FROM MOUNTAINS TO LOWLANDS: EXPLORING SOLID WASTE MANAGEMENT KNOWLEDGE, ATTITUDE AND PRACTICES IN TANGUB CITY, MISAMIS OCCIDENTAL, PHILIPPINES

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ABSTRACT

Inadequate solid waste management (SWM) continues to be a significant issue, primarily due to gaps in knowledge, attitude, and practices. This study aimed to determine and compare the levels of knowledge, attitudes, and practices regarding SWM among upland and lowland residents of Tangub City, Misamis Occidental, Philippines. A total of 833 respondents, 370 from the upland and 463 from lowland areas, were randomly selected and interviewed using a structured questionnaire with a 5-point Likert scale. The results revealed that participants had relatively adequate knowledge (3.67) and positive attitudes (4.13), but poor actual waste management practices (2.53). Lowland residents showed significantly higher knowledge, suggesting a better access to local government programmes and environmental education. While positive attitude reflects both communities' sense of responsibility and the need to comply with SWM policies, this does not resonate into actual practices, as residents tend to disregard household-level practices and engage more in locally-facilitated initiatives. Only knowledge and attitude showed a moderate significant association with r_s values ranging from 0.48 - 0.61 for both areas, indicating that increased awareness shaped residents' perceptions. The study's findings suggest the importance of enhanced educational campaigns and adequate SWM facilities to encourage community participation and enhance compliance.

Keywords: *solid waste management, knowledge, attitude and practices, community participation*

INTRODUCTION

Solid waste has become a major environmental concern resulting in pollution, loss of biodiversity [1], and health risks to human beings [2]. Population growth, urbanization, economic growth, and industrialization are the drivers of the increase in the production of

solid waste worldwide [3 - 5]. In particular, urbanization intensifies the problem by contributing to greater waste generation and improper disposal practices [6]. Solid waste deposition into existing urban drainage systems (UDSs) further reduces the hydraulic conveyance capacities, thereby increasing the risk of surface water flooding [7]. This led people to move to higher altitudes to avoid low-lying areas susceptible to flooding due to waste accumulation. Developing countries, in particular, face challenges in collecting, transporting, and disposing of solid waste [1]. Municipal solid waste (MSW) originates from various sources, including residential, commercial, institutional, and industrial sectors [8]. The most significant generation of MSW in the Philippines is from residential sources with 70.59 %, followed by commercial sources (25.09 %), industrial sources (2.64 %), and institutional sources (1.70 %) [9]. Organic waste constitutes the largest proportion of the waste from residential sources with a share of 50 %, followed by plastics and paper with 16 %, metals with 4 %, and other materials with 14 % [10].

The Philippine government passed the Ecological Solid Waste Management Act (ESWMA) in 2000 or Republic Act (RA) 9003 to address the looming issues of solid wastes. This Act provides a framework for organized, integrated, and ecological solid waste management programs of local government units (LGUs) [11]. The legislation aims to reduce waste by 25 % through the 3Rs: reduce, reuse, and recycle [12]. The main activities are waste management reduction, segregation, reuse, recycling, proper disposal [13], market linkage for income generation, coordination between LGUs and civil society organizations [14], and composting [15]. Furthermore, the Act outlines the responsibilities of both households and LGUs, including Section 21, 10, 17, and 32. Section 21 mandates the segregation of solid wastes at the household level into biodegradable, recyclable, residual, and special wastes [16, 17]. Section 10 assigns the LGUs as primarily responsible for solid waste collection and disposal, including planning, implementation, and education [18, 19]. Section 17 requires LGUs to develop a 10-year solid waste management plan (SWMP), including waste characterization, collection schedules, and identification of final disposal sites [20, 21]. Additionally, Section 32 mandates the establishment of a materials recovery facility (MRF) in every barangay or cluster of barangays [22 - 24].

Despite these provisions, the effectiveness of the law primarily relies on strict implementation by local governments and communities. In reality, implementation and compliance remain a challenge in many LGUs, especially in developing areas. For example, Tangub City faces increasing migration from lowland to upland areas, leading to increased generation of waste. Improper waste disposal threatens rivers and coastal areas, particularly Panguil Bay, a vital area known for marine biodiversity and ecosystem services. According to the Tangub City solid waste management plan (2019 - 2028), the city is projected to generate 28,575.95 t of residential waste in 2025, with 26,887.09 kg of solid waste per day, accounting for 89.07 % of the city's total waste generation. This makes the residential sector the leading contributor to the city's solid waste stream, far surpassing other sectors. This amount of residential waste requires increased segregation practices, investment in infrastructure, and localized education programs targeting households.

In addition, Tangub City implements a "No Segregation, No Collection" policy, where segregated household waste - biodegradable, recyclable, and residual - is expected to be placed in separate containers or sacks, not in the mandatory standardized color-coded bins. The waste collection is also handled by the City Environment Natural Resource Office and Solid Waste Management Office, with daily garbage collection in urban lowland barangays and weekly or bi-weekly collections in upland areas, depending on accessibility. Despite scheduled collection of non-biodegradable waste (Monday, Wednesday and Friday), biodegradable (Tuesday, Thursday and Saturday) and e-waste, recyclables, and hazardous waste (1st and 3rd Sundays), the absence of actual segregation at the dumpsite undermines residents' efforts to

adhere to proper waste practices. The city's limited logistical capacity, with only three garbage trucks serving all barangays, further weakens implementation. Moreover, pursuant to City Ordinance No. 2014-09-0019, all 33 barangays in Tangub City must establish a materials recovery facility (MRF). However, the actual number of functional MRFs is uncertain, as official documentation and consolidated lists are not publicly available. Currently, some MRFs are either non-operational or exist in name only, particularly in remote upland areas. This limited transparency and uneven implementation present challenges to fully assessing the effectiveness of waste segregation and recycling systems.

Among the most critical reasons for improper waste management are the poor knowledge, attitude, and practices (KAP) of the residents. Sound knowledge is significant for understanding environmental problems [25], whilst good attitude reflects concern and responsibility for the environment [26, 27]. Sound practice in solid waste management (SWM) not only promotes public health, but also enables resource rationalization and sustainable development [28, 29]. Although KAP is very important, it has not been evaluated among Tangub's residents so far. The determination of upland and lowland residents' KAP and its correlation with socio-demographic profiles is therefore essential in informing policies and strengthening community participation in sustainable solid waste management.

