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GIS MAPPING OF HEALTH CARE WASTE TREATMENT EQUIPMENT IN NIGERIA

TECHNICAL REPORT

AIDSTAR-One
AIDS SUPPORT AND TECHNICAL ASSISTANCE RESOURCES

MAY 2013

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AIDS Support and Technical Assistance Resources Project
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Cover photo: High-temperature 500 kg per hour rotary kiln incinerator at the National Hospital, Abuja.

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CONTENTS

ACRONYMS

AIDSTAR-One	AIDS Support and Technical Assistance Resources
CDC	Centers for Disease Control
FCT	Federal Capital Territory
FMOH	Federal Ministry of Health
GIS	geographic information system
GON	Government of Nigeria
GPS	Global Positioning System
HCW	health care waste
HCWM	health care waste management
kg	kilogram
km	kilometer
LGA	local government authority
PEPFAR	U.S. President's Emergency Plan for AIDS Relief
PPE	personal protective equipment
USAID	U.S. Agency for International Development
USG	U.S. Government
WDU	waste disposal unit
WHO	World Health Organization
WTE	waste treatment equipment

EXECUTIVE SUMMARY

Approximately 10 to 25 percent of health care waste (HCW), including sharps and materials that contain blood and body fluids, may be infectious, with the potential to create health risks. Poor HCW management exposes health care workers, waste handlers, and the community at large to infections and injuries. To ensure proper treatment and disposal logistics for HCW generated by Nigeria's health facilities, it is necessary to understand the various types, capacities, and locations of available waste treatment equipment (WTE) and to determine HCW ease of movement to these locations. The overall goal of this study was to understand the spatial dynamics of health care waste management (HCWM) in Nigeria by using geographic information systems (GIS).

The study team visited 64 facilities in 32 states and the Federal Capital Territory (FCT) in Nigeria's six geopolitical zones (North East, North West, North Central, South-South, South West, and South East). These facilities included all tertiary, secondary, and primary facilities with waste treatment equipment (WTE) (n=41), as identified by Nigeria's Federal Ministry of Environment and by the Hospital Services Department of the Federal Ministry of Health (FMOH). An additional 23 facilities in nearby areas were assessed after the study found facilities with WTE that the FMOH had not previously identified.

Of the 64 facilities visited, 52 were identified as having WTE and a total of 65 pieces of equipment of different types, sizes, incinerating capacities, and functional status observed; waste disposal units (WDUs) were the most commonly noted equipment category. Most WTE was in tertiary facilities, and very little was in primary facilities. Nearly all was government owned, primarily by the federal government. Sixty-nine percent of the equipment was operational; the rest was either nonfunctioning, not yet commissioned, or not yet installed. Few facilities were observed treating more than 100 kilograms (kg) of waste per hour. Approximately half of the assessed facilities use ash pits and possess secure waste storage space. Few facilities with WTE followed a regular maintenance schedule; among those that did, frequency varies.

Although some health facilities may appear close to WTE, an inadequate road network may impede waste transfer. The GIS mapping identified that at least 46 percent of health facilities in Nigeria's 32 states and the FCT currently have access to functioning WTE. If all equipment was functioning (including equipment that is currently nonfunctioning or is not yet commissioned or not yet installed), 58 percent of health facilities would have access.

High coverage was observed in Abuja, Anambra, Imo, Enugu, Lagos, and Ogun states, where more than 85 percent of facilities were within 70 kilometers (km) by road of a functioning HCW treatment facility.

Low coverage, with fewer than 40% of facilities in a district within 70 km by road of known, functioning WTE, was observed in 15 states: Adamawa, Akwa Ibom, Bayelsa, Benue, Borno, Cross River, Ekiti, Kaduna, Kogi, Nasarawa, Niger, Ondo, Taraba, Yobe, and Zamfara states. No health facilities in Adamawa or Taraba states were within 70 km of WTE.

Demonstrating which facilities are within 70 km of functioning WTE via existing roads, this mapping can assist the Government of Nigeria (GON) and other program planners in considering how best to allocate resources to repair present facilities and construct new ones. The mapping will also help stakeholders to create and properly implement HCWM plans within facilities, local government areas, and states.

INTRODUCTION

BACKGROUND

HEALTH CARE WASTE

The term "health care waste" (HCW) refers to all the waste generated by health care establishments, medical research facilities, and laboratories. Between 75 and 90 percent of this waste, including paper, food scraps, and the like, is considered "general" waste. The remaining 10– 25 percent includes sharps, materials that contain blood and body fluids, and other items that are considered infectious and have the potential to create health risks. Poor HCW management exposes health care workers, waste handlers, and the community at large to infections, toxicities, and injury.

Health care waste management (HCWM) requires specific commodities and supplies as well as training and is strongly influenced by cultural and social as well as economic circumstances. A well-designed waste policy, a legislative framework, and plans for achieving local implementation, education, and behavior change are essential. Change may be gradual and should be technically and financially sustainable over the long term.

Hospitals and other health care establishments have a "duty of care" for the environment and for public health and, with that, a particular responsibility for the waste they produce. Thus, the onus is on them to ensure that their waste handling, treatment, and disposal activities produce no adverse consequences for the public health and the environment. By developing and implementing a policy for HCWM, medical and research facilities move toward achieving a safe, healthy environment for their employees, patients, and communities.

MAPPING WASTE TREATMENT EQUIPMENT

To ensure proper treatment and disposal logistics for HCW generated by health facilities in Nigeria, it is necessary to understand what equipment is available; the various types, capacities, and locations of that equipment; and the ease of moving HCW to these locations.

TYPES OF HEALTH CARE WASTE TREATMENT EQUIPMENT

The need for medical waste incinerators to treat HCW appears to be growing rapidly in Nigeria: health facilities are generating increasingly large quantities of HCW because of their expanding systems and services, their increased use of disposable (single-use) items, and poor waste segregation practices that add to the quantities of waste requiring treatment as well as disposal.

In response to immediate concerns about disease transmission due to exposure to HCW, many states, local government authorities (LGAs), and health facility managers have opted to incinerate HCW. Some facilities use open burning; others have installed combustion devices.

Incinerators range from sophisticated, high-temperature operating plants to basic combustion units that operate at much lower temperatures. All types of incinerators, when operated properly, reduce waste to ashes. However, for health care wastes (e.g., pharmaceuticals, highly infectious wastes, pathological wastes, and chemical wastes), complete destruction requires higher temperatures. These temperatures, combined with cleaning of the exhaust gases, limit the atmospheric pollution and odors that incineration can produce.

Incineration equipment is typically chosen on the basis of available resources, the local situation, and risk–benefit considerations, balancing the public health benefits of pathogen elimination against the potential risks of air or groundwater pollution caused by inadequate destruction of certain wastes.

Four basic types of incinerators (Annex 3) are used for treating HCW:

- **Rotary kilns:** Operating at high temperatures, these are used to destroy cytotoxic substances and heat-resistant chemicals. They can incinerate a variety of waste streams with minimal waste pre-processing required. However, they are expensive to purchase and maintain.
- **Double-chamber, high-temperature incinerators:** These are designed to eliminate the health risks of infectious waste with complete destruction of waste. However, the investment and operation cost is high and they require skilled staff for operation and maintenance.
- **Single-chamber, high-temperature incinerators:** These cost less, do not require highly trained operators, and are used when double-chamber incinerators are not affordable. However, they create significant emission of pollutants and do not destroy sharps.
- **Drum or brick (clay) incinerators:** Operating at lower temperatures, these are less effective, but can be made locally using readily available materials.

An autoclave is a device used to sterilize equipment and supplies by subjecting them to high pressure saturated steam. Materials that are typically autoclaved include laboratory glassware, surgical instruments, and medical waste. Preparation of material for autoclaving requires segregation to remove unsuitable material and shredding to reduce the size of the individual pieces for greater treatment efficiency. Small autoclaves are common for sterilization of medical equipment; however, HCW autoclaves can be expensive and require a high level of operation and maintenance support. While the output from an autoclave is non-hazardous and can usually be landfilled together with municipal waste, there is also wastewater that must be disposed of appropriately.

