Solid Waste Management in the Pacific
Appropriate Technologies

INTRODUCTION

Effective management of municipal solid waste (MSW) in Pacific developing member countries (DMCs) is difficult because of several country-specific characteristics. These include limited land area, customary land ownership; environmental fragility; limited human and financial capacity; and in some countries, a heavy reliance on tourism. The challenges mean that selecting technologies that are appropriate to the physical and socioeconomic context of Pacific DMCs is critical for improving solid waste management (SWM) in the region.

SWM includes the collection, transport, minimization, recycling, and disposal of wastes. Although SWM systems are operated in 15 urban areas of the 14 Pacific DMCs covered in this assessment, the coverage, reliability, and efficiency of these systems, and their impacts on public health and the environment, vary considerably.

WASTE COLLECTION AND TRANSFER

MSW is a general term for nonhazardous solid wastes. Households and commercial and institutional establishments, such as shops, offices, schools, and public and government buildings generate MSW. MSW includes non-hazardous wastes from industrial facilities, green waste, street sweeping waste, and small amounts of hazardous household waste. The quality and reliability of data on the amounts and types of MSW generated in the Pacific region's urban areas is highly variable. An estimate shows that the region's per capita MSW generation rate is 0.45 kilograms (kg) per person per day. Surveys indicate that this includes a high proportion of organic waste (up to 60%); followed by paper, plastic, metal and glass, collectively contributing a further 30% or more by weight.

Although fledgling waste segregation and recycling initiatives exist in Pacific DMCs, the vast majority of MSW is collected, dumped on vacant areas or in the ocean, or collected in piles and burned. The illegal dumping of waste is a key challenge for many Pacific DMCs, as is the burning of MSW. Both are extremely dangerous practices. Waste burning (low temperature incineration) releases carcinogenic and otherwise harmful chemicals into the atmosphere, and contributes to climate change.

As shown in Table 1, in many cases, government municipal waste collection services collect only a small proportion of MSW generated, estimated to be as low as 20%–30% in some cases. MSW collection is also often complicated where municipal service boundaries are unclear, such as in the cities of Honiara and Port Moresby that are struggling to provide services to the extensive and growing informal settlements around their perimeter.

In the Pacific DMCs various containers are used to store MSW for collection by agencies, including steel oil drums, plastic bags, and wheelie bins. In Fiji, Papua New Guinea, and Samoa, raised storage platforms are common to keep scavenging animals away from MSW. These platforms range from flimsy wooden structures to properly manufactured steel ones. Timor-Leste has a unique system of "brick-and-mortar" storage facilities to store MSW, which has to be transferred to smaller containers for uploading to the collection vehicles, a time-consuming process. As also shown in Table 1, MSW collection frequencies are highly variable. Several cities, such as Apia (Samoa), operate daily waste collection services to highly urbanized areas. In areas where services are regular, the collection frequency is from two to three times per week. It is estimated, however, that many of the urban areas surveyed collect less than half of the MSW generated, resulting in large populations being

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Table 1 Municipal Solid Waste Collection Systems in the Pacific Developing Member Countries

Pacific DMC	Urban Area	Waste Collection System Coverage (Where Known)	Waste Collection Frequency (Where Known)
Cook Islands	Rarotonga	High	6 times per week
Fiji	Suva	High	3 times per week; 6 times per week for central area
Kiribati	Tarawa		Once per week; twice for large generators
Marshall Islands	Majuro	Low	Once per week
Federated States of Micronesia	Kosrae	Low	Variable, sporadic
	Pohnpei		One per week; twice per week for businesses
Nauru	Yaren		Daily
Palau	Koror		
Papua New Guinea	Port Moresby	Low	Generally twice per week
Samoa	Upolu (Apia)	90%	Twice per week, daily for large generators
Solomon Islands	Honiara	Low	Variable, sporadic
Timor-Leste	Dili		Daily
Tonga	Tongatapu	65% urban 20% rural	Once per week
Tuvalu	Funafuti	80%	Variable, sporadic
Vanuatu	Port Vila	50%	Variable, sporadic

DMC = developing member country, MSW = municipal solid waste.