MATERIALS AND METHODS

Description of the study area

The research was carried out in Tangub City, renamed as the God-Centred City, located in the province of Misamis Occidental. The geographical coordinates of the city are 8.09592° latitude and 123.684699° longitude, with a total area of 16,572 hectares. Tangub City has a population of 76,213 people, according to 2021 statistics from the City Planning and Development Office's, and is one of the three cities in the province. This study targets the most populous barangays, specifically Bintana and Caniangan in the uplands, and Isidro D. Tan and Sta. Maria in the lowlands (Figure 1).

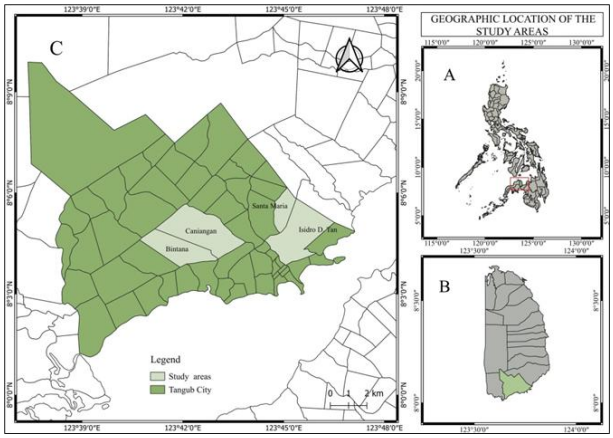

Figure 1. Geographical locations of the sampling areas. Source: QGIS v.3.36.2
Note: A) Map of the Philippines with the province Misamis Occidental highlighted, B) Misamis Occidental and the location of Tangub City, C) the selected barangays: Bintana, Caniangan, Isidro D. Tan and Sta. Maria

Research instrument

The survey has four components: (1) socio-demographic background, (2) questions about awareness of the Republic Act 9003 of 2000 and the SWM-related local ordinances in Tangub City. These include the City Ordinance No. 2014-09-0019, the comprehensive solid waste management of Tangub City which mandates household waste segregation (biodegradable, recyclables and residuals), prohibits open dumping and burning, and requires the establishment of a materials recovery facility (MRF) in each barangay. Other SWM ordinances have also been adopted, including City Ordinance No. 2018-07-016 which regulates the use of plastic bags, plastic cellophane, and expanded polystyrene (styrofoam) and City Ordinance No. 2020-08-023, imposing fee for special garbage collection. However, only the City Ordinance No. 2014-09-0019 is currently

being implemented. Despite these provisions, gaps in implementation and coverage persist, especially in upland areas where MRFs are often inactive or non-existent. The third (3) component are the statements related to attitude towards SWM, and the fourth (4) component deals with typical solid waste management practices. This survey aims to measure the level of knowledge, attitude and practices towards SWM. It is based on a 5-point Likert scale and was adapted from an article [30] that was pre-tested with 30 respondents to confirm quality, clarity, and validity. For this study, minor revisions and contextual modifications were made to suit the local setting. Subsequently, the instrument also underwent content validation by three experts in the field of environmental science to ensure the relevance and clarity of each item.

Respondents of the study

The most populated residential areas in upland barangays are in Bintana and Caniangan with a total of 367 and 324 households, respectively. On the other hand, the lowland barangays of Isidro D. Tan and Sta. Maria had 673 and 458 respondents, respectively. A systematic random sampling method was used to select sample respondents in the identified populated barangays. Slovin's Formula was used in determining the sample size, resulting in a total of 833 respondents. The number was distributed among the four barangays, as follows: 191 respondents in Barangay Bintana, 179 respondents in Barangay Caniangan, 250 respondents in Isidro D. Tan, and 213 respondents in Sta Maria.

Data collection

The study used a mixed-method combining qualitative and quantitative approaches for data collection and analysis. Face-to-face interviews were conducted, with the researchers securing informed consent from respondents prior to the survey to ensure ethical standards and data integrity.

Data analysis

Descriptive statistics such as mean and grand mean were used to represent the knowledge level, attitude and practice of upland and lowland residents towards solid waste management, based on Likert responses. When determining the minimum and maximum intervals of the 5-point Likert scale, the range was computed by subtracting the lowest value from the highest (5 – 1 = 4). This is then divided by five, since this is the highest value of the scale (4 ÷ 5 = 0.80) [31]. This value (0.80) is sequentially added to the lowest value on the scale (1.0) to obtain the ranges or cut-off values for each category [31], as shown in Table 1. Spearman's rank correlation coefficient (rs) was used to examine the association of KAP variables towards SWM. Furthermore, an independent t-test (Equation 1) was performed to assess the differences in KAP between the two communities, with $p < 0.05$ considered statistically significant.

Table 1. Five-point Likert scale with verbal interpretation, and score points and corresponding range of values

Variables			Score point	Range of values (mean)
Knowledge	Attitude	Practices		
Verbal interpretation				
Not at all aware	Strongly disagree	Never	1	1.00 - 1.80
Slightly aware	Disagree	Seldom	2	1.81 - 2.60
Somewhat aware	Agree	Sometimes	3	2.61 - 3.40
Moderately aware	Strongly agree	Often	4	3.41 - 4.20
Extremely aware	Very strongly agree	Always	5	4.21 - 5.00

Independent two-sample t-test formula:

$$t = \frac{(\bar{x}_1 - \bar{x}_2)}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \qquad (1)$$

where is: $\bar{x}$ - sample means of lowland (1) and upland (2), s^2 - sample variances of lowland (1) and upland (2), n - sample sizes in lowland (1) and upland (2).