The number of imported small- to mid-size incinerators that have minimal pollution controls is increasing in Nigeria, as is the number of inadequately controlled large incinerators in central facilities.

AIDSTAR-ONE NIGERIA

With field support funding from the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) through USAID/Nigeria, AIDSTAR-One provides technical assistance to the GON to prevent the medical transmission of HIV and other blood-borne pathogens through improved injection safety and health care waste management in health facilities. The project aims to expand injection safety interventions with a focus on health facilities in Bauchi, Benue, and Sokoto states, working with the GON and the U.S. Government, including USAID/Nigeria and other PEPFAR partners. In addition, the project continues to monitor injection safety programs in two existing catchment areas (Cross River and Lagos) and in the FCT.

ASSESSMENT PURPOSE

To ensure proper treatment and disposal logistics for HCW generated by health facilities in Nigeria, it is necessary to collect and analyze data on the various types, classes, capacities, and locations of waste treatment equipment and to determine the ease of moving HCW to these locations.

ASSESSMENT OBJECTIVES

The overall goal of the study was to understand the spatial dynamics of health care waste management in Nigeria using geographic information systems (GIS). The study involved a preliminary GIS mapping of all WTE in Nigeria and was intended to open the way for further detailed investigations.

Specific study objectives were:

- To identify all facilities that used one or more types of waste disposal equipment, high-temperature incinerators, or autoclaves for HCWM
- To identify the type of WTE found in each location
- Using Global Positioning System (GPS) receivers, to establish the WTE locations
- Using digital cameras, to document the equipment
- To identify the status and capacity of each WTE
- To identify operators' level of training.

METHODOLOGY

To achieve study objectives, both primary and secondary data were used. Primary data was collected using a health facility questionnaire (Annex 1) and facilities' spatial data captured with the aid of GPS receivers and digital cameras. Information on the state of the incinerators and waste disposal units (WDUs) as well as on disposal methods was collected via observation and interviews.

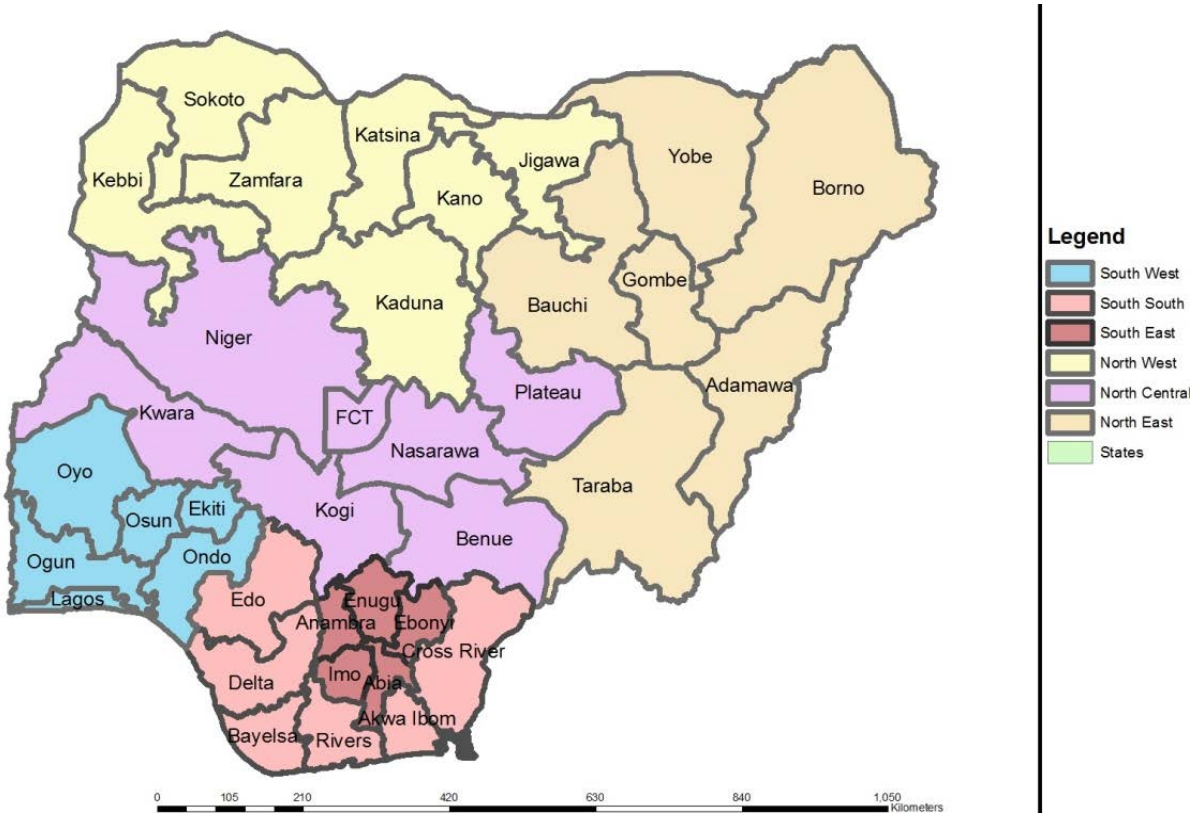
Secondary data was obtained from both published and unpublished documents on WTE. Previous studies carried out on HCW disposal at global, regional, national, and local levels were reviewed. GIS spatial and statistical analyses were used to summarize the collected data.

GEOGRAPHICAL INFORMATION SYSTEMS

A geographic information system is designed to manage, analyze, and display geographic data. The power of a GIS comes from its ability to relate and display different information in a spatial context based on geographic location. It is a valuable tool to assist in health research, education, and the planning, monitoring, and evaluation of health programs and systems.

Garmin GPSMAP 60CSx receivers were used for the assessment. They feature 30-second acquisition times and are accurate to plus or minus two meters. GIS data was analyzed with ArcMap 10 software.

Figure 1. Map of Nigeria's States and Geopolitical Zones



FACILITIES

There are approximately 30,000 health care facilities in Nigeria, with more than 85 percent classified as primary care facilities, 14.3 percent as secondary care, and fewer than 1 percent as tertiary care. More than 70 percent of the primary care facilities are in rural areas; almost all secondary and tertiary care facilities are in urban areas (Federal Ministry of Health [FMOH] 2012).

Study staff visited 64 facilities in 32 states and the FCT in Nigeria's six geopolitical zones (North, North West, North Central, South-South, South West, and South East). The 64 included all tertiary, secondary, and primary facilities identified as having WTE (n=41) from a list collected from the Federal Ministry of Environment and the Hospital Services Department of the FMOH. See Annex 2 for a list of all facilities visited.

FIELD WORK

Twelve data collectors from Fazako Associates participated in the assessment, with two covering each of the six geopolitical zones over 7–10 days in March 2012. They obtained the information by direct observation. Collectors used a GPS receiver to capture each facility's coordinates and a digital camera to photograph facilities from at least two different viewpoints. The GPS information was immediately saved and transferred manually to the questionnaire.

ASSESSMENT LIMITATIONS

Service provision areas for existing waste treatment equipment were determined by 70 km distance buffers along road lines to estimate a drivable distance range along major roads. Alternatively, distances other than the 70 km could be considered. In addition, road quality could be analyzed as well as changes in accessibility of those roads during peak rain periods.

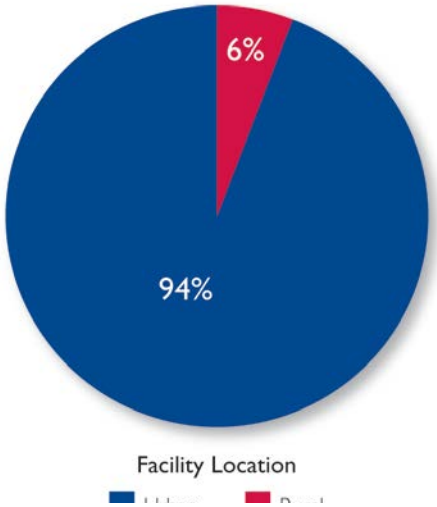
The analysis was limited to the 32 states and the FCT for which a census of health facilities was available. Oyo, Kebbi, Jigawa, and Delta states were excluded, because the health facility censuses of those states were incomplete at the time of the study.