Source: Author estimates.

without municipal collection services at all. This is causing serious environmental and public health impacts.

All of the urban areas surveyed have truck fleets to transfer MSW directly to their respective disposal sites. Transfer stations are not yet used in the Pacific DMCs surveyed, although in Fiji, the Department of Environment is currently contemplating the construction of a transfer station to reduce haulage costs to the Naboro disposal site, located 24 kilometers (km) from Suva city center. The waste transfer vehicles used are primarily open-topped dump trucks of variable sizes, and have a limited number of compactor trucks.

For many island groups, MSW collection and transfer services are extremely difficult to operate and maintain. Waste amounts are relatively small and often spread over large areas. Roads are often narrow and in poor condition, resulting in time-consuming waste transfers to small vehicles, which are subject to excessive wear. MSW pickups are often manual rather than automated. These constraints often result in significant costs per ton for MSW collection and transfer, frequent system breakdowns, and poor overall reliability.

In many Pacific DMCs, equipment provided through external development assistance is not suitable for their conditions. For example, compactor trucks that are widely used in developed countries are not always the best suited to Pacific DMCs. The bulk of the wastes in Pacific DMCs is organic, which means that waste is already dense and the potential for compaction is limited. Fuel costs and maintenance requirements are higher, especially where roads are not well-paved. Specialized skills are needed to maintain and repair compactor trucks. Regular trucks may be better suited to countries with limited human and financial resources.

Many of the SWM departments responsible for the urban areas need to consider ways to increase MSW collection coverage, and improve service levels and operational efficiencies. The existing situation requires an assessment, starting with surveys of the volumes and characteristics of MSW being generated, and the waste generators being served. Only from this information can a waste collection logistics assessment be completed, to define the precise location of MSW generators, amount of MSW that they generate, and most efficient way to collect and transport the MSW to a designated disposal facility. The result of this analysis should be a definitive MSW collection program, complete with the most efficient collection vehicle complement, route maps, and schedules. Global positioning systems can be fitted to collection vehicles to track their movements.

WASTE MINIMIZATION AND RECYCLING

Reducing the quantity of solid waste to be transported and disposed of is a key SWM goal. This is done by minimizing and recycling wastes.

Several recycling initiatives have been, and continue to be, pilot tested in the Pacific DMCs. Such initiatives are summarized in Table 2. So far, however, only the consolidation and export of ferrous and nonferrous metals to international gateway ports that have proven commercially sustainable over the long term, if at times only marginally sustainable. Commercial metals recycling operations exist in most of the Pacific DMCs. Different metals are collected and exported for sale. At the other end of the recycling spectrum, many households and communities segregate or divert certain wastes from the waste stream. These include food waste for animal feed; green waste for compost; and the ad hoc reuse of items of perceived value, such as plastics and glass bottles.

Table 2 identifies a host of other initiatives that are being, or have been, tried particularly in the Cook Islands, Fiji, Kiribati, the Marshall Islands, the Federated States of Micronesia, and Palau. Their initiatives include the small-scale recycling of paper and cardboard, plastics (particularly polyethylene terephthalate), crushed glass (for construction and as landfill cover), batteries, and tire shredding; and a pilot e-waste program. Unfortunately, these initiatives cover only a small fraction of the total waste streams of these Pacific DMCs, and their long-term sustainability is not assured.

There are two basic and obvious reasons for the difficulty of economically driven recycling programs being sustained in the Pacific DMCs. First, the costs to collect, consolidate, and transport recyclable materials to distant international markets are high. And second, local secondary markets are extremely limited or nonexistent in the Pacific island countries for many recycled products, due to the limited size of these economies that subsequently limits opportunities to establish new recycling industries. Also, practically all island governments have yet to formulate and implement national waste minimization and recycling programs, complete with recycling targets, and incentive and enforcement mechanisms, although many are considering such initiatives. Several governments are also considering innovative ways to gradually make recycling sustainable by imposing levies on imported materials and introducing redemption programs.