RESULTS AND DISCUSSION

Assessment of knowledge, attitude, and practices

Knowledge of solid waste management

Table 2 shows that the residents of lowlands in Tangub City were more aware of solid waste management (SWM) (3.87) than the upland residents (3.46). The difference is explained by more regular LGU-initiated activities and learning sessions in lowlands (bi-weekly) than in uplands (monthly). Both groups recorded a high level of awareness of the environmental and health hazards posed by indiscriminate waste disposal (item 10 - 4.78 for the lowland and 4.37 for the upland). Residents have reported suffering from health problems, including dengue and headaches due to improper waste disposal and open burning of plastics, despite knowing that such practices are prohibited (item 6 = 4.21). In upland communities, the clogging of rivers with solid waste served as a barrier, which raised the risk of flooding, especially for people living along riverbanks. Low-lying regions experienced various issues as a result of this improper disposal; water stagnation due to clogging resulted in unpleasant odours from rotting solid waste and dead animals in the canals.

Table 2. Knowledge of upland and lowland respondents about solid waste management

Key indicators	Mean score			Interpretation		
	Upland	Lowland	Combined mean	Upland	Lowland	Combined mean
1. How familiar are you with the Republic Act No. 9003, also known as the "Ecological Solid Waste Management Act of 2000"?	2.51	2.87	2.69	SLA	SWA	SWA
2. Do you know that households are required to construct compost pits?	4.07	4.56	4.32	MA	EA	EA
3. Are you familiar with the local SWM program policy?	2.65	2.81	2.73	SWA	SWA	SWA
4. How aware are you of the materials recovery facility (MRF) in your community?	3.92	4.28	4.10	MA	EA	MA
5. Are you familiar with the purpose of the management in implementing the SWM program?	2.86	3.29	3.08	SWA	SWA	SWA
6. Do you know that illegal dumping and burning of wastes is prohibited?	4.00	4.42	4.21	MA	EA	EA
7. How aware are you of the corresponding sanction of any violation of the ecological SWM ordinances and orders?	3.07	3.52	3.30	SWA	MA	SWA
8. Are you aware of the classification of wastes (biodegradable, recyclable, residual, special, hazardous)?	3.91	4.47	4.19	MA	EA	MA
9. Are you aware of the current status of the SWM in your barangay?	3.20	3.72	3.46	SWA	MA	MA
10. Do you know that improper disposal of solid waste can cause diseases and threat to the environment?	4.37	4.78	4.58	MA	EA	EA
Grand mean	3.46	3.87	3.67	SWA	MA	MA

Note: NA - Not at all aware, SLA - Slightly aware, SWA - Somewhat aware, MA -Moderately aware, EA - extremely aware

Both the upland and lowland respondents were generally aware of the requirement to construct compost pits (item 2 = 4.32), the presence of materials recovery facility (MRF) (item 4 = 4.10), and classification of wastes into biodegradable, recyclable, residual, special, and hazardous categories (item 8 = 4.19), suggesting familiarity with the basic SWM practices. However, awareness of violating the provisions of SWM ordinances (item 7) was comparatively lower (3.30), implying that although communities are aware of proper practices, knowledge of enforcement mechanisms is lacking. In particular, lowland residents recorded the lowest awareness (mean = 2.81) regarding the solid waste management (SWM) program policy (item 3), while upland residents had the lowest awareness (mean = 2.51) of the Republic Act No. 9003 (item 1). This difference indicates knowledge gaps between the two areas, with lowland residents being less aware of local policy implementation, while upland communities are less familiar with national legislation. Their lower mean scores indicate that, although residents recognize the risks of improper disposal, they are not aware of regulatory mechanisms, including the City Ordinance No. 2018-07-016 on regulating the use of plastic and City Ordinance No. 2020-08-023 on special garbage collection fees. Although residents are generally knowledgeable that efficient solid waste management is beneficial, inadequate policy dissemination, campaigns, and signages could restrict their complete awareness and active engagement in efficient waste management practices. These results are consistent with findings from various Philippine KAP studies in both rural and urban settings. For example, a study conducted in Cebu City's upland barangays also revealed low practice scores despite moderate to high levels (2.75) of awareness, attributed to poor infrastructure and cultural practices [7]. Similarly, a study by Molina and Catan (2021) in Zamboanga City showed that senior high school students were aware (3.28) of proper waste segregation, but had poor (2.98) compliance due to lack of support and monitoring [13]. Also, Batacandolo et al. (2024) found that although community awareness of ordinances in Capiz was relatively high (3.65), implementation was inconsistent, limiting behaviour change [32].

This study uniquely provides a comparative KAP assessment between upland and lowland communities within the same city (Tangub), a distinction that has rarely been explored in previous research. This upland-lowland comparison highlights that geographic location and access to city services significantly affect SWM knowledge and practices, contributing to the understanding of spatial disparities in environmental behaviour. According to research, although lowland communities have better infrastructure and access, knowledge is still poorly translated into action, implying that infrastructure must be paired with active implementation and behaviour change strategies. The limited implementation of City Ordinance No. 2014-09-0019 also highlights the necessity of specific educational campaigns on policies, penalties, and procedures, as awareness alone has not ensured compliance due to weak enforcement [32, 33].

Attitude towards solid waste management

Table 3 shows a generally positive attitude (3.95 - 4.30) towards solid waste management (SWM) in Tangub City, indicating favourable perspective toward proper waste disposal. Both communities highly acknowledged the importance of proper SWM (item 1) with a mean score of 4.29. This reflects that a shared understanding is necessary for maintaining a healthy community and sustainable environment. This is complemented by their concern about the prevalent improper waste disposal in their areas (item 4; upland = 3.86, lowland = 4.25). Respondents also highlighted the role of individual responsibility, agreeing that self-discipline is crucial in waste management (item 6, mean score = 4.22). This sense of responsibility extended to the wider environment, as indicated by their strong agreement that SWM contributes to achieving a clean and green community (item 7, mean score = 4.29) and by recognizing the

importance of collective action through community participation for the effective implementation of SWM programs (item 9, mean score = 4.26). Similarly, there was a strong agreement regarding segregation of waste (item 10), where upland residents scored 4.56, and lowland residents scored even higher at 4.75. This implies that both communities had a positive attitude towards the necessity of throwing garbage into the correct segregation bins, as prescribed by the authorities. This positive attitude expressed a sense of responsibility towards the well-being of the community [34], which can be built upon to strengthen sustainable SWM practices, and is aligned with item 8 (upland = 3.95, lowland = 4.33), demonstrating recognition of the 3Rs (reduce, reuse, recycle) as key strategies for waste minimization.