Details of WTE locations was limited to the list made available by the FMOH, the Federal Ministry of Environment (Ecological Fund Office), and PEPFAR partners who had procured WDUs. During the study, 23 sites not previously listed as having WTE were visited in addition to the 41 known to have such equipment. The assessment team observed WTE at some of these sites. Therefore, it is possible that the study assessment may not capture all WTE in Nigeria. In the event that new WTE is discovered or procured, the data entry tool utilized for the current assessment (Annex 1) can be used and GIS data entered once the questionnaire has been administered to the additional facilities.

FINDINGS

Out of the 64 facilities visited, 94 percent were in urban areas (Figure 2). The 64 facilities covered the six geopolitical zones, with North Central and South West having the largest numbers because of the large populations concentrated in Lagos State and the FCT.

Figure 2. Urban–Rural Distribution of Health Care Waste Treatment Facilities



FACILITIES WITH WASTE TREATMENT EQUIPMENT

Fifty-two of the sixty-four facilities assessed had WTE.

The 52 facilities had a total of 65 pieces of equipment of different types, sizes, incinerating capacities, and operational status. Some facilities, including University College Hospital Ibadan, Federal Medical Centre Keffi, and National Hospital, Abuja, had more than one piece of equipment.

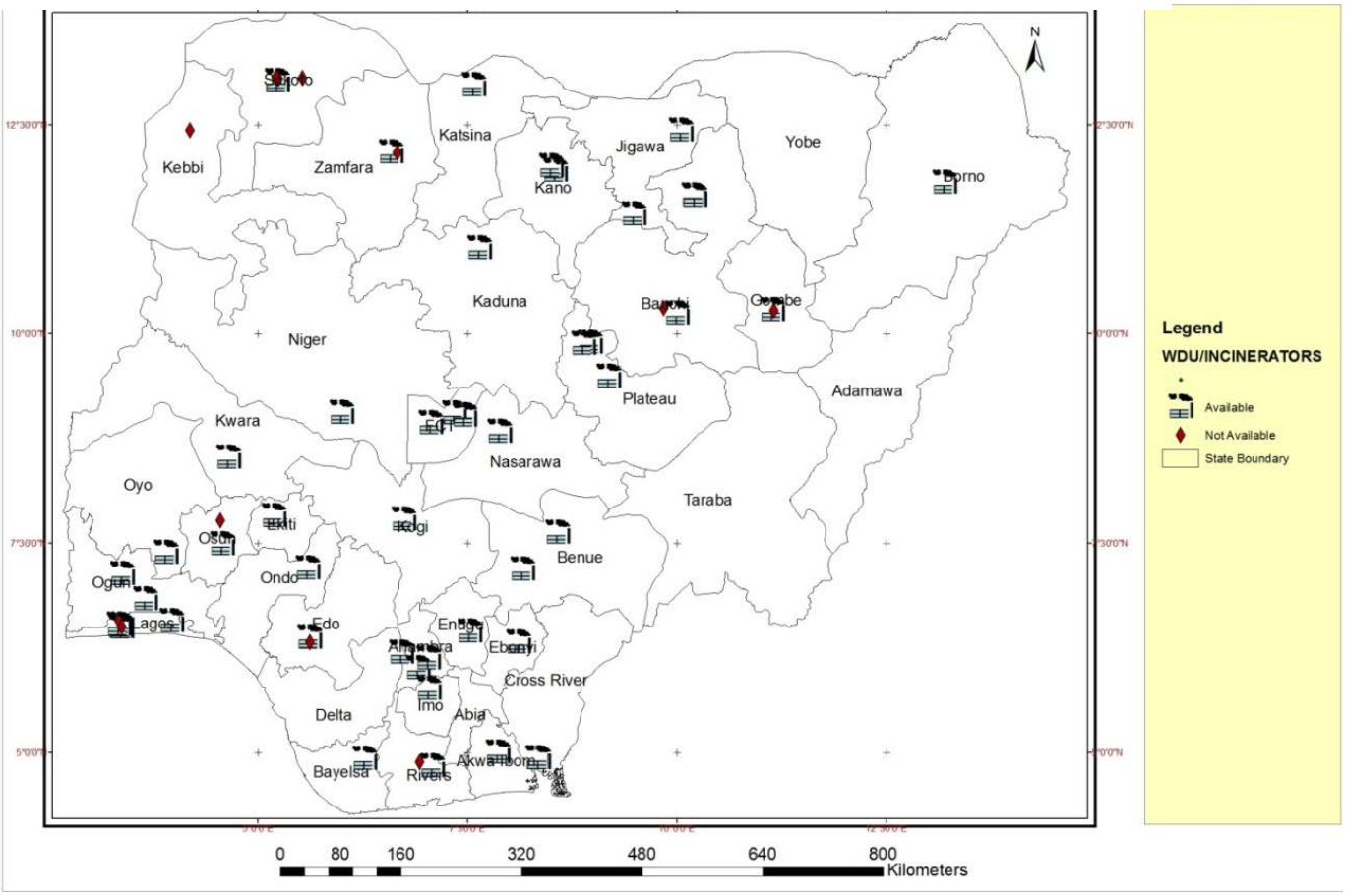


Figure 4. Ownership of Health Care Waste Treatment Facilities Visited (n=64)

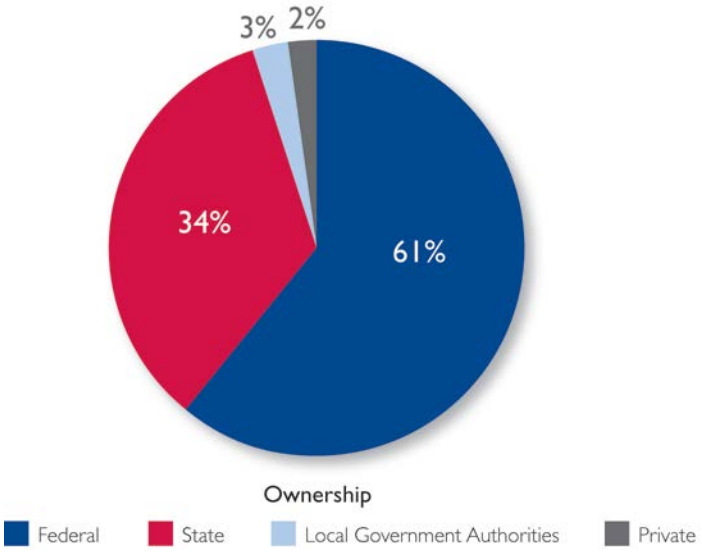
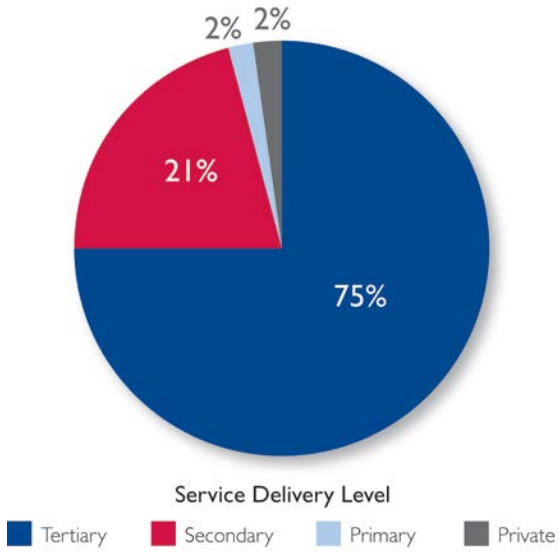


Figure 5. Health Care Waste Treatment Equipment Availability, by Service Delivery Level (n=52)



Of the 65 pieces of WTE, 98 percent were government owned—more than 61 percent by the federal government, 34 percent by the state government, and 3 percent by LGAs (Figure 4).

Most waste treatment equipment (75%) was in tertiary facilities and very little (2%) in primary facilities (Figure 5).

