REVIEW ON THE IMPACTS OF WASTE DISPOSAL SITES IN THE PHILIPPINES

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ABSTRACT: *The Republic Act (RA) 9003-Ecological Solid Waste Management (ESWM) Act of 2000 of the Philippines provides the mandate and framework for solid waste management in the country. The implementation however on the local government units reflects the lack of institutional arrangements for waste management. This has been reflected through the utilization of unregulated dumpsites and landfills exhaustively although other alternatives can be considered. Primary reasons were drawn from inadequate technical and financial resources, lack of political will, unwillingness of stakeholders, and minimal local awareness. Consequently, there is absence of comprehensive monitoring scheme of dumpsites and landfills operation in the country. Present studies reviewed in this paper evidenced the threat that disposal sites may pose to the environment from potential leaching of hazardous chemicals due to dumped wastes. Exposure of communities to health risks is also reviewed in this paper. Present review also highlights the opportunities drawn by adjacent community through employment (scavenging) from the disposal sites. While these disposal sites may attract locals or informal settlers due to perceived opportunities, they are similarly exposed to health risk. Overall, this review also summarizes key points to propose a mechanism to improve the solid waste disposal system to meet the policies of RA 9003.*

Keywords: disposal sites, Republic Act (RA) 9003, landfill, dumpsites

1. INTRODUCTION

Rapid urbanization of developing countries coupled with population growth resulted to uncontrolled generation of uncharacterized solid wastes (SW) elsewhere [1, 2, 3, 4]. In the case of the Philippines, waste generation rate progressed from 10.6 million tonnes in 2012 to a projected doubling rate by 2025 [5], consequently increasing the need for more disposal facilities. Disposal facilities commonly landfills and dumpsites are convenient options owing to accessibility, inexpensiveness, and potentiality for methane gas recovery [6, 7] although other alternatives are available (e.g recycling and composting). However, the prevalent use of landfills and dumpsites in the case of the Philippines is reflective of the gaps for solid waste management (SWM) implementation under the Republic Act 9003 (RA 9003)-Ecological Solid Waste Management Act of 2000. This is attributed to te high cost of management and lack of enabling agencies [4], hindering SWM.

Disposal sites must have appropriate control for leachate, landfill gas, and a lined pit [8] to ensure safe operations [9]. On site monitoring, however, revealed incomplete leachate and gas handling [10] and a need to rehabilitate the disposal site facilities. This is a major concern for countries like the Philippines whose major option for SW disposal is through landfills and dumpsites. The possibility of environmental contamination and human exposure to leachate and other contaminants from the disposal sites are inevitable. Previous studies revealed contamination of groundwater [8, 11, 12, 13, 14, 15, 16, 17], contamination of soil [18], human health risks [19, 20, 21, 22, 23], and risk exposure of other organisms [24, 25, 26]. While established literature elsewhere exhaustively summarized the potential hazards brought by disposal sites, however, few studies focused in the case of the Philippines.

It is seen vital to address SWM by integrating the informal sector [27] and establishing institutional arrangements [28] to mitigate the dependence on disposal sites. Similarly, a need to present the current status of SWM and disposal sites in the country is timely to extrapolate recommendations for establishing future SWM strategies. This paper highlights the concern by trying to synthesize the environmental ill effects, potential health risks, and economic opportunities brought by landfills and dumpsites in the country. The review covers published studies covering the year 2000 to present.

2. MATERIALS AND METHODS

2.1 Framework

This paper reviews the impacts of waste disposal sites in the Philippines. Emphases were given to the impacts it may bring to the environment, public health, and economic opportunity of the adjacent community. Primarily these key areas were evaluated to extrapolate an overall condition of disposal sites direct effect to communities. Figure 1 presents the conceptual framework of the study. Environmental impacts of disposal sites were reviewed as a basis to recommend for either closure of disposal sites as per mandate of RA 9003 or for rehabilitation. Public health was also discussed in this review to draw findings of the health risks disposal sites may bring to communities. Present literature does not show a strong association between disposal sites to acquiring diseases, however, few studies found prevalence of certain diseases [23, 29, 30, 31, 32] common among adjacent communities. Economic opportunities were also evaluated to potentially recommend livelihood option among household adjacent to disposal site if the closure will be considered. These areas were seen as vital features to establish available data on the environmental ill effects, public health risks, and economic opportunities of present disposal practices (landfills and dumpsites) may bring and to potentially recommend a shift towards sustainable SWM practices.

