On the Quality of Barangay River

Table 16. Use of the River to the Residents' Daily Activities

What is the use of the river in the barangay for you? (You may choose one or more)				
Issues	Alas-Asin	Baseco	Sisiman	Total
Source of drinking water	27	18	30	8.33%
Washing clothes	82	117	63	29.11%
Irrigation	56	89	97	26.89%
For fishing	121	130	119	41.11%
Recreational Activities	80	87	103	30%
Others	14	36	28	8.67%

The barangay river continues to serve as a critical natural resource for many residents, with Table 16 indicating its multipurpose use: 41.11% of respondents report fishing, 30% cite recreational use such as swimming, and 29.11% note it is used for domestic chores like washing clothes. These findings underscore the functional dependency of local communities on natural freshwater systems, making river health a vital concern for both livelihood and well-being.

Table 17. Cleanliness of Barangay River Based on Respondents' Perceptions

How clean is the river in your barangay?				
Degree	Alas-Asin	Baseco	Sisiman	Total
Excellent	0	0	0	0%
Good	3	3	5	1.22%
Fair	147	119	172	48.69%
Poor	147	172	121	48.89%
Very Poor	3	6	2	1.22%
TOTAL	300	300	300	100%

Despite the river's role in daily life, residents express deep concern about its current condition. As seen in Table 17, 48.89% rate the river's cleanliness as poor, while 48.69% classify it as fair a nearly unanimous consensus that the river is far from pristine. This perception illustrates the growing dissonance between the community's reliance on the river and its deteriorating state, highlighting an urgent need for coordinated conservation and clean-up initiatives.

Table 18. Change in the Quality of Barangay River

In recent years, have you noticed any changes in the river of the barangay?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	202	17	81	300
Baseco	236	0	64	300
Sisiman	208	8	84	300
TOTAL	71.78%	2.78%	25.44%	100%

The community's awareness of environmental change is evident in Table 18, where 71.78% acknowledge a noticeable decline in river quality in recent years.

Table 19. Signs on the Change of Quality of Barangay River

If yes, what are these changes? (You may choose one or more)				
Issues	Alas-Asin	Baseco	Sisiman	Total
Unclear water	164	200	136	55.56%
Bad smell	88	110	102	33.33%
Color change	43	41	35	13.22%
Soil Erosion	36	101	54	21.22%
Increasing amount of floating objects	87	66	73	25.11%
Increasing algae	80	62	51	21.44%
Decreasing fish catch	33	16	28	8.55%
Others	21	17	32	7.78%

The specific symptoms of this degradation are detailed in Table 19: 55.56% of respondents report that the river water has become unclear, and 33.33% mention a bad smell. These observations suggest the presence of organic and industrial pollutants, possibly including untreated sewage, siltation, or chemical discharge threats that compromise both environmental and human health.

Table 20. Causes of Pollution in the River

In your opinion, what are the reasons for pollution in the river? (You may choose one or more)				
Reasons	Alas-Asin	Baseco	Sisiman	Total
Wastes from factories	103	112	76	32.33%
Soil Erosion	30	72	54	17.33%
Water from dirty farm or mountain	13	23	8	4.89%
Sewer pipe of the toilet	56	69	44	18.78%
Disposal of human waste	97	111	106	34.89%
Others	22	30	15	7.44%

The perceived sources of river pollution are clearly articulated in Table 20, with 34.89% attributing it to the disposal of human waste and 32.33% to waste from factories. These findings are consistent with research by Caruso et al. (2019), which points to the compounding effects of poor sanitation infrastructure and unregulated industrial activities as key contributors to water pollution in developing regions. This supports the need for policy enforcement, waste management improvements, and pollution source tracking at the barangay level.

Table 21. Effects of Pollution in the River

In your opinion, how does a polluted river affect the environment? (You may choose one or more)				
Effects	Alas-Asin	Baseco	Sisiman	Total
Killing of marine lives	80	77	84	26.78%
Increasing algae	33	46	44	13.67%
Destruction of plants and river	132	121	115	41%
Contamination of drinking water	151	170	163	53.78%
Poisoned soil around the river	69	77	92	26.44%
Others	34	50	48	14.67%

The consequences of a polluted river extend beyond aesthetics or usage limitations. As shown in Table 21, 53.78% of respondents believe that river pollution contaminates their drinking water, while 26.78% observe that it has contributed to the decline of aquatic life. These sentiments reflect a broader ecological and public health crisis, where contaminated surface water potentially seeps into groundwater systems or directly impacts human populations through daily contact and consumption. Studies by WHO (2019) and Uddin et al. (2021) support the notion that community water systems interconnected with polluted rivers pose a significant risk for gastrointestinal diseases and biodiversity loss.

The synthesis of Tables 16 to 21 paints a stark but actionable picture: while rivers are deeply integrated into community life, their health is in steep decline due to unsustainable human activities and lack of regulatory oversight. These findings demand a holistic and participatory approach to river management one that includes environmental education, barangay-led clean-up programs, stricter waste disposal regulations, and long-term monitoring efforts. In conclusion, the state of barangay rivers in Mariveles reflects both ecological vulnerability and community reliance, revealing a complex interplay of usage, degradation, and the urgent need for sustainable intervention.