CHARACTERISTICS OF WASTE TREATMENT EQUIPMENT

Fifth-two of the sixty-four facilities visited were found to have WTE of various types, sizes, and incinerating capacities (Figure 6). Waste disposal units were observed at the largest number of facilities (29%), followed by rotary kilns (17%). Some facilities prefer WDUs because they do not require electricity or diesel for power. See Annex 2 for descriptions and photos of the different types of WTE.

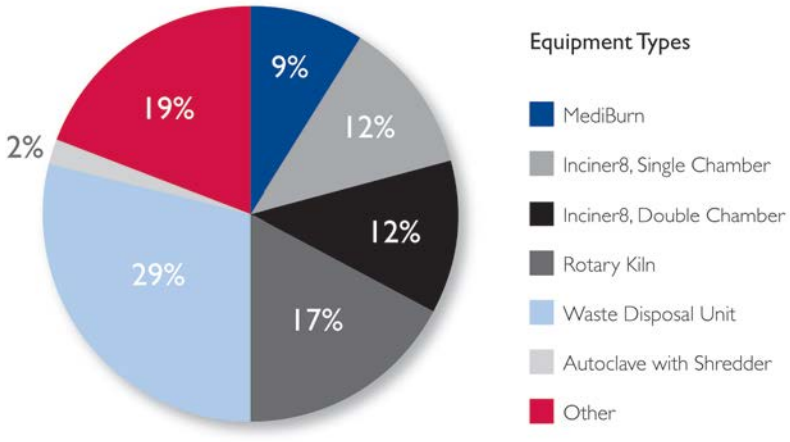
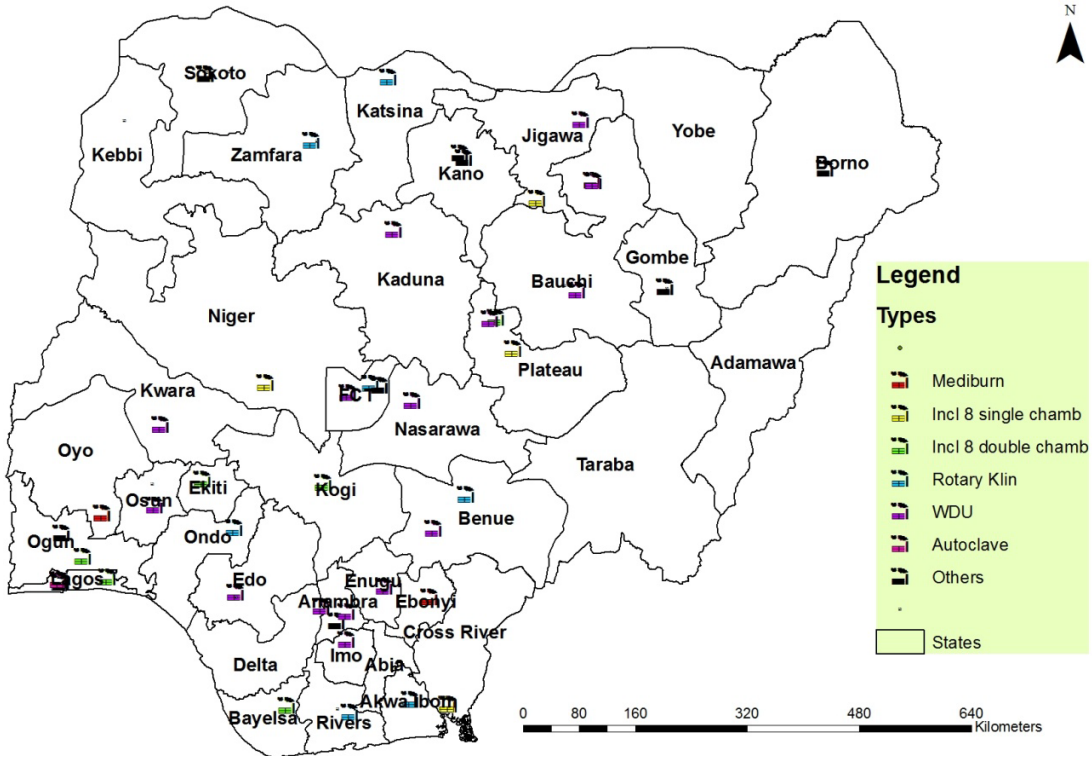


Figure 7 shows the geographic distribution of the different types of available waste treatment equipment.

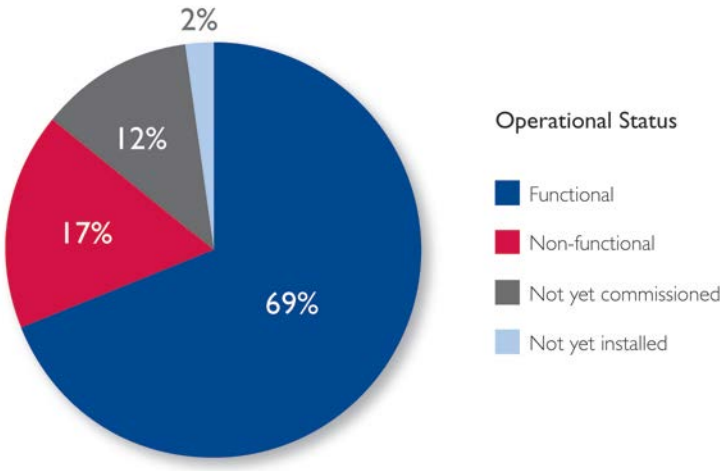
Figure 7. Geographic Distribution of the Waste Treatment Equipment



Of the 65 items of WTE observed at the 52 facilities, 69 percent were functioning at the time of the visit. Overall, 17 percent were observed to be nonfunctioning, 12 percent not yet commissioned (i.e., tested and put into use), and 2 percent not yet installed (Figure 8).

Few facilities were observed treating more than 100 kg of waste per hour. Overall, 91 percent incinerated an average of 1–100 kg of waste per hour (Figure 9). WDUs, comprising the bulk of WTE, have a capacity of 8–10 kg per hour. Capacity is 100–150 kg per hour for rotary kilns, 30–300 kg per hour for other units.

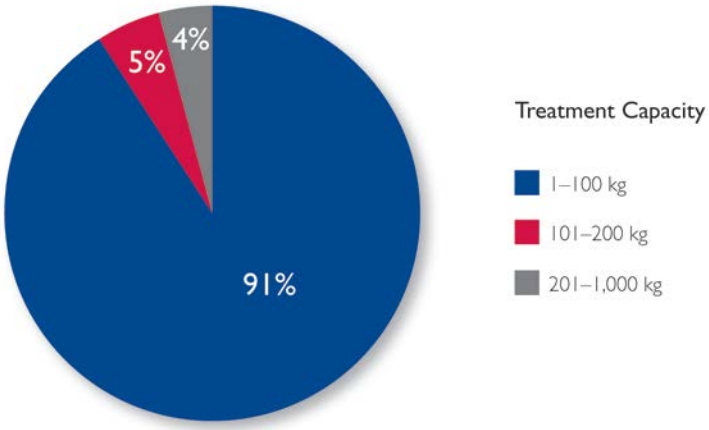
Figure 8. Waste Treatment Equipment Status (n=65)



Ash pits, which hold ash and other residues of incineration, are considered the final disposal point for HCW. Use of ash pits was observed to be low. Overall, 58 percent of facilities with incinerators, whether functional or non-functional, were observed to have an ash pit.