2.2 Description of reviewed disposal sites

The disposal sites reviewed in this paper are summarized in Table 1. These were chosen based on available published studies about disposal sites in the Philippines. Overall, about twenty one landfills, open dumpsites, and controlled dumpsites served as reviewed sites in this paper.

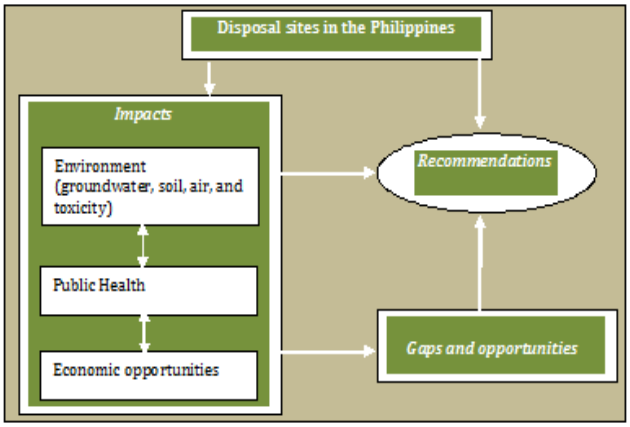

Fig (1) Conceptual Framework of the Study

Table (1) Overview of disposal sites reviewed in this paper

Disposal Site	Location	Description	Number of Studies reviewed
Cebu City Sanitary Landfill	Cebu City, Region 7	15.41 ha 450 tons of waste/day [20]	7
Umapad dumpsite	Mandaue City, Region 7	5 ha 195 tons of waste/day [33]	1
Lapu-lapu City dumpsite	Lapu-lapu City, Region 7	No data	1
Bais City landfill	Negros Oriental	No data	1
Bayawan City landfill	Negros Oriental	No data	1
Zayas landfill	Cagayan de Oro Region 10	13 ha [34]	3
Payatas dumpsite	Quezon City, NCR	13 ha	5
Smokey Mountain	Manila, NCR	Operated for 40 years and was closed in 1995	1
Rodriguez dumpsite	Rodriguez, Rizal, NCR	No data	1

RESULTS AND DISCUSSION

3.1 Current status of disposal sites

The waste generation of the Philippines over the last four years increased (Table 2). Metropolitan cities in key Regions (3, 4a, 6, 7 and NCR) had high SW generation as evidence of growing economy, population growth, and changing lifestyle [1]. In return the need of goods and services increased, consequently producing more waste streams at the latter.

The RA 9003 prohibits establishment and operation of open dumpsites [36]. The present state, however reveals continuous use evidenced in the third quarter report of 2011 with the Philippines having a total of 640 open dumpsites and 38 landfills [20, 36]. Figure 2 presents the total number of dumpsites in the Philippines. The overall trend showed a slight decline on the total number of open dumpsite from 806 on 2008 to 523 on 2014. Regions 7, 1, and 5 had the most number of dumpsites while NCR, ARMM, and 4B ranked the lowest.

Sanitary landfill is another disposal site in the country. The total number however is less as compared to open dumpsites. The overall number of landfills increased from 2008 to 2014 (refer to Figure 3) with Regions 1, 3 and 4A ranking highest as of 2014 [36]. However, sanitary landfills gradually with poor maintenance and regulation are presently converted into open dumpsite like the case of Cebu City Sanitary Landfill [20] (see Figure 4). This is of primary concern given the economic growth in the metropolitan

Table (2) Projected solid waste generation per day (ton) [35]