Notably, upland residents expressed a negative sentiment regarding item 3 (3.53), highlighting the lack of regular monitoring and control by the city government over illegal dumping in their barangays, indicating a failure in implementing SWM-related policies, programs, and enforcement measures. This concern is further illustrated in item 5, where upland residents have a relatively similar lower satisfaction (3.61) with the way authorities handle solid wastes. This is attributed to the limited waste collection services in their area which occur weekly or bi-weekly, depending on availability, compared to more frequent collection in lowland barangays. This result suggests that upland residents experience less institutional support, which contributes to their dissatisfaction with SWM.

Table 3. Attitude of upland and lowland respondents towards solid waste management

Key indicators	Mean score			Interpretation		
	Upland	Lowland	Combined mean	Upland	Lowland	Combined mean
1. Proper solid waste management is important.	4.16	4.4	4.29	SA	VSA	VSA
2. Practicing SWM saves money and energy.	3.58	3.85	3.73	SA	SA	SA
3. The city government should conduct regular monitoring and control of illegal dumping of solid waste in your barangay.	3.53	4.06	3.82	SA	SA	SA
4. You are concerned about improper solid waste disposal in your environment.	3.86	4.25	4.07	SA	VSA	SA
5. Satisfied with the way the authorities handle solid waste.	3.61	4.16	3.91	SA	SA	SA
6. Self-discipline in waste management is very important.	4.06	4.36	4.22	SA	VSA	VSA
7. Management of solid waste is a great help in achieving a clean and green environment.	4.20	4.38	4.29	SA	VSA	VSA
8. Waste can be minimized by reusing, recycling and reducing.	3.95	4.33	4.16	SA	VSA	SA
9. Community participation ensure the effective and successful implementation of SWMP.	4.02	4.47	4.26	SA	VSA	VSA
10. It is mandatory to throw garbage into appropriate segregation bins (biodegradable, recyclable, and residuals).	4.56	4.75	4.67	VSA	VSA	VSA
Grand mean	3.95	4.30	4.13	SA	SA	SA

Note: SD – Strongly disagree, D – Disagree, A – Agree, SA - Strongly agree, VSA - Very strongly agree

Furthermore, both communities show a low attitude towards practicing SWM in terms of saving money and energy (item 2), with a combined mean of 3.73. Their responses are attributed to reluctance in practicing SWM, as they feel that it takes up a lot of their time and causes inconvenience in their daily lives. To overcome resistance in adopting SWM practices, this two-way approach is proposed. First, residents need to be properly informed about the immediate benefits of SWM, such as cleaner streets that reduce the risk of diseases. The second is improving SWM practices with easier segregation, more frequent collection, and accessible waste disposal sites. Public education campaigns could also promote a collective sense of environmental responsibility. This is consistent with the findings from Maguindanao Province where municipal residents showed a high level of positive attitudes toward SWM, with a willingness to participate and support segregation efforts [35]. However, attitudes were generally neutral towards practical challenges such as inconvenience or cost, as also reported by lowland residents in this study.

Solid waste management practices

Table 4 shows low to moderate overall participation in Tangub City's solid waste management practices, reflected by a grand mean of 2.53, interpreted as “seldom”. For the individual items, results showed a low engagement by both groups for sustainable practices, such as using kitchen utensils in buying food instead of plastics (item 1= 2.02), recycling (item 3 = 2.47), segregation using three types of bins (item 4 = 2.13), using proper waste containers with cover (item 5 = 2.02) and burying waste in the ground (item 8 = 2.17). All of these activities are labelled as “seldom” practiced, indicating a gap in everyday SWM practices at the household-level. Surprisingly, high participation in waste management activities and programs was reported (item 10) with a mean score of 4.17, suggesting that individuals are willing to participate when initiatives are structured, facilitated and supported by local leadership. This can further be attributed to the active involvement of barangay officials in facilitating and mobilizing residents for community-led activities. This is also confirmed by [36, 37, 38], stating that the role of barangay officials is crucial in formulating effective and sustainable waste management systems, as they not only drive program implementation, but also ensure community participation.

On the contrary, certain practices showed slightly higher engagement, such as the reuse of plastic bottles (item 2 = 2.82) and the use of eco-bags (item 9 = 3.22), which were interpreted as “sometimes” practiced, with lowland residents (3.52) being more consistent than upland residents in using eco-bags. Open burning (item 6 = 2.90) was reported as sometimes practiced, particularly among lowland residents (3.14) despite the awareness of its prohibition. Some respondents claim that they resort to burning as a way of preventing waste accumulation, often when waste collection is delayed or absent.

In contrast, both populations obtained low scores (1.39) for throwing garbage into rivers or canals (item 7). However, this is contradictory to the actual observation as waste is being continuously disposed despite the ban and presence of "no littering" signs. This discrepancy could be attributed to fear of consequences, as respondents are aware that such acts are prohibited, which led them to underreport this practice. The survey further revealed a lack of translation from awareness into behaviour, reflected in low waste segregation (item 4 = 2.13) and the use of single-use sacks instead of reusable bins. These entrenched unsustainable cultural practices hinder behavioural change, requiring stronger community education and active involvement. Similarly, findings revealed that high levels of awareness do not necessarily translate into effective practice in the absence of adequate resources (recycling facilities, recycling schemes), sanctions, and monitoring [39]. Insufficient resources, such as few waste collection trucks and insufficient staff, and inadequate facilities, including non-functional MRFs and a lack of recycling centres,

collectively lead to illegal dumping and poor waste management. In fact, based on a report on the solid waste management sector project in the Philippines, many municipalities suffer from inefficient waste collection, insufficient treatment facilities, and weak enforcement of laws [40], similar to the challenges described in Tangub City. This highlights the importance of investing in facilities, equipment, service delivery, and community involvement to improve participation and outcomes in solid waste management.