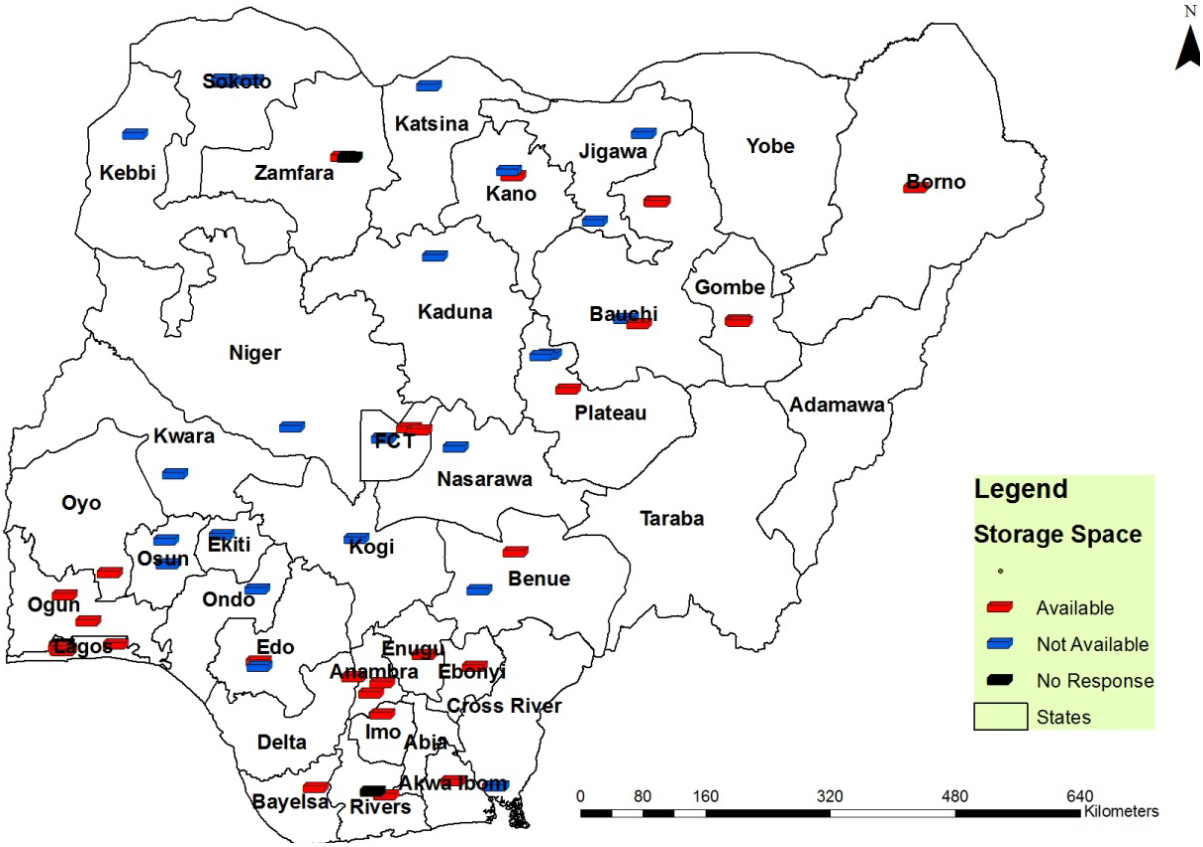
Safe HCWM protocols mandate that space be provided to store safety boxes and other infectious waste that awaits incineration and that this space be secured to prevent unauthorized access and covered to keep the safety boxes dry and prevent degradation of the cardboard.

Figure 9. Average Waste Incinerated per Hour



Secured storage space for waste was observed at just over half of assessed facilities (51%). Figure 10 shows the geographic distribution of facilities with secured storage space.

Figure 10. Facilities with Secured Health Care Waste Storage Space



TRAINING AND RESPONSIBILITIES OF THE INCINERATOR OPERATOR

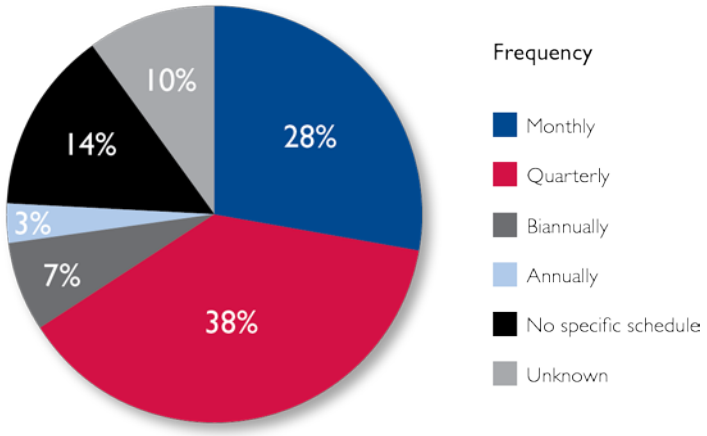
Incinerator operators are expected to be skilled at ensuring that waste has been properly burned and the ash properly disposed of. Operators' personal protective equipment (PPE), including apron, heavy-duty gloves, boots, and face mask, should be adequate, properly maintained, and kept clean (although these items must remain at the health facility and not taken home, in order to avoid spreading infection into the community). All waste handlers, including incinerator operators, must be trained to use appropriate PPE when handling HCW, to follow correct incinerator operations procedures, to ensure an adequate supply of fuel, and to record the weight and type of HCW received.

Overall, 71 percent of facilities visited reported that waste disposal personnel had received training. Even health care facilities lacking functional WTE may need capacity building on how best to manage their health care waste.

Records help to budget for incineration, to monitor and evaluate the incineration process, and to organize waste audits. However, waste log books and scales were not available at all sites. Overall, only 25 percent of observed facilities with WTE reported availability of a scale to weigh HCW being processed, and only 28 percent of facilities reported availability of a log book for record keeping.

Incinerators, like other equipment, need to be maintained regularly in order to operate smoothly and over many years. An inspection and maintenance checklist should guide each step of the incineration process. Operators are expected to follow incinerators' regular maintenance schedule. However, only 14 of the 52 facilities with WTE (27%) follow a regular maintenance schedule, and the frequency of that schedule varies (Figure 11).

Figure 11. Waste Treatment Equipment Scheduled Maintenance Frequency



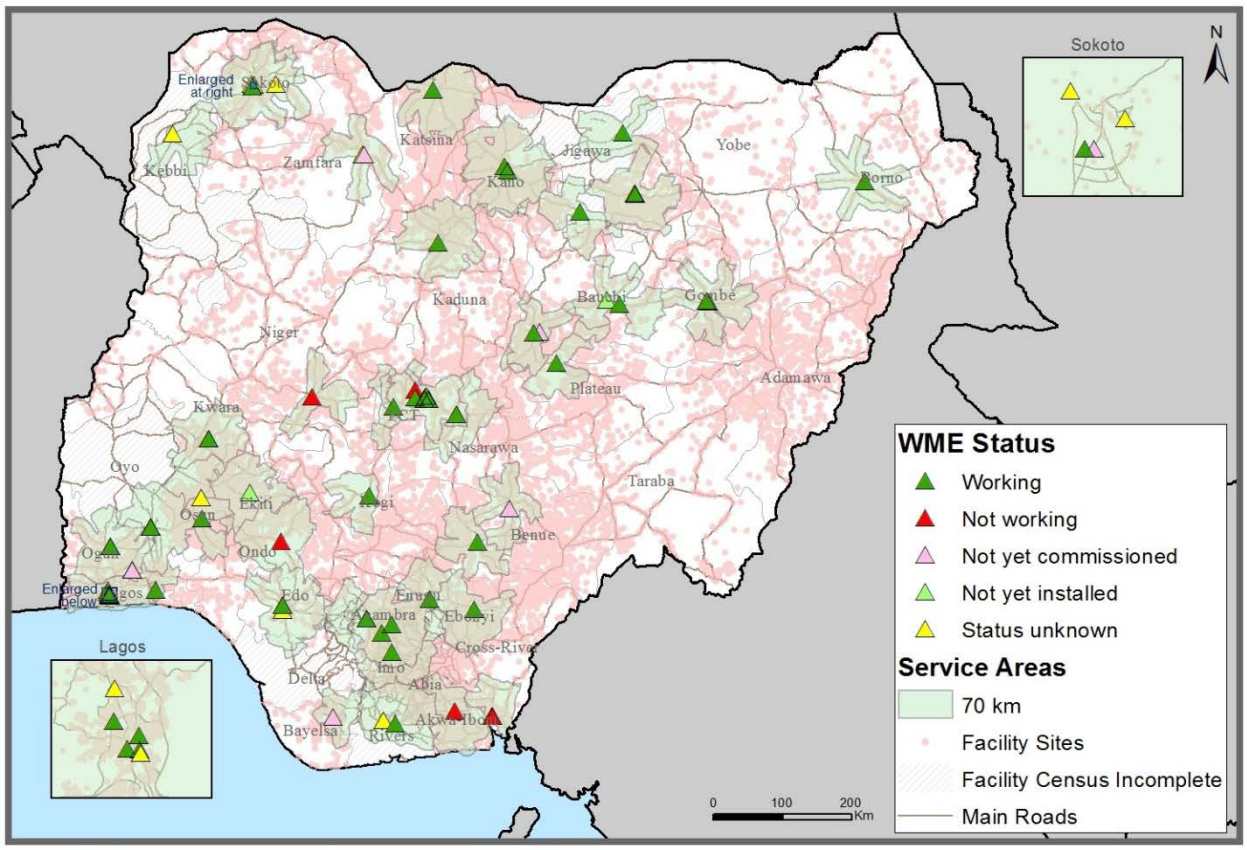
DETERMINATION OF CATCHMENT AREAS

Given the difficulties involved in installing and operating WTE, it would be cost effective for its use to be shared by multiple health facilities.

