



**Environmental Research  
& Education Foundation**

*Lighting a path to sustainable waste management practices*

# Climate Change Impacts on Solid Waste Management

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# **Climate Change Impacts on Waste Management – Project Goal**

Conduct a review of relevant studies and literature to assess implications of climate change impacts on integrated solid waste management activities as related to greenhouse gas emissions, impacts on landfill capacity, increased environmental risks, etc.

# General Climate Change Impacts & Example Outcomes

## Impact

- Increasing average temperature
- More extreme weather events
- Changing rainfall patterns
- Changes in water resources
- Sea level rise
- Ecosystem change

## Example Outcome(s)

- Increased stress on infrastructure (e.g. power demand, transport, etc.)
- Food supply disruption/reduction
- Increased drought/water scarcity
- More intense/frequent storm events
- Increased flooding
- Health impacts (heat stress, poorer air quality, more disease)
- More vermin/insects
- Species habitat change/shifts

# Climate Change Impacts on Waste Management

## – Policy Focus

Climate change/global warming is a commonly cited justification for policy/guidance related to:

1. Landfill gas emissions – gas collection & control systems, increased monitoring
2. Vehicular emissions/electric or hybrid – not specifically focused waste collection vehicles
3. “Sustainable Materials Management” and circular economy focus
  1. Increasing recyclability/use of recycled materials
4. Extended producer responsibility
5. Product packaging design

# Waste Management Areas Impacted by Climate Change

1. Waste Generation
2. Waste Collection
3. Processing/Disposal Facilities (e.g. recycling, composting, landfill)
4. Workforce
5. Economic

# Potential Climate Change Impacts: Waste Generation

## 1. Changes in ecosystems/living conditions

- Increased crop pests/disease may increase food waste generation
- May result in significant demographic shifts or changes in population densities in areas

## 2. Warmer temperatures/Longer growing season

- increased yard/garden waste
- Higher energy demand

## 3. Extreme weather events/conditions

- More disaster debris (volume & frequency) from storms, wind damage, flooding events
- More wear/tear or reduced material life expectancy (eg. roofing shingles, HVAC systems)

## 4. Changes in consumer habits

- Shift in waste composition due to lifestyle/consumptive habits



# Potential Climate Change Impacts: Waste Collection

1. **Warmer temperatures/Longer growing season**
  1. Increased odors from collected garbage may result in increased collection frequency
  2. Increased nuisance potential/higher putrescence rates may require different container design
  3. Permafrost/ice melt may permanently impact access/waste transport in northern areas
  4. Increased fuel efficiency (but this may be negated by other factors – heavier loads, more frequent collection)
  5. Hotter running equipment may
    1. require additional cooling capability to reduce engine wear
    2. Increase potential for fires





# Potential Climate Change Impacts: Waste Collection (*continued*)

## 2. Extreme weather events/conditions

- a. More disaster debris increases need for specialized collection equipment (e.g. grapple, rear load)
- b. Disruption of collection schedule results in delays/backlogs for waste pickup
- c. Routing of trucks more complex/challenging
- d. Difficulty accessing transfer stations/disposal facilities





# Potential Climate Change Impacts: Processing/Disposal Facilities

## 1. Warmer temperatures/Longer growing season

- a. Increased odor management challenges at landfills, compost facilities
- b. Longer operating 'season' for outdoor composting facilities
- c. Waste degradation rates will be higher, which will increase:
  - composting rates
  - landfill gas production rates
  - settlement rates at landfills – potentially inducing waste mass stability issues
  - emissions (GHG, particulate, etc.)



# Potential Climate Change Impacts: Processing/Disposal Facilities (*continued*)

## 2. Extreme weather events/conditions & Sea Level Rise

- a. More waste generation may stress sites with limited remaining airspace/capacity
- b. Increase in weather related damage to buildings
- c. Higher fire risk and more damage from fires at facilities under higher drought/wind conditions
- d. Temporary or permanent inundation of facilities or access roads
- e. Facility closure/relocation or significant remodeling may be required
- f. More extremes may require more redundancy capacity in management infrastructure (e.g. landfill leachate treatment systems, auxiliary processing capacity, etc.)





# Potential Climate Change Impacts: Waste Management Workforce

1. Driving/work conditions more hazardous which increases potential for accidents (e.g. property damage, injury)
2. Increased exposure to hazardous work conditions at facilities
3. Extreme weather events result in less predictable work schedules (e.g. more hours over shorter time frames for emergency response)
4. Highly variable workforce needs may create worker shortages/surpluses that impact management/operations
5. Health Impacts
  - Increased heat stress
  - Poor air quality impact on respiratory conditions (e.g. asthma)
  - More frequent sickness or medical care needs for employees