Region	2012	2013	2014	2015	2016
1	1709.17	1739.54	1769.90	1800.27	1830.64
2	1100.64	1120.19	1139.75	1159.31	1178.86
3	3631.99	3696.52	3761.05	3825.58	3890.12
4a	4145.52	4219.18	4292.83	4366.49	4440.15
4b	909.43	925.59	941.74	957.90	974.06
5	1878.74	1912.12	1945.50	1978.88	2012.26
6	2700.14	2748.11	2796.09	2844.06	2892.04
7	2605.68	2651.97	2698.27	2744.57	2790.86
8	1479.47	1505.75	1532.04	1558.33	1584.61
9	1391.95	1416.68	1441.41	1466.15	1490.88
10	1693.94	1724.03	1754.13	1784.23	1814.32
11	1818.05	1850.35	1882.65	1914.95	1947.26
12	1348.20	1372.15	1396.10	1420.06	1444.01
13	884.69	900.41	916.13	931.85	947.57
CAR	620.64	631.67	642.70	653.72	664.75
NCR	8601.60	8754.43	8907.26	9060.09	9212.92
ARMM	907.64	923.76	939.89	956.02	972.14
TOTAL	**37427.46**	**38092.46**	**38757.46**	**39422.46**	**40087.46**

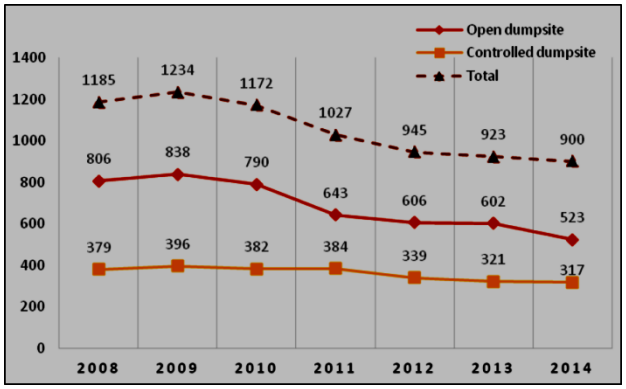

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Fig (2) Number of dumpsites still existing from 2008 to 2014 [36]

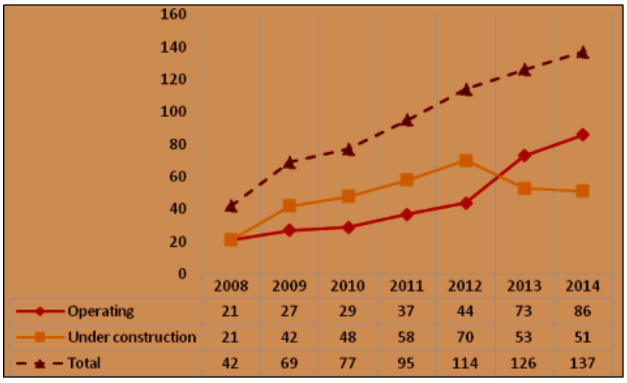

Fig (3) Number of operating sanitary landfills and sanitary landfills under construction from 2008 to 2014 [36]

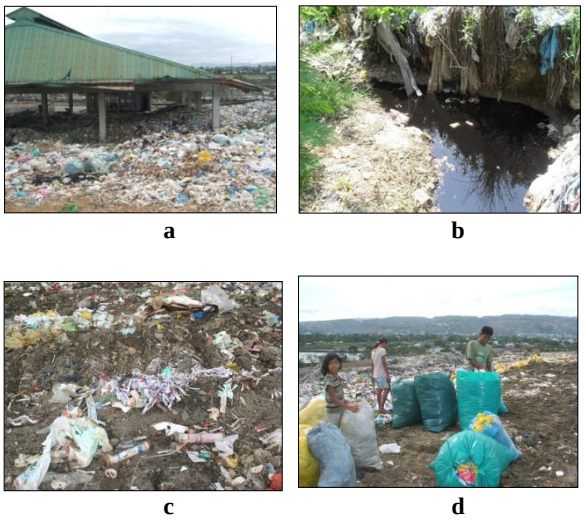

Fig (4) Cebu City Sanitary Landfill a) MRF acts as reservoir for excess waste from the landfill site; b) uncontained leachate pools; c) medical wastes dumped in the landfill; and d) scavengers exposed to medical wastes [20]

3.2 Environmental Impacts of waste disposal sites

The impacts of waste disposal sites to the environment had been explored ranging from ill effects to water, soil, plants, and scavenging animals [8, 11-18, 24, 25, 26]. This section reviews the case of the Philippines disposal sites (refer to Table 3 and 4).Overall, most water quality parameters on studied tube and deep wells were within the standard set except for coliform and total dissolved solids (TDS). Underserviced communities in disposal sites utilized deep wells for domestic purposes [20, 36, 37], consequently increasing susceptibility to water borne illnesses.