There is a growing realization by many Pacific DMC governments that waste reduction and recycling practices are now critical issues, as they cannot any longer sustain

Table 2 Formal Recycling Initiatives in the Pacific Developing Member Countries

Pacific DMC	Urban Area	Recycling Initiatives	Green Waste	Metals	Paper	Plastic	Glass	Others
Cook Islands	Rarotonga	Commercial-scale metals and batteries export, small amounts of paper and polyethylene terephthalate plastic, and glass used as for concrete blocks and road aggregate	–	✓	✓	✓	✓	✓
Fiji	Suva	Green waste composting; microrecycling of plastics, paper, and waste oil; and commercial-scale scrap metals recycling	✓	✓	✓	✓	–	✓
Kiribati	Tarawa	Pilot scrap metal barging operation; e-waste recycling planned; container deposit scheme for aluminum cans, plastic bottles, and batteries	–	✓	–	✓	–	✓
Marshall Islands	Majuro	Micro paper fuel briquette, metals recycling, composting, tire shredding, and battery recycling	✓	✓	–	✓	–	✓
Federated States of Micronesia	Kosrae	Beverage container (aluminum, glass, plastic) and battery deposit scheme; scrap metal recycling	–	✓	–	✓	✓	✓
	Pohnpei	Aluminum beverage redemption and recycling initiative (circa 2011)	–	✓	–	–	–	–
Nauru	Yaren	Limited segregation of green wastes for valuable topsoil creation	✓	–	–	–	–	–
Palau	Koror	Recycling of metals, plastics, paper, and glass; and composting and tire shredding (circa 2011)	✓	✓	✓	✓	✓	✓
Papua New Guinea	Port Moresby	Two commercial metals exporters	–	✓	–	–	–	–
Samoa	Upolu (Apia)	One commercial metals exporter, and tire shredding operation being planned	–	✓	–	–	–	–
Solomon Islands	Honiara	Limited to commercial, small-scale metals recycling and export	–	✓	–	–	–	–
Timor-Leste	Dili	Limited scrap metal exports, and microscale paper exports	–	✓	✓	–	–	–
Tonga	Tongatapu	Aluminum, steel, plastic, paper, cardboard, batteries, scrap metals	–	✓	✓	✓	–	✓
Tuvalu	Funafuti	One commercial small-scale metals exporter, other programs curtailed, and composting being piloted	✓	✓	–	–	–	–
Vanuatu	Port Vila	One commercial small-scale metals exporter	–	✓	–	–	–	–

— = not available, DMC = developing member country.

Source: Author estimates.

increasing levels of waste generation. This is particularly acute in several smaller island countries, where waste dumping and burning practices are having significant adverse impacts on pristine environments, causing serious ecological destruction and threatening economies heavily dependent on tourism.

There are also groups of informal recyclers that scavenge the dumpsites in certain Pacific DMCs. These disadvantaged groups work in dangerous and unhealthy conditions to scratch out a living by sifting through piles of garbage at the dumpsites, dumping grounds, and scattered waste piles to segregate and recover recyclables from the wastes. They also purposefully set fire to the wastes to recover metals from the waste piles, a most dangerous practice.

Governments need to prioritize the formulation of waste minimization and recycling policies, laws, and regulations to establish or enhance existing policy and regulatory frameworks. These initiatives should include measurable and achievable targets for waste minimization, waste reduction, segregation, and recycling; and provision of funding and other means necessary to ensure that the targets are met.

A paradigm shift is required on the funding of waste minimization and recycling initiatives, moving away from the belief that Pacific DMC recycling should be based exclusively on the resale value of the recycled materials. It is not economically viable to collect, store, process, transport,

and resell many of the recycled materials locally or in foreign ports.