To properly assess catchment areas for each HCW treatment facility, study staff conducted an analysis that examined the distance along main roads between health facilities and current WTE. Together with estimates of how far a facility likely would be willing to transport waste to the nearest waste treatment facility, this network was mapped (Figure 12) to assess coverage.

HCW treatment needs of facilities located within 70 km of existing equipment were considered "covered."

Figure 12. Status of Waste Treatment Equipment in Assessed Catchment Areas



COVERAGE

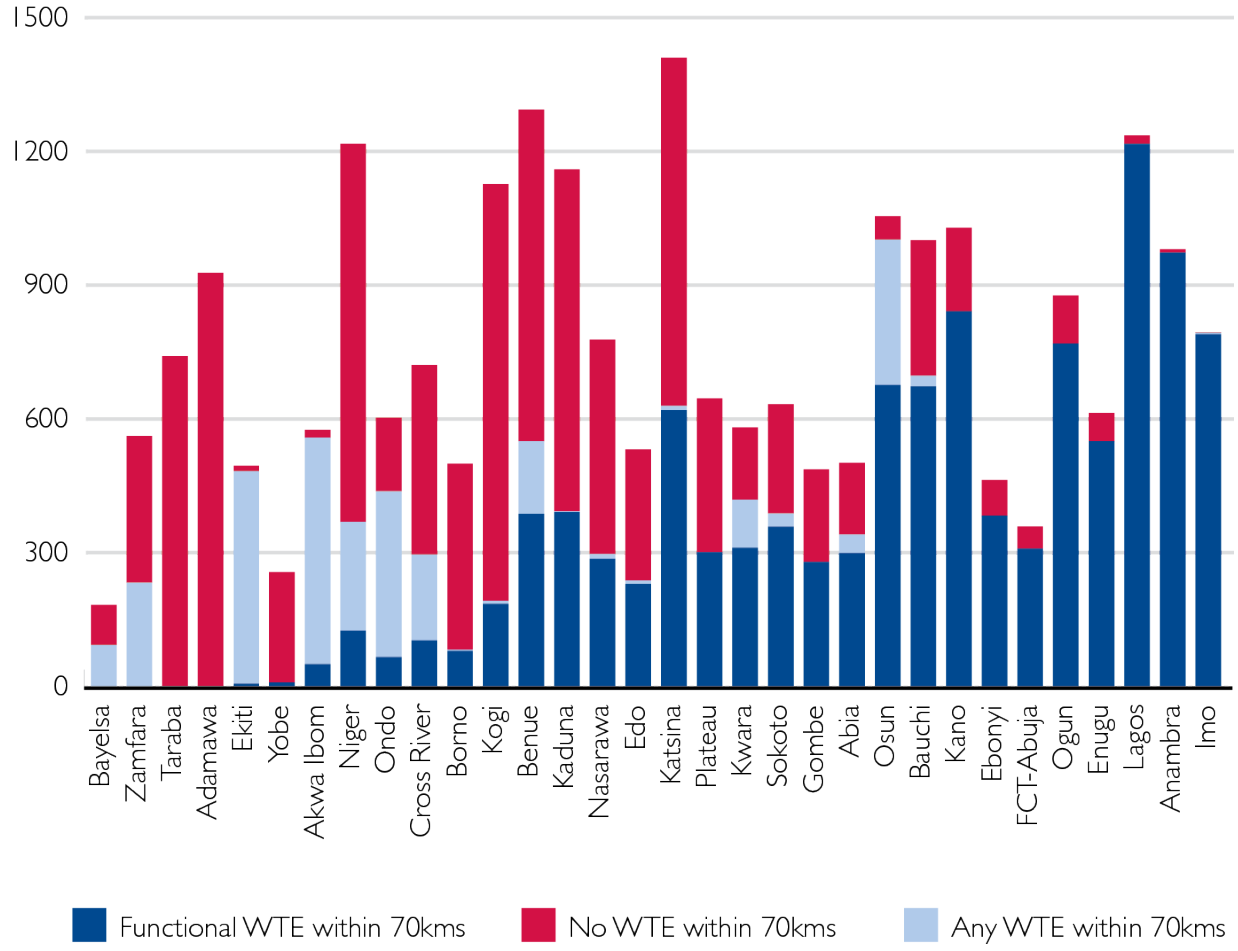
Based on the mapping, it is clear that because of the limitations of the road network, some health facilities are less accessible to WTE than they might appear to be.

Overall, 46 percent of health facilities have access to functioning WTE. If all such equipment were functional (including equipment that is now either nonfunctioning, not yet commissioned, or not yet installed), 58 percent of health facilities would have access to functioning WTE within 70km.

Low coverage, with fewer than 40% of facilities in the district located within 70 km by road of known, functioning WTE, was observed in 15 states: Adamawa, Akwa Ibom, Bayelsa, Benue, Borno, Cross River, Ekiti, Kaduna, Kogi, Nasarawa, Niger, Ondo, Taraba, Yobe and Zamfara states. No health facilities in Adamawa, Taraba, or Yobe states were within 70 km of WTE. If all known WTE, regardless of functionality, is considered, the number of low-coverage states falls to eight (Adamawa, Borno, Kaduna, Kogi, Nasarawa, Niger, Taraba, and Yobe states).

More than 85 percent of facilities observed in Abuja, Anambra, Enugu, Imo, Lagos, and Ogun states were within 70 km of a functioning waste treatment facility.

Figure 13. Health Facility Access to Functioning Waste Treatment Equipment, by District



The mapping also permits state-by-state analysis to determine strategic needs to repair nonfunctioning equipment and to construct new equipment. For example, in Figure 13, bars indicate health facilities located within 70 km of a functioning waste treatment facility (dark blue), facilities within the catchment area of a nonfunctioning waste treatment facility (light blue), and facilities outside the catchment area of any waste treatment facilities (red). Focusing repairs on existing equipment that would impact the greatest number of health facilities—that is, in areas denoted by the longest light blue bars—could help ensure benefits to the greatest number of communities. Similarly, constructing new equipment in areas represented by the longest red bars, would benefit the largest number of facilities and their communities.

RECOMMENDATIONS

Undertake additional studies.
Additional studies should be undertaken to acquire additional and more detailed information about HCW burning and incineration and its consequences in Nigeria. These studies should analyze and quantify the impact of these activities on public health.

Develop and implement plans and policies on HCW treatment.
To ensure continuity and clarity in the proposed recommendations, clear plans and policies on managing and disposing of HCW should be developed and integrated into workers' routine training, continuing education, and systems and personnel evaluation processes. The map should be updated periodically as new WTE is installed.

Improve waste management education for all health workers.
Facility managers must offer proper education and training in waste treatment to all health providers, waste handlers, incinerator operators, and cleaners. To properly allocate funding, managers should understand the importance of appropriate waste management supplies (e.g., waste bin liners and bins in the correct colors, log books, and scales for weighing waste) and the need to maintain a clean environment and to provide safety protection for waste handlers in the form of appropriate PPE.