# Potential Climate Change Impacts: Waste Management Economy

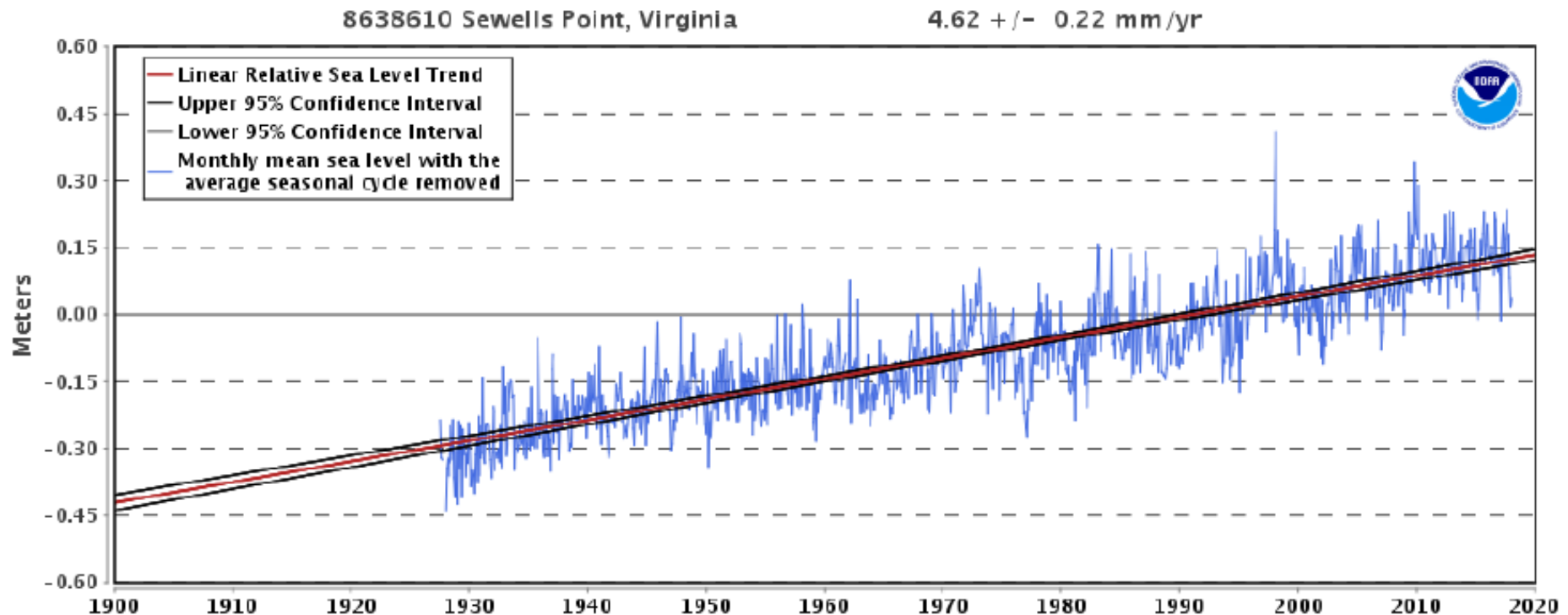
1. Increased risk/volatility
2. Increased costs
  1. Energy
  2. Fuel
  3. Facility operations/processing
  4. Health insurance/benefits
  5. Hazard pay
  6. Overtime
3. Increase in non-routine collection revenue (eg. special waste, disaster waste)
4. Impacts to value added outputs:
  1. Lower quality in collected fiber for recycling if more frequent wetting/inundation
  2. Higher landfill gas generation rates may increase revenue if converted to electricity/heat



# Life Cycle Evaluation of Impacts Case Study: *Norfolk, VA (USA)*

(Source: U.S. EPA, 2019)

1. Used Norfolk, VA (2<sup>nd</sup> most climate vulnerable in U.S.) as case study location
2. Three areas of impact evaluated: temperature, precipitation, sea level rise
3. Looked at the impact on collection, transfer station, landfill, recycling, WTE



Source: NOAA, 2018

# Life Cycle Evaluation of Impacts Case Study:

## ***Key Findings***

*(Source: U.S. EPA, 2019)*

1. Transport of collected waste to other facilities that are further away is necessary when typical facilities are not available (recycling going to landfill or MRF further away)
2. Likelihood of extreme weather events (e.g. hurricanes) that result in disruption of waste services ranges from 10% to 100% as event severity increases
  - Disruption can last weeks depending on severity of event
3. Increased emissions
4. Increased cost



# Acknowledgements/References

1. Dr. Calvin Lakhan, York University
2. USAID (2012), “Assessing Climate Change Impacts on Infrastructure Fact Sheet.” [Infrastructure SolidWasteManagement.pdf \(climatelinks.org\)](#)
3. WRAP (2011), “Applying the waste hierarchy: A guide to business.” Retrieved from <http://www.fccenvironment.co.uk/assets/files/pdf/content/wrap-applying-wastehierarchy.pdf>
4. U.S. EPA (2019), “Vulnerability of Waste Infrastructure to Climate-Induced Impacts.”



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# **Thank You**

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