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PROFILE

Regionalization of Municipal Solid Waste Management in Japan: Balancing the Proximity Principle with Economic Efficiency

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Abstract The proximity principle—disposing of waste close to its origin—has been a central value in municipal solid waste (MSW) management in Japan for the last 30 years and its widespread adoption has helped resolve numerous ''Not in My Backyard'' issues related to MSW management. However, MSW management costs have soared, in large part because of aggressive recycling efforts and because most MSW is incinerated in a country that has scarce landfill capacity. In addition, smaller, less sophisticated incinerators have been closed because of high dioxin emissions. Rising costs combined with the closure of smaller incinerators have shifted MSW management policy toward regionalization, which is the sharing of waste management facilities across municipalities. Despite the increased use of regionalized MSW facilities, the proximity principle remains the central value in Japanese MSW management. Municipal solid waste management has become increasingly regionalized in the United States, too, but different driving forces are at work in these two countries. The transition to regionalized MSW management in Japan results from strong governmental control at all levels, with the central government providing funds and policy direction and prefectures and municipalities being the primary implementing authorities. By contrast, market forces are a much stronger force with US MSW management, where local governments—with state government oversight—have primary responsibility for MSW management. We describe recent changes in Japan's MSW programs. We examine the connections between MSW facility regionalization, on the one hand, and, on the other hand, the proximity principle, coordination among local governments, central government control, and financing mechanisms.

Keywords Japan · Municipal Solid Waste · Regionalization · Proximity Principle

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Municipal solid waste (MSW) management in Japan revolves around the proximity principle, the notion of managing waste close to its source. This principle has strongly affected facility siting decisions in the past three decades, starting with the ''The Tokyo Garbage Wars'' in 1971. During this incident, citizens from Tokyo's Suginami ward opposed an incinerator in their ward, and residents of Koto ward became upset because Suginami's MSW was being dumped at Koto's large landfill in Tokyo Bay. This ''Not in My Backyard'' (NIMBY) dispute escalated to the point that MSW remained uncollected in Suginami ward and the Governor of the Tokyo Metropolitan Government declared an emergency.

So that waste could be managed as close as possible to its origins, the Tokyo Metropolitan Government decided to construct an incinerator in all 23 wards in urban Tokyo, which, at 621 km^2, is about the same size as New York City. The resulting ash would be shipped to an offshore

landfill in Tokyo Bay. Before this time, MSW facility siting was accomplished through political persuasion, adoption of advanced pollution control technologies, and monetary compensation, including funding for local development (Honda 1998). However, cases similar to that experienced in Tokyo erupted throughout Japan, and the proximity principle became the national social norm in MSW management.

Whereas the proximity principle is also a key element of the European Union environmental and waste management policy (Council Directive 75/442/EEC on waste, as amended by Council Directives 91/156/EEC and 91/692 and Commission Decision 96/350/EC), it is especially deeply woven into waste management policy in Japan because it is seen as a social principle rather than an environmental policy. It is difficult to explain exactly why the proximity principle became such a central value, but the following factors likely played important roles: high population density; a relatively flat, egalitarian social structure that is reflected in political decisions; Confucian philosophy; strong central government control; and a paucity of information on alternative approaches. Japan's population density is 350 persons/km^2, as contrasted with an average of 32 persons/km^2 in the United States (World Bank 2005), thus making it difficult to construct waste management facilities anywhere in Japan without encountering forceful NIMBYism. It is possible that Japanese politicians and bureaucrats wanted a simple rule to settle the inevitable conflicts. Historically, Japan's social structure has been relatively egalitarian, which has discouraged inequitable distribution of waste management facilities. Confucian philosophy, which emphasizes social responsibility, is widely embraced in Japan. Central government fiscal policies redistribute tax revenues to rural areas, which can then resist becoming dumping grounds for urban areas, unlike rural areas in the United States that must rely more on local property taxes to support basic public services like schools and MSW management. Strong central government control over waste management in Japan has enabled social principles like conflict resolution to prevail over the kinds of economic efficiency arguments that would prevail in the United States. Finally, inadequate information dissemination and policy analysis have made it difficult to advocate alternative approaches.

