



# SOLID WASTE MANAGEMENT

## ADDRESSING CLIMATE CHANGE IMPACTS ON INFRASTRUCTURE: PREPARING FOR CHANGE

Leachate running from a break in a landfill wall following a major storm. Photo Credit: Joe Teixeira, 2011



- ▶ Climate change impacts on solid waste management infrastructure and surrounding environment may be temporary or long-lasting.
- ▶ Poor management of solid waste can lead to rodent infestations, disease outbreak, and groundwater contamination.
- ▶ Solid waste-related adaptation options include protecting critical infrastructure, reducing facility needs through recycling and demand management, and requiring waste treatment facilities to prepare adaptation plans.

### SOLID WASTE MANAGEMENT IS INTEGRAL TO DEVELOPMENT PRIORITIES

Solid waste collection, processing, and disposal is critical to development practitioners' environment and health sector priorities, including maintaining clean air, soil, and water; particularly in urban settings. Moreover, most solid waste management helps mitigate greenhouse gas emissions.

Trash collection is important for maintaining sanitary conditions, particularly in residential and business areas where food debris can attract rodents and insects while decaying organic matter can cause unpleasant odors. Once collected, solid waste must be separated and managed by type such as municipal waste; commercial, industrial, and construction waste; agricultural waste; and medical and hazardous waste. Medical and hazardous waste should be treated and/or contained so that it does not contaminate people, ground and surface water, soil, or air. Municipal waste should be sorted to remove reusable or recyclable material and stored in a landfill designed to contain waste and manage decomposition.

While many areas around the world do not yet have established waste management systems, it is critical that all new and existing solid waste management systems be designed and maintained to be resilient to climate change. **By supporting programs to reduce waste, increase collection, and build and maintain climate-resilient disposal sites, USAID and other development practitioners can contribute to health and resource management objectives that promote lasting program benefits.**

#### SOLID WASTE MANAGEMENT INCLUDES:

- Collection
- Processing, treatment, and recycling
- Disposal

#### SOLID WASTE MANAGEMENT SUPPORTS:

- Urban programs
- Health programs
- Environmental management

### CLIMATE STRESSORS CAN SIGNIFICANTLY IMPACT SOLID WASTE MANAGEMENT SERVICES

Climate stressors can impact solid waste facilities both directly and indirectly. For example, while higher temperatures may directly alter decomposition rates, climate change may also affect access to roads, ports, and energy, indirectly limiting the collection of waste and operation of waste management sites.

Flooding poses the biggest threat to solid waste infrastructure. Without proper water catchment systems around a landfill, heavy rain events can degrade the landfill, causing breaks in the containment structure that allow debris and leachate to escape from the landfill and contaminate local resources. Flooding from extreme storms may undermine landfill foundations, releasing leachate into groundwater or block collection routes, sweep waste into waterways, and cause waste to clog other infrastructure. Landfills near the coast or in low-lying areas are vulnerable to sea level rise and storm surge. Water infiltration of the pit can lead to an overflow of waste from the landfill. Saltwater infiltration from below can deteriorate the impermeable lining of sanitary landfill facilities.

Temperature increases may necessitate more frequent waste collection schedules and rigorous landfill management practices, as odors will be stronger. Higher temperatures and drought may also increase the risks of fire at waste facilities.

These and other climate change risks vary in relative importance, with a range of cost implications, compounding effects, and impacts on development objectives. Please see Table 1 on the next page for additional examples.