Additional financial, economic, environmental and social benefits should also be considered in the "recycling equation." First, for every ton of MSW diverted and recycled from the waste stream, there are direct and measurable savings in the collection, transfer, and disposal of a ton of waste. These savings are considerable in the Pacific, as on a cost-per-ton basis, island transfer and disposal costs are high. If these expenditures are avoided through diversion and recycling, it then follows that a proportion of the savings should be invested in the recycling activity that achieves the savings. Second, savings are achieved in the reduction of crucial scarce land used for landfills, and enormous savings in the land destroyed by dumpsites. And third, there are many other environmental and social benefits resulting from waste reduction. MSW minimization and recycling opportunities should therefore be reassessed, prioritizing the evaluation of funding and assistance innovations for recycling. These could include import duties on materials, redemption programs, reduced taxation for recycling entities, subsidized export costs, preferential loans, and investments in and support for small-scale localized recycled material industries.

WASTE TREATMENT AND DISPOSAL

A significant amount of MSW generated in many Pacific DMCs does not enter the municipal system, being illegally dumped on vacant areas or burned, resulting in significant environmental damage. In some countries, this amount may exceed 70% of the total MSW generated. This is a serious issue for many island countries. The situation is often much worse outside the main urban areas, where in many cases, municipal SWM systems do not exist at all.

After limited waste diversion and recycling, residual MSW is generally dumped without further treatment. Rarotonga (the Cook Islands) is an exception, with MSW being baled prior to disposal to reduce its volume and extend the service life of the existing landfill facility. Broadly, there are two systems being used in the Pacific DMCs for waste disposal: open dumpsites (referred to simply as dumpsites), and upgraded systems that include engineered disposal sites (called landfills). As shown in Table 3, there are seven urban areas surveyed that currently use dumpsites and eight have upgraded to landfills.

Dumpsites use the most basic waste disposal methodology. This is where wastes are dumped in

Typical waste collection vehicle

Photo by M. Iyer

Table 3 Municipal Solid Waste Disposal Sites

Pacific DMC	Urban Area	Engineered Disposal Sites	Open Dumpsites
Cook Islands	Rarotonga	▮	
Fiji	Suva	▮	
Kiribati	Tarawa	▮	
Marshall Islands	Majuro		▮
Federated States of Micronesia	Kosrae	▮	
	Pohnpei		▮
Nauru	Yaren		▮
Palau	Koror	▮	
Papua New Guinea	Port Moresby		▮
Samoa	Upolu (Apia)	▮	
Solomon Islands	Honiara		▮
Timor-Leste	Dili		▮
Tonga	Tongatapu	▮	
Tuvalu	Funafuti		▮
Vanuatu	Port Vila	▮	

DMC = developing member country.
Source: Author estimates.

piles, directly unto the ground, without any engineered environmental protection systems. Dumpsites are largely unfenced, unrestricted, and open areas, where wastes are dumped in an unsupervised, ad hoc manner.

Where equipment to spread out the wastes is not available, dumpsites conventionally develop through the deposition of individual, adjacent waste mounds with a thickness of 2 to 3 meters, due to the fact that the incoming vehicles are unable to traverse to the top of existing mounds to dump more wastes. Where spreading equipment is available, vehicles can traverse over progressive waste layers, with the wastes reaching thicknesses of 10 meters or more. Invariably, dumpsites cover large land areas compared with the volume of wastes deposited. The resulting waste piles are rarely covered, needlessly exposing people and the environment to the wastes directly, and the dangers that this brings. Being uncovered, the wastes are also exposed to precipitation, greatly accelerating the formation of harmful liquids, known as leachate. It emanates from the base and sidewalls of the waste piles, contaminating the land, surface water, and groundwater resources. Leachate can also generate gases, which are potentially toxic, explosive, and contribute to global warming; and it can contain a mixture of organic and inorganic contaminants including heavy metals, posing a significant threat to humans and the environment.