Although we can only speculate about the proximity principle's wellsprings in Japan, its geographic, fiscal, and environmental effects are readily apparent. Its most startling impact has been the construction of numerous incinerators and landfills. In 2002, there were 1490 incinerators and 2047 MSW landfills in Japan (Ministry of the Environment 2005a), which means that Japan—with a population of 127 million and an annual MSW stream of 51.6 million Mg/year—has 15 times as many incinerators and more MSW landfills than does the United States, which in 2002 had 107 incinerators, 1767 landfills, and a 2002 population of 288 million generating 213 million Mg of MSW (Kaufman and others 2004; US Census Bureau 2005; US Environmental Protection Agency 2005). One observer claims that Japan is home to ~70% of the world's MSW incinerators (Yoshida 2005). Japan's investment in so many facilities implies inefficiency and high costs. Further, sprinkling waste management facilities widely increases the population at risk of exposure to environmental pollution associated with MSW disposal practices.

Taking care of trash close to home ensures that the interprefectural transport of MSW in Japan is quite low. Japan's 47 prefectures are the intermediate level of government hierarchy in Japan and they are roughly comparable to state governments in the United States. The main exporters of MSW are the prefectures around Tokyo, such as Saitama, Kanagawa, Yamanashi, and Chiba Prefectures, and Aichi Prefecture in central Japan. Tokyo has a number of offshore and inland MSW landfills and is not an exporter of MSW. Major importers are Nagano, Gunma, and Nara Prefectures, which are the less urbanized prefectures around metropolitan Tokyo and Osaka. MSW or incinerator ash moving across prefecture lines for final disposal was estimated at 0.438 million Mg in 2002, which is less than 1% of the overall MSW generated (Ministry of the Environment 2005a). By contrast, the reported interstate transport of MSW in the United States was 39.6 million Mg in 2003 (McCarthy 2004), which amounted to 17% of all MSW generated. In the United States, trash moves hundreds of miles before disposal in landfills that are often enormous and located in rural areas (Thomson and Okuda 2005). The relative magnitude of long-distant transport of MSW in the United States becomes even larger if we consider that the interprefectural transport in Japan more closely resembles intercounty transport in the United States: Japan (378,000 km^2) is about the same size as California (404,000 km^2).

Despite fierce dedication to the proximity principle, escalating costs have driven many Japanese municipalities to join forces. Municipalities in urban areas find it hard to locate new waste management facilities, whereas small rural communities cannot secure the necessary financial resources and technical expertise to maintain sophisticated facilities that meet appropriate environmental standards. Although regionalization runs contrary to the proximity principle, it is still respected within the groups of municipalities that manage their waste jointly and by individual prefectures (Central Environmental Council 2001; Japan Center for Cities 1998; NIRA 2003; Takahashi 2001). A 1997 survey of mayors showed that, of those municipalities (or groups of municipalities) that manage MSW, 84%, 98%, and 83% recover/recycle, incinerate, and dispose of

their MSW within their regional administrative areas, respectively (Japan Center for Cities 1998). In 2002, 77% of MSW disposal occurred within the municipality or group of municipalities within which the waste was generated (Ministry of the Environment 2005a).

MSW Management Trends: 1990–2005

Municipal solid waste management in Japan is in a critical phase because, on the one hand, landfill capacity is quite low and, on the other hand, construction of new landfills is formidably difficult. Overall, MSW generation rose by 35% between 1975 and 2002, although most of that increase occurred between 1975 and 1990 (Fig. 1). By the early 1990s, the average landfill had a remaining life of 7–8 years and many municipalities had even less landfill capacity (Ministry of the Environment 2005b). As of 2001, there were 463 disputes over landfills, incinerators, and other MSW management facilities (Taguchi 2002). Many cases were deadlocked in the courts, and citizens in some municipalities used referenda to halt construction of MSW facilities.