**Table I.** Examples of Potential Climate Change Impacts on Solid Waste Management Infrastructure and Services

	Collection	Processing	Disposal
<b>Temperature Change</b>	<ul style="list-style-type: none"> <li>Increased odor and pest activity requiring more frequent waste collection</li> <li>Overheating of collection vehicles requiring additional cooling capacity, including to extend engine life</li> </ul>	<ul style="list-style-type: none"> <li>Overheating of sorting equipment</li> </ul>	<ul style="list-style-type: none"> <li>Altered decomposition rates</li> <li>Increased maintenance and construction costs due to thawing permafrost</li> <li>Increased risk of fire at disposal sites</li> </ul>
	<ul style="list-style-type: none"> <li>Greater exposure of workers to flies, which are a major cause of infectious diseases (flies breed more quickly in warm temperatures and are attracted to organic waste)</li> </ul>		
<b>Precipitation Change</b>	<ul style="list-style-type: none"> <li>Flooding of collection routes and landfill access roads, making them inaccessible</li> <li>Increased stress on collection vehicles and workers from waterlogged waste</li> </ul>	<ul style="list-style-type: none"> <li>Increased need for enclosed or covered sorting facilities</li> </ul>	<ul style="list-style-type: none"> <li>Increased flooding in/around sites</li> <li>Increased leachate that needs to be collected and treated</li> <li>Potential risk of fire if conditions become too dry and hot</li> </ul>
<b>Sea Level Rise</b>	<ul style="list-style-type: none"> <li>Narrowed collection routes</li> <li>Potentially increased waste in a concentrated area as people crowd into higher elevations within an urban area</li> </ul>	<ul style="list-style-type: none"> <li>Damage to low-lying processing facilities</li> <li>Increased need for sorting and recycling to minimize waste storage needs</li> </ul>	<ul style="list-style-type: none"> <li>Deterioration of impermeable lining</li> <li>Water infiltration of pit leading to possible overflow of waste</li> </ul>
	<ul style="list-style-type: none"> <li>Permanent inundation of collection, processing, and disposal infrastructure</li> </ul>		
<b>Storm Surge</b>	<ul style="list-style-type: none"> <li>Temporary flooding of and diminished access to roadways, rails, and ports for waste collection, sorting, and disposal</li> <li>Closure of facilities due to infrastructure damage</li> </ul>		
<b>Extreme Wind</b>	<ul style="list-style-type: none"> <li>Dispersal of waste from collection sites, collection vehicles, processing sites, and landfills</li> <li>Reduced access to collection and landfill access routes due to damage and debris</li> </ul>		

## SOLID WASTE MANAGEMENT-RELATED ADAPTATION CAN BE MAINSTREAMED INTO EXISTING PROGRAMS

USAID and other development practitioners can identify adaptation action priorities and integrate them into existing improvement and maintenance programs. Waste collection and disposal facilities are critical to protecting human health and local resources (particularly water and soil resources). Regular collection, particularly in residential areas, reduces exposure to contaminated waste and disease-carrying rodents and insects. Properly sited, constructed, and maintained disposal facilities can minimize the risk of water and soil contamination from the consequences of climate change impacts.

Reducing the amount of solid waste stored in landfills is one of the easiest ways to reduce their vulnerability. Establishing waste sorting and recycling facilities can create local jobs and perhaps provide work for trash pickers whose livelihoods were compromised by a more robust municipal waste collection system. Recycling also reduces resource use and the amount of waste that must be managed in a landfill.






Proper siting of landfills is another low-cost adaptation option. Landfills should be sited in areas where there is reliable access to the dumping site but away from bodies of water and areas with high water tables. Sites should be selected based on the municipality's long-term planning objectives and include input from the public.

Through a screening process, adaptation action priorities can be selected based on local decision-makers' assessment of the following four key factors (presented with illustrative questions). Please see the Overview for more information.

- **Criticality** – How important is the infrastructure to the community or region? How large is the population served by the waste management system? Are backup services available?
- **Likelihood** – Given climate projections, what is the probability that the collection, processing, or disposal infrastructure will be affected?
- **Consequences** – How significant is the impact? Will the impacts complicate solid waste management? Will the impacts have health implications?
- **Resources available** – Can changes be made to collection, processing, or disposal using a reallocation of existing time and resources? Are additional resources, such as additional workers, required?

