LANDFILL METHANE EMISSIONS

TIME TO TACKLE THIS MAJOR ENVIRONMENTAL & CLIMATE JUSTICE THREAT

Report Analysis

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ACRONYMS

BIPOC	Black, Indigenous, and Other People of Color
CO2	Carbon Dioxide
CEJST	Climate and Economic Justice Screening Tool
DSCEJ	Deep South Center for Environmental Justice
EIP	Environmental Integrity Project
EJScreen	Environmental Justice Screen and Mapping Tool
EPA	Environmental Protection Agency
HCEJST	HBCU Climate and Environmental Justice Screening Tool
LFG	Landfill Gas
LMOP	Landfill Methane Outreach Program
MMTCO2e	Million Metric Tons of Carbon Dioxide Equivalent
MSWLF	Municipal Solid Waste Landfills
NECI	National Enforcement and Compliance Initiative
OECA	Office of Enforcement and Compliance Assurance
UCC	United Church of Christ's Commission for Racial Justice
U.S.	United States

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Landfills: Overview

Municipal Solid Waste Landfills in the United States

There are more than 3,000 active and 10,000 inactive (closed) total landfills in the United States. Landfills are essential for the proper disposal of solid waste. Landfills reduce waste that gets into the environment, prevent disease transmission, and help keep the community clean. However, they have significant environmental and social impacts. Municipal solid waste landfills (MSAELFs) are the nation's third-largest source of climate-destabilizing methane pollution, after the largest source, agriculture, and nearly equal to oil and gas, the second largest (U.S. Environmental Protection Agency [EPA], n.d., 2011, 2023a; The White House, 2022; Vasarhelyi, 2021).

One of the more concerning environmental issues regarding landfills is their release of methane gas. Landfills are the single largest source of U.S. industrial methane emitters Decomposing organic mass in landfills releases methane gas, which is 84 times more effective at absorbing heat from the sun than carbon dioxide (CO_2). Methane is thus the most potent greenhouse gas, and its emissions are a significant contributor to climate change. Methane seeping from landfills can pose a significant threat to human health (see "Hazards" in the later section "Landfills: Methane Gas and Hazards") (UN Environment Programme, 2022; Vasarhelyi, 2021; The White House, 2022).

African Americans are 75% more likely to live near hazardous waste facilities than the average American. *Trashing the Climate: Methane from Municipal Landfills,* a recent report from the Environmental Integrity Project (EIP), reveals that landfills are frequently situated near communities of color and/or low-income residents. According to the report, 54% of the landfills listed in the EPA's greenhouse gas emissions database are located in close proximity (within one-mile radius) to communities whose populations exceeds the national averages for people categorized as having low incomes (EIP, 2023; EPA, 2011); Villarosa, 2020).

Dr. Robert Bullard, an expert witness and researcher in the 1979 lawsuit Bean v. Southwestern Waste Management Corp found that 82% of all landfill disposal of solid waste in Houston, Texas, from the 1930s to 1978 was dumped in predominantly Black neighborhoods even though Blacks made up just 25% of Houston's population. He further discovered that five out of five city-owned landfills in Houston were located in predominantly Black neighborhoods. This case was the first to challenge, under civil rights law, the discriminatory placement of a waste facility. This Houston waste study found a clear racial pattern in the city's dumping. Houston lacks zoning laws, a fact that can leave some communities vulnerable to health risks. Landfills produce toxic pollutants that can cause cancer and produce smog. (Bullard 1987, 1990)

Landfills can be categorized into four types: municipal solid waste landfills, industrial waste landfills, hazardous waste landfills, and green waste landfills. An MSWLF is a chosen area of land or excavation that receives household waste. Some familiar household wastes are food scraps,

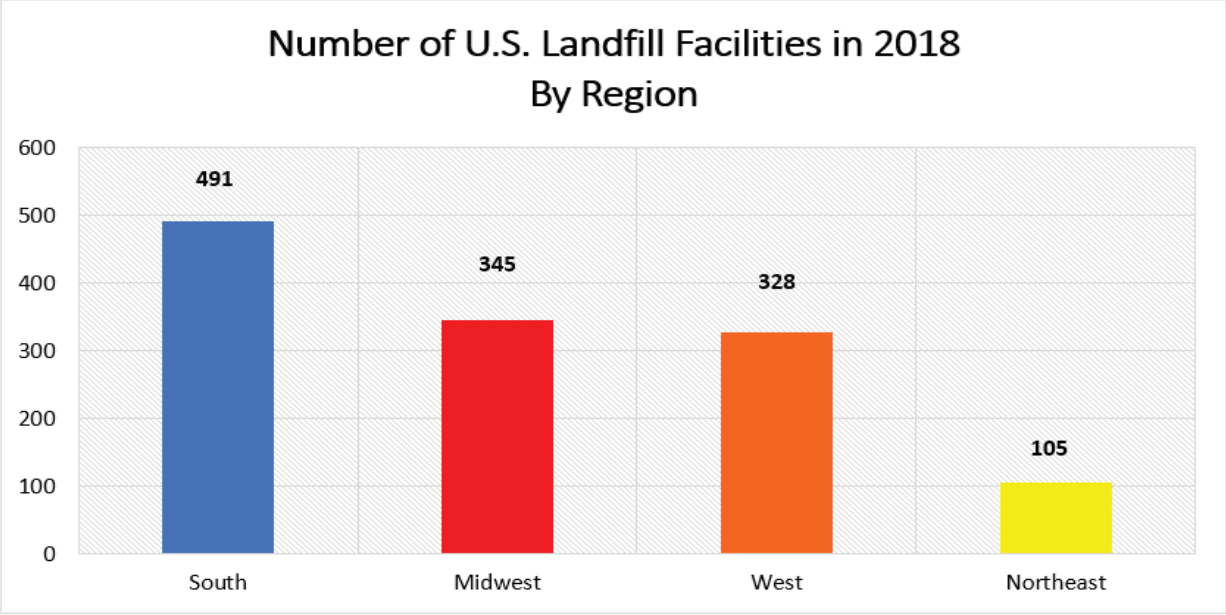
newspapers, grass clippings, furniture product packaging, appliances, leather, rubber, batteries, bottles, and textiles. An MSWLF may also be the destination of other types of nonhazardous waste, such as industrial nonhazardous solid waste, nonhazardous sludge, commercial solid waste, and conditionally exempt small quantity generators. (Behm, 2023; US EPA, n.d., 2023b)

According to the EPA's most recent *Inventory of U.S. Greenhouse Gas Emissions and Sinks,* updated annually, 122.6 million metric tons, measured by carbon dioxide equivalent (MMTCO2e) of methane into the Earth's atmosphere in 2021. This number represents the total United States anthropogenic methane emissions of 16.9% across all sectors. Municipal Solid Waste landfills' contributions of methane emissions were 103.7 MMTCO2e or 14.3% of total United States Methane emissions. Industrial landfills contributed to the remaining 2.6% of the total or 18.9 MMTCO2e. (Ramseur, 2023; (US EPA, 2023a)

Location and Number of Landfills

As of 2023, more than 1,250 MSWLF landfills were located in the U.S. Southern states, and the Midwestern states host most of these landfills. Southern states had 491 landfills, and the West had 328. The number of landfills in the United States has significantly decreased since the 1990's because more landfills were being closed versus opening. (HWH Environmental, 2024; Tiseo, 2023) To protect the environment from possible contaminants in solid waste, the United States must design an order of protection. An order of protection means the government should enforce more regulations on monitoring landfills. Currently, methane gas is a significant concern of solid waste landfills. (America's Infrastructure Report Card, 2021; HWH Environmental, 2024; Tiseo, 2023;)

Figure 1. Number of U.S. Municipal Solid Waste Landfills Facilities by Region, 2018



Source. Data adapted from Statista (2023).

Landfills: Methane Gas & Hazards

Hazards

Landfills are man-made waste storage facilities that can be highly toxic and damaging to human health if not managed properly. Landfills present various hazards, including unpleasant odors, smoke, noise, insect infestations, and contamination of water supplies. Emissions from landfills pose health risks to nearby residents and workers. A study in New York revealed a 12% higher risk of congenital malformations in children born to families living within a mile of a hazardous waste landfill site. (Vasarhelyi, 2021) Many types of gases are found in landfills: landfill gas contains 45% to 60% methane and 40% to 60% carbon dioxide, oxygen, hydrogen, nitrogen, ammonia, and sulfides, with the remaining 2%-to10% made up various other gases. Bacteria breakdown of organic waste produces gases in landfills. (Department of Health, 2023; The White House, 2022; US EPA, 2023)

Landfill gases such as methane can move through the soil, up to surface level, into the air, and into buildings. Outdoor landfill gases enter buildings through doors, windows, and ventilation systems. Landfill gases such as methane can seep into the soil, a process called soil vapor intrusion. The gases move through the soil and enter buildings through cracks in basements and walls, floor drains or sump pump holes, and utility entry points. Once landfill gases such as methane enter a building, they may collect in areas of poor ventilation, such as basements, crawlspaces, and utility tunnels. (Bruggers et al, 2021; New York State Department of Health, 2023)

Proper Management and Hazard Reduction

Landfills can benefit us if the facilities are well maintained, and municipalities employ proper recycling; methane gas can be used to our benefit as well (see the following section). Waste diversion initiatives and requirements are integral to maintaining MSWLFs. When we sort our waste, it keeps less waste out of the landfill and extends its life, saving the city and citizens money. Although some waste diversion can start at the citizens' residents through separating recyclables and chemicals from other waste, best practices say that waste diversion must be done at the landfill by workers and by allowing citizens to drop off particular waste at the landfill. The goal is zero-waste tolerance. Sanitation departments should accept solvents, cleaners, used motor oil, oil filters, poisons, and insecticides, which should be handled and stored by licensed hazmat workers. Processes such as these helps create jobs. Green waste, yard waste, and food waste can be recycled to produce high-quality mulch, wood chips, and compost that can be given to citizens or used on-site. (City of San Diego Official ESD, 2023) (EPA, 2023) (Bruggers, 2021)

Landfill cells should be lined with high-grade plastic to protect from pollutants such as methane gas seeping into the groundwater. Technology and engineering, such as methane monitoring and recycling, are crucial. Workers must cover landfills daily to prevent the spreading of contaminants, dust, and disease. When a landfill section is full, restoration can begin, including replanting trees, bushes, and possible animal habitats. (Bruggers et al, 2021; City of San Diego Official ESD, 2023; EPA, 2023c)

Recycled Energy Use

Landfill gas can be used to produce electricity and heat. This energy source can be produced 24 hours a day, seven days a week, so it is very reliable. The United States can drastically reduce methane gas emissions by using LFG-produced energy instead of energy from fossil fuels, thus reducing nitrogen oxides, sulfur dioxide $CO_{2,}$ and other pollutants generated from the combustion of fossil fuels. The process can reduce pollutants that contribute to local smog and acid as well. (City of San Diego Official ESD, 2023; EPA, 2011)

One program that has been implemented to recycle methane gas is the Landfill Methane Outreach Program (LMOP). One part of LMOP is harnessing LFG energy. LFG energy projects use methane gases produced from waste that has not been diverted away from landfills. To encourage the use of LFG energy is not to discourage waste diversion—the initiative does not compete with recycling, waste reduction, and composting. The promotion of LFG aims to benefit from the use of LFG that originates from waste disposed at MSWLFs. Recycling LFG helps reduce greenhouse gas emissions that contribute to global climate change, improves local air quality, offsets the use of nonrenewable resources, generates revenue for landfills, provides energy cost reductions for LFG energy users, and promotes investment in local businesspeople and creates jobs. (City of San Diego Environmental Services Department, 2023; EPA, 2011, 2023c)

Landfills: Effects on Americans

Residents Living Near Toxic Waste Sites

In 1982, the United Church of Christ's (UCC's) Commission for Racial Justice began an investigation to challenge the alarming presence of toxic substances in residential areas across the United States. The UCC's investigations led it to examine the relationship between hazardous waste storage, treatment, and disposal and race issues. In 1987, after the investigation, the UCC's Commission for Racial Justice published its landmark report *Toxic Wastes and Race in the United States* (Bullard et al., 2008; Commission for Racial Justice, 1987). The information in the report attracted governmental and academic attention and set in motion a national grassroots environmental justice movement. The investigation showed that people-of-color and low-income communities nationwide bore disproportionate environmental burdens. Specifically, it documented that three out of every five Black and Hispanic Americans (more than 15 million Blacks and more than 8 million Hispanics) resided in communities with uncontrolled toxic waste sites. This report discovered that race was the most influential variable in predicting where such facilities were located, even more potent than household income and the value of homes. African Americans and other minority groups often lack the resources to fight against the placement of such facilities. Fewer resources make them vulnerable to landfill placement in their communities rather than in higher-income locales (Bullard et al., 2008; Commission for Racial Justice, 1987).