Increased use of incinerators has reduced the demand for landfill space: 75% of MSW was burned by the early 1990s (Fig. 1). However, incineration suffered a setback in the late 1990s with the discovery of dioxin pollution problems in different parts of the country. A media report of high dioxin levels on vegetables grown around technologically primitive industrial solid waste incinerators in Saitama Prefecture caused consumer boycotts. At about the same time, high soil dioxin levels were found near an incinerator in Osaka Prefecture. These incidents stirred public anxiety about incinerators, which were estimated to emit over 7500 g-TEQ (2,3,7,8-TCDD Toxic Equivalent)/year of dioxin, or 90% of all dioxin released to the environment in 1997, according to the Ministry of the Environment (2005b). Yoshida (2005) claimed that, as of the late 1990s, Japan was ''more polluted by dioxins and related compounds than any other country in the world.'' To address this highly charged problem, the Ministry of Public Health (whose waste management functions have subsequently been subsumed under the Ministry of the Environment) issued an ordinance whose effect was to close many outdated or small, intermittently operated incinerators. Those incinerators were replaced or renovated, and by 2003, according to the Ministry of Environment (2005b), new dioxin releases had decreased by 98% relative to those in 1997. Despite these improvements, controversy remains about the effectiveness of the actions taken by the government to reduce overall environmental risk associated with dioxins (see Kishimoto and others 2001; Nakanishi 2004).

Recycling has also become a central tool in government attempts to reduce the generation of municipal and industrial waste. The Law for Promotion of Utilization of Recycled Materials was promulgated in 1991 and five related laws and acts—the Containers and Packaging Law, the Electric and Household Appliances Recycling Law, the Food Recycling Law, the Automobile Recycling Act, and the Construction Material Recycling Act—were established in the late 1990s and early 2000s. Recycling has been vigorously pursued in the public and private sectors alike and, as a result, Japan has become one of the world leaders in recycling. Five to eight categories of recycling exist in the typical Japanese municipality (Ministry of the Environment 2005b). In the extreme example of Kamikatsu, a city of 2200, officials have demarcated 44 recycling categories in an effort to meet their goal of

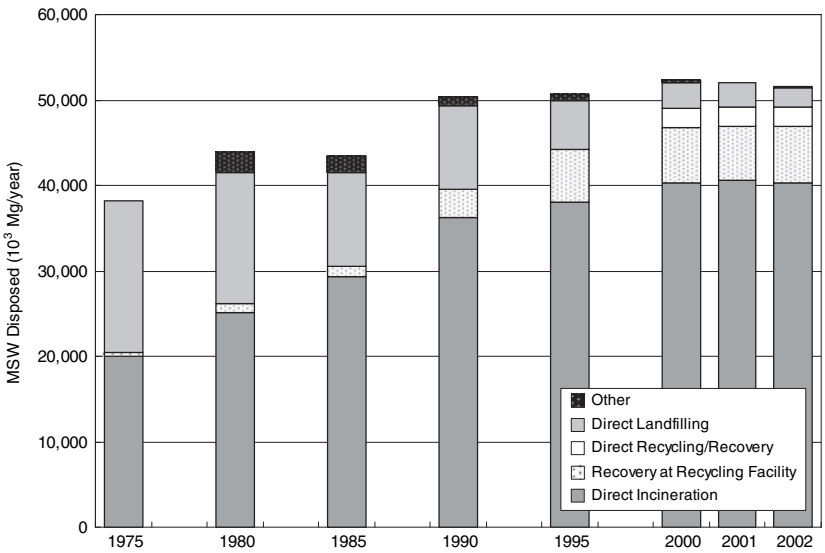

Fig. 1 MSW generation and disposal methods in Japan. Note: Recycling data are based on MSW collected by municipalities and thus they do not include privately recycled materials. ''Other'' includes the difference between the generation and disposal statistics. Data based on Ministry of the Environment (2005a)

zero garbage by 2020 (Onishi 2005). Recycling in Japan is now seen as one central means of establishing an environmentally sustainable society (see, e.g., Ueta and Kitagawa 2001; Yorimoto 2003), which, to Japanese policy-makers, must involve a more holistic, closed-loop approach to materials flow. The goal is to establish ''venous industries,'' which would be based on recycling materials, to complement the more traditional ''artery industries,'' which use raw materials (Ministry of the Environment 2005b; Ueta and Kitagawa 2001).

Although the official MSW recycling rate was a relatively modest 16% in 2002 (Ministry of the Environment 2005b), this figure does not include privately collected recyclables, such as newspapers recycled by private recyclers and glass bottles returned to retailers (Ministry of the Environment 2003) (these items are excluded from the government's figures because they are not considered waste under the Waste Management and Public Cleansing Law). If privately recycled materials are added into the official recycling figures, the national MSW recycling rate rises to 35%, thereby exceeding the 30% recycling rate achieved in the United States (US Environmental Protection Agency 2005). More recycling means that less MSW is going to landfills, and average landfill life in Japan has risen to 13 years (Fig. 2). Each Japanese now makes an estimated 0.57 Mg of MSW annually, as compared with 0.75 Mg/capita in the United States [(Thomson and Okuda 2005). Our estimate of MSW generation in Japan includes privately collected recyclables, which are excluded in the official government estimate of 0.41 Mg/capita-year in 2002 (Ministry of the Environment 2005b).]