Table 4. Practices of upland and lowland respondents regarding solid waste management

Key indicators	Mean score			Interpretation		
	Upland	Lowland	Combined mean	Upland	Lowland	Combined mean
1. Do you use kitchen utensils in buying food instead of plastics?	2.09	1.95	2.02	SE	SE	SE
2. Do you use your reusable waste like plastic bottles?	2.61	2.99	2.82	SO	SO	SO
3. Do you recycle your waste?	2.45	2.49	2.47	SE	SE	SE
4. Do you have three types of bins (biodegradable, recyclable, and residuals) for segregation in your house?	2.28	2.01	2.13	SE	SE	SE
5. Do you have a proper waste container with cover?	2.20	1.88	2.02	SE	SE	SE
6. Do you burn waste in the open?	2.59	3.14	2.90	SE	SO	SO
7. Do you throw waste into a river, canal, etc.?	1.39	1.39	1.39	NE	NE	NE
8. Do you bury solid wastes in the ground?	2.38	2.00	2.17	SE	SE	SE
9. Do you use an eco-bag instead of plastic bag when you buy something?	2.84	3.52	3.22	SO	OF	SO
10. Do you participate in various programs/activities related to waste reduction in your barangay?	3.89	4.30	4.17	OF	AL	OF
Grand mean	2.47	2.58	2.53	SE	SO	SE

Note: NE - Never, SE - Seldom, SO - Sometimes, OF - Often, AL - Always

Relationship between knowledge, attitude, and practices in solid waste management in upland and lowland areas

Upland residents

Table 5 shows that there is significant and strong correspondence between knowledge and attitude (r_s = 0.61, $p < 0.05$), suggesting that increased awareness yields more favourable attitudes towards solid waste management (SWM). Increased awareness and higher awareness were observed among several residents from the uplands, suggesting that the monthly barangay meetings raised awareness and shaped residents' perceptions regarding proper waste disposal. Environmental impacts and education stimulated residents to perform more responsible practices. Practices and knowledge (r_s = 0.25, $p < 0.05$) show a weaker but significant association, indicating that although residents are educated, functional constraints impede correct conduct. For example, inoperative material recovery facilities (MRFs) and inadequate waste infrastructure were the most frequently mentioned constraints.

Table 5. Correlation of knowledge, attitude and practices of solid waste management in upland and lowland areas

Variables	Spearman's (r_s)		p-value	
	Upland	Lowland	Upland	Lowland
Knowledge* Attitude	0.61	0.48	< 0.05	< 0.05
Knowledge* Practices	0.25	0.11	< 0.05	0.02
Attitude* Practices	0.28	0.10	< 0.05	0.03

Practices and attitude (r_s = 0.28, $p < 0.25$) show that attitudes will have an impact on behaviour, but the relationship is weak. Favourable attitudes may not always have a corresponding action as there is limited infrastructure, such as non-operational MRFs, lack of standardized color-coded bins, and failed collection probably due to insufficient garbage trucks available in the city, leaving upland areas less frequently served. These limitations in SWM infrastructure in Tangub City are a reflection of broader systemic issues observed in many LGUs in the Philippines. While RA 9003 mandates the establishment of MRFs and adequate waste collection systems, implementation varies greatly due to budgetary limitations, lack of technical expertise, and poor enforcement mechanisms [14, 15]. In upland barangays, challenging terrain and accessibility issues further hinder regular collection of waste and the establishment of permanent MRFs. Some barangays lack the funds to maintain facilities or hire trained personnel, and in others infrastructure exists only on paper. These shortcomings highlight the need for stronger inter-agency coordination, resource allocation, and monitoring systems to ensure that infrastructure provisions are not only mandatory, but also implemented at the community level, with attention paid to incentives and cultural factors. In addition to structural barriers, cultural factors also contribute to the gap between knowledge and actual SWM behaviour. In both upland and lowland areas, long-standing practices, such as burning leaves in the open or dumping food scraps into backyard pits, are considered "normal" or "harmless," especially in rural households. These habits are passed down through generations and are rarely questioned unless they are directly linked to health threats. Moreover, many respondents view cleanliness simply as removing visible waste from one's home, even if it means dumping it in nearby rivers or vacant lots. This indicates that waste is considered someone else's concern rather than a shared responsibility of the community.

Although this study did not directly investigate religious influences, informal interviews suggested that some residents associate waste with "natural decay," reducing the perceived need for regulated disposal. These cultural mindsets must be addressed through targeted behaviour change campaigns that localize environmental responsibility and redefine community standards of cleanliness and health. This is consistent with [41], which shows that structural support is necessary for behaviour change. These results indicate that the integration of education and infrastructural development is essential. Partnerships between LGUs and NGOs (non-governmental organizations) can improve involvement and reduce barriers. The KAP framework is useful in designing sustainable SWM programs, particularly in rural areas [42].

Lowland residents

Knowledge and attitude are highly correlated (Table 5, r_s = 0.48, $p < 0.05$), indicating that educational activities had a positive impact on residents' attitudes. Participants raised awareness through barangay campaigns, social media, and other platforms, which has motivated many to report adopting more responsible waste management habits due to a better understanding of the health and environmental problems associated with improper waste disposal. The correlations between knowledge and practice (r_s = 0.11) and attitude and practice (r_s = 0.10) were weak, showing a discrepancy between awareness and real behaviour. Respondents cited irregular waste collection, lack of enforcement, and poor facilities as the main obstacles. Some admitted that although they know proper waste management practices, they usually end up using improper disposal due to convenience or community non-compliance.

These results imply that knowledge and attitude, although a prerequisite, are not sufficient. Facilitating systems such as regular garbage collection, strict policy implementation, and available facilities are needed. Public participation, education, and infrastructure need to accompany each other to promote sustainable behaviour change [43]. To improve solid waste management behaviour,

more specific and localized interventions can be recommended. First, a city government can initiate a pilot project of mobile MRF stations in remote upland areas where permanent infrastructure is not feasible due to terrain or cost. These mobile units can be rotated on a weekly basis and are staffed by trained waste handlers. Second, a community-based incentive system can be established, whereby barangays or households that demonstrate high compliance with segregation and collection protocols receive recognition, certificates, or subsidies (e.g., free compost or materials). Third, the institutionalization of SWM modules in primary and secondary education, using interactive and community-based learning formats, can be recommended. These measures are more likely to produce long-term behavioural change than general awareness campaigns. Finally, LGUs can explore public-private partnerships to finance waste infrastructure and increase accountability in the system.