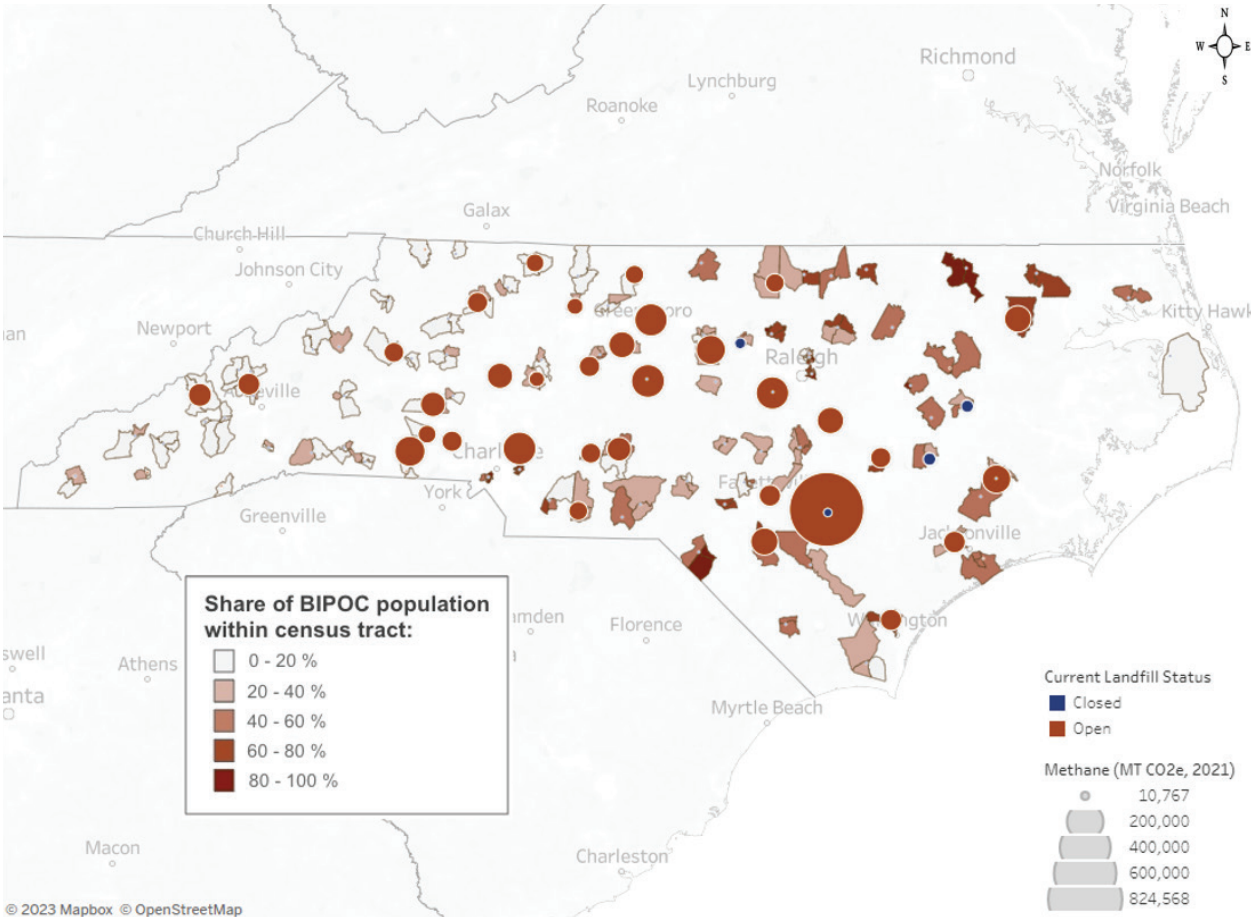
In 2007, the leading environmental justice scholars for the UCC's Commission for Racial Justice wrote a new report commemorating and updating the 1987 report. The new report takes stock of progress made over the last 20 years (Bullard et al., 2008). From 1987 to 2007, that progress includes extensive studies, objective research, purposeful networking, organizing through grassroots tactics, and timely public hearings to build an environmental justice movement. Substantial progress has been made in mainstreaming environmental protection as a social justice and civil rights matter; however, certain regions, communities, and neighborhoods are still dumping grounds for toxic chemicals. Such dumping grounds are usually home to people of color and low-income populations, who are also left to fend for themselves before and after man-made and natural disasters (Bullard et al., 2008). This shows that all communities continue not to be created equal.

In 2021, the U.S. Department of Health and Human Services documented that most of the U.S. population (38.4%) lives in the South. It was further documented that the 10 states with the largest non-Hispanic Black populations in 2020 were the southern states of Alabama, Arkansas, Delaware, Georgia, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, and Virginia (U.S. Department of Health and Human Services Office of Minority Health, 2023). Texas has the largest Black population in the United States—3,936,669, who account for about 14 percent of Texas's total population, according to the 2023 World Population Review (World Population Review, 2023a) Following Texas is Florida, with 3,867,495 (18%), New York, with 3,763,977 (19%), and Georgia, with 3,549,349 (34%). As Figure 1 (in the earlier section "Location and Number of Landfills") shows, of the four U.S. regions the South is home to most of the country's landfills (Tamir, 2021).

North Carolina provides a stark example of injustice—seven of its 10 highest methane-emitting landfills are situated in communities in which the percentages of Black, Indigenous, and people-of-color (BIPOC) individuals as well as low-income individuals exceed the state average. For example, according to findings by Industrious Labs, North Carolina is home to 123 open and closed identified landfills (40 open landfills), which is nearly one and a half times the number in New York (Industrious Labs, n.d.). This is a notable observation, especially considering that New York has a population nearly twice the size of North Carolina but maintains only 86 landfills, as indicated by EPA data. According to the U.S. Census Bureau, North Carolina's total population is 10,698,973. The racial demographics in North Carolina are as follows: 61.5% White (not Hispanic or Latino), 22% Black, 10.5% Hispanic, 3.6% Asian, and 1.6% American Indian (United States Census Bureau, 2022). Yet an analysis of North Carolina landfills by Industrious Labs reveals a striking disparity in landfill proximity in North Carolina, with Black individuals being more than 2.5 times more likely to reside near landfills than their White counterparts (Industrious Labs, n.d.). Furthermore, within the North Carolina Black community, the likelihood of living near a landfill is more than twice that of Black Americans in other states, according to the Industrious Labs report. The statistics for Spanish-speaking residents in North Carolina are also concerning, as they are nearly 1.7 times more likely to live near landfills than Spanish-speaking Americans nationwide. Remarkably, North Carolina features a higher rate of landfill placement within 1 mile of Spanish-speaking households, 42%, than the U.S. average of 24.8%. Low-income individuals in North Carolina face a 40% elevated likelihood of

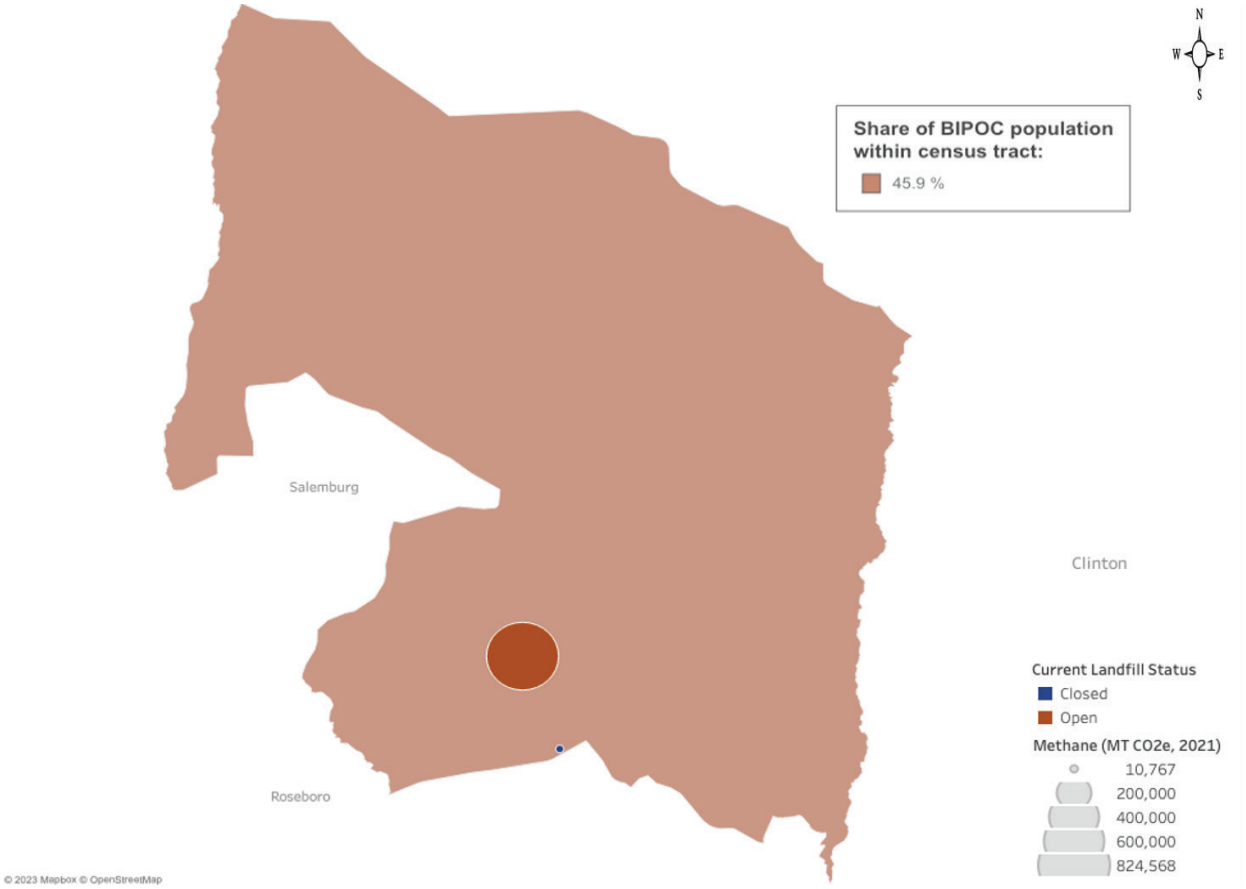
living near landfills compared to low-income Americans. In North Carolina, 55% of the state's 123 active and closed landfills (68 landfills in total) are located within communities featuring a higher percentage of BIPOC individuals, along with low-income populations, surpassing the state average (Industrious Labs, n.d.). Figures 2 through 4 show a geographic information system (GIS) mapping of the percentage of the BIPOC population residing within 1 mile of North Carolina landfills, the percentage of the BIPOC population in Snow Hill, North Carolina (45.9%), and the percentage of the low-income population in Snow Hill (43.9%) (Industrious Labs, n.d.). Snow Hill has a high percentage of African Americans in residence. The total population of Snow Hill is 1,526, which declined from 1,546 in 2021, according to the 2023 World Population Review. The racial demographics are as follows: 43.18% Black or African American (Non-Hispanic), 37.3% White (Non-Hispanic), and 10.57% Hispanic (World Population Review, 2023b).

Figure 2. Percentage of Black, Indigenous, and People of Color (BIPOC) Population within 1 mile of North Carolina Landfills



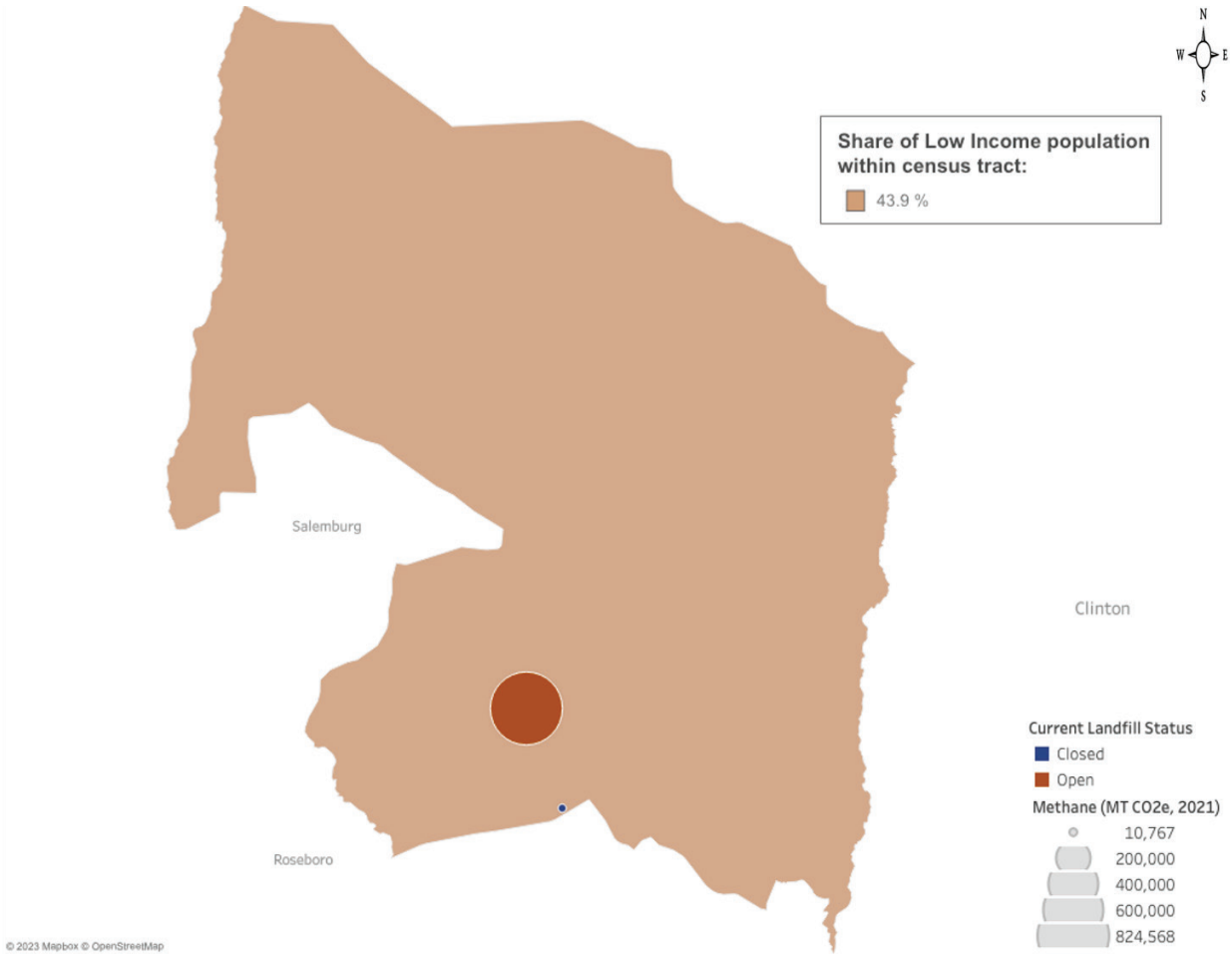
Source. Yliluoma (2023).
https://public.tableau.com/app/profile/riikka.yliluoma/viz/MSWLFs_EPAEJScreen2023_1MileBUFFER/NCMSWLFEJMap20231-mile

Figure 3: Percent of Black, Indigenous, and People of Color (BIPOC) population in Snow Hill, North Carolina



Source. Industrious Labs (2023).

Figure 4: Percent of Low-Income Population in Snow Hill, North Carolina



Source. Industrious Labs (2023).

Who Emits More, Who Feels the Brunt More?

Whereas all types of humans emit a certain percentage of pollution into the air, White people emit a greater amount of pollution into the air than other racial groups. They breathe in less pollution and are affected less by the large amount of pollution they emit, while people of color are affected by air pollution the most. The study, conducted by researchers from the University of Minnesota and the University of Washington, is the first to quantify the racial disparity between those who generate air pollution and those exposed to it (Tessum et al., 2019, University of Minnesota, 2019). Children of color are affected by air pollution, which affects their ability to learn. To be clear, Blacks and Hispanics generate less pollution because, on average, they have less wealth, and Whites spend more on pollution-intensive goods and services because they have more wealth to spend (Katz and Environmental Health News, 2012; Rice, 2019). On average, the race classified as non-Hispanic Whites tends to have an advantage in not experiencing air pollution as much as other races—they experience 17% less exposure to air pollution than is

caused by their consumption. To be specific, Blacks experience around 56% more pollution than is caused by their consumption on average. The numbers are slightly higher for the Hispanic population at 63%. The waste produced goes to landfills. In turn, landfills produce high levels of methane gases. Whites, on average, do not live near toxic waste sites. People of color suffer from exceptional environmental burdens that cause health hazards for many members of their communities (Tessum et al., 2019; University of Minnesota, 2019). As we have previously noted, African Americans are 75% more likely than other groups to live near sites that emit hazardous waste. A study published in 2016 in *Environmental Research Letters*, a research team led by Paul Mohai and Robin Saha from the University of Michigan and the University of Montana discovered a consistent pattern, over a 30-year period, of placing hazardous waste facilities in communities of poor people of color (Schlanger, 2017; Villarosa, 2020; Watson, 2023).

Employees of Landfills

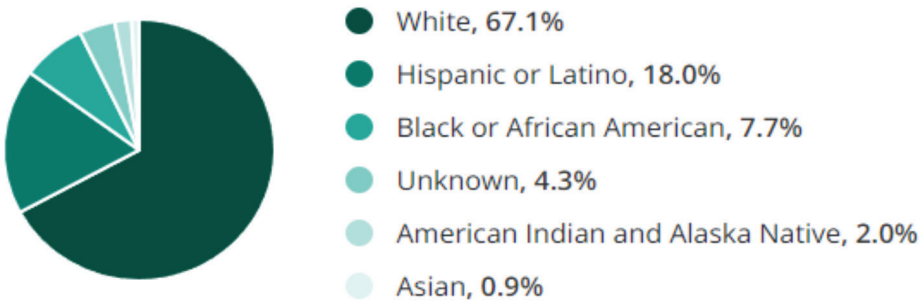
Earlier we mentioned that an EIP report reveals that African Americans are 75% more likely than other groups to reside close to hazardous waste facilities (EIP, 2023a; Schlanger, 2017; Villarosa, 2020). That report also points out that municipal waste landfills are often located in areas primarily inhabited by individuals from marginalized communities or those with low incomes. The report indicates that 54% of the landfills recorded in the EPA's greenhouse gas database are situated within a 1-mile radius of people of color or low-income communities. At the same time, however, African Americans and other people of color make up a significantly lower percentage of employees who work as sanitary landfill operators. And it should be noted that those people of color who do live and work in such facilities experience a double exposure of pollution daily. Figures 5 and 6 provide a breakdown of sanitary landfill operator demographics by race and by race and ethnicity over time. Figure 7 shows the wage gap by race for sanitary landfill operators (Zippia, 2023).

Figure 5. Sanitary Landfill Operator Demographics by Race

SANITARY LANDFILL OPERATOR DEMOGRAPHICS BY RACE

The most common ethnicity among sanitary landfill operators is White, which makes up 67.1% of all sanitary landfill operators. Comparatively, 18.0% of sanitary landfill operators are Hispanic or Latino and 7.7% of sanitary landfill operators are Black or African American.

Job Title

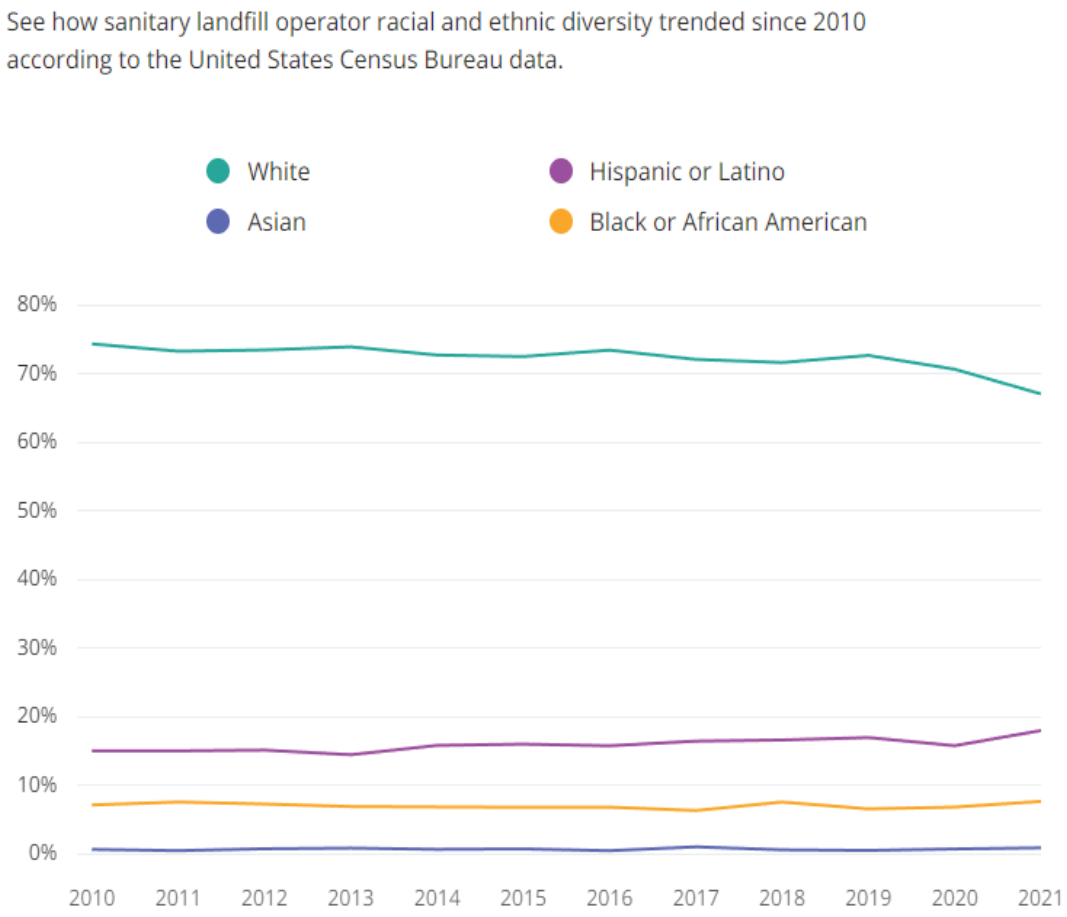


Sanitary Landfill Operator Race

Sanitary Landfill Operator Race	Percentages
White	67.1%
Hispanic or Latino	18.0%
Black or African American	7.7%
Unknown	4.3%
American Indian and Alaska Native	2.0%
Asian	0.9%

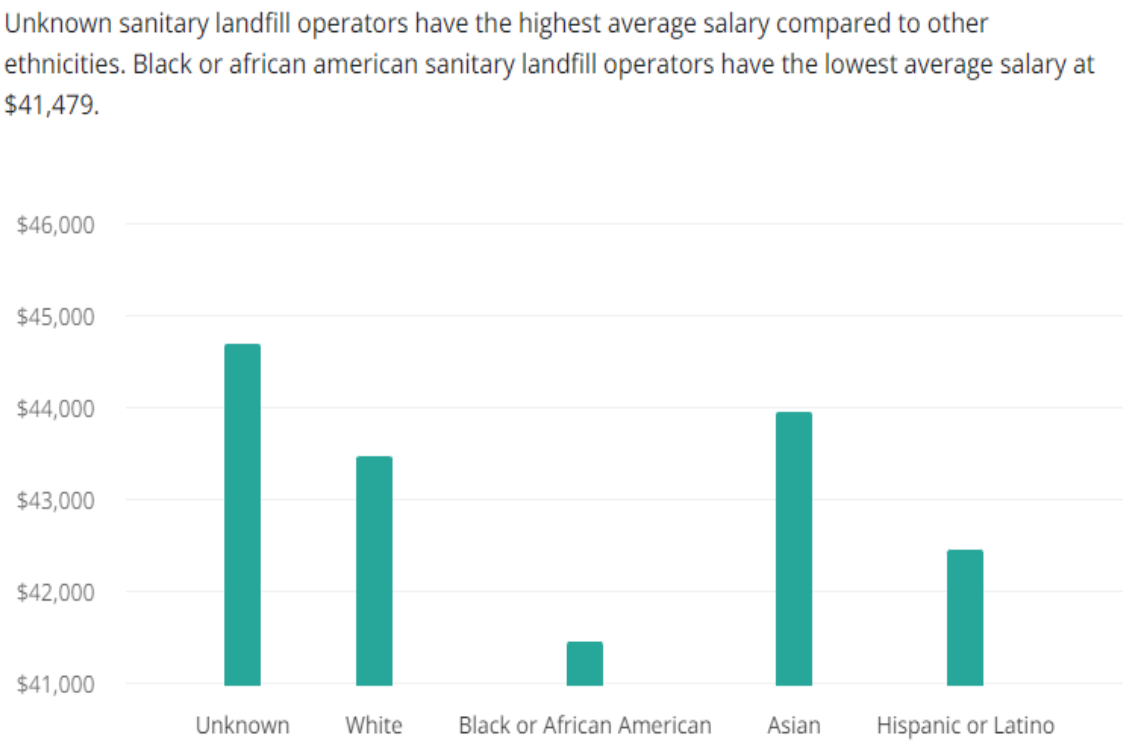
Source: Zippia, (2023)
https://www.zippia.com/sanitary-landfill-operator-jobs/demographics

Figure 6. Sanitary Landfill Operator Race and Ethnicity over Time



Source: Zippia, (2023)
https://www.zippia.com/sanitary-landfill-operator-jobs/demographics

Figure 7. Sanitary Landfill Operator Wage Gap by Race



Source: Zippia, (2023)
https://www.zippia.com/sanitary-landfill-operator-jobs/demographics

Landfills: Impacts of Landfills

Climate Change

When landfills produce high levels of methane gas, it contributes significantly to climate change. Methane gas possesses a significantly greater heat-trapping capacity than carbon dioxide, but its presence in the atmosphere is relatively short-lived as it naturally decomposes over time. In contrast, CO_2 exhibits a persistent nature, as it does not break down like methane, leading to its potential to remain in the atmosphere indefinitely. Methane gas is estimated to contribute to approximately 25% of the temperature increase associated with climate change (UN Environment Programme, 2022; U.S. Geological Survey, 2023). Climate change impacts fall disproportionately on people-of-color communities, who often are the least able to prepare for and recover from heat waves, poor air quality, flooding, and other impacts, according to a 2021 EPA report Climate Change and Social Vulnerability in the United States September 2021. Climate change is expected to hit the most impoverished regions and the poorest people the hardest. Parts of the American South will be hit the hardest, with up to a 20% decline in economic activity due to global warming projected by the end of the century (Doshi, 2023; U.S. EPA, n.d.; U.S. EPA, 2021).

Climate change and global warming have significant effects on existing inequalities, racial factors, and the health and wealth gap in the United States and globally. Climate change has negative impacts on and increases inequalities for people with low incomes in a way that it does not for people with higher incomes. The poor are trapped in poverty, with no means to get out, which leaves them with little access to resources, often inadequate transportation, no formal insurance, and low incomes. Affluent and upper-middle-class communities, families, and individuals can merely adjust thermostats, go on vacations, and or move to where they want to live, which is a luxury people with low incomes do not have. The health repercussions of climate change are severe (Doshi, 2023; U.S. Global Change Research Program [USGCRP], 2016). Through temperature-related deaths, air quality impacts, water-related illnesses, effects on mental health, and vector-borne diseases, climate change and global warming affect people's health. Changes in the climate affect our breathing, whether we are outdoors or indoors. For example, climate change is responsible for changing weather patterns. This has influenced the locations and levels of outdoor pollutants, such as fine particulate matter and ozone levels, which can negatively affect the human respiratory and cardiovascular systems (USGCRP, 2016).

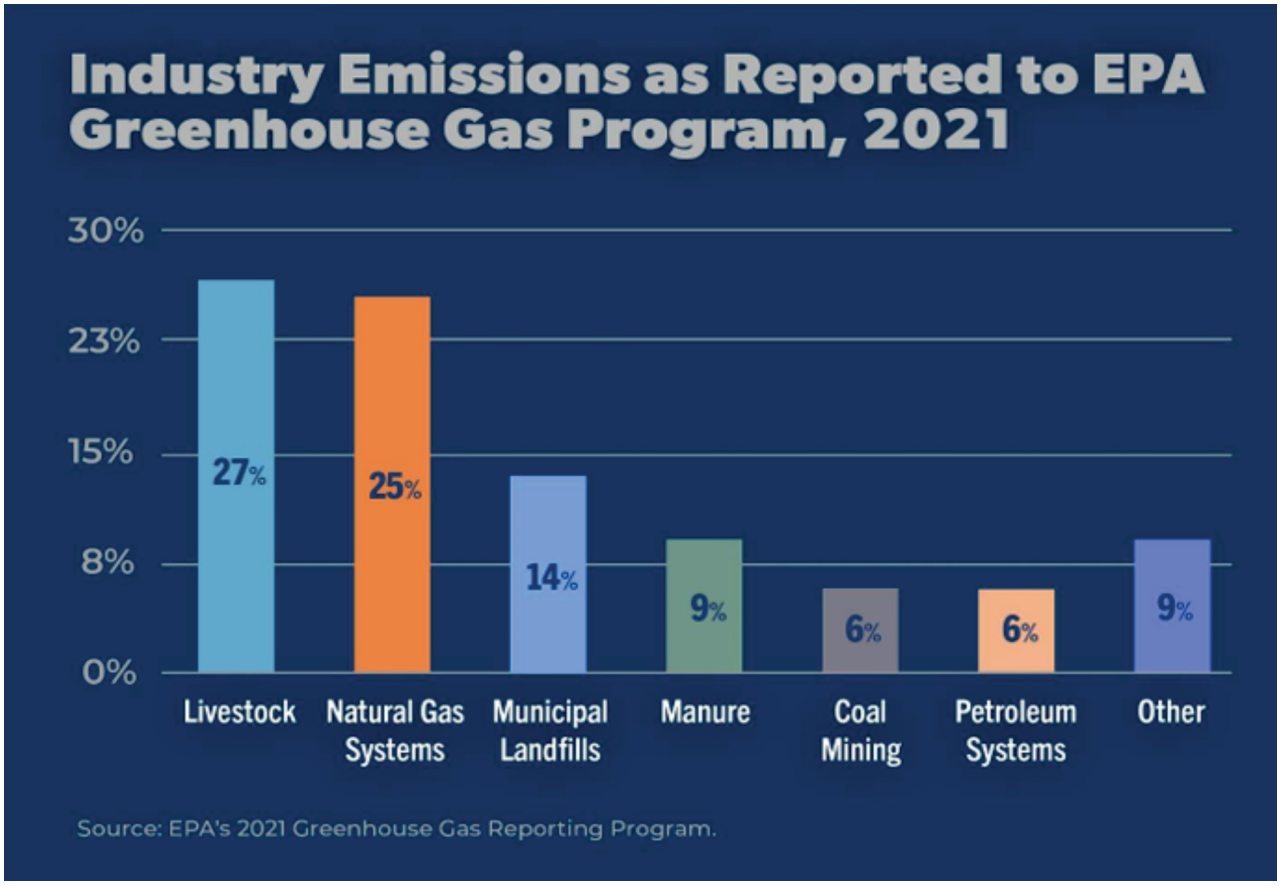
Air Quality

Methane is a greenhouse gas found in small quantities in the atmosphere and is the simplest hydrocarbon, composed of four hydrogen atoms and one carbon atom. Methane is potent (i.e., very effective at trapping heat), flammable, and used worldwide as fuel. Natural gas's primary component is methane. Burning methane in the presence of oxygen releases CO_2 and water vapor. Methane and CO_2 are odorless gases that can replace oxygen in enclosed spaces. The harmful effects on health due to methane and CO_2 result from the lack of oxygen rather than direct exposure. Once the level of oxygen in the air falls, one's heart beats faster and one has to take deeper breaths, just as if one were going through a strenuous workout. An oxygen level that is well below its usual level of 21% of total air volume can cause unconsciousness, reduced coordination, nausea, vomiting, and fatigue (New York State Department of Health, 2023).

The methane gas in our atmosphere occurs from natural and human sources. Methane is a potent heat absorber that can help trap heat in the Earth's atmosphere. Per molecule, methane traps more heat than CO_2, which makes it 80 times more harmful (UN Environment Programme, 2022; The White House, 2022). The concentration of methane gas in our atmosphere has risen by about 150% since 1750 due to human activity, and methane accounts for approximately 20% of the effects of all the greenhouse gases combined. Human activities that generate methane gas are landfills, energy generation, production (agriculture/farming), and raising cattle and other ruminant animals (UN Environment Programme, 2022; University Corporation for Atmospheric Research, 2023; The White House, 2022).

Figure 8 shows industry methane emissions as reported to the EPA's Greenhouse Gas Reporting Program in 2021. As you can see, municipal landfills accounted for 14% of methane emissions by industry, ranking in third place (EIP, 2023a).

Figure 8: Industry Emissions Reported to the EPA Greenhouse Gas Program, 2021



Source. Reproduced from EIP (2023a). Original data from the EPA's Greenhouse Gas Reporting Program. **https://environmentalintegrity.org/reports/trashing-the-climate**

States and Counties Whose MSWLFs Emit the Largest Amounts of Methane Gas

The states with the highest methane emissions from landfills can differ by reporting year, but generally the same states are in the top 10 of methane and CO_2 emitters every year. EIP's analysis found that Texas and California are the highest emitters of landfill methane, with Texas occupying the top spot in the top 10 emitters. However, it's essential to consider that Texas and California boast approximately twice the number of landfills compared to other states (EIP, 2023). The United States' most densely populated state, California, has the highest percentage of landfills with gas collection and the lowest rate of landfill methane emissions, according to EIP's analysis. California leads all other states in the amount of waste deposited in landfills, but it enforces more stringent regulations governing landfills, which has resulted in proportionately lower emissions. On the contrary, Texas, with its comparatively lax regulations, reported more than 130,000 metric tons of methane emissions in 2021 than California. This disparity persists despite Texas having deposited 20 percent less trash in its landfills over the past decade (EIP, 2023).

North Carolina ranks among the top 10 states in the country in terms of estimated methane emissions and is home to the largest emitter of them all, the Sampson County landfill. The Sampson County site ranks second among U.S. landfills in methane emissions primarily due to the massive tonnage of decomposing trash, according to a 2023 article published on NC Newsline. Located in the Snow Hill community, the Sampson County landfill was ranked number one among U.S. landfills in terms of estimated methane emissions, according to estimates reported to the EPA in 2021 (Sorg, 2023; Wagner, 2023). Rotting food is part of the problem. There are 25 million tons of rotting garbage from 44 counties statewide in the Sampson County landfill. According to the 2021 EPA figures, that amounts to 824,568 metric tons of CO_2 equivalent. (McKenna & Green, 2023; Sorg, 2023; Wagner, 2023).

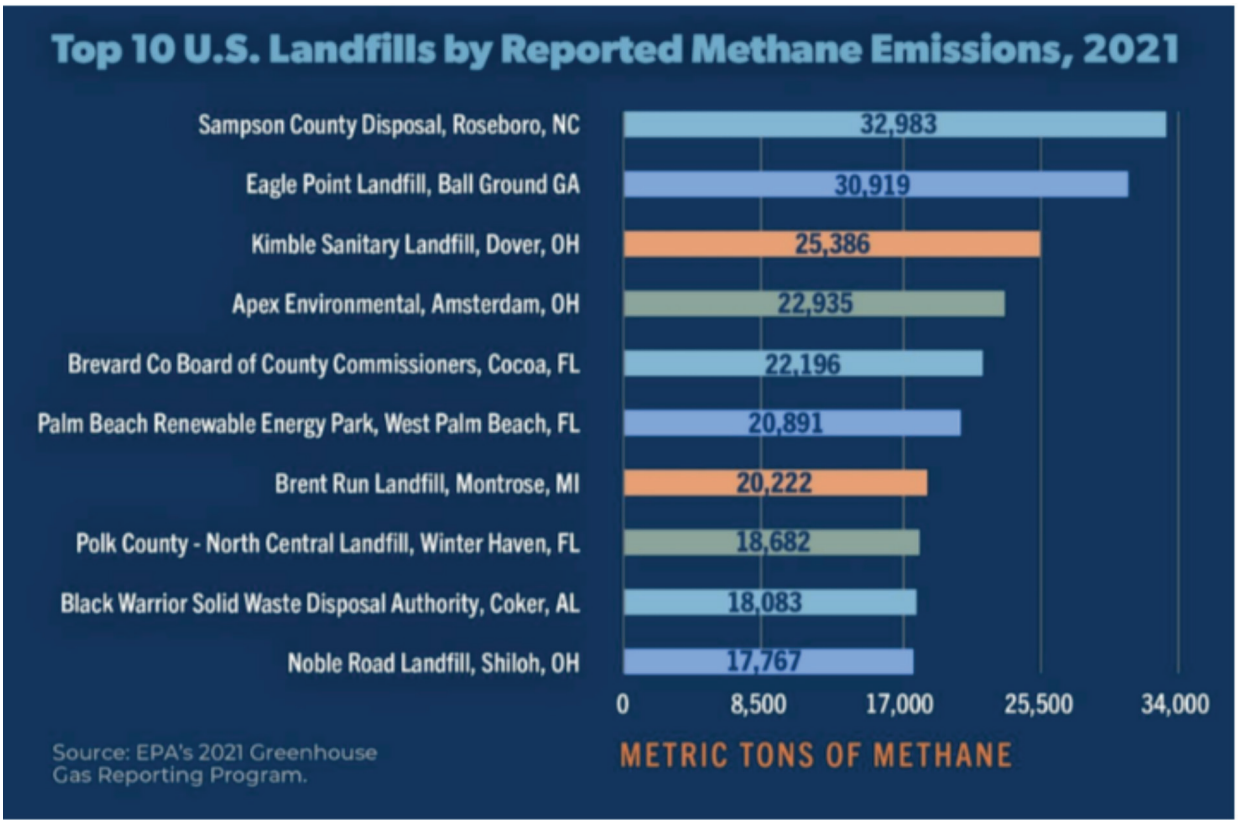
Figure 9. Top 10 States by Reported Emissions from Municipal Waste Landfills, in 2021

State	Total Reported Emissions (Metric Tons of Methane)	Total Reported Emissions (Metric Tons of CO2e)	Number of Landfills	% of Landfills with Gas Collection Systems	Total Quantity of Waste in Landfills (Metric Tons)
TX	389,437	31,038,131	98	72%	1,018,067,371
CA	260,214	20,739,081	94	96%	1,575,534,337
FL	239,792	19,111,446	46	70%	501,026,912
GA	188,349	15,011,377	48	65%	324,600,177
OH	188,032	14,986,119	42	79%	522,385,830
MI	155,552	12,397,486	49	86%	609,299,295
NC	148,647	11,847,191	38	74%	218,322,768
AL	125,495	10,001,980	27	63%	157,085,456
IL	111,627	8,896,680	54	83%	545,086,364
VA	110,249	8,786,809	37	70%	309,660,679

Source: EPA's 2021 Greenhouse Gas Reporting Program. CO_2e calculated using the most recent estimate (International Panel on Climate Change Sixth Assessment Report, 20-year global warming potentials).

Source. Reproduced from EIP (2023a). Original data from the EPA's Greenhouse Gas Reporting Program. **https://environmentalintegrity.org/reports/trashing-the-climate**

Figure 10. Top 10 U.S. Landfills by Reported Methane Emissions in 2021

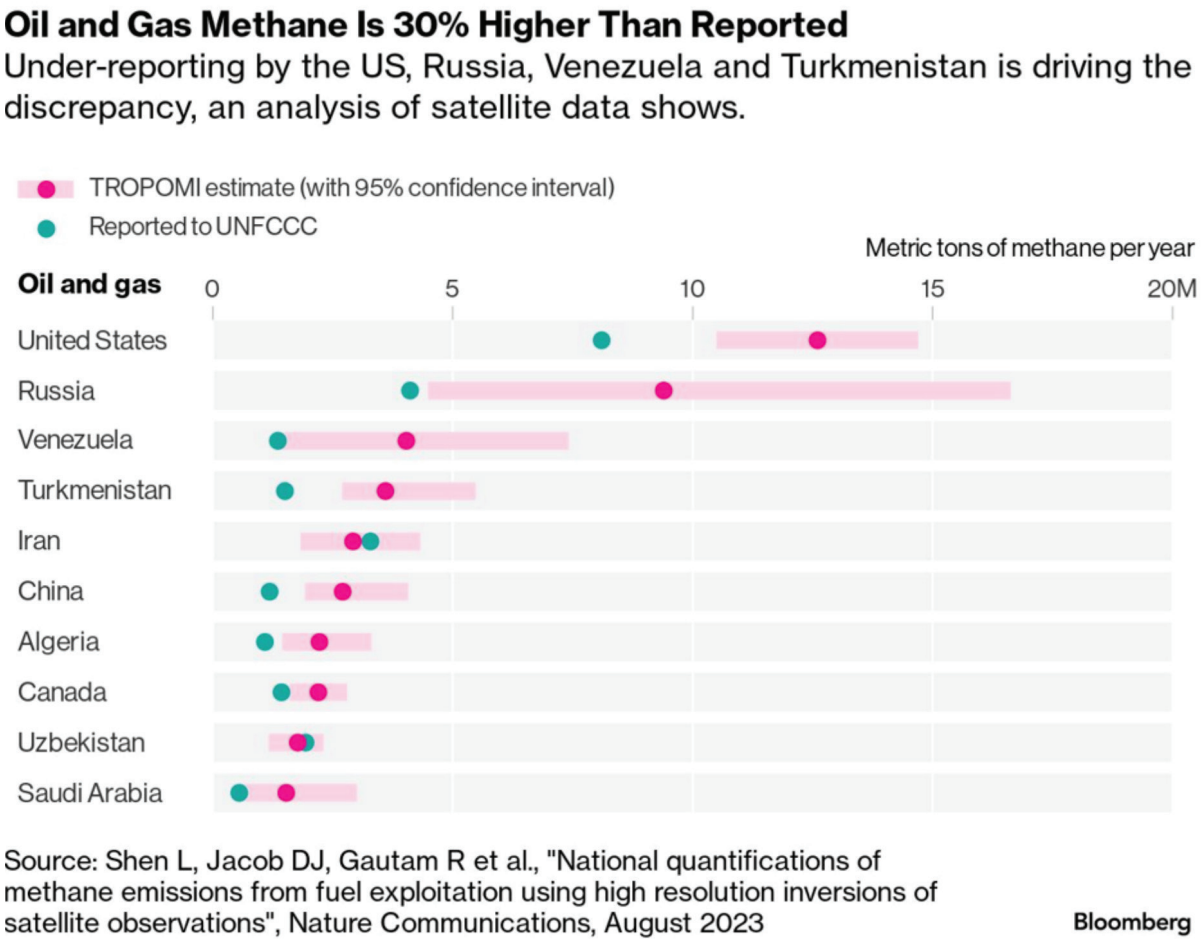


Source. Reproduced from EIP (2023a). Original data from the EPA's Greenhouse Gas Reporting Program. **https://environmentalintegrity.org/reports/trashing-the-climate**

Countries Underreporting Methane Gas Emissions

According to an August 2023 report published in Nature Communications, data show that countries' methane releases from global oil and gas operations were 30% higher than they estimated in reports to the United Nations. The new study analyzed satellite surveillance. The United States, Russia, Venezuela, and Turkmenistan are the world's four largest emitters of oil and gas, and those four countries also account for the most overall discrepancies (Clark, 2023). The real-world satellite data challenged the figures the countries were reporting to the United Nations, indicating that those countries' estimates are much lower than reported. The authors of the report used a 22-month detection technique from the European Space Agency's Sentinel-5P satellite in a "top-down" approach to model and estimate the majority of fossil fuel production (Clark, 2023).

Figure 11. Countries Underreporting Methane Releases



Source. Reproduced from Clark (2023) originally published at Bloomberg. **https://www.energyconnects.com/news/gas-lng/2023/september/methane-from-oil-and-gas-are-worse-than-reported-to-un-satellites-show**

Illegal Dumping

The landfill dumping grounds also attract illegal dumping, that is, the unauthorized practice of depositing waste materials on both private and public property where such disposal is not sanctioned (Texas Disposal Systems, 2021). Research has shown that people involved in illegal dumping are more inclined to target areas with existing dumpsites, compelling cities to allocate millions of dollars annually to clean up the unlawful dumpsites and curb further instances of illegal dumping. This encompasses improperly disposing of various items, including appliances, tires, household refuse, construction debris, vehicles, and yard waste. Not only is the improper disposal of waste a criminal violation, but it also presents a substantial risk to the overall health and safety of the public. In rural settings, illegal dumping frequently occurs in areas such as forests, open fields, drainage ditches, water bodies, and behind culverts (Bullard, 1987, 1990; Texas Disposal Systems, 2021). In urban environments, this problem manifests in vacant lots, alleyways, and within

dumpsters. Any act of dumping waste materials outside of officially designated disposal sites constitutes an act of illegal dumping. Illegal dumping yields a plethora of adverse consequences for the environment. When nonbiodegradable materials are discarded, hazardous substances and chemicals seep into the soil, tainting the earth and adjacent water bodies. Plastics have the potential to contaminate rivers, lakes, streams, and oceans. Wildlife, including birds and fish, may suffer harm from ingesting plastic waste or becoming tangled in it (Texas Disposal Systems, 2021; North Central Texas Council of Governments, 2023). Moreover, illegal dumping poses a significant fire risk. Accumulated piles of refuse and abandoned chemicals can combine to generate flammable gases and serve as fuel sources for potential fires. Furthermore, those engaged in illegal dumping may inadvertently harm legitimate businesses since they avoid paying the appropriate waste disposal fees. Illegal dumpsites can give rise to a host of health and safety concerns affecting local residents and the environment. These sites often contain shattered glass, hazardous materials, exposed metals, and other dangerous substances that pose risks to children at play and adults working in proximity and have the potential for runoff that can contaminate nearby water sources. These dumping grounds also serve as magnets for rodents, snakes, mosquitoes, and various other pests, heightening the danger they pose to the community. As reports have revealed, municipal waste landfills are frequently situated in areas predominantly inhabited by African Americans and other people of color as well as low-income communities, including their children, who are the ones mostly in danger and at risk (Bullard, 1987, 1990; Texas Disposal Systems, 2021).

Illegal dumping was identified as a problem more than 36 years ago in Robert Bullard's book *Invisible Houston: The Black Experience in Boom and Bust,* and remains a problem. Between 2008 and 2011, 18,367 nonemergency "311" illegal dumping calls were registered with the Houston Solid Waste Department. The predominantly Black and Latino council districts B, D, and H received a disproportionately large share of illegal dumping calls for each of the four reporting years—59% of calls in 2008 and 66% in 2009–2011. Figure 12 shows details of the calls made to report illegal dumping incidents in Houston in the years 2008–2011 (Bullard, 1990, 2014).

Figure 12. Illegal Dumpsites 311 Calls by Council District Houston, Texas, 2008-2011

COUNCIL DISTRICT	PERCENT MINORITY	CALLS 2008	CALLS 2009	CALLS 2010	CALLS 2011
A	75%	158	260	238	198
B	94%	796	1312	1226	1115
C	39%	358	506	414	337
D	87%	672	1517	1251	904
E	47%	105	128	145	69
F	84%	93	120	120	98
G	37%	39	50	40	28
H	87%	514	1002	889	669
I	91%	322	466	388	309
J	88%	49	90	69	44
K	83%	249	350	349	314
	TOTAL	3355	5801	5126	4085

Source: Bullard, (2014).
https://www.planning.org/knowledgebase/resource/9190379
Note. Percentages are based on 2010 Census figures.

Landfills: Current Policy & Initiatives

To reduce methane gas and other harmful pollutants from MSWLFs, we must ensure the government enforces laws and regulations equally and fairly without regard to race and income. The United States could meet the Paris Agreement goal of limiting global warming to 1.5 degrees Celsius by 2030 if we cut methane emissions by 45%. The EPA's Office of Enforcement and Compliance Assurance (OECA) addresses pollution that affects American communities through vigorous civil and criminal enforcement. The OECA enforcement activities target severe water, air, and chemical hazards (U.S. EPA, 2023a; The White House, 2022).

The National Extension Climate Initiative helps link professionals who are interested in assisting in the climate initiative with associations, education programs, and research extension programs associated with climate change. The objectives associated with the initiative are to promote climate education and research throughout the extension system, pursue active learning and collaborative efforts that enhance professional development, and communicate regularly through inclusive and transparent practices. Other objectives are to represent and coordinate participating land and sea grant universities, national associations, related committees, organizations, and partnerships (National Extension Climate Initiative, 2023).

Mitigating climate change entails reducing the flow of heat-trapping greenhouse gases, including methane gas, into the atmosphere. Soil, forests, and oceans absorb and store these gases and are an essential part of the solution. Recognizing the need to address communities that suffer impacts from higher than average levels or multiple sources of toxic air pollution (hazardous air pollutants), the OECA decided to focus its fiscal years 2024–2027 air enforcement initiative on such overburdened communities selected by region (U.S. EPA, 2023a).

The OECA has identified "Mitigating Climate Change" as one of its new National Enforcement and Compliance Initiatives (NECIs) because tackling the climate crisis is the EPA's top priority, and enforcement and compliance efforts that reduce greenhouse gas emissions will help limit the worst effects of climate change. Climate change poses a substantial threat to public health and safety, water resources, agriculture, infrastructure, and ecosystems (U.S. EPA, 2023a).

The Mitigating Climate Change NECI will use the OECA's criminal and civil enforcement authorities to address three separate and significant contributors to climate change: (1) methane emissions from oil and gas facilities; (2) methane emissions from landfills; and (3) the use, importation, and production of hydrofluorocarbons (U.S. EPA, 2023a).

In January 2021 with Executive Order 14008, President Biden established the Justice40 Initiative, setting a goal of circulating 40% of the overall benefits of certain federal investments to disadvantaged communities that are underserved, marginalized, and overburdened by pollution. The Inflation Reduction Act of 2022 contains measures to pursue the Justice40 Initiative by reducing pollution—it provides for the creation of climate and justice block grants to address disproportionate environmental and health harms related to climate change and pollution and to facilitate community-led projects in disadvantaged communities. The program is designed to support and fund initiatives that will substantially reduce greenhouse emissions by 2030 and beyond, particularly addressing organic waste and landfill methane emissions and ensuring that low-income and disadvantaged communities benefit from these efforts. The plan focuses on two phases. The first phase includes formula grants totaling $250 million. In this phase, recipients are provided formula grants to develop climate action plans with strategies and initiatives to reduce gas emissions and combat climate change. The second phase consists of competitive grants totaling $4.6 billion. Once the climate action plans are developed, the program offers competitive grants to implement those plans. This funding is intended to support and execute the strategies outlined in the action plans (U.S. EPA, 2023d).

Reducing the amount of food waste in landfills must be another priority. An estimated 30% to 40% of the food America produces goes to waste—resulting, among other things, in excessive methane emissions. Notably, food constitutes around 24% of the material in landfills, decomposing and releasing substantial amounts of methane that remain inadequately captured. Past presidential administrations have recognized the environmental, economic, and equity issues associated with food waste (The White House, 2022). In 2015, the EPA and the U.S. Department of Agriculture (USDA) jointly established a national objective to slash food loss and

waste by 50% by 2030, employing a collaborative strategy on both domestic and international fronts. In response to the food waste problem, the agencies initiated joint programs and undertook actions such as education and outreach, research, community investments, voluntary programs, and public–private partnerships. Under the Biden–Harris Administration, the USDA, the EPA, and the U.S. Food and Drug Administration are now collaborating more closely than ever to meet the 50% reduction goal in food loss and waste by 2030. The administration's vision for tackling this issue aims to enhance food security and nutrition, boost farmer income and rural prosperity, alleviate strain on natural resources, and meet targets for reducing greenhouse gas emissions (The White House, 2022; US EPA, 2022).

On July 29, 2022, EIP and allies sued the EPA, arguing that the agency's outdated methods for estimating air-polluting emissions from landfills resulted in significant underreporting. On April 10, 2023, the EPA responded with an agreement with EIP that requires the EPA to assess the current defects in the methodology used to report landfill methane and, if necessary, revise them no later than August 2024. Suggestions for actions the EPA can take are to implement new regulations mandating the installation of effective methane collection systems and to adhere to improved operational standards in many landfills, focusing on ensuring their efficacy in reducing pollution. The EPA should enforce the direct quantification of methane emissions at landfills by employing innovative technologies such as ground-based monitoring and aerial surveillance systems (EIP, 2023a, 2023b). In 2022. a scrutiny of EPA inspection reports across 29 MSWLFs in eight states uncovered numerous methane exceedances. Among the 22 landfills where EPA inspectors conducted emissions monitoring, 711 methane exceedances exceeding 500 parts per million—the methane concentration limit established by the EPA—were recorded. The examination of the inspection reports also unveiled concerning disparities. Several landfill operators reported minimal or no methane exceedances at their facilities, whereas EPA inspectors discovered numerous instances, some reaching explosive levels, of methane exceedances (Industrious Labs, 2024). To address such issues effectively, it is imperative to implement more robust and comprehensive methane leak monitoring using state-of-the-art technologies that simplify the detection and rectification of methane leaks while minimizing errors. Furthermore, it is essential to ensure that methane emissions data are publicly accessible. Moreover, there is an urgent necessity to enforce the earlier installation of gas capture systems and leak detection mechanisms. Research by the EPA reveals that 50% of the carbon in food waste degrades into methane within 3.6 years. However, current federal regulations allow a five-year period to pass before landfill operators are required to upgrade their gas collection systems. As a result, an estimated 61% of methane produced by landfill food waste is released into the atmosphere (Industrious Labs, 2024).

Clearly, the EPA needs to enhance the reporting criteria for landfills nationwide while establishing a standardized approach for estimating emissions for waste disposal sites. And not only the federal government but individual states as well should promote composting and recycling among consumers and municipal governments while encouraging the reduction of food waste (U.S. EPA, 2023b).

President Clinton signed Executive Order 12898 in 1994 directing the federal government to assess the environmental and human health impacts of federal initiatives on minority and low-income communities, all with the ultimate objective of ensuring environmental protection for every community. The EPA developed and used multiple mapping tools, making them available to the public (U.S. EPA, 2024. To better serve the EPA, its governmental partners, and the public in understanding the environmental and demographic characteristics of the United States, the EPA created the Environmental Justice Screening and Mapping Tool (EJScreen) and made it accessible to the public for whoever is interested in environmental issues. Development of the tool began in 2010, and it was released to the public in 2015. It is updated annually with the latest and best data available. EJScreen gives users access to high-resolution and demographic information on locations in the United States and compares selected areas to other places in the state, the EPA region, or the nation (U.S. EPA, 2024). The tool can assist users in identifying regions characterized by

- communities with people-of-color and/or low-income populations;
- potential environmental quality concerns;
- a combination of environmental and demographic indicators that exceed typical levels; and
- other relevant factors.

EJScreen can also provide support for various purposes such as

- educational programs;
- grant proposal writing; and
- community awareness initiatives.

This screening tool and its data are a valuable asset for community residents and other stakeholders seeking environmental and demographic information. Additionally, it can contribute to a broad spectrum of research and policy objectives. EJScreen has been used by the public in diverse locations and for various applications.

The EPA is making EJScreen accessible to the public with the following aims:

- Enhancing transparency in how environmental justice is considered in the agency's work
- Aiding stakeholders in making informed decisions regarding environmental justice issues
- Establishing a shared starting point for addressing environmental justice matters between the agency and the public (U.S. EPA, 2024)

In 2023, Texas Southern University launched the HBCU Climate and Environmental Justice Screening Tool (HCEJST) as part of the Justice40 Hub Leaders initiative. Leading figures Dr. Robert D. Bullard of the Bullard Center for Environmental and Climate Justice and Dr. Beverly

Wright of the Deep South Center for Environmental Justice (DSCEJ) are collaborating to implement President Biden's Justice40 Initiative by introducing the HCEJST. The Bullard Center assembled a team of data and GIS experts from historically Black colleges and universities (HBCUs), headed by Dr. David Padgett, to create the HCEJST as a complementary tool to the Council on Environmental Quality's Climate and Economic Justice Screening Tool (CEJST), which does not account for race (King, 2023). These experts, affiliated with the Bullard Center, the DSCEJ, and the HBCU Consortium Technical Support Team, have been providing training to 21 Justice40 hubs across 10 states. The aim is to enhance their understanding of how environmental data are gathered, using both the CEJST and the HCEJST. The HCEJST identifies census tracts that are overburdened and underserved, emphasizing them as disadvantaged areas on the map. Additionally, the tool recognizes federally recognized tribes, including Alaska Native villages, as disadvantaged communities (King, 2023).

Reducing emissions requires rethinking society, politics, economics, and science. The quicker we act to reduce emissions, including methane gas emissions, the better off we will be now and in the future.

Appendix

History of Harris County Landfills

In Houston, Texas, located in Harris County, a coalition of African American homeowners embarked on an urgent campaign to oppose the establishment of the Whispering Pines Sanitary Landfill within 1,500 feet of a local public school (and within 2 miles of six schools). These residents organized themselves into the Northeast Community Action Group (NECAG). In 1979, alongside their attorney, Linda McKeever Bullard, NECAG filed a class action lawsuit, Bean v. Southwestern Waste Management, Inc., marking the inaugural instance in the United States where environmental discrimination in waste facility placement was challenged under civil rights laws. Despite the lawsuit's ultimate failure to prevent the landfill's construction, it was a pivotal moment for environmental justice, resonating with similar cases nationwide (U.S. EPA, 2024).

Dr. Robert Bullard, a sociology professor at Texas Southern University in Houston, and husband of Linda McKeever Bullard, conducted a groundbreaking study documenting the location of municipal waste disposal facilities in Houston. *Solid Waste Sites and the Black Houston Community* marked the first comprehensive examination of environmental racism in the United States. Bullard and his research team, which included Texas Southern University students, revealed a pattern wherein African American neighborhoods in Houston were disproportionately selected as sites for toxic waste facilities. Despite making up only 25% of the city's population, these neighborhoods bore a disproportionate burden, as they were the site of all five city-owned garbage dumps, 80% of city-owned garbage incinerators, and 75% of privately owned landfills (U.S. EPA, 2024).

The accompanying figures show GIS mappings of Harris County, Texas's currently active and closed landfills data 2024 from the U.S. Census Bureau American Community Survey and Tiger/line Shapefiles (U.S. Census Bureau, 2023a). Figure A1 displays vulnerability to the landfills of the non-Hispanic population in Harris County—that is, it shows the proximity to the landfills of the county's non-Hispanic residents. The map shows that the landfills are significantly situated in heavily African American–populated communities. Figure A2 shows vulnerability to the landfills of the Hispanic population in Harris County. It shows that the landfills are situated in areas containing relatively larger populations of Hispanic residents. Figure A3 displays vulnerability to Harris County's landfills by residents' income—that is, according to the percentage of the neighborhood living in poverty. In the United States poverty is considered one person making less than $15,852 a year and for a family of four making $30,900 a year (US Census Bureau, 2023b) The map tells us that poverty is not a determinant of where landfills are placed. What is significant is that the landfills are situated in African American communities on a greater scale regardless of their income. Figure A4 shows the location of Harris County's landfills in relation to the neighborhood's score on a social vulnerability index (SVI). The GIS mapping reveals that active and closed landfills are more often than not located in communities with relatively higher SVI measures.

As Dr. Bullard discovered, from the 1930s through 1978 to the present time, in Harris County waste disposal sites have been disproportionately located in African American communities.

Figure A1. Location of Harris County Landfills according to Racial Vulnerability Non-Hispanic Ethnicity

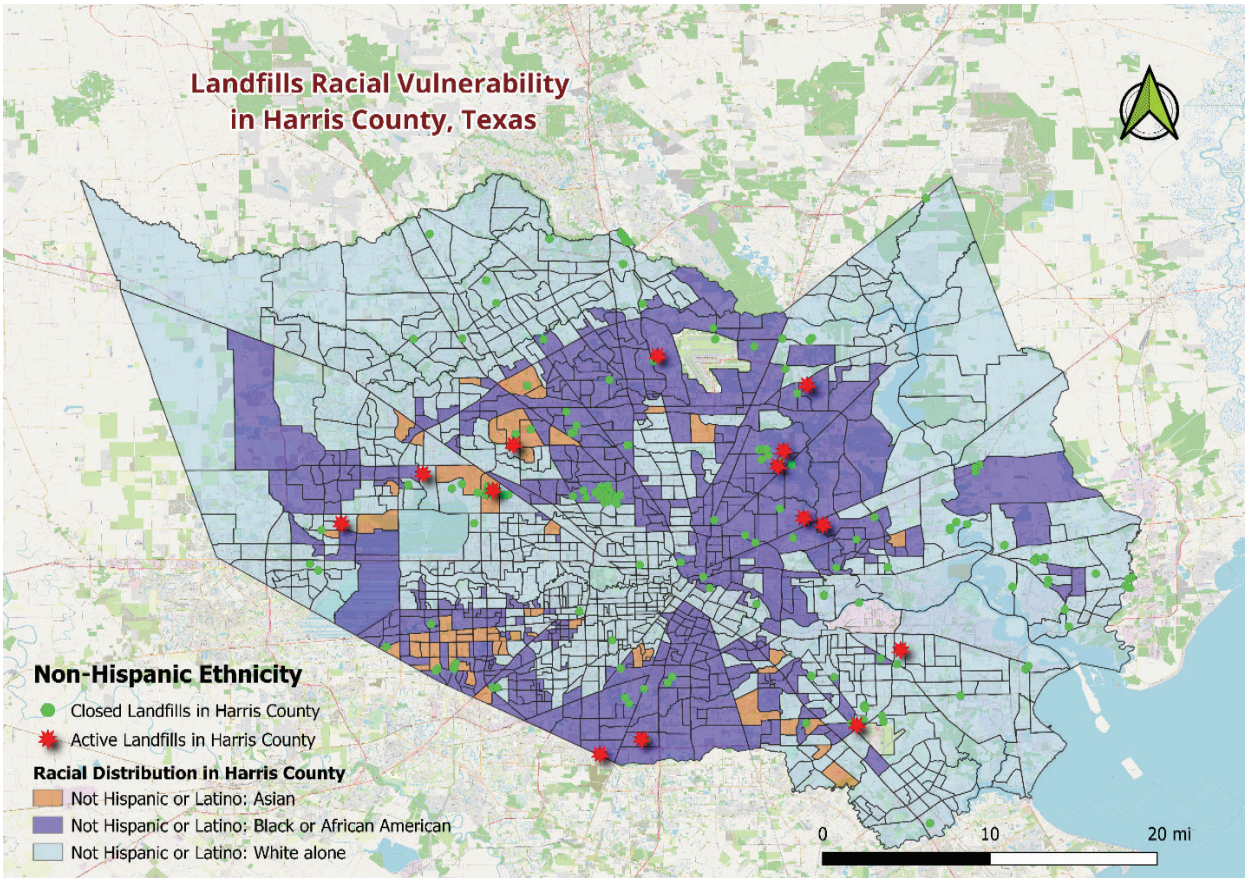


Figure A2. Location of Harris County Landfill according to Racial Vulnerability Hispanic Ethnicity

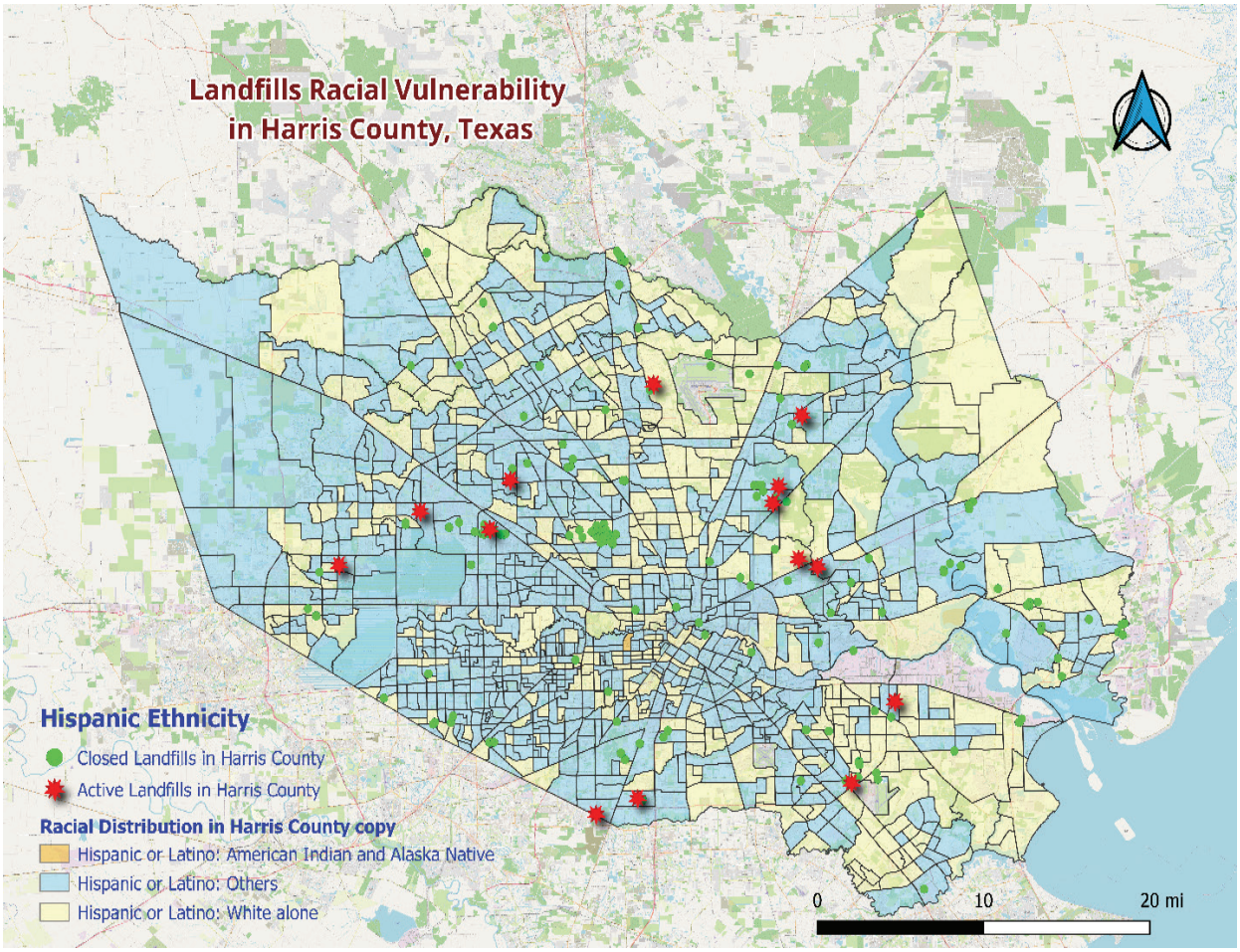


Figure A3. Location of Harris County Landfills according Poverty Vulnerability

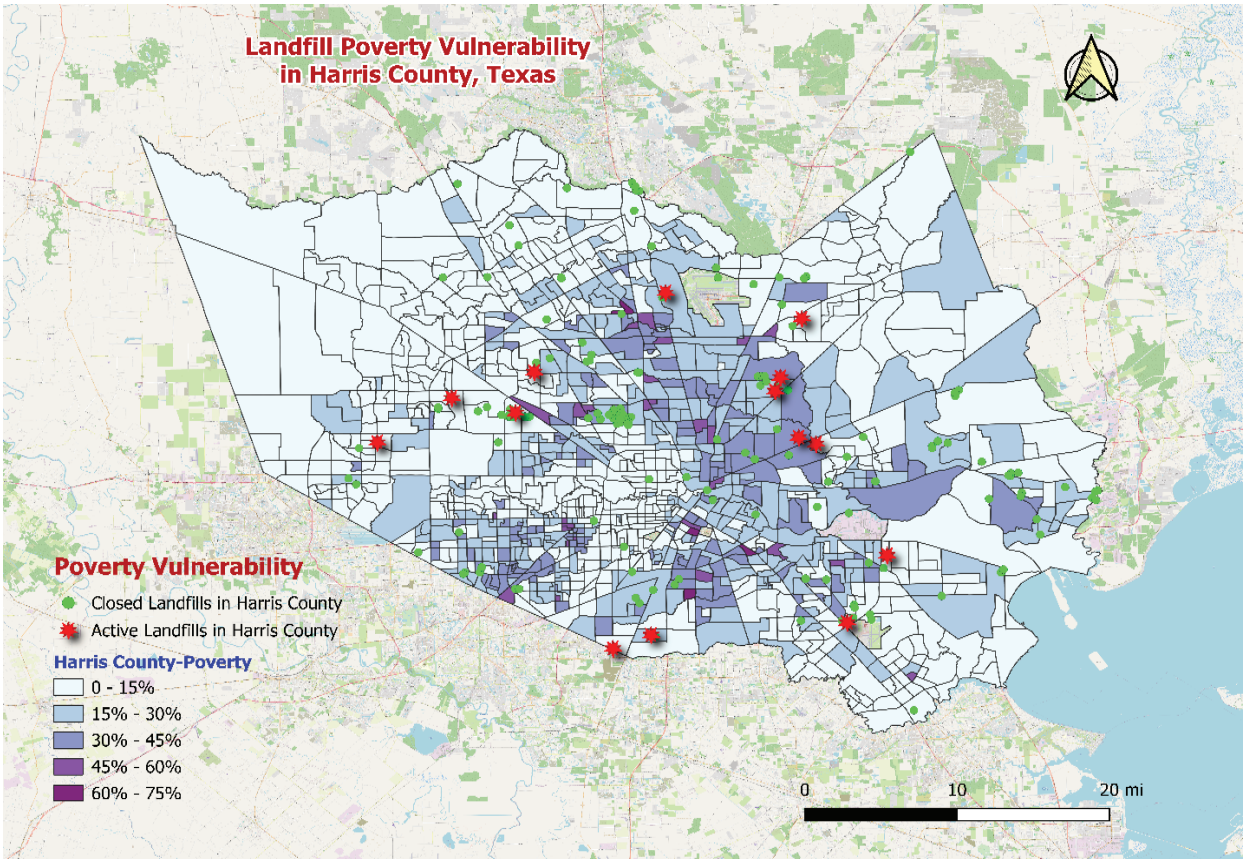
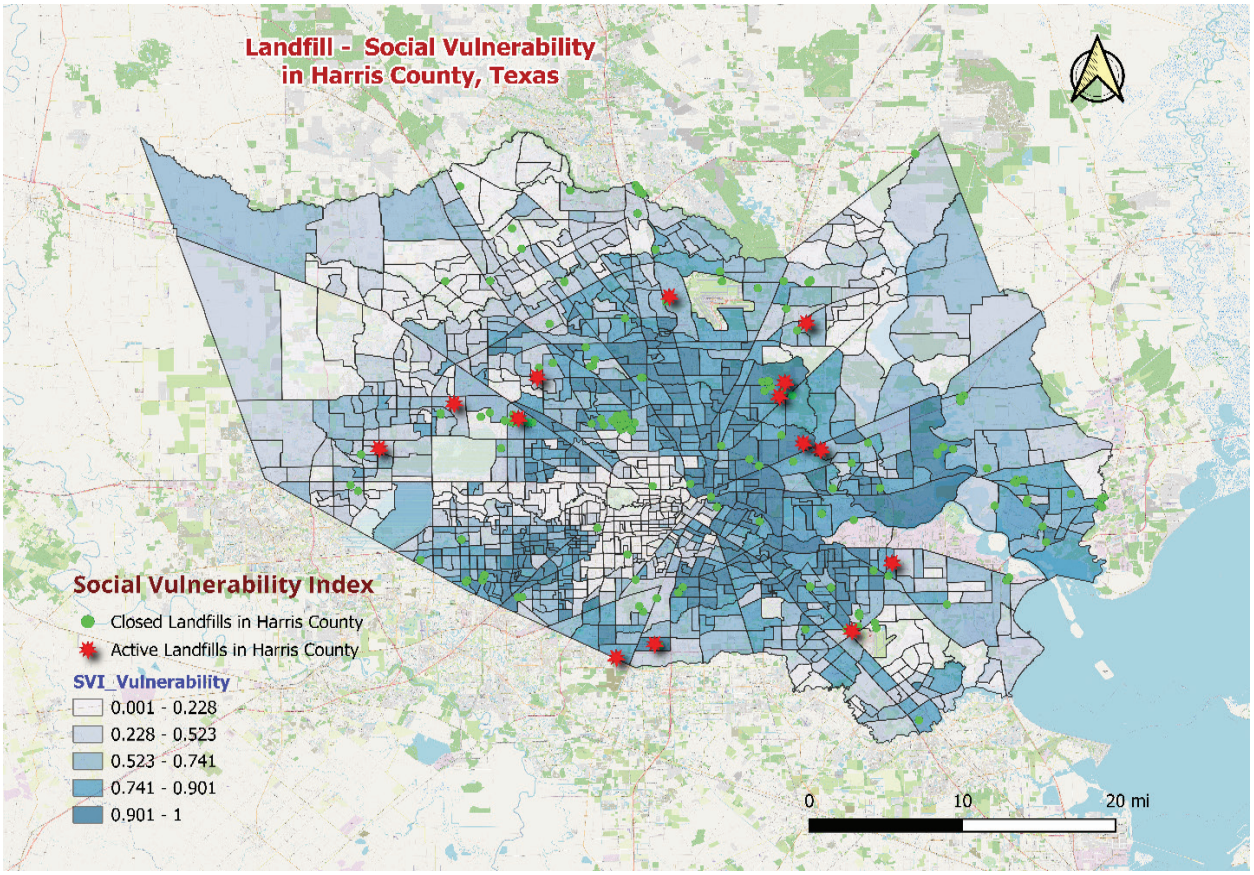


Figure A4. Location of Harris County Landfills according to Social Vulnerability



Emissions Tracking Tools

Carbon Mapper

Carbon Mapper is both a nonprofit organization and a program designed to monitor and facilitate the acceleration of global methane and CO_2 emissions reductions. The collaborative partners in the Carbon Mapper program are NASA's Jet Propulsion Laboratory (JPL), the State of California, Arizona State University (ASU), the University of Arizona, Planet, RMI, and the High Tide Foundation (Carbon Mapper, 2023).

The program was founded on the ongoing efforts of its current science and research team. Since 2016, these experts, in collaboration with JPL and ASU, have employed aircraft equipped with prototypes of the Carbon Mapper satellite instruments, along with other observing systems and datasets, to evaluate methane emissions in representative regions and economic sectors across the United States. Carbon Mapper's data are poised to contribute to accelerating and supporting emissions reduction initiatives undertaken by operators, regulators, community groups, and major international programs such as the Oil and Gas Methane Partnership, the Global Methane Pledge, and the International Methane Emissions Observatory (Carbon Mapper, 2023). Here is the link to Carbon Mapper's data portal: **https://data.carbonmapper.org.**

Climate TRACE

A collective of AI specialists, data scientists, researchers, and nongovernmental organizations established the Climate TRACE coalition. Present members include CTrees, Duke University's Nicholas Institute for Energy, Carbon Yield, Earth Genome, former Vice President Al Gore, Environment & Sustainability, Hypervine.io, Johns Hopkins University Applied Physics Lab, TransitionZero, OceanMind, RMI, WattTime, and Global Energy Monitor. Additionally, Climate TRACE receives support from more than 100 other contributing organizations and researchers, including Google.org, Michigan State University, Descartes Labs, Minderoo Foundation/Global Plastic Watch, Universiti Malaysia Terengganu, Planet Labs PBC, Synthetaic, and others (Climate TRACE, 2023).

Climate TRACE provides an exceptionally detailed emissions inventory pinpointing nearly every major greenhouse gas (GHG) emission source globally. The inventory provides independently produced estimates of emissions from various human-caused sources such as power plants, steel mills, ships, and oil refineries, as well as other emitting activities, including fertilizer application, deforestation, and wildfires. Climate TRACE's expanded database now covers GHG emissions from more than 352 million assets, reflecting a remarkable 4,400-fold increase compared to the assets covered in the inventory last year (Climate TRACE, 2023). All Climate TRACE data are accessible to the public, free of charge, with the aim to facilitate action and accountability on a massive scale essential for global progress. This unprecedented level of detail supports private-sector initiatives, particularly for companies aiming to decarbonize their supply chains. Notably, major electric vehicle manufacturers such as Tesla and Polestar have already initiated collaborations with Climate TRACE to enhance their emissions data related to steel and aluminum suppliers. Boeing has committed to partnering with Climate TRACE to explore how its innovative emissions inventory can aid Boeing's efforts in assessing aviation's pathways to decarbonization. Numerous other organizations are leveraging Climate TRACE data to address data gaps (Climate TRACE, 2023).

By using satellites, various forms of remote sensing, and additional public and commercial data, Climate TRACE provides emissions data that may go unreported in traditional inventories. Even when emissions are absent from official reporting, Climate TRACE monitors what the atmosphere observes. Remarkably, most corporate emissions worldwide included in the Climate TRACE inventory are still absent from self-reported environmental, social, and governance databases (Climate TRACE, 2023). Here is the link: **https://climatetrace.org/explore.**

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