Increased dedication to incineration and recycling has lengthened landfill life. However, these policy choices have also involved a substantial financial burden, which in Japan is borne by government entities. Table 1 shows that total expenditures for MSW management in 2002 were ~$19 billion, or $150/per capita and $374/Mg. Disposal fees in the United States are substantially lower. No state in the United States reports average disposal fees exceeding $88/Mg ($80/ton) (Kaufman and others 2004), thus making MSW management in Japan expensive by US standards. As Table 1 suggests, the construction and operation of ''intermediate treatment'' (incineration and recycling) facilities comprise a large fraction of overall expenditures. As is the case in other countries with aggressive recycling programs (e.g., Germany), the supply of collected recyclables can outstrip demand for their use (Yoshida 2005). To address this gap the government wishes to streamline international recycling markets, especially because the demand for recyclables is soaring in countries like China [e.g., Ministrial Conference on the 3R Initiative (2005) held in Tokyo in 2005]. The impetus to internationalize recycling markets must be balanced against concerns about illegal shipping of toxic wastes and with the desire to sustain fragile domestic recycling markets in Japan (Environmental Group of Industrial Structure Council of Ministry of Economy, Trade and Industry 2006; Yorimoto 2003).

The government relies on private firms for much MSW collection and management. In 2002, private firms collected and disposed of ~65% of MSW. As Table 1 indicates, about 21% of overall expenditures flowed to contractors. However, MSW management is still under tight public control, partially because it has been considered the responsibility of municipalities, which are charged with meeting the ''national minimum'' in sanitation. Moreover, there is a deep mistrust of private waste companies, as there have been numerous incidents involving illegal disposal of industrial wastes.

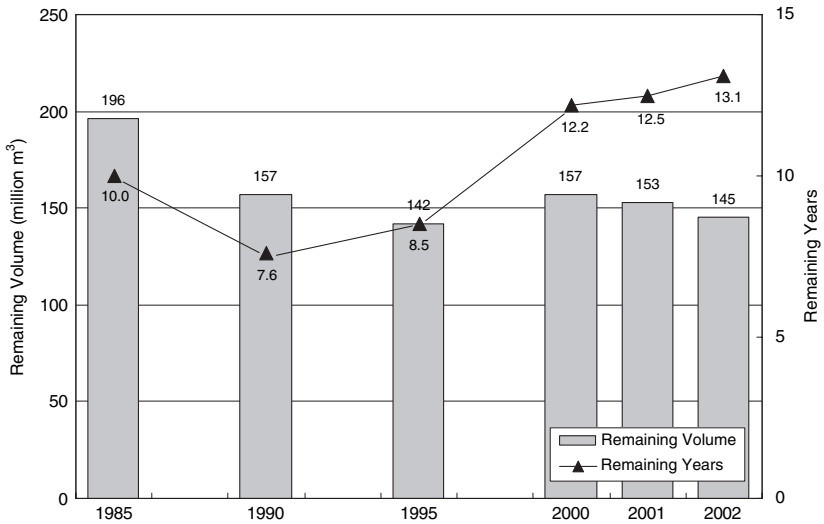

Fig. 2 Changes in remaining volume and remaining life of MSW landfills in Japan. Data compiled based on Ministry of the Environment (2005a)

Table 1 Expenditures for MSW management in Japan in FY 2002[a]

Category	Breakdown	Expenditure (million USD)	Percentage
Construction	Intermediate treatment[b] facility	5,235	27%
	Final disposal facility	641	3%
	Other	191	1%
	Study	60	<1%
	Subtotal	6,126	32%
O&M	Salary	4,710	25%
	Transport	634	3%
	Intermediate treatment	2,153	11%
	Final disposal	344	2%
	Procurement of trucks	95	<1%
	Contract out	4,034	21%
	Others	362	2%
	Subtotal	12,332	64%
Other		707	4%
Total[c]		19,165	100%

[a] The Japanese fiscal year covers April 2002 to March 2003

[b] Intermediate treatment includes recovery/recycling and incineration

[c] The total does not add up due to rounding of figures

Source: Data based on Ministry of the Environment (2005a), recalculated assuming US$ 1 = JPY 125

Local Government Coordination and Financing Mechanisms

As a result of soaring costs, difficulties in siting MSW management facilities, and pollution problems, more municipalities are choosing to manage their MSW jointly. According to a 1997 survey, 35%, 50%, and 45% of all municipalities jointly implemented recovery, incineration, and final disposal operations, respectively. However, collection service was provided independently by nearly 90% of municipalities (Japan Center for Cities 1998).