Comparison of KAP between upland and lowland residents

As shown in Table 6, there are significant differences in knowledge ($t = 8.42$, $p < 0.05$), attitude ($t = 7.20$, $p < 0.05$), and practices ($t = 2.74$, $p < 0.05$) between upland and lowland residents, indicating that geographic location significantly affects solid waste management (SWM). These findings support existing literature, which links variations in SWM behaviours to differences in access to information, infrastructure, and enforcement [44].

Table 6. Comparison of KAP between upland and lowland residents

Upland	Lowland	t-value	p-value
Knowledge	Knowledge	8.42	< 0.05
Attitude	Attitude	7.20	< 0.05
Practices	Practices	2.74	< 0.05

Upland residents show significantly lower knowledge of SWM than those in lowlands ($t = 8.42$, $p < 0.05$). This gap is likely a result of better access to education campaigns, media, and structured waste programs in lowland areas. Environmental literacy tends to increase with urbanization and exposure to reliable sources of information [45]. There is also a significant difference in attitude ($t = 7.20$, $p < 0.05$), with lowland residents showing more positive views and greater willingness to engage in proper waste disposal practices. This can come from stronger policy enforcement, social awareness, and community programs [46]. In contrast, upland communities face limited access to waste facilities, weaker government presence, and socio-economic barriers that hinder prioritization of environmental concerns. Behavioural differences are evident ($t = 2.74$, $p < 0.05$), with lowland residents practicing more compliant waste disposal, which is supported by better infrastructure and services. Upland communities often resort to open burning or indiscriminate dumping due to limited systems. Similarly, the National Solid Waste Management Status Report in the Philippines shows that while urban centres (often lowland) benefit from greater waste collection coverage and enforcement of segregation at the source, rural and upland barangays face major challenges such as lacking collection and limited infrastructure, undermining knowledge and positive attitudes toward SWM in upland communities [47]. In addition, a study in an upland urban barangay in Samar confirms this, noting that the area is inaccessible to garbage trucks, which hinders effective waste management [48]. In short, lowland residents show better KAP in SWM. Addressing gaps in upland areas requires targeted education, infrastructure upgrades, and localized policy efforts to promote sustainable waste management practices in different geographic areas.

CONCLUSION

This study assessed and compared the knowledge, attitudes, and practices (KAP) of upland and lowland residents in Tangub City regarding solid waste management (SWM). The findings revealed that lowland residents had significantly higher mean scores in

knowledge (3.87 vs. 3.46), attitude (4.30 vs. 3.95), and practice (2.58 vs. 2.47) than upland residents. Despite generally adequate awareness and favourable attitudes, both groups showed low levels of actual waste management behaviour, indicating a gap between what people know and how they act.

Correlation analysis using Spearman's rank coefficient (rs) showed a strong positive relationship between knowledge and attitude in both areas (rs = 0.61 upland; rs = 0.48 lowland), but there are weak correlations between knowledge and practice and between attitude and practice, indicating that behaviour is influenced by factors above awareness, such as limited infrastructure, weak enforcement, and cultural norms.

Addressing this gap requires localized solutions: improved implementation of existing policies (City Ordinance No. 2014-09-0019, City Ordinance No. 2018-07-016, and City Ordinance No. 2020-08-023), increased access to functional MRFs, especially in upland areas, and targeted education campaigns that emphasize practical action over theoretical awareness. The introduction of mobile MRF units, a reward system for households that comply with regulations, and integration of SWM education into schools are also recommended.

In conclusion, although both upland and lowland communities show potential for effective SWM behaviour, structural and cultural barriers must be addressed through context-sensitive and community-driven interventions to translate knowledge and attitudes into sustainable environmental practices. In addition, future research should validate the residents' KAP (knowledge, attitude and practices) results by conducting research on the quantity and characterization of waste at the household level to assess the effectiveness of waste management practices in reducing waste.

REFERENCES

[1] N. Ejaz, N. Akhtar, H. Nisar, U. Ali Naeem, Environmental Impacts of Improper Solid Waste Management in Developing Countries: A Case Study of Rawalpindi City, Transactions on Ecology and the Environment 142(2010), 379-387. https://doi.org/10.2495/SW100351

[2] P. Gupta, A. Sharma, L.K. Bhardwaj, Solid Waste Management (SWM) and Its Effect on Environment & Human Health, Futuristic Trends in Agriculture Engineering & Food Sciences, Volume 3, Book 4, 2024, IIP Series, 91-101. https://doi.org/10.58532/V3BCAG4P1CH7

[3] I.A. Al-Khatib, M. Monou, A.S.F.A. Zahra, H.Q. Shaheen, D. Kassinos, Solid waste characterisation, quantification and management practices in developing countries. A case study: Nablus District - Palestine, Journal of Environmental Management 91(2010) 5, 1131-1138. https://doi.org/10.1016/j.jenvman.2010.01.003

[4] P. Bhada-Tata, D.A. Hoornweg, What a waste: A global review of solid waste management, Urban Development Series Knowledge Papers, No. 15, Washington, DC: World Bank Group, 2012, 1-116.

[5] V. Srivastava, S.A. Ismail, P. Singh, R. Singh, Urban solid waste management in the developing world with emphasis on India: challenges and opportunities, Reviews in Environmental Science and Bio/Technology 14(2015), 317-337. https://doi.org/10.1007/S11157-014-9352-4

[6] E.I.S. Prieto, An assessment of the solid waste management practices in the upland communities of Cebu City, University of the Philippines Open University, Los Baños, Laguna, 2022. https://doi.org/10.5281/zenodo.6976000

[7] N. Barthelémy, F.M. Fru, N.J. Ludovic, N.N.R. Césaire, Validation of models used for simulating solid domestic wastes and soil sediments flow in urban drainage systems, International Journal of Advanced Research in Science,

Engineering and Technology 3(2016) 12, 3078-3083.