Waste collection in Timor-Leste

Photos by M. Iyer

Composting in Dili

Photo by M. Iyer

Dumpsites pose serious risks to waste workers at the facilities and surrounding communities, and lead to significant habitat imbalance and destruction. In the Pacific DMCs, dumpsites also attract large numbers of waste scavengers, who are also exposed to health hazards.

International best practice favors the use of sanitary landfills for solid waste disposal, extensive site preparation, fencing, full leachate and gas control, compaction, and daily cover. They have higher initial investment costs and are expensive to operate and maintain compared with controlled dumps, and are therefore beyond the financial means of many island countries in the Pacific. The urban areas of Rarotonga (Cook Islands), Nuku'alofa (Tonga), and Suva (Fiji) have modern engineered sanitary landfills that approach or meet international standards, financed through external development assistance. The Government of Fiji has opted to contract out the management of Naboro landfill to a private sector operator, with the required technical capacity to manage the landfill.

Controlled dumps provide a more viable solid waste disposal option for Pacific DMCs because of their lower capital investment, operation, and maintenance costs. In Apia (Samoa), Koror (Palau), Kosrae (the Federated States of Micronesia), and Port Vila (Vanuatu), the Japanese International Cooperation Agency and Secretariat of the Pacific Regional Environment Programme have worked closely with their respective government counterparts to develop controlled semi-aerobic landfill facilities, known as "Fukuoka landfills." While these facilities lack certain components of leachate and landfill gas collection and treatment systems, they represent a dramatic improvement over open dumping methods. These facilities generally include site security and management; gatehouse complex; proper internal access roads; and defined landfill cells with compacted earth basal areas, rudimentary leachate and gas collection systems, and leachate treatment. They include improved operational practices in vehicle movements and waste deposition methods.

However, landfill facilities need land, which is not easily available in many of the Pacific island countries. In some cases, there is simply the lack of physical space, such as on Rarotonga (Cook Islands), where the existing landfill is coming to the end of its life. In other cases, most of the land is owned by communities under customary rights; and agreement cannot be reached with landowners to lease land for waste disposal purposes, as in the case of Honiara (Solomon Islands).

In small island countries that face land constraints, making the construction of landfills unsuitable, incineration of wastes has the benefit of reducing the volume of solid

Photo by N. Allen

Illicit waste dumping in Port Moresby

wastes by up to 90%. Incineration of MSW, or waste-to-energy (WTE) plants that transform solid waste into energy, are used in many parts of Asia and Europe, as well as in island countries, such as Bermuda and the Canary Islands.

While incineration could offer several advantages to smaller Pacific DMCs, incineration plants have very high capital, operation, and maintenance costs. In the case of WTE, energy sales can partially offset costs. However, overall costs still tend to be higher compared with solid waste disposal using conventional sanitary landfills. Also, the operation of these plants requires highly skilled personnel. Incineration of solid waste produces dioxins, a toxic substance needing costly and complex control measures for its capture. Incineration also produces toxic ash, which must be properly disposed of.

Many Pacific DMCs have received small incinerators through external development assistance to dispose of hazardous medical waste. The fact that many of these are nonoperational or improperly operated shows the challenge of using incineration as a means of solid waste disposal in the region. This technology would likely be viable only when public–private partnership arrangements were used. Private operators could provide the required technical capacity to properly operate waste incineration plants. However, adequate financing would remain a significant constraint.

The Government of the Marshall Islands is currently considering a WTE proposal for a 15-year build-operate-transfer contract with a private sector investor, which could reduce the volume of wastes entering Majuro's dumpsite by around 90%.

It is recommended therefore that Pacific DMCs operating open dumpsites should initially upgrade their facilities to controlled dumpsites, emulating the "Fukuoka method" of facility development or higher standards if possible. This would mean upgrading existing facilities, or building new facilities; in either case, it is essential that improvements be implemented soon. Technical and operational improvements are also recommended for the seven upgraded disposal facilities, to fully meet recognized international standards. ■

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