By understanding the answers to these questions, adaptation actions (like those listed in Table 2) can be integrated into the upfront design, construction, operation, and maintenance of solid waste management systems. Integrating adaptation can prevent maladaptive decisions that increase the vulnerability of the infrastructure and people they are trying to serve. Table 2 illustrates this approach, aligned with the Climate-Resilient Development (CRD) Framework. See the Overview for further guidance on the CRD Framework.

**Table 2.** Examples of Solid Waste Management-Related Actions by Project Cycle Stage

Project Cycle Stage	Project Cycle Actions		
	<ul style="list-style-type: none"> <li>Identify solid waste-related development goals important to the country, community, or sector you are working with</li> <li>Identify inputs and enabling conditions necessary to achieving those goals</li> <li>Consider the impacts of climate and non-climate stressors on those inputs</li> </ul>		
	<ul style="list-style-type: none"> <li>Assess climate threats, vulnerabilities, and impacts to solid waste collection, processing, and storage to understand adaptation needs</li> <li>Evaluate climate-related risks in light of all existing risks to solid waste</li> </ul>		
 <p>Planning Policy Changes Project Development</p>	<b>Adaptation Options (Examples)</b>		
	<b>ACCOMMODATE/MANAGE</b> <ul style="list-style-type: none"> <li>Properly site landfills away from floodplains, wetlands, or areas with high water tables</li> <li>Site landfills away from drinking water supplies</li> <li>Develop sites large enough to accommodate projected population growth and corresponding waste generation</li> <li>Design sites with sorting, recycling, and composting facilities to reduce waste storage needs</li> </ul>	<b>PROTECT/HARDEN</b> <ul style="list-style-type: none"> <li>Update design standards to elevate and strengthen containment walls to accommodate future sea level rise and high winds</li> <li>Design water catchment systems that can keep pace with projected rainfall patterns</li> <li>Update equipment design standards to increase efficiency and reduce maintenance costs in changing climate, particularly for complex, HVAC-dependent equipment</li> </ul>	<b>RETREAT/RELOCATE</b> <ul style="list-style-type: none"> <li>Plan for secure landfill closure and/or relocation</li> <li>Plan for extreme event evacuation</li> </ul>
 <p>Construction Operation Maintenance Program Activities</p>	<b>Adaptation Options (Examples)</b>		
	<b>ACCOMMODATE/MANAGE</b> <ul style="list-style-type: none"> <li>Increase financial and technical resources for more frequent maintenance and repairs</li> <li>Train waste sorters and educate the public about separating recyclable and compostable material from other waste</li> <li>Maintain collection vehicles to minimize disruptions due to mechanical failures</li> </ul>	<b>PROTECT/HARDEN</b> <ul style="list-style-type: none"> <li>Prevent erosion of landfill slopes, covers, and roads into and around landfills</li> <li>Maintain storm water catchment systems to ensure proper function</li> </ul>	<b>RETREAT/RELOCATE</b> <ul style="list-style-type: none"> <li>Cover threatened landfills and develop new sites in more secure locations</li> </ul>
	<ul style="list-style-type: none"> <li>Regularly inspect the integrity of water catchment systems and containment walls, particularly following extreme rain or storm events</li> <li>Continue to monitor landfills for groundwater contamination and cover erosion</li> </ul>		

## FURTHER READING

United Nations Environment Programme (UNEP), 2010. Waste and Climate Change: Global Trends and Strategy Framework. <http://www.unep.or.jp/ietc/Publications/spc/Waste&ClimateChange/Waste&ClimateChange.pdf>.

United Nations Human Settlement Programme (UN-HABITAT), 2010. Solid Waste Management in the World's Cities: Water and Sanitation in the World's Cities. <http://www.unhabitat.org/pms/listItemDetails.aspx?publicationID=2918>

United Nations Human Settlement Programme (UN-HABITAT), 2011. Planning for Climate Change: A Strategic, Values-based Approach for Urban Planners. <http://www.unhabitat.org/downloads/docs/PFCC-14-03-11.pdf>