Regionalization of MSW management in Japan has come about in part because of a long-term, larger impetus to consolidate public services. For decades, the central government has promoted regionalization generally to control urban development, improve efficiency of municipal services, and boost financial conditions. As a result, the number of municipalities has decreased steeply since the early 1950s, from 9868 in 1953 to 2377 in 2005. When municipalities cannot merge, they often form associations to share a variety of public services, such as firefighting, night-soil collection, as well as solid waste management.

However, the dioxin problem, which arose only in the 1990s, also underlies the government's strong push to regionalize MSW management. In 1997, the Ministry of Health issued an ordinance whose goal was to reduce the risk of dioxin pollution associated with small incinerators. That ordinance suggested that municipalities should employ large incinerators (capacity exceeding 100 Mg day/unit) combined with ash melting facilities to control dioxin, or if this proved impossible, install a RDF (refuse-derived fuel) conversion facility to transform waste into fuel to be burned at a large incinerator. The Ministry further suggested that municipalities form regional blocks to share large incinerators, and the national government distributed grants for their construction. In response, most prefectures developed MSW regionalization plans and many associations/blocks of municipalities were formed. Because of the proximity principle and the high costs of constructing new incinerators, many municipalities faced serious public opposition (Takahashi 2001; Yamamoto 2001) and chose to renovate their incinerators rather than join in regional operations. Still, the number of MSW incinerators has decreased from 1872 in 1996 to 1490 in 2002 while overall incineration capacity has increased from 191,239 Mg/day in 1996 to 198,874 Mg/day (Ministry of the Environment 2005a).

Prefectures play a particularly important role in the regionalization of MSW management by coordinating administrative services across municipalities, developing waste management plans for their jurisdictions (including regional MSW management plans), and authorizing construction of waste management facilities. Through these instruments, prefectures can control waste flows and they also coordinate the efforts of municipalities. Such governmental flow control can extend beyond the boundary of prefectures. A special example is the Osaka Regional Offshore Environmental Improvement Center—a 500-ha landfill facility with capacity of 76 million m^3—shared by 201 municipalities from the prefectures of Osaka, Shiga, Nara, and Wakayama (Osaka Bay Regional Offshore Environmental Improvement Center). The Greater Tokyo Metropolitan area (Kanto area) has a coalition of eight prefectures/cities (Tokyo Prefecture, Kanagawa Prefecture, Saitama Prefecture, Chiba Prefecture, Yokohama City, Chiba City, Saitama City, and Kawasaki City) that discusses both MSW and industrial solid waste (ISW) issues (Eight Prefectures and Cities Waste Management Committee 2003). The Ministry of the Environment helps coordinate waste management activities among prefectures.

National fiscal policy has been another force in the regionalization of MSW management in Japan. MSW programs are financed almost wholly by government authorities, and although municipalities are integrally involved in MSW management, the national government closely controls MSW management through public financing mechanisms. Many municipalities, mainly small

Table 2 Revenues for MSW management in Japan in FY 2002

Breakdown	Revenue (million USD)	Percentage
General revenue	11,840	75%
National government fund	427	3%
Prefectural government fund		
Fund	64	<1%
User fee	1,094	7%
Loan	1,885	12%
Other	498	3%
Total	15,808	100%

Source: Data based on Ministry of the Environment (2005a), recalculated assuming US$ 1 = JPY 125

rural municipalities but also some larger cities, have introduced user fees, a commonly used method of financing MSW management in the United States (US Environmental Protection Agency 1998). As of 2003, 42% and 70% of Japanese municipalities had introduced service fees for household and commercial MSW management, respectively (Ministry of the Environment 2005b). Many municipalities charge fees for management of special waste, such as bulky waste. Prepaid garbage bags or stickers like those used in American pay-as-you-throw systems are the usual method of collecting garbage management fees from Japanese households. However, the per-capita cost of MSW management is about $150/year, and if all of these costs were recovered from users, the necessary fee would be about $5 for a typical kitchen garbage bag. Thus, most municipalities have introduced user-fee systems as an economic incentive to reduce the amount of MSW rather than as a primary source of program financing.