Incinerator operators should be trained on proper methods for receiving, recording, and storing waste. They should also be taught incinerator operation and maintenance and provided with appropriate PPE.

Ensure proper waste segregation at the point of generation.
Segregating HCW at the point of generation should be standard practice in all health care facilities. Mixing HCW and general waste as they are generated, collected, transported, and finally disposed of—as is current practice—endangers waste handlers and overburdens WTE. Better education and supervision is necessary to effect improvements in this area.

Studies have shown that only 15-20 percent of waste generated in health facilities is potentially infectious. Segregating and then incinerating HCW will help prolong the life of existing WTE.

Ensure availability of HCW log books and scales at all facilities.
To plan, budget, and monitor HCWM activities effectively, facilities must have functional scales and a waste log book. These items will help to give management an overview of the quantity of waste generated in their facility as well as to keep proper records of waste destroyed (e.g., pharmaceutical waste) for audit purposes.

Introduce a zero medical waste program.
Facility managers should immediately introduce a zero medical waste program and eventually develop it into policy. A zero medical waste program focuses on reducing or minimizing waste or transforming it into new products that can be used for other purposes—a policy that can be very effective at minimal cost.

Focus on repair of nonfunctioning WTE strategically.
Repairing WTE in Akwa Ibom, Ekiti, Ondo, and Osun will impact the largest number of facilities and the clients they serve, followed by repairs to equipment in Niger and Zamfara states.

Focus new construction of waste treatment equipment strategically.
Most facilities with waste treatment equipment are in urban areas. At the time of analysis, states with large areas of low coverage (of any equipment, regardless of functionality) included Adamawa, Akwa Ibom, Bayelsa, Benue, Borno, Cross River, Ekiti, Kaduna, Kogi, Nasarawa, Niger, Ondo, Taraba, Yobe, and Zamfara. Adamawa and Taraba states had no WTE. New WTE construction or installation should focus on these states, considering needs in both rural and urban areas.

Figure 14. Incinerator Site in Bauchi State

To avoid the effect of environmental pollution on large populations, WTE without flue gas emission control is best located in areas that are rural or non-residential. However, WTE location is often lopsided, rural areas often have low coverage, while WTE is located in urban, densely populated areas creating high levels of exposure to pollutants.

In determining the category and capacity of units to be installed, the type of facility, the population of the catchment area, and proximity to other facilities within that catchment area should be considered, as should ease of maintenance. For example, it was observed that for rotary kilns manufactured locally by Nigerian company BOSKEL, breakdowns were fewer and routine maintenance more accessible, given the manufacturer's in-country location. For primary health care facilities in rural areas, waste disposal units might be encouraged, because they do not require electricity or diesel for power.

Encourage private-sector facilities to intensify their focus on improving HCWM.
Most equipment observed was government owned. Private-sector facilities should also be encouraged to prioritize health care waste management. This could be facilitated by the approval of the national HCWM policy spelling out the private sector role in HCW collection, transportation, treatment, and disposal. The policy could help ensure private-sector involvement.

Facility management should ensure that WTE is regularly maintained and sites kept clean.
A regular maintenance schedule is essential to prolong the life of equipment and ensure its proper use. An inspection and maintenance checklist is also necessary. Waste treatment sites must not be used as open dump sites (as was observed in some facilities; see photos in Figure 14 and 15). An ash pit and a secured storage area for HCW awaiting incineration are both integral to the waste treatment process and should be available at all sites.

Figure 15. An Open Waste Dump in Bauchi State

CONCLUSION

Every day, health care facilities generate waste, some of it potentially infectious or otherwise hazardous. Unfortunately, lack of equipment, lack of planning, inadequate funding, and other factors prevent facilities—particularly primary facilities—from introducing or maintaining WTE and a proper plan for HCWM. Identifying catchment areas for existing WTE by using GIS can be useful in planning and budgeting. Not every health facility in Nigeria can have WTE, but all can be grouped with an accessible facility that does have equipment. Grouped facilities might pay service charges to the host facility to enable regular, adequate equipment maintenance.

Demonstrating which facilities are within 70 km of functioning equipment via current road networks, this mapping can also assist the GON and other program planners in considering how resources might best be spent to repair existing facilities and construct new ones. Finally, the mapping results will inform program planners undertaking waste management planning and will ensure proper implementation of facility, LGA, and state plans for HCWM.

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APPENDIX I

GIS MAPPING OF WASTE MANAGEMENT DISPOSAL UNITS IN NIGERIA

Date: _____ Time: _____
DD MM YYYY

SECTION ONE

A. RESPONDENT(S) BACKGROUND

S/N	Name	Designation	Phone Number	Section Completed

B. GPS INFORMATION

101a	GPS I.D	
101b	WAYPOINT I.D	
101c	ALTITUDE (HEIGHT)	
101d	LATITUDE (Northing)	N .
101e	LONGITUDE (Easting)	E .

C. FACILITY INFORMATION CODE

102a	STATE NAME:
102b	LGA NAME:
102c	LOCALITY NAME:
102d	FACILITY NAME:
102e	FACILITY Tel. No:
102f	ADDRESS OF FACILITY:
102g	E-mail of FACILITY:
102h	NAME OF HEAD OF FACILITY:
102i	Tel No. of HEAD OF FACILITY:
102j	YEAR ESTABLISHED:

SECTION TWO

FACILITY CLASSIFICATION

201	Is Facility Urban or Rural					
		1	2			
202	Is Facility owned by Government or Non Government					
		1				2
203	If owned by government, what tier:			Federal	State	LGA
				1	2	3
204	If owned by Non-government: Is it PRIVATE FBO CBO NGO OTHERS (Specify)					
		1	2	3	4	5

205	Is the Facility classified as		Primary	Secondary	Tertiary	
	(Check certificate of registration)		1	2	3	

SECTION THREE

A. WASTE TREATMENT EQUIPMENT

206	Does this Facility have a Waste Treatment Equipment		Yes	1	No	2
207	If yes to 206, What is the type/model of your incinerator					
	Mediburn (1)	Inclner 8 single chamber (2)	Inclner 8 double chamber (3)	Rotary klin (4)	WDU (5)	
	Autoclave with shredder (6)	Others specify (7)	*Please indicate in the box provided*			
208	Is the incinerator currently working? Yes – 1 No – 2 Not yet commissioned – 3 Not yet installed – 4 *Please indicate in the box provided*					
209	How many Kilogram (KG) of waste can the incinerator burn per hour? **Kg**					
210	Is there an ash pit for ash disposal after incineration? Yes – 1 No – 2 I don't know – 3 *Please indicate in the box provided*					
211	Does the facility have a secured storage space for filled safety boxes/bagged waste?		Yes	1	No	2
212	How many incinerator operators do you have? *Please indicate in the box provided*					

213	List Names and Phone numbers of the operators/supervisors below		
	1		
	2		
	3		
	4		
214	Is the Incinerator operator/supervisor trained? Yes – 1 No – 2 I don't know – 3 *Please indicate in the box provided*		
215	When was he trained? *Please indicate YEAR TRAINED in the box provided*		
216	Does the facility have a waste weighing scale? Yes – 1 No – 2 I don't know – 3 *Please indicate in the box provided*		
217	Does the facility have a waste weighing log book? Yes – 1 No – 2 I don't know – 3 *Please indicate in the box provided*		
218	How many kgs of waste are incinerated per day in this health facility? *Please indicate in the box provided*		
219	How many years old is the incinerator? *Please indicate in the box provided*		
220	How often are the incinerator maintained: Monthly – 1 Quarterly – 2 Bi-annually – 3 Annually – 4 No specific time – 5 I don't Know – 6 *Please indicate in the box provided*		

221	How many hours per day is the incinerator in use? *Please indicate in the box provided*	
222	What is the average temperature of the incinerator when it is in use? *Please indicate in the box provided*	