[8] S. Mor, K. Ravindra, Municipal solid waste landfills in lower-and middle-income countries: Environmental impacts, challenges and sustainable management practices, Process Safety and Environmental Protection 174(2023), 510-530. https://doi.org/10.1016/j.psep.2023.04.014

[9] J.M. Ngohayon, J. Tulagan, Analysis and characterization of municipal solid wastes generated in a community in the Northern Philippines, Nature Environment and Pollution Technology 21(2022) 5, 2291-2297. https://doi.org/10.46488/NEPT.2022.v21i05.024

[10] D.G.J. Premakumara, Survey of household solid waste generation and public awareness on waste separation and composting practices in Cebu City, IGES - Institute for Global Environmental Strategies, Kitakyushu City, Japan, 2011. https://www.iges.or.jp/system/files/publication_documents/pub/discussionpaper/2592/Cebu.Survey.Report%5Bfinal%5D.pdf, Accessed: January 21, 2025.

[11] S.V.P. Oandasan, Influencing Factors Affecting the Implementation of Republic Act 9003 (Ecological Solid Waste Management Act) in the Province of Laguna, EPRA International Journal of Research & Development (IJRD) 8(2023) 6, 204-217. https://doi.org/10.36713/epra13628

[12] R. González-Sánchez, S. Alonso-Muñoz, M.S. Medina-Salgado, Circularity in waste management: a research proposal to achieve the 2030 Agenda, Operations Management Research 16(2023), 1520-1540. https://doi.org/10.1007/s12063-023-00373-0

[13] R.A. Molina, I. Catan, Solid Waste Management Awareness and Practices among Senior High School Students in a State College in Zamboanga City, Philippines, Aquademia 5(2021) 1, Article ep21001. https://doi.org/10.21601/aquademia/9579

[14] S.N. Domingo, A.J.A. Manejar, An analysis of regulatory policies on solid waste management in the Philippines: Ways forward, Philippine Institute for Development Studies, Discussion Paper Series, No. 2021-02, Quezon City, Philippines, 2021. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps2102.pdf, Accessed: January 21, 2025.

[15] M.E.C. Caramillo, L.M. Bellotindos, A Study of Policy Implementation and Community Participation in the Municipal Solid Waste Management in the Philippines, Applied Environmental Research 43(2021) 2, 30-45. https://doi.org/10.35762/AER.2021.43.2.3

[16] M.E.C. Bennagen, G. Nepomuceno, R. Covar, Solid waste segregation and recycling in Metro Manila: Household attitudes and behavior, Research Report No. 2002-RR3, Resources, Environment & Economics Center for Studies (REECS), Quezon City, Philippines, 2002. https://nswai.org/docs/Solid%20Waste%20Segregation%20and%20Recycling%20in%20Metro%20Manila.pdf, Accessed: August 18, 2025.

[17] National Solid Waste Management Commission, NSWMC Resolution No. 60, Series of 2013, Resolution providing guidelines for mandatory solid waste segregation-at-source, segregated collection and recovery, and to prescribe fines and penalties for violations thereof, Quezon City, Philippines, 2013. https://nswmc.emb.gov.ph/wp-content/uploads/2018/01/RESO-60-SAS.pdf, Accessed: August 18, 2025.

[18] Department of the Interior and Local Government (Region XII), Memorandum Circular No. 2018-112, Organization or reorganization of the Barangay Ecological Solid Waste Management Committee (BESWMC), July 12, 2018, Philippines. https://region12.dilg.gov.ph/sites/default/

files/issuances/MC2018-112.pdf, Accessed: August 18, 2025.

[19] Ten-Year Solid Waste Management Plan (2019-2028), Paniqui Municipal Government, Paniqui, Tarlac, Philippines, 2023. https://paniquitarlac.gov.ph/wp-content/uploads/2023/05/Solid%20Waste%20Management%20Plan%20(2018-2028).pdf, Accessed: August 18, 2025.

[20] National Solid Waste Management Commission (NSWMC), SWM Updates, January 2019, Philippines, 2019. https://nswmc.emb.gov.ph/wp-content/uploads/2019/02/swm_udpates_jan2019.pdf, Accessed: August 18, 2025.

[21] Republic Act No. 9003 (Ecological Solid Waste Management Act of 2000), Republic of the Philippines, 2000. https://pepp.emb.gov.ph/wp-content/uploads/2016/06/RA-9003-Ecological-Solid-Waste-Management-Act-of-2000.pdf, Accessed: August 18, 2025.

[22] GAIA (Global Alliance for Incinerator Alternatives) and Mother Earth Foundation (MEF), A 10-Step Manual to Implementing a Community Zero Waste Program, March 2022, Quezon City, Philippines. https://www.no-burn.org/wp-content/uploads/2024/06/A-10-Step-Manual-to-Implementing-a-Community-Zero-Waste-Program.pdf, Accessed: August 18, 2025.

[23] Regional Knowledge Centre for Marine Plastic Debris (RKC-MPD), National laws and regulations, The Philippines. Economic Research Institute for ASEAN and East Asia (ERIA), 2024. https://rkcmpd-eria.org/the-philippines/national-laws-and-regulation, Accessed: August 18, 2025.

[24] National Solid Waste Management Commission (NSWMC), Support in the Establishment of MRFs and Closure and Rehabilitation of Open/Controlled Dumpsites, NSWMC Solid Waste Management Division, Philippines, September 18, 2018. https://nswmc.emb.gov.ph/?p=1913, Accessed: August 18, 2025.

[25] G. Liobikienė, M.S. Poškus, The Importance of Environmental Knowledge for Private and Public Sphere Pro-Environmental Behaviour: Modifying the Value-Belief-Norm Theory, Sustainability 11(2019) 12, Article 3324. https://doi.org/10.3390/su11123324

[26] J.J. Momoh, D.H. Oladebeye, Assessment of awareness, attitude and willingness of people to participate in household solid waste recycling programme in Ado-Ekiti, Nigeria, Journal of Applied Sciences in Environmental Sanitation 5(2010) 1, 93-105.

[27] L.C. Zelezny, P.W. Schultz, Psychology of promoting environmentalism: Promoting environmentalism, Journal of Social Issues 56(2000) 3, 365-371. https://doi.org/10.1111/0022-4537.00172

[28] D. Hoornweg, P. Bhada-Tata, C. Kennedy, Environment: Waste production must peak this century, Nature 502(2013), 615-617. https://doi.org/10.1038/502615a

[29] S. Kaza, L. Yao, P. Bhada-Tata, F. Van Woerden, What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, Urban Development Series, World Bank Group, Washington DC, 2018. https://espas.secure.europarl.europa.eu/orbis/system/files/generated/document/en/211329ov.pdf, Accessed: January 21, 2025.

[30] E.N.T. Cando III, K. Burdeos, D. Gonzales, E. Arlan, S.R. Permanes, C. Garcia, Knowledge, Attitude and Practices on Solid Waste Management Among Households in the Urban Communities of Butuan City, Philippines, Journal of Environmental Science and Management 25(2022) 1, 1-8. https://doi.org/10.47125/jesam/2022_1/01

[31] Z.B. Mohammed, D.D. Hankebo, Instructional leadership practices in the primary schools of Siltie Zone, Ethiopia, International Journal of Current Research 11(2019) 11, 8509-8516.

https://doi.org/10.24941/ijcr.36971.11.2019

[32] P.R.B. Batacandolo, H.L.E. Casa, M.D. Villanueva, F.D. Anabo, J.K.A. Ada, M.A.A. Balbino, Community Awareness and Compliance to the Municipal Ordinances in the First District of Capiz, Western Visayas, Philippines, International Journal for Multidisciplinary Research 6(2024) 5, 1-27. https://doi.org/10.36948/ijfmr.2024.v06i05.27715

[33] S. Bagolong, Perspectives of single parents on their roles, rules, rituals and relationships in the community, 2016. https://www.semanticscholar.org/paper/Perspectives-of-Single-Parents-on-Their-Roles%2C-and-Bagolong/573dbdd1427287eaa149b7e6e157e1e591b986d2, Accessed: January 21, 2025.

[34] W. Fadhullah, N.I.N. Imran, S.N.S. Ismail, M.H. Jaafar, H. Abdullah, Household solid waste management practices and perceptions among residents in the East Coast of Malaysia, BMC Public Health 22(2022) 1, Article 1. https://doi.org/10.1186/s12889-021-12274-7

[35] N.M. Laimot-Mamalac, Knowledge, Attitude, and Practices on Solid Waste Management Among Municipal Residents in Maguindanao Province, Global Scientific Journal 13(2025) 3, 1222-1233.

[36] A.M. Alazada, D.C. Magnaye, Greening the Local Solid Waste Management Through Community Participation: Unfolding the challenges and Creating Opportunities for Development Planning, in: Building Resilient and Healthy Cities: A Guide to Environmental Sustainability and Well-being, eds.: A.L. Pisello, I. Pigliautile, S.S.Y. Lau, N.M. Clark (eds), HERL 2022, Advances in Science, Technology & Innovation, Springer, Cham, 2024, 7-24. https://doi.org/10.1007/978-3-031-33863-2_2

[37] M.D.T. Bose, Solid waste management system of Barangay Deet, IAMURE International Journal of Ecology and Conservation 31(2020), 29-53.

[38] S. Rijal, The Importance of Community Involvement in Public Management Planning and Decision-Making Processes, Journal of Contemporary Administration and Management (ADMAN) 1(2023) 2, 84-92. https://doi.org/10.61100/adman.v1i2.27

[39] M.A.E. Aming-Hayudini, M.Y.T. Jaddani, S.I. Habibun, Practices on waste disposal and its environmental effects, International Journal of Multidisciplinary: Applied Business and Education Research 3(2022) 8, 1569-1576. https://doi.org/10.11594/ijmaber.03.08.19

[40] Asian Development Bank, Republic of the Philippines: Solid Waste Management Sector Project, Technical Assistance Consultant's Report, Project Number 45146, December 2014. https://www.adb.org/sites/default/files/project-documents/45146-001-tacr-01.pdf, Accessed: August 18, 2025.

[41] P. Alam, K. Ahmade, Impact of solid waste on health and the environment, International Journal of Sustainable Development and Green Economics (IJSDGE) 2(2013) 1, 165-168.

[42] L.A. Guerrero, G. Maas, W. Hogland, Solid waste management challenges for cities in developing countries, Waste Management 33 (2013) 1, 220-232. https://doi.org/10.1016/j.wasman.2012.09.008

[43] D.C. Wilson, L. Rodic, A. Scheinberg, C.A. Velis, G. Alabaster, Comparative analysis of solid waste management in 20 cities, Waste Management & Research: The Journal for a Sustainable Circular Economy 30(2012) 3, 237-254. https://doi.org/10.1177/0734242X12437569

[44] A. Omran, A. Mahmood, H. Abdul Aziz, G.M. Robinson, Investigating households' attitude toward recycling of solid waste in Malaysia: A case study, International Journal of Environmental Research 3(2009) 2, 275-288. https://doi.org/10.22059/ijer.2009.55

[45] W. Singhirunnusorn, K. Donlakorn, W. Kaewhanin, Household Recycling Behaviours and Attitudes toward Waste Bank Project: Mahasarakham Municipality, Journal of ASIAN Behavioural Studies 2(2017) 5, 17-26. https://doi.org/10.21834/jabs.v2i5.215

[46] K. Govindan, M. Shaw, A. Majumdar, Social sustainability tensions in multitier supply chain: A systematic literature review towards conceptual framework development, Journal of Cleaner Production 279(2021), Article 123075. https://doi.org/10.1016/j.jclepro.2020.123075

[47] Environmental Management Bureau, Department of Environment and Natural Resources, National Solid Waste Management Status Report (2008 - 2018), 2020. https://eeid.emb.gov.ph/wp-content/uploads/2020/07/SOLIDWASTE-LAYOUT_final.pdf, Accessed: August 18, 2025.

[48] E.A. Irene, Solid Waste Management in an Upland Urban Village of Samar, Philippines, The Countryside Development Research Journal 2(2014) 1, 99-106.