In the case of Cebu City Sanitary Landfill high levels of total lead (Pb) and cadmium (Cd) were determined [16, 17]. This was in agreement of the findings in Bais City and Bayawan City landfills with high levels of Pb [38]. Although present result may not conclusively summarize the overall status owing to lack of studies, it is however clear that there is potential migration of landfill contaminant to groundwater (see Table 3).

Table (3) Water quality adjacent to waste disposal sites in the Philippines

Dumpsite/ Landfill	Location	Findings	Reference studies
Cebu City Sanitary Landfill	Region 7 Cebu City	TDS Total coliform Total Cd and Pb were beyond the standard	[16] [17]
Payatas dumpsite	NCR, Quezon City	Total coliform exceeded the standard high levels of TDS, TSS and total coliform and low pH levels	[15] [40]
Rodriguez Landfill	NCR Rodriguez , Rizal	Sporadic contamination of isotopes from leachate	[41]
Zayas landfill	Region 10 Cagayan de Oro	pH, sulphate, chloride, and nitrates were within the standard	[34]
Bais landfill Bayawan fandfill	Negros Oriental	Total coliform exceeded the standard Pb 0.022-0.057 ppm	[39]

Table 4 presents the summary of review on soil, plants and toxicity studies adjacent to disposal sites. Studies on soils in disposal sites revealed a higher concentration of mercury (Hg) [42, 43] as compared to world median level (0.05 ppm). No direct study however associates directly Hg in soil to affect human health. A note similarly on TSP study in Payatas dumpsite revealed presence of Pb and Cd [44]. Prolong exposure of human to air particulate matter may result to health ill effects. Lastly, studies on both plants [45, 46] and animals [47] exhibited potential toxicity. Analysis of corn's roots, leaves, and seeds in the latter closed Smokey Mountain showed high levels of Pb as compared to World Health Organization/Food and Agriculture Organization (WHO/FAO) [46]. Laboratory analysis using leachate from Cebu City Sanitary landfill exhibited toxicological response of tilapia fingerlings leading to mortality [47].

Table (4) Summary of other environmental quality adjacent to waste disposal sites in the Philippines

Dumpsite/landfill	Location	Findings	Reference studies
Soil			
Cebu City Sanitary Landfill	Region 7 Cebu City	Hg in soil (0.238 ppm) higher than the world median (0.05 ppm)	[42]
Zayas landfill	Region 10 Cagayan de Oro	Highest recorded level of Hg was 0.164 ppm	[43]
Air & particulate matter			
Bais landfill Bayawan landfill	Negros Oriental	Carbon dioxide concentration 390-397 ppm	[39]

Payatas dumpsite	NCR, Quezon City	Pb and Cd found in total suspended particulate (TSP) fraction	[44]
Toxicity studies			
Cebu City Sanitary landfill	Region 7 Cebu City	Increased concentration (% v/v) kills Oreochromis niloticus	[47]
		Muntingia calabura and *Tridax procumbens* exhibited effective uptake of Hg	[45]
Smokey Mountain, Manila	NCR	Pb in roots (4.811 ppm), leaves (0.555 ppm), and seeds (0.676 ppm) in Zea mays (corn) were beyond the WHO/FAO standard	[46]

3.3 Public health

Table 5 presents the summary of results for the health responses among community adjacent to disposal sites. Prevalent diseases were gastrointestinal, upper respiratory and skin diseases [15, 20, 33, 45, 47, 48]. Potentially, the use of contaminated tube and deep well's [15, 17, 39, 40] may likely be attributed to cause gastrointestinal diseases. The occurrence of respiratory diseases among neighbouring population to waste disposal site was relevant [29]. Present review is in agreement with past studies on prevalence of respiratory symptoms among municipal solid waste workers [30] and waste-picking children [49] which can be attributed to potential high levels of particulate matter. Overall, the underserviced and poor environmental condition impacts the health of slums [50] and increasing vulnerabilities to diseases.