B. RESEARCHER'S DETAILS

301	Name:	
302	Organization	
303	Tel. Number	
304	e-mail address	
305	Date of visit *(dd/mm/yyyy)*	/ / TIME Hrs

APPENDIX 2

LIST OF FACILITIES VISITED

S/N	STATE	FACILITY	STATUS
1	Akwa Ibom	UNIVERSITY OF UYO TEACHING HOSPITAL	1
2	Anambra	NNAMDI AZIKWE UNIVERSITY TEACHING HOSPITAL	1
3	Anambra	NAFDAC LABORATORY	1
4	Bauchi	SPECIALIST HOSPITAL BAUCHI	2
5	Bauchi	FEDERAL MEDICAL CENTRE AZARE	1
6	Bauchi	PRIMARY HEALTH CARE CENTER KANGERE	1
7	Bayelsa	FEDERAL MEDICAL CENTRE YENAGOA	1
8	Benue	GENERAL HOSPITAL OTUKPO	1
9	Benue	FEDERAL MEDICAL CENTRE MAKURDI	1
10	Borno	UNIVERSITY OF MAIDUGURI TEACHING HOSPITAL	1
11	Cross River	GENERAL HOSPITAL CALABAR	1
12	Cross River	UNIVERSITY OF CALABAR TEACHING HOSPITAL	1
13	Delta	FEDERAL MEDICAL CENTRE ASABA	1
14	Ebonyi	FEDERAL MEDICAL CENTRE ABAKALIKI	1
15	Edo	CENTRAL HOSPITAL BENIN	2
16	Edo	UNIVERSITY OF BENIN TEACHING HOSPITAL	1
17	Ekiti	FEDERAL MEDICAL CENTRE	1
18	ENUGU	NATIONAL ORTHOPEADIC HOSPITAL	1
19	FCT	ASOKORO DISTRICT HOSPITAL 1	1
20	FCT	GENERAL HOSPITAL KUBWA	1
21	FCT	DISTRICT HOSPITAL, MAITAMA	1
22	FCT	GENERAL HOSPITAL WUSE	1
23	FCT-Abuja	NATIONAL INSTITUTE FOR PHARMACETICAL RESEARCH AND DEVELOPMENT (NIPRD)	1
24	FCT-Abuja	UNIVERSITY OF ABUJA TEACHING HOSPITAL	1
25	FCT-Abuja	NATIONAL HOSPITAL, ABUJA	1

26	Gombe	SPECIALIST HOSPITAL GOMBE	2
27	Gombe	FEDERAL MEDICAL CENTRE GOMBE	1
28	Imo	IMO STATE UNIVERSITY TEACHING HOSPITAL ORLU	1
29	Jigawa	GENERAL HOSPITAL HADEJIA	1
30	Jigawa	FEDERAL MEDICAL CENTRE BIRNIN KUDU	1
31	Kaduna	NATIONAL TUBERCULOSIS & LEPROSY TRAINING CENTRE	1
32	Kano	AMINU KANO TEACHING HOSPITAL	1
33	Kano	NATIONAL ORTHOPAEDIC HOSPITAL DALA	1
34	Katsina	FEDERAL MEDICAL CENTRE KATSINA	1
35	Kebbi	HAJJI CAMP	2
36	Kogi	FEDERAL MEDICAL CENTRE LOKOJA	1
37	Kwara	UNIVERSITY OF ILORIN TEACHING HOSPITAL	1
38	Lagos	LAGOS STATE UNIVERSITY TEACHING HOSPITAL (LASUTH)	2
39	Lagos	NEUROPSYCHATRIC HOSPITAL	2
40	Lagos	GENERAL HOSPITAL, EPE	1
41	Lagos	LAGOS UNIVERSITY TEACHING HOSPITAL (LUTH)	1
42	Lagos	NIGERIAN INSTITUTE OF MEDICAL RESEARCH	1
43	Lagos	NATIONAL ORTHOPAEDIC HOSPITAL	1
44	Lagos	LAGOS WASTE MANAGEMENT AUTHORITY(LAWMA)	1
45	Nasarawa	FEDERAL MEDICAL CENTRE KEFFI	1
46	Niger	FEDERAL MEDICAL CENTRE BIDA	1
47	Ogun	OLABISI ONABANJO UNIVERSITY TEACHING HOSPITAL SAGAMU	1
48	Ogun	FEDERAL MEDICAL CENTRE ABEOKUTA	1
49	Ogun	OLABISI ONABANJO TEACHING HOSPITAL WATERSIDE	1
50	Ondo	FEDERAL MEDICAL CENTRE OWO	1
51	Osun	OBAFEMI AWOLOWO UNIVERSITY TEACHING HOSPITAL	1
52	Osun	LADOKE AKINTOLA UNIVERSITY TEACHING HOSPITAL (LAUTECH)	2
53	Oyo	UNIVERSITY COLLEGE HOSPITAL IBADAN	1
54	Plateau	JOS UNIVERSITY TEACHING HOSPITAL	1
55	Plateau	PLATAEU STATE HUMAN VIROLOGY CENTRE	1

56	Plateau	COCIN HOSPITAL & REHAB CENTRE	1
57	Rivers	UNIVERSITY OF PORT HARCOURT TEACHING HOSPITAL	2
58	Rivers	BOSKEL THERMAL PROCESS ENGINEERING COMPANY	1
59	Sokoto	MARYAM ABACHA WOMEN & CHILDREN HOSPITAL.	2
60	Sokoto	SPECIALIST HOSPITAL	2
61	Sokoto	NOMA HOSPITAL	2
62	Sokoto	USMAN DANFODIO UNIVERSITY TEACHING HOSPITAL	1
63	Zamfara	FEDERAL MEDICAL CENTER GUSAU	1
64	Zamfara	FARIDA GENERAL HOSPITAL GUSAU	2

Note:

1 = Incinerator available, 2 = Incinerator not available

Total number of facilities visited = 64

Total number of facilities with WTE = 52

Total number of facilities without WTE = 12

Total number of WTE of various types/capacity/status observed = 65

APPENDIX 3

TYPES OF WASTE TREATMENT EQUIPMENT

MEDIBURN

MediBurn is a diesel-fueled medical waste incinerator for hospitals and clinics. MediBurn incinerates everything from laboratory waste to animal remains with clean emissions. The incinerator's small footprint makes it easy to fit into facilities with limited space. Its portability and simple installation offer flexibility for relocation. MediBurn is easy to operate and requires minimal training. MediBurn offers dual-chamber combustion and high exhaust temperatures in excess of 1,000°C.

WASTE DISPOSAL UNIT

A waste disposal unit is a small-scale incinerator appropriate in size for rural hospitals and primary health care facilities. Its capacity to tolerate up to 100 percent plastic (safety boxes)—unusual among incinerators—makes it ideal to handle not only facilities' routine curative waste but also waste overflow resulting from immunization campaigns. Waste disposal units are well suited to primary health care facilities with low patronage in rural areas. They do not require electricity or diesel to function, just dry wood or leaves to ignite.

INCINER8 SINGLE-CHAMBER INCINERATOR

An Inciner8 single-chamber incinerator burns at high temperatures, with virtually no smoke or odors. Its refractory lining provides excellent heat retention. Heat-up times are short and burn rates high, at up to between 30 and 50 kg per hour. Installation and maintenance are both considered simple.

INCINER8 DOUBLE-CHAMBER INCINERATOR

An Inciner8 double chamber incinerator burns at high temperatures, with virtually no smoke or odors. Its refractory lining provides excellent heat retention. It heats up quickly and burns at rates of up to 300 kg per hour. Installation and maintenance are both considered simple.

ROTARY KILN INCINERATOR

The rotary kiln incinerator consists of a slightly inclined rotating primary combustion chamber. The waste is introduced at its highest end while de-ashing takes place at its lowest part. Because of the rotary kiln's cylindrical form, the heat is equally refracted to the burning waste, and heat transfer and control are optimal. Rotary kilns are equipped with flue gas emission control systems, which include quenchers and alkaline scrubbers and, in some units, activated-carbon filter beds.

AUTOCLAVE

An autoclave is a device used to sterilize equipment and supplies by subjecting them to high pressure saturated steam at 121 °C for approximately 15-20 minutes. Materials that are typically autoclaved include laboratory glassware, surgical instruments, and medical waste.

For more information, please visit aidstar-one.com.

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