Table 2 displays the various sources of MSW management funding for 2002, which included ''general revenues'' of municipalities (75%), local bonds (12%), user fees (7%), and special national grants (3%). Although property taxes and municipal resident taxes constitute the main source of municipal general revenue, about 40% of municipal general revenue comes from national taxes as general revenue sharing. These general tax grants are based in part on the difference between expected local revenue and expenditures. This allocation system is meant to adjust for the disparity in revenue among urban and rural municipalities so that relatively more national funding flows to rural areas. Generous central government funding helps rural communities in Japan afford expensive MSW management systems even though they have limited financial resource bases of their own. These less populated areas are thus able to resist becoming the dumping grounds for cities. Not surprisingly, politicians have employed this system as one means of retaining power (Broadbent 2005). Japan is not alone in its redistribution of tax revenue between national and local governments: many European governments adopt much the same approach (Policy Research Institute of Ministry of Finance 2002).

Redistributing national taxes has several disadvantages. It causes local fiscal dependence on the national government. When local governments can rely on funding from the national government, they are less inclined to increase local revenues because that would have the perverse effect of reducing a municipality's share of national funding. Further, this system does not encourage municipalities to improve the efficiency of their MSW management programs.

The Japanese central government also provides direct funding for MSW facility construction. In 2000, $8 billion was used to construct MSW facilities, and of that total amount, projects costing $5 billion were funded through national grants. Only 3% of this $5 billion came from municipal general revenues. The other 97% was covered through the special national grant fund (37%), local bonds (58%), and prefectural grants (1%) (Yorimoto 2003). Moreover, a large portion of local bonds comes from the national fiscal loan fund, the national pension fund, and/or the postal savings fund. With such strong central government control over financing, municipalities must adhere to the national government's MSW policies.

Although regionalization in MSW management makes fiscal sense and has helped reduce dioxin emissions from inefficient incinerators, it has not escaped criticism. Some in Japan believe that regional MSW management violates the self-governing right of municipalities and blurs responsibility for waste management (Takahashi 2001; Yamamoto 2001). Moreover, new conflicts of interest often emerge among the member municipalities, as local flows of waste from urban to rural areas are sometimes created within regional blocks (Yamamoto 2001). Another objection is that the government promotes expensive and sophisticated devices that are difficult to operate and that require a constant flow of garbage (Takahashi 2001; Yamamoto 2001). Some local governments resent the MSW program costs imposed on them by the national government and they would prefer to have more fiscal and management autonomy (Yoshida 2005). The Koizumi administration tried to reduce financial support and transfer more fiscal authority to local governments. It is still too early to see how this policy of devolution will affect MSW management. However, given its high costs, more municipalities might choose to regionalize their MSW facilities.

Conclusions

In every country, social values, fiscal concerns, and accustomed institutional patterns of behavior shape MSW

management programs. In Japan the resulting set of policies forms an interesting counterpoint to those in the United States. The proximity principle has ensured that, even as MSW management costs rise, Japanese municipalities make every effort to disposal of waste within their borders. As a result, waste disposal facilities are numerous and widely scattered around the country, and trash moves only a limited distance from generation to disposal. In the United States, trash management is dictated to a much greater extent by market forces and the proximity principle is virtually unknown. Garbage moves over increasingly long distances and it is often disposed of in huge landfills located in rural areas. Incineration is common in Japan, a country in which land is a far more precious commodity than in the United States, where filling the earth with trash is not yet regarded as needlessly wasting land. Japanese government officials are willing to endure MSW costs that would stagger the imagination of most Americans involved in MSW management. In Japan, all levels of government are integrally involved in MSW management, whereas local and state governments are responsible for managing trash in the United States, with minimal involvement from the federal government.

Regionalization of MSW services is a trend in both the United States and Japan, but to say this masks vital differences in how the two countries approach this environmental issue. Deeply imbedded practices and cultural expectations are likely to perpetuate these interesting differences.

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