Table (5) Summary of health responses from community adjacent to disposal sites

Disposal Site and Location	Findings	Reference studies
Cebu City Sanitary Landfill, Cebu, Region 7	Gastrointestinal upper respiratory skin diseases dengue	[20] [45]
Umapad dumpsite, Mandaue City, Region 7	Upper respiratory and skin diseases	[33]
Lapu-lapu City dumpsite, Region 7	Gastrointestinal and upper respiratory health response	[47]
Zayas landfill, Cagayan de Oro Region 10	Dengue cases	[38]
Payatas dumpsite, Quezon City	Prevalence of diarrhoea and water borne illnesses	[15, 48]

3.4 Economic opportunities

Despite the poor environmental condition adjacent to disposal sites, informal settlers flocked these areas owing to perceived opportunities. This is the case in most disposal sites since scavenging provides sustainable livelihood among those who cannot secure employment in the formal urban market [51]. The informal sectors which included scavengers residing near the sites are key players in SWM implementation. Economic dependence to disposal sites [52] exists owing to perceived employment and resources [20, 33, 52, 53] (see Table 6).

The highest income recorded was in Payatas dumpsite [52] and the lowest recorded income was in Zayas landfill [38]. It is evident however that stable monthly income can be generated from a site near to MRF like the case of Lapu-lapu City dumpsite [37]. Distinctly, the implementation of RA 9003 affected the income of scavengers in Umapad dumpsite [33]. Overall, average income of households in dumpsites ranged from Php 3,000 –Php 12,000 which was still below the poverty line (refer to Table 7).

Table (6) Summary of economic opportunities of adjacent communities to disposal sites

Disposal site/location	Findings	Reference studies
Cebu City Sanitary Landfill, Cebu	Scavenging ranked highest as the form of employment.	[20]
Umapad dumpsite, Mandaue City, Cebu	About 300-400 households primarily relied on the dumpsite to earn a living (scavenging)	[33]
Lapu-lapu city dumpsite, Cebu	About 14% of households were scavengers and 43% were MRF workers.	[37]
Payatas dumpsite, Quezon City	Economic dependency on garbage through scavenging, vending, and operating junkshop	[52]
Zayas landfill, Cagayan de Oro City	84% of respondents were self- employed including scavengers.	[38]

Table (7) Average income of adjacent community to disposal sites

Disposal site/location	Average income	Reference studies
Cebu City Sanitary Landfill, Cebu	Php 4,044.26/monthly	[20]
Umapad dumpsite, Mandaue City, Cebu	Php 146.08-387.82/daily	[33]
Lapu-lapu city dumpsite, Cebu	Php 7,780.00/ monthly	[37]
Payatas dumpsite, Quezon City	Php131.00-421.14/ daily	[52]
Zayas landfill, Cagayan de Oro City	Php3,001-5,000/monthly	[38]

3.5 Future trends for SWM

To ensure a better environment, SWM strategies must entirely enforce the mandate of RA 9003. This may include closure of the latter dumpsites, establishment of a well-

engineered landfill, and reduction of SW by providing MRF in small communities. The following are present practices that are recommended to be maximized and integrated in the SWM strategies.

1. Rehabilitation the latter disposal sites through establishing methane gas facilities [54, 55, 56].
2. Providing MRF and test its functionality in local communities. The MRF can provide economic opportunities to the scavengers [37] while reducing the environmental impacts at the process level. Similarly, scavengers can be provided with more systematic and convenient form of SW recovery [27].
3. Integration of vermicomposting as a waste management technology and livelihood alternative.
4. Lastly, institutional arrangements [28] as an evidence of good governance through participation of various stakeholders, awareness campaigns, and replication of innovative SWM technologies [57].

3. CONCLUSIONS

The review highlighted qualitatively the present status of SW disposal sites in the Philippines. Overall, it can be inferred that potential contamination of disposal sites to environment can manifest in groundwater, soil, air, plants, and scavenging animals adjacent to the site. Adjacent community can similarly be affected jeopardizing their own health. Prevalence of gastrointestinal, skin, upper-respiratory, and dengue diseases were likely common. Although disposal sites can pose health risks, community tends to continually settle with present options owing to perceived economic dependence through employment and resources. It is fundamental that local government units will consider the economic options, health, and environment of adjacent communities while pursing the mandate of RA 9003.

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