On Environmental Programs

Table 22. Respondents' Awareness on Initiatives of the Community in Dealing with Environmental Problems in the Barangay

Do you have any knowledge of community initiatives to address environmental issues in the barangay?				
Barangays	Yes	No	Not Sure	Total
Alas-Asin	33	111	156	300
Baseco	38	121	141	300
Sisiman	48	128	124	300
TOTAL	13.22%	40%	46.78%	100%

Table 22 reveals a concerning insight into community engagement with environmental programs: 46.78% of respondents are uncertain whether any environmental initiatives exist in their barangay, while 40% firmly state that they are unaware of such efforts. This means that nearly 9 out of 10 respondents lack awareness or knowledge of environmental programs in their localities. Such low levels of awareness suggest a critical disconnect between barangay-level environmental actions and public information dissemination.

This aligns with the findings of Khan et al. (2018) and Uddin et al. (2021), who stress that community education and active information campaigns are foundational to any successful environmental management strategy. Without awareness, residents are less likely to participate in or support initiatives that address pollution, climate resilience, and ecological preservation. Thus, the data underscores the need for more visible, inclusive, and participatory environmental governance at the grassroots level.

Table 23. Evident Initiatives of the Community in Dealing with Environmental Problems in the Barangay

If yes, please provide information about these initiatives or actions:				
Initiatives	Alas-Asin	Baseco	Sisiman	Total
Cleaning of River	0	2	2	0.44%
Banning of waste disposal in the river	5	11	11	3%
Banning of burning of trashes	2	7	4	1.44%
Recycling of waste products	3	1	4	0.89%
Waste segregation	15	5	17	4.11%
Others	8	12	10	3.33%

The situation is further contextualized in Table 23, which shows that only 4.11% of respondents identify waste segregation as the sole environmental initiative in their barangay. While waste segregation is a critical step in reducing environmental impact, its narrow reach and limited implementation among respondents indicate minimal institutional support and low community mobilization. This suggests a lack of diversity in environmental programming and potentially a lack of enforcement or advocacy from local government units (LGUs).

CONCLUSION

The findings of this study stress out the urgent and multifaceted environmental challenges faced by the communities of Mariveles, Bataan. From limited access to safe and reliable drinking water to poor air and river quality, the results reveal a compelling need for immediate, coordinated, and

sustained action. These environmental issues not only affect public health but also pose a threat to sustainable community development and ecological stability.

The study further reveals gaps in public awareness and engagement, suggesting that environmental issues are not only infrastructural and technical in nature but also deeply rooted in informational and participatory deficiencies. Addressing these challenges requires a holistic approach one that combines infrastructure development, policy enforcement, community education, and cross-sector collaboration.

Therefore, it is imperative for all stakeholders local government units, environmental agencies, community leaders, industries, and residents to commit to a shared vision of environmental stewardship. By translating the research findings into actionable programs, the community can lay the groundwork for long-term improvements in environmental health and quality of life. Through continuous collaboration and a collective sense of responsibility, the people of Mariveles can build a more resilient and sustainable future for present and future generations.

Based on the findings of this study, several key recommendations are proposed to effectively address the pressing environmental concerns in Mariveles, Bataan. First and foremost, there is a clear need to enhance access to safe and reliable drinking water. Local government units, in coordination with barangay officials, should prioritize infrastructure improvements, such as upgrading water pipelines, filtration systems, and water storage facilities. Regular water quality testing must also be institutionalized and publicly communicated to ensure transparency and foster public trust. In addition, educational campaigns must be launched to promote awareness of water safety practices, proper storage, and conservation efforts to prevent contamination at the household level.

To improve air quality in the barangays, installing air quality monitoring systems in strategic areas is highly recommended, especially in zones near industrial activities. The data gathered from these systems should guide decision-making and policy adjustments. At the same time, stricter enforcement of environmental regulations is needed to reduce emissions and promote compliance among industries. The local government, in partnership with environmental agencies, should encourage cleaner production methods and support industries in adopting eco-friendly technologies through incentives and technical assistance.

The quality of the barangay rivers must also be addressed urgently. Community efforts to clean and rehabilitate the rivers should be intensified, accompanied by stricter prohibitions against the dumping of human and industrial waste. Local sanitation facilities should be expanded and improved to reduce reliance on river systems for waste disposal. Barangay-led clean-up drives, coupled with information dissemination on the ecological value of rivers, can contribute significantly to preserving these vital water bodies. Establishing river patrol or monitoring groups within the community may further help maintain cleanliness and accountability.

Equally important is the need to enhance community engagement and education. Comprehensive outreach programs such as barangay forums, school-based initiatives, and house-to-house campaigns can be effective in instilling environmental responsibility. These programs should focus on promoting sustainable habits, including waste segregation, recycling, and proper disposal methods. By involving residents in the design and execution of such activities, communities will likely develop a greater sense of ownership and commitment to environmental protection.

Moreover, collaboration among key stakeholders is crucial to the success of any environmental initiative. Partnerships between GNPower, local government units, non-governmental organizations, and community groups must be strengthened to pool resources and share expertise. These collaborations can foster more innovative and scalable environmental solutions, while also ensuring inclusivity and responsiveness to local contexts. Joint programs on reforestation, waste management, and sustainable livelihoods may be explored as part of a broader environmental agenda.

Lastly, regular monitoring and evaluation of environmental projects should be instituted to assess their effectiveness and relevance. Data-driven assessments will help identify strengths, gaps, and areas for improvement. Equally important

is the establishment of feedback mechanisms where residents can voice their concerns, report environmental issues, and provide suggestions for program refinement. This participatory approach will help ensure that environmental strategies remain grounded in the real needs and aspirations of the community.

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