Waste-to-energy: sustainable solution to reduce methane emissions

WtERT 2024 Biennial Conference

The City College University of New Yok

New York, USA

MSc. YURI SCHMITKE A. B. TISI
Vice President LATAM of Global WtERT Council
Executive President of ABREN

Brazilian Association for Energy Recovery from Waste – ABREN

Associated companies:

International cooperations:

Funded by the European Union

EU Climate Dialogues (EUCDs)

Brazilian Association for Energy Recovery from Waste – ABREN

ABREN WtERT as a tool to improve the waste management sector in Brazil

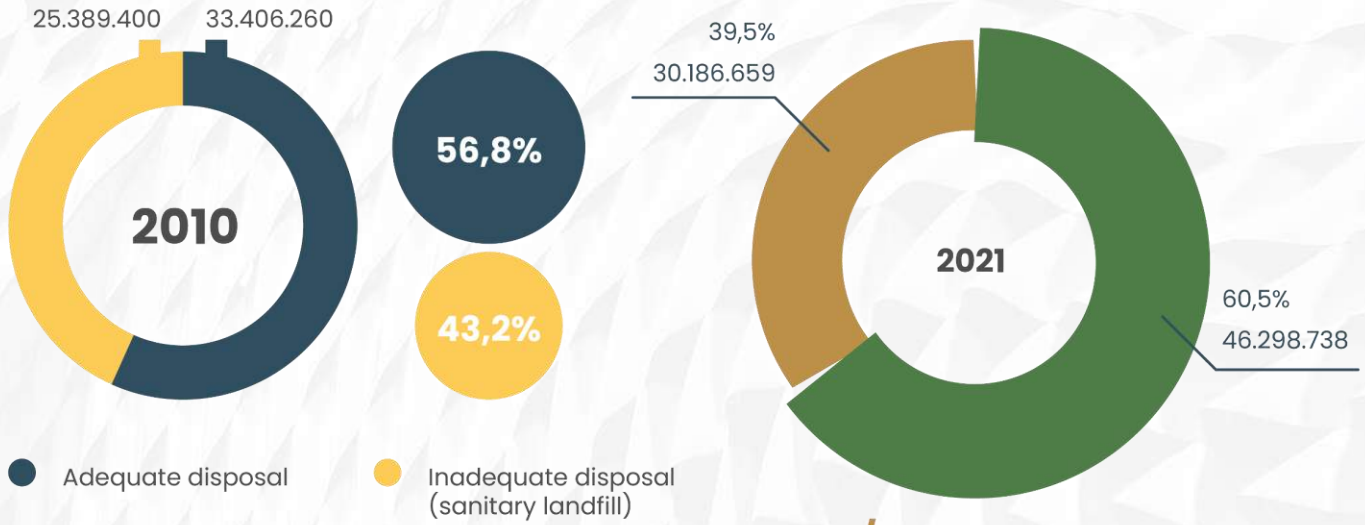
- Non-profit Brazilian Association for Energy Recovery from Waste (ABREN);
- Created in May 2019;
- In 2020 started to officially represent the Waste-to-Energy Research and Technology Council – WtERT Brasil;
- 36 members;
- ABREN WtERT is currently one of the largest associations in the waste sector in Brazil and Latin America;
- Focus on relations with the press, academia, government and parliament to develop the sector;

- Companies from all environmental ecosystem required to implement Waste-to-Energy (WtE) projects are part of ABREN:
  - ✓ machine and equipment manufacturers;
  - ✓ construction companies (EPC);
  - ✓ operators;
  - ✓ concessionaire operators;
  - ✓ trading companies;
  - ✓ engineering and specialized consulting companies.

Current status of Waste Management in Brazil

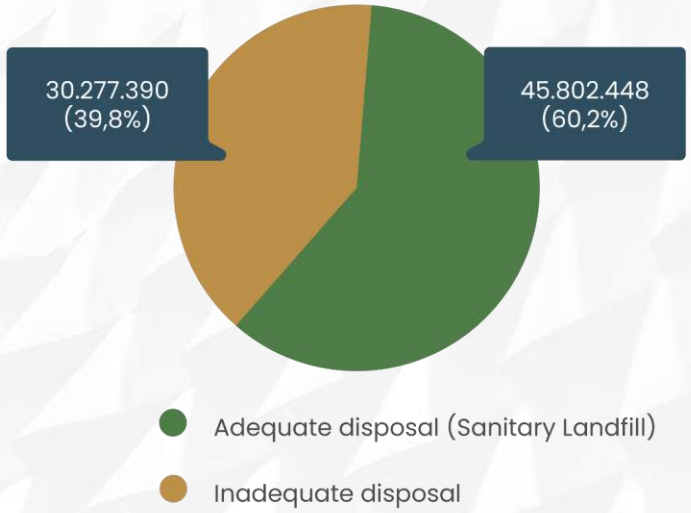
After 2 decades of discussion in Congress and 1 decade since approval of the “National Solid Waste Policy (PNRS)”, the amount of MSW disposed of in dumps and Unsanitary landfills (which should have been extinguished by 2014), remains at same level

Destionation of MSW 2010 and 2021



30Mt/y - 39,5% dump and non-sanitary landfills

Destionation of MSW 2021
(76 M Tons Collected)



Source: Panorama 2021 / 2022 ABRELPE

LEGAL FRAMEWORK IN BRAZIL

LAW N. 14.026, 15 JULY OF 2020:

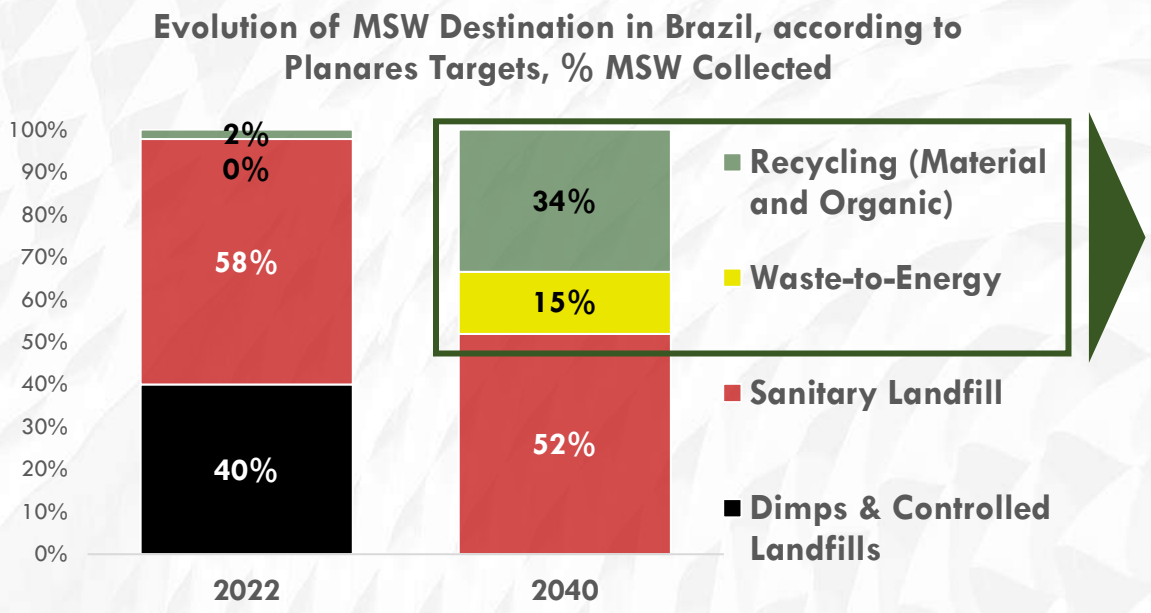
- **All the municipalities must contract with concession**: PPPs or administrative concession;
- **Prohibition of short-term contracts**, still widely used in Brazil;
- **Tariff through consumption bills**: water or electricity;
- Creation of **regional blocks** or **consortium of municipalities.**

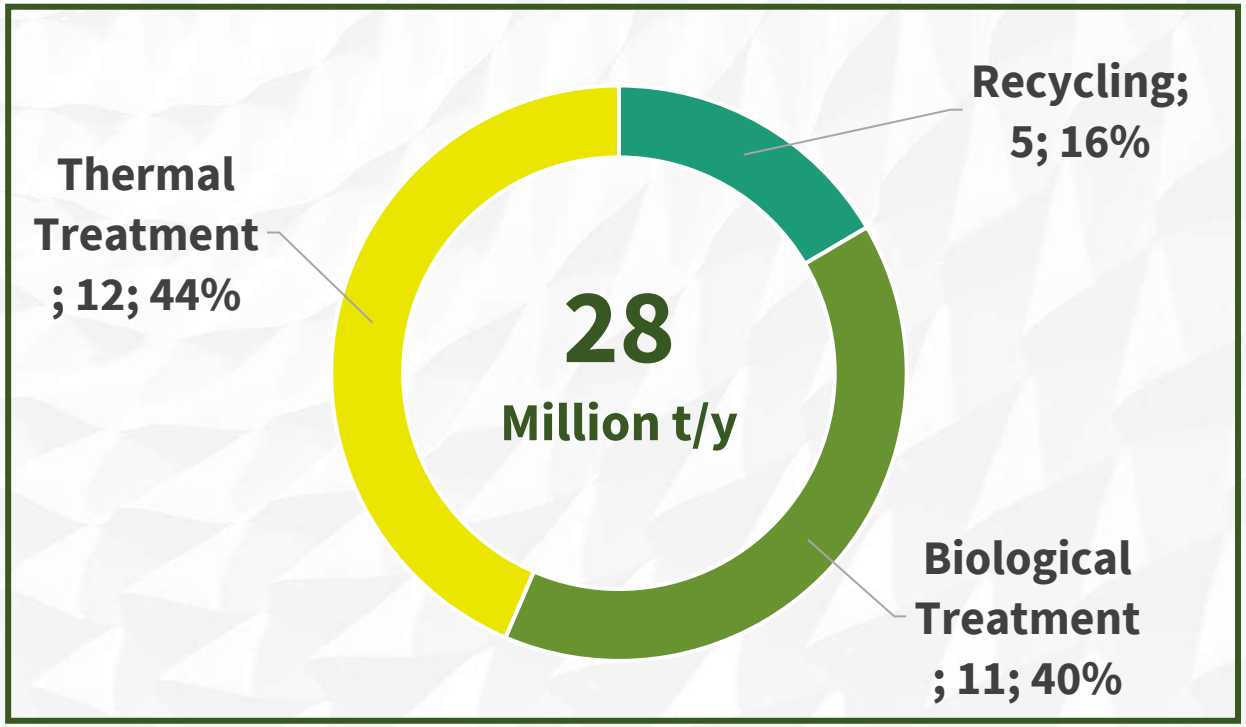
BILL N. 1.202/23 AND N. 924/22 - NATIONAL PROGRAM FOR ENERGY RECOVERY FROM WASTE

- **Government obligation to contract waste-to-energy:** around 66 MW of power per year;
- **Federal government cooperation with municipalities:** make concession bids feasible;
- **Municipal Technical and economic feasibility:** studies will available waste-to-energy;
- **Exemption from taxes**: purchase and sale of energy and machinery and equipment.

National Waste Management Targets (Planares)

PLANARES 2022 (TARