

## **Municipal Solid Waste Management in Madang Town**

**Jose Orathinkal, Jacqueline Tama,  
Rawali Kere & Silentia Tulem**

### **Abstract**

This cross-sectional study explored municipal solid waste management in the town of Madang in Papua New Guinea. The participants in this study consisted of 67 people, including town residents and a municipal government authority. The study involved two phases: an interview with the municipal authority of the Madang urban local level government and a house-to-house survey in three selected areas representing differing socio-economic classes. The study used a structured schedule for the interview while a survey questionnaire was used to collect information from three selected areas: Kalibobo, Newtown and Gavstoa. The participants of this study were selected randomly. Findings from the municipal authority and the 66 residential participants showed that solid waste management was a serious problem in the town of Madang. Results indicated that the most common solid wastes were tins and cans in high and middle socioeconomic areas (21%) and organic waste in low-income areas (20%). It also found that the waste collection system was inconsistent and very poorly managed due to insufficient compactors, funds and commitment from workers. Some storage receptacles and disposal methods for urban solid waste were inappropriate and causing environmental pollution, aesthetic and health problems. In light of these findings, the researchers have made recommendations for some practical solutions to the problems of municipal solid waste management in Madang.

### **Introduction**

While environmentalists try to educate people to dispose of trash thoughtfully and appropriately, it can be argued that humans can be careless in their rubbish disposal management practices. Garbologists have discovered that many people let trash fall where it may. There has been a problem of trash management from earliest times of human settlement (Barbalace, 2003). Therefore throughout history, people have developed varied methods to manage solid waste disposal.

### **Terms and definition**

Municipal solid waste, also called urban solid waste, is a type of waste that includes predominantly household waste (domestic waste), with commercial refuse, construction and demolition debris, dead animals and abandoned

vehicles (Cointreau, 1982). The majority of these wastes include paper, vegetable matter, plastics, metals, textiles, rubber and glass (Wolf, 2004).

Municipal solid waste management is the generation, storage, collection, transportation and disposal or recycling of solid waste in small commercial and residential areas. The aim of developing a waste management system in most countries is to protect public health in a way that sustains economic growth, environmental conservation and aesthetics, and is responsive to public demands (World Wildlife Fund, 2009). The authority in control is usually the local authorities in support of public and private sectors. These authorities are usually formed by the government to manage basic services in each province or state of a country. In urban areas, especially in rapidly growing towns of the developing world, problems and issues of municipal solid waste management are of immediate health importance. This has been acknowledged by most governments; however rapid population growth overwhelms the capacity of most urban waste management authorities (Zurbrugg, 2003).

### **Municipal solid waste management problems at global, regional (Pacific) and national level**

The environmental problem of increased generation of solid waste is linked to other issues. These problems come about at different levels which include: global, regional (Pacific) and the national level.

Different researchers have investigated problems contributing to municipal solid waste management. These problems include industrialization, population growth and rural populations shifting to urban centres seeking improved life styles, employment and educational opportunities. As a result, solid waste management has escalated over the past few decades. This has further overloaded existing waste disposal systems that were already struggling to cope in the first place (PNG Office of Environment & Conservation, 2000; Esra & Ibrahim, 2005).

Industrialization has made a major impact to the lives of people by transforming a pre-industrial society into an industrial one. It has led to negative consequences which are now the leading problem of solid waste management. Its concentration of labour into factories brought about the rise of large towns to serve and house the working population in which urbanization has taken place leading to the influx of waste being produced (Wikipedia, *Industrialisation*, 2009).

Comparing developed countries with developing countries, and also urban and rural areas, municipal solid waste management differs. In developing countries, there is a much higher proportion of organic material and considerably less plastics (Wolf, 2004). The large amount of organic matter makes the waste denser, with greater moisture and smaller particle size (Wolf, 2004). Another difference is that, technologies used in industrialized/developed countries are often inappropriate for developing countries. Even garbage trucks are less effective because of the much heavier, wetter, more corrosive quality of their

burden (Wolf, 2004). As a result, waste is not being collected. Again it is also due to developing countries being characterized by unplanned, haphazardly constructed, sprawling settlements with narrow roads that are inaccessible to collection vehicles.

Urbanization is another growing concern to the problem of solid waste management in developing countries. Throughout the developing countries, it is often peri-urban areas that suffer most from the life-threatening conditions deriving from inadequate municipal solid waste management (Zurbrugg, 2003). According to Merz, (2000), there is a lot of movement in Papua New Guinea between the highlands, outer islands and urban centres, which has resulted in an increase in the urban population growth rate of 43 per cent. The report further stated that the increase in urban population places more pressure on municipal solid waste management. The underlying cause of urbanization in Papua New Guinea is that employment opportunities are limited in rural areas therefore intensifying an urban migration that has led to a rapid increase in the quantities of waste that require disposal (Borden & Ward, 2006).

Although Pacific Island countries share many common problems with developing countries in other parts of the world, solid waste management problems in Pacific Island countries are quite unique, requiring special attention by the decision-makers in charge of solid waste management. In many developing countries of the Pacific, equipment has always been a problem in the management of municipal solid waste. Maintenance of equipment, especially sophisticated equipment such as compactor vehicles and incinerators, is quite difficult in Pacific Island countries because of the problems encountered in acquiring spare parts, humid tropical conditions, salty air in coastal regions, and insufficient skilled mechanics

Collection of solid waste in Pacific Island countries is being carried out with a variety of vehicles, many of which are provided under foreign aid programs, predominantly by Australia, New Zealand and the United States of America. With very little attention given to logistics in the past, it is not surprising that very often different models of vehicles by different manufacturers are found in use in one location. Some of these are sophisticated compactor vehicles designed to achieve high collection efficiency under conditions prevailing in developed countries and for the kind of wastes found in those countries. As the conditions found in the Pacific Island countries differ considerably from those of developed countries and the necessary maintenance support is often not available, the operation of such vehicles becomes ineffective and their maintenance becomes a difficult and costly problem. Similar incidences of mismatch between other solid waste management equipment and their intended purposes are also encountered in Pacific Island countries (WHO, 1996).

There is also the problem of the type and volume of wastes generated in the country becoming more abundant and complex as demands for imported canned, plastic-wrapped or bottled goods have increased (PNG Office of Environment & Conservation, 2000). Since the economies of urban settlements are moving towards a cash-based consumer goods society, the volume and

complexity of waste products has increased (South Pacific Regional Environmental Programme, 1999). Most of these wastes are of modern materials which may take many years to break down. This has led to the per capita generation of solid waste increasing by 50%-100% over the last 20 years (WHO, 2008). Solid waste collection systems in many towns cannot cope with the increasing volume of solid waste in which collection service coverage of 70% is not uncommon (WHO, 2008). Upon the commitment made by the Government of Papua New Guinea to the United Nations Framework Convention on Climate Change, the PNG Government has embarked on a number of new initiatives. As future environmental trends will include increased problems of waste disposal, it has opted for ways to reduce waste generation, one of them being the mechanism of education, training and awareness.

Thoughtful and appropriate waste disposal is a priority issue for cleanliness and health reasons. Suitable waste management practices have to be in place to avoid the many problems of improper waste disposal which includes the problem of determining appropriate disposal sites. A repeatedly raised concern related to the increase in municipal solid waste is a shortage of suitable disposal sites where the authorities can dump the waste. The search for environmentally safe and socially acceptable areas for disposal of wastes is an ongoing problem faced by towns and villages (PNG Office of Environment & Conservation, 2000).

Problems have arisen from the increased generation of solid waste and inappropriate or inefficient waste management practices. Many towns face serious environmental degradation and health risks due to uncollected domestic refuse on streets and in public areas, clogged urban drainage systems, and by contamination of water resources near uncontrolled dumping sites (Schertenleib & Meyer, 1992). The effects of mismanagement of municipal solid waste have caused problems to human beings and the environment they live in. The Bubonic plague, cholera and typhoid were diseases that altered the population of countries as a result of waste being discarded improperly. Improper waste management also harboured rats and contaminated the water supply (Barbalace, 2003). With an increase in solid waste, disposal sites tend to become a problem for responsible authorities. There are inadequate sites for the proper disposal of solid waste and there is inadequate waste management undertaken, resulting in quantities of unprocessed rubbish that are a source of disease and pollution either in the form of leaching or from ending up in the rivers as the only perceived method of disposal (Borden & Ward, 2006).

### **The relevance of this study**

This study attempts to identify municipal solid waste management the problems and their causes in the PNG town of Madang. This study is the first of its kind for this location and it is expected to explore the issues related to municipal solid waste management. The results of the study have the potential to inform both public and responsible authorities within the town about underlying issues of solid waste management. The findings could also be

helpful to implement strategies to address the issues that are raised by the public, thereby, helping authorities and town councillors to initiate waste management projects to help communities use better methods to safely dispose of their municipal solid waste at homes and/or around their community.

### **Research questions**

The purposes of the study were to acquire information on garbage collection services and the types of municipal waste generated that pose waste management problems. Findings would assist in formulating appropriate recommendations and strategies to improve current municipal waste management practices. In order to attain the objectives of the study, the following research questions were formulated:

- 1) What are the different types of municipal solid waste generated in and around Madang town?
- 2) What are the common types of disposal methods used?
- 3) What are some of the issues and concerns of municipal authorities with regard to municipal solid waste management?

### **Design of the study**

This was a cross-sectional study in which multiple methods of data collection were used to collect data, such as survey questionnaire, interviews and observation. These qualitative and quantitative methods were used to get people's responses and views regarding the research topic. It was conducted from two different perspectives, that is, the government authority's perspective and the public taxpayer's perspective.

There were a total of 67 participants, 66 from three different areas of the town and one person, a representative from the waste management authorities of the Madang Urban Local Level Government. The three areas selected were Kalibobo, Newtown and Gavstoa representing higher income, middle income and low income residents respectively. Twenty-one participants were randomly selected from the Kalibobo higher income area, 21 participants from the Newtown middle income residents and 24 participants from the low income Gavstoa shanty settlement area. These 66 residents were from different backgrounds, cultures and races, including both Papua New Guinean and international residents. The participants were from different wards in Madang town and the houses and family sizes varied. The areas represented different socio-economic groups. The sole government representative was the Coordinator for Social and Health Services.

The research was conducted using a researcher-made survey questionnaire, an interview schedule and observations. The questionnaire contained eight items all relating to types of waste, disposal methods and concerns regarding municipal solid waste management.

Procedures of this study involved two phases. The first phase involved an interview with the Social and Health Services Coordinator. It was aimed at obtaining background information on the management boundaries, and population distribution in all the wards within Madang, and to identify management problems with regard to employees, collection vehicles and financial issues. Before interviewing the responsible officer, the intention of the study was made clear through a letter that was hand delivered.

The second phase involved developing a questionnaire and pre-testing it in order to avoid errors and ambiguous terms. Further, a house to house survey was conducted among the different socio-economic groups in Madang town. For this phase, questionnaires were handed out to the residents randomly and collected back immediately upon completion. The survey also needed assistance from people who were familiar with the selected areas, therefore four people assisted with the survey.

The collected data from both the survey questionnaires and interview were summarized using descriptive statistics at a Divine Word University computer laboratory.

### **Research findings**

The findings of this study are presented under three different headings: (1) types of municipal solid waste generated; (2) common disposal methods used; (3) the concerns, problems/issues encountered by the municipal authorities.

#### **Types of solid waste generated within Madang town**

Most solid waste produced in Madang town is waste from manufactured products such as food packaging, packets, cartons, rice and flour bags, plastics, bottles and tins/cans. From the survey, it was identified that the most produced waste type within Kalibobo and Newtown areas, was tins/cans with a composition of 21%. However, Gavstoa unlike Kalibobo and Newtown produce about 19% of organic waste.

Figure 1 summarizes the different categories of waste produced in each area according to each level of production. The findings include: high income areas with organic waste 18%, plastics 20%, papers 16%, bottles 19%, others 4% and all 2%. In middle income areas there was 19% organic waste, 20% plastics, 19% papers, 15% bottles, 3% others and 2% all. And for low income areas there was 19% tins/cans, 19% plastics, 19% papers, 19% bottles, 3% others and 1% others.

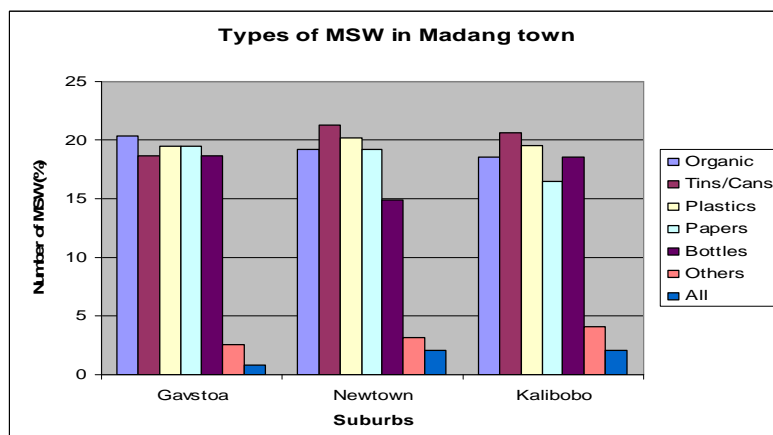


Figure 1: Summary of waste composition in Madang town

### 3.2. Common disposal methods used in Madang town

The final stage of solid waste management is disposal where associated risks to humans or the environment are intended to be minimized. The main disposal methods applied in Madang for the disposal of municipal solid waste were:

1. Open dumping: Disposal of solid waste in Madang is catered for by only one open dump.
2. Composting: Most organic waste created by the residents is usually put as fertilizer for flower beds and vegetable gardens.
3. Sea or river tipping: Solid waste in some areas is being dumped into the river and sea illegally
4. Burning: Combustible solid waste produced in residential areas is mostly burned to reduce waste for collection.

Table 1: Percentage of disposal methods used in Madang town

Methods	High-Income	Middle-Income	Low Income
Put out for collection service	44	45	0
Thrown in sea or river	2	0	59
Other methods	4	2	0
Burning	35	33	29
Burying	6	10	6
Pile up (indiscriminate)	9	10	6
Total	100%	100%	100%

As Table 1 shows, a high percentage of solid waste is put out for collection service by town residents. However, only the Kalibobo and Newtown areas receive waste collection services from Madang Town Council, and thus their wastes are dumped at the main landfill dump at Mero. Collection services done at Kalibobo are scheduled for Mondays and Thursdays, while for Newtown, waste collection is scheduled for every Tuesday and Friday. Collection is not

always effective and sometimes delayed due to vehicle breakdown, workers on strike or residents not paying collection fees.

Unfortunately, for Gavstoa settlement there is no waste collection service. The Social and Health Services Coordinator stated that Gavstoa shanty settlement did not receive waste collection services because it was not regarded as a legal housing area and was not in the zoned boundaries of Madang town for garbage collection. The settlers' solid waste disposal methods included burying, burning, sea or river tipping, or dumping by roadsides or, if possible, taking the rubbish to the Council dump site themselves. From interviews it was learned that some of the residents arranged their own transportation to dispose of their waste at the Mero dump. However, during rainy seasons there were road problems and people hesitated to go to the dump site in fear of scavengers or hold-ups. When they could not get to the dump, the people dumped their waste in the sea, in the rivers along the North Coast Highway, or along the roadsides leading to the dump site. Some burnt papers and plastic products in their backyards and piled up bottles, tins and cans in plastic bags.

### Frequency of collection services

Figure 2 indicates the Kalibobo and Newtown respondents' views on the frequency with which they received waste collection services.

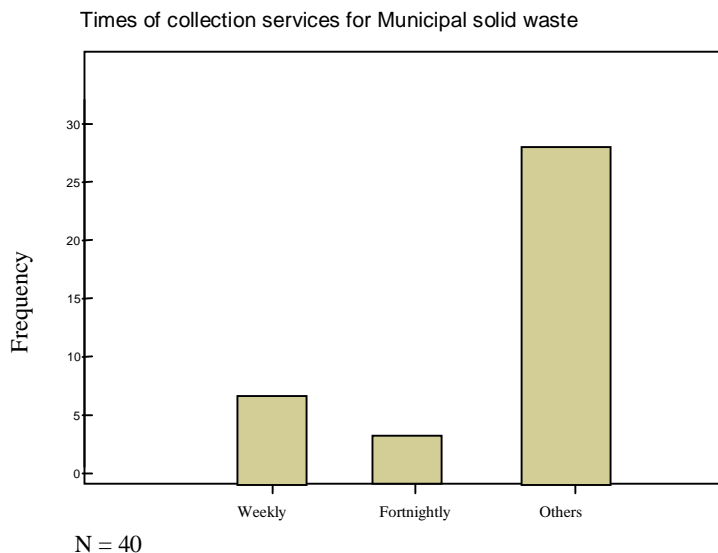


Figure 2: Times of waste collection service provided by the Madang Urban Town council for Kalibobo and Newtown residents in 2009

The column on the left indicates that 17% of the 40 respondents reported a consistent weekly waste collection service. The column in the middle shows that 10% of the 40 respondents reported a consistent fortnightly waste collection service. However the bar on the right indicates that 73% of the 40 respondents reported unreliable and irregular times for waste to be collected.



The data also identified receptacles used by Kalibobo (higher income) & Newtown (middle income) residents for putting out their rubbish for collection. The comparative data for the two areas in Figure 3 indicates: wheelie bins (3-0), standard garbage bins (18-18), 44 gallon drums (5-4), rubbish racks (10-7), plastic shopping bags (26-53), garbage bags (35-14) and others (3-4). The most popular container for the higher income residents was commercial garbage bags (35%) and for the middle income residents it was shopping plastic bags (53%).

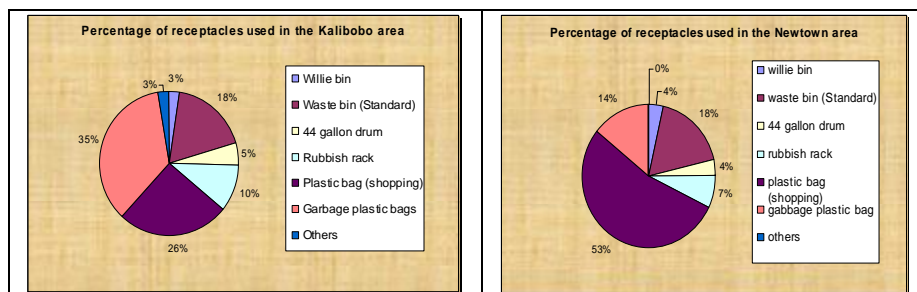


Figure 3: Comparison of waste receptacles used in middle and high-income areas

### Local authorities and municipal waste management

Municipal solid waste collection service in Madang town is a responsibility of the Madang urban local level government. It is headed by the Town Manager and implemented by the Social and Health Services Department. Within this department there is a Coordinator and three officers. They employ several people in town cleaning and maintenance. According to the Social and Health Services Coordinator, effective waste collection in Madang town depends on several factors, such as (1) transport availability, (2) workers' performance, and (3) adequate funds. Following are summarized comments from the interview with the Coordinator.

- 1) *The town council has two six-tonne compactor trucks, an open back Hino dump truck and two two-tonne compactors. Currently these compactor vehicles are under maintenance and thus the Council has to hire two open back Dyna trucks from two business houses to help with the collection. The Council spends a lot of money on hiring vehicles to help with waste collection services when their compactor vehicles are undergoing maintenance. The collection has not been effective because the hired vehicles are not able to cope with the collection in the whole of Madang town. Therefore sometimes the rubbish is not collected in certain areas.*
- 2) *Workers' performance also determines how effective and efficient are the services provided to the residents and business houses. Often workers focus more on waste from business establishments than on residential areas. More time is spent collecting waste around hotels, clubs and the*

*Madang Resort. Many workers have the mentality of receiving gifts in return for their service, even though they are being paid fortnightly by the Council. Another contributing factor is workers' unnecessary strikes, which often lead to duties being left incomplete and no one carrying out the services. Thus the services do not reach all areas as scheduled, contributing to waste accumulation in each household bin, attracting vermin and animals and at the same time causing a nuisance and releasing bad odours to nearby residents.*

- 3) *Collection fees are the only source of funds that support maintenance of collection vehicles. Collection fees are low so that they are affordable by residents. Most of the compactors are purchased overseas and their spare parts are not available in the country. If there is a need to purchase a spare part for a broken-down vehicle, it has to be ordered from overseas. Freight is an additional cost in addition to the products being purchased. To obtain products from overseas is very expensive for a low income earning organization like the town council. There is also a time delay in obtaining the goods when means the collection vehicle is out-of-action and this hinders collection services.*

*These are some of the issues affecting the collection of municipal solid waste by the responsible authority. However, despite these factors we still try our best to provide expected rubbish collection services.*

## **Discussion**

### **Types of waste**

Waste in Madang is an unavoidable by-product of human activities for economic development, urbanization and town life styles. This has led to an increase in the quantity and complexity of waste generation (Zahur, 2007). The findings of this study showed that the residents in Madang town generate many types of household waste. These include plastics, tins, cans, rubber products, scrap metals, food peelings, plants and tree cuttings. The study identified the most common solid waste products of three socio-economic areas. For low-income areas, people mostly produced organic waste, and for the middle and high-income areas there was a high number of tins and cans.

Several reasons have been identified as to why people in these areas generate the different types of waste. The ongoing growth and development of Madang contributes to the town becoming a cash-based society and the problem of illegal settlements by people migrating into the area. Urbanization and living standards in towns lead to an increase in the quantity and complexity of generated waste (Kansal, 2003). Subsistence life styles in villages primarily generate organic biodegradable waste. This is quite different in urban areas.

People in rural areas migrate to towns in large numbers seeking employment, education and a better quality of services and lifestyles. Many do not find employment and they live with relatives or *wantoks* in town housing or shanty

settlements. It is common for a house intended for a married couple and four children to be housing in excess of ten family members. The additional people in a house increase the additional waste that is generated. Feeding a large family in a town is financially challenging and foods such as rice, tinned fish and meat are cheaper than fresh fish or root vegetables from the market. As a result, the purchasing of manufactured food products leads to the generation of solid waste materials that require disposal.

It is suggested that the Provincial government, working in collaboration with the Madang building board, could create a policy to limit the number of people that can live in houses according to the capacity of each house. This is one way to manage the potential quantity of waste generated from individual homes.

Problems and issues of municipal solid waste management are of immediate importance as towns expand their commercial, government and private activities. Urbanization has led to the increase of people residing in Madang town. Karani and Mutunga (2004) noted that the population increase in urban areas of Kenya resulted in a high rate of solid waste generation. The same seems to apply to the Madang private businesses and residential houses. Because the economies of urban towns and its cash based, consumer goods society, the volume and complexity of waste products continually increase (South Pacific Regional Environmental Programme [SPREP], 1999).

With access to shops and supermarkets, urban residents can access processed foods and manufactured household items that are not available in villages and this increases their access to materials that end up being solid household waste. Tins, cans, bags, plastic containers and food wrappers were common items in urban waste, particularly from high and middle income areas. In low income areas, there was a higher proportion of organic waste matter than in high and middle income areas, as low income families supplement shop purchases by establishing and maintaining home-grown garden fruits and vegetables or keeping domestic animals such as chickens. As much of this waste is organic, it can be disposed of through composting.

Municipal tax and fee revenues are not likely to increase with the influx of people. This is due to the fact that of the majority of people moving into the city is likely to be poor migrants from rural areas in search of employment and will be unable to contribute significantly to the revenues of the municipality. Although they may demand marginally fewer services due to their lower level of consumption, they are likely (at least at first) to congregate in the poorer, more densely settled areas, exacerbating the health and sanitation problems posed by these often unplanned communities. For example, in the Gavstoa settlement the number of people has increased creating a lot household waste. As stated earlier, the organic waste can be disposed of by composting, but the tins, cans, bottles, cartons, bags and other solid waste need different methods of disposal. The problem in Gavstoa as in other most settlement areas is that municipal authorities do not provide waste management services.

As the Social and Health Services Coordinator mentioned, the Madang Local Level Government is not providing garbage collection services to the areas where people are living illegally on Government land. This is contributing to a lot of household waste from settlement areas lying around houses or being dumped into the sea, rivers or along the sides of roads, causing environmental pollution. Other settlements in Madang apart from Gavstoa, are Kambramba, Sisiak 2, Sisiak 3; Mero, Wagol and DCA. These are major areas accommodating ever-growing large numbers of people, most of whom are unemployed. All these settlements are without Council garbage collection services. According to the *National Health Plan 2001-2010* (Papua New Guinea Ministry of Health, 2001), one of the unhealthy aspects that predispose individuals and communities to diseases and ill health is poor disposal of solid waste. Thus any form of household waste cannot be ignored by municipal authorities and must have recommended methods for appropriate and hygienic disposal.

### **Common methods of municipal solid waste disposal**

Madang town's main method of disposing of solid waste is through the provision of waste removal or collection services provided by municipal authorities. These wastes are then dumped into a dump site provided by the provincial government which is authorized under the laws of the Independent State of Papua New Guinea. The most common method of disposal is open land filling which is the method adopted by the Madang Local Level Government. In landfills, waste is spread thin, compacted into layers and covered by a layer of clean earth. Pollution of surface water and underground water is minimized by lining and countering the fill, compacting and planting the uppermost cover layer (Bassis, 1995). If the waste is disposed of in open dumps in an uncontrolled manner it can be detrimental to the urban environment (Zurbrugg, 2003).

The Madang landfill dumpsite is located several kilometres outside the main township. The Health and Social service Coordinator stated that the dump had reached its maximum limit covering six hectares of land with a lifespan of 24 years in operation. This site is a contributing factor to water contamination and air pollution caused by poor management, dust, fumes, smoke and particles from open burning which also causes poor visibility for civil aviation and is an unsightly problem aesthetically.

The findings of this the study indicate the need for strategies to educate residents on ways to minimise solid waste generation and apply appropriate and hygienic disposal methods. Some household solid waste disposal habits pose problems. Sometimes, individuals do not remove or store their solid waste properly resulting in messy areas around the home. When the Council is not regular or effective in carrying out collections services, some people choose to dump their solid waste in rivers, seas or illegal dumpsites.

There should be more awareness carried out with residential families to implement waste management strategies for safe disposal methods. In the

awareness programs, the residents should be encouraged to reduce their amount of waste generated by the separation of all household waste. For example, the residents can separate all combustible waste such as paper and plastic from non-combustibles. By separation method, plastics and papers are put out for burning, garden food waste and hedge trimmings for garden compost and tins and bottles can be stored for collection. As a result, the waste originally generated becomes less and does not overflow as observed in the residential areas within the town. These will also reduce the likelihood of household solid waste being a nuisance for the residents, town councillors and the general public. This in turn shows an effective waste management strategy in homes.

The poorly managed open dump for municipal solid waste in Madang makes environmental pollution highly probable. Water sources nearby may be vulnerable to pollution because the dump is located near a river system near which humans reside. Not only is it a danger in polluting the river but in causing vector borne diseases and other illnesses. This is a contributing factor to public health hazards where it is a breeding site for disease-causing vectors such as the rats. Settlements are common around the dump-site area and there could be an outbreak of diseases like the Black Death plague, experienced in Europe in the 14<sup>th</sup> century (*Environmental Code of Practice for Sanitary Landfill Sites* – PNG 2001).

Municipal solid waste is a contributing factor to environmental pollution, public health hazards and aesthetic problems in the areas close to the Madang dump site. There has to be some strategies implemented for municipal authorities to improve collection services and landfill management and for generators of solid waste to reduce their contribution to the landfill dump. At present, there is no control on waste generators at source to minimize the quantity of waste they produce. The research study has identified some of the issues with waste disposal in Madang so that municipal authorities can consider strategies to improve disposal methods.

### **Waste collection problems**

As the population and quantity of waste increases in each Madang household, and with problems maintaining collection vehicles, the Council is finding that it does not have the capacity to provide garbage collection services for the frequency and standard expected. It is time consuming and very expensive for the town authorities to effectively deliver waste collection services when faced with such problems. In most developing countries modern urban living brings on the problem of waste management, which increases in quantity and composition with each passing day (Sanjay, 2004). In Newtown, several residents mentioned that bottles, tins and cans were piled in their back yards and they did not know where to dispose of them.

Collection vehicles are made purposely for certain types of wastes (Wolf, 2004). However, in most towns of Papua New Guinea, the collection vehicles are loaded with large and heavy materials for which the vehicles were not designed, which indirectly contributes to the decline of the vehicles' life span.

Garbage trucks are adversely affected because of the much heavier, wetter, more corrosive quality of their burden (Wolf, 2004). Organic wastes which contain moisture and are dense should be used for compost. Bottles, tins and cans can be separated for recycling.

### **Problems faced by responsible authorities**

As this study has shown, the responsible authorities in the Madang Urban Local Level Government are faced with many problems that affect municipal solid waste management services, particularly in the areas of financial and transportation constraints.

#### **Financial constraints**

The dilemma of inadequate finance to deliver required government services in many developing countries may be due to poor management skills. Government grants, budget allocations and fees charged collectively need to be sufficient to provide an efficient garbage collection service. If fees from residents receiving the service are inadequate to cover the real costs of the service, funding must be allocated from the provincial government budget. Allowance needs to be made for hiring of private vehicles if the experience is that Council vehicles may be unavailable when they are waiting to be repaired. If non-professionals are employed as town litter patrols to collect rubbish from the streets, their salaries must be budgeted for. Workers go on strike if they do the work and there are delays in receiving payment for work done. For urban environmental protection and attractive and hygienic conditions for residents and visitors to Madang, it is essential that solid waste disposal has an adequate financial allocation for necessary services.

#### **Transportation problems**

Transportation is another major problem of municipal authorities in Madang town. Transportation of wastes become harder when there is only one compactor used, the type of material carried in the body of the compactor and the accessibility of the roads. These operational vehicles have frequent breakdowns and, coupled with parts shortages, can immobilize collection vehicles for extended periods. Vehicle breakdowns are the major cause of poor service provided by the responsible authorities. Zerbock (2003) stressed that frequent breakdowns coupled with parts shortages can immobilize collection vehicles for extended periods of time. Most often, this occurs in Madang town with the town authorities seeking funds to assist with the purchase of parts from overseas countries. This is an expensive exercise and frequently lasts for extended periods. This leads to the lack of collection and transportation of solid wastes. Educating people to separate their waste for collection may assist in prolonging the life of vehicles if they are used to carry the type of rubbish for which they are designed.

The chairman of the Madang Chamber of Commerce and Industry estimated that 90 percent of collection/transfer vehicles may be out of action at any one

time. This often resulted in no collection of town waste for several weeks. The chairman also added that there were complications with the roads to the dump at that time and a plan was underway for a new sanitary landfill dump. The roads to the dumps had deteriorated with the weight of the compactors and other dump trucks. It was an issue because, at the time data was collected for this study, municipal solid waste was not being transported to the dump. This solid waste was being dumped on vacant government land, seafronts, parks or storm water drains. This has caused much environmental pollution and drain blockage in the main town resulting in local flooding during periods of heavy rain.

### **Summary**

This cross-sectional study examined the existing municipal solid waste management problems in Madang town. There were a total of 67 participants involved in providing data for the study. One participant was the social and health services coordinator from the government municipal authorities and the other 66 were town residents. The study involved two phases: a desk interview and a house-to-house survey in three selected areas representing high, medium and low income socio-economic classes. The participants were randomly selected randomly from Kalibobo, Newtown and Gavstoa Settlement areas. The study used a researcher-made questionnaire to collect information from the selected areas while a structured schedule was used for the desk interview.

The main findings of the study are as follows.

- The most common wastes generated are tins and cans from high and middle socioeconomic group and organic waste in low-income areas.
- Disposal methods in Madang include: open dumping, composting, sea/river tipping, burying and burning. The most common are open dumping and sea/river tipping. Waste collection services are provided to the high and middle income areas, but no services are provided to illegal settlements on government land.
- Municipal authorities dump collected waste at the public landfill dump at Mero. However, Gavstoa Settlement does not receive waste collection services and most of their wastes are tipped into the sea. Within Kalibobo and Newtown the waste collection system is unreliable and inconsistent due to inadequate compactors, funds and workers' commitment.
- Concerns and issues encountered by the municipal authorities include: not enough compactor vehicles, workers' poor performance in carrying out their assigned duties effectively, lack of funds to purchase vehicle spare parts and inadequate wages for workers.
- The storage receptacles and disposal methods applied to municipal solid waste were inappropriate and contributing to environmental pollution, aesthetic and health problems.

### **Limitations of this study**

Some limitations of the research were evident. The sample size of this study was small considering the total number residents in the three areas that were selected for the study. The researcher made questionnaire was written in English resulting in some residents misinterpreting the questions, as *Tok Pisin* is the main language used in and around Madang. Interview meetings with various officers were delayed or postponed due to their unavailability at the office during official working hours. Strikes by some of the grounds-men delayed observation. The researchers intended to observe collectors of litter at work, but at the scheduled time these workers went on strike, and observations were postponed to a later time. Some of the male workers were unethical in their work. One particular grounds-man who accompanied the female researchers was verbally harassing them, asking them for phone numbers and causing them to feel uncomfortable. Meeting with the government personnel was difficult to arrange because of their busy schedules. The researchers intended to conduct a desk interview with four senior town government authorities on municipal solid waste management practices. Unfortunately, they conducted only two interviews with these responsible authorities.

### **Recommendations**

Based on the findings and experience of this study the following recommendations are made.

1. That a follow up study be conducted using a bigger sample size involving more localities in and around Madang.
2. That home composting be promoted as a desirable method for residents to dispose of household organic matter such as vegetable peelings, food waste, plant trimmings and leaves. This provides benefits to home gardens for waste that would otherwise be taken to the landfill dump. Environmental Health Officers could initiate public awareness programs through various forms of media.
3. That recycling be encouraged for individuals, families, businesses and the local authorities. It turns materials that would otherwise become waste into valuable resources. Collecting and sorting used bottles, cans, and newspapers and taking them to a collection facility is the first step that generates a host of financial, environmental and social returns. There exist scrap metal and can recycling companies in Madang and a small scale business for plastic containers. Residents should be encouraged to recycle these materials to lessen their municipal waste.
4. That waste reduction at source be encouraged by discouraging excessive and unnecessary packaging of products. Source reduction of waste is the practice of designing, manufacturing, purchasing, or using materials in ways that reduce the amount or toxicity of waste created. This approach can help reduce waste disposal and handling costs, because it avoids the cost of recycling, municipal composting, land filling and combustion. It is



the best approach because it conserves resources and reduces pollution, including greenhouse gases that contribute to global warming.

5. That relevant sectors of the Madang community collaborate to devise a strategic plan for ongoing activities for public awareness of sanitary ways to manage solid waste disposal and the health and environmental effects of improper management.

### Conclusion

The concurrent effects of urbanization, population growth, financial constraints, vehicle maintenance, poor roads and squatter settlements, present a challenging framework for municipal waste management services. The inability of the Local Level Government to meet the demands at an ideal standard is a serious health and environmental issue for the town of Madang. The result of this study has shown that there are many wastes generated that accumulate in residential areas, squatter settlements and illegal dumpsites. The dumping of solid waste in rivers, the sea, on vacant land and along the sides of roads is totally undesirable. The problems with the Mero landfill dump need to be overcome quickly and a suitable, alternate landfill site established. An adequate level of financial resourcing must be achieved to enable suitable vehicles to be purchased and maintained and workers' salaries to be paid. The practices of reduce, re-use and recycle must be promoted through public education and awareness programs to alleviate pressure on government garbage collection and disposal services. Where necessary, training must be provided for people responsible for municipal solid waste management so that a sustainable system is in place for the collection, transportation and processing of urban solid waste. These are issues for not only the well-being of the Madang urban community, but also other communities throughout Papua New Guinea.

### References

- Barbalace, C.R. (2003). *The History of Waste*, environmental chemistry. [Online] Available: [environmentalchemistry.com](http://environmentalchemistry.com)
- Bassis, L. (1995). *Waste Disposal*. USA, [Online] Available: [www.solidwastemag.com](http://www.solidwastemag.com)
- Borden, W. & Ward, G. (2006). *Country Environmental Profile of Papua New Guinea*. European Union, [Online] Available: [ec.europa.eu](http://ec.europa.eu), Census, 2000, National Statistics Office
- Cointreau, S.J. (1982). *Environmental Management of Urban Solid Wastes in Developing Countries: A Project Guide (1<sup>st</sup> ed.)*. World Bank, Washington DC.
- Kansal, S. (2003). *Urbanization and Municipal Solid Waste Management: A Critical Analysis of Existing Municipal Solid Waste Management Practices in Mumbai*. [Online], Available: [www.ihdp.uni](http://www.ihdp.uni)
- Karani, P. & Mutunga, C. (2004). *Waste Water Treatment and Improved Sanitation*. [Online], Available: [www.beainternational.org](http://www.beainternational.org)
- Merz, S. K. (2000). *Solid Waste Characterisation*. [Online], Available: [www.sprep.org](http://www.sprep.org)

- Papua New Guinea Ministry of Health (2001). *National Health Plan 2001-2010, Chapter 7-Section 7.3 Sustainable Development and Healthy Environment*. Ministry of Health, Papua New Guinea.
- Papua New Guinea Office of Environment & Conservation (2000). *Initial National Communication: Framework Convention on Climate Change*. [Online] Available: [www.unfccc.int](http://www.unfccc.int)
- Posanau, P. (2009). Coordinator health and social service, Madang urban local level government. Interviewed June 16<sup>th</sup>.
- Sanjay, K.G. (2004). *Rethinking Waste Management, Karmayong-India*. [Online] Available: [www.indiatogether.org](http://www.indiatogether.org)
- Schertenleib, R. & Meyer, W. (1992). *Municipal Solid Waste Management in Developing Countries Problems and Issues, Need for Future Research*. [Online], Available: <http://www.bvsde.paho.org>
- South Pacific Regional Environmental Programme (1999). *Guidelines for Municipal Solid Waste Management Planning in Small Island Developing States in the Pacific Region*. [Online] Available: [www.sprep.org](http://www.sprep.org)
- Wikipedia (2009). *Industrialization*, [Online] Available: [www.wikipedia.org](http://www.wikipedia.org).
- Wolf, S. (2004). *Municipal solid waste management in developing countries, Nigeria*. [Online] Available: [www.dnr.cornell.edu](http://www.dnr.cornell.edu)
- World Health Organization (1996). *Guides for Municipal Solid Waste Management in Pacific Island Countries*. [Online] Available: [www.wpro.who](http://www.wpro.who)
- World Health Organization (2008). *Waste management*. [Online] Available: [www.wpro.WHO](http://www.wpro.WHO)
- World Wildlife Fund (2009). *Green Recovery Programme*. [Online] Available: [www.worldwildlife.org](http://www.worldwildlife.org)
- Zahur, M. (2007). *Solid Waste Management of Dhaka City: Public, Private Community Partnership*. Bangladesh, BRAC University.
- Zerbock, O. (2003). *Waste Reduction in Developing Nations*. [Online], Available: [www.cee.mtu.edu/peacecorps](http://www.cee.mtu.edu/peacecorps)
- Zurbrugg, C. (2003). *Solid Waste Management in Developing Countries*. [Online], Available: [www.eawag.ch/organisation](http://www.eawag.ch/organisation)

### Authors

Dr Jose Orathinkal is a Divine Word Missionary from India. He holds a PhD in Public Health from Kuleuven in Belgium. His research interests are mental health, couples' conflicts and relationship issues. He lectures in the Faculty of Health Sciences at the Divine Word University, Madang. Jacqueline Tama, Rawali Kere and Silentia Tulem were final year students in the Bachelor of Environmental health program at DWU at the time the research was conducted.

Email [orathinkal@dwu.ac.pg](mailto:orathinkal@dwu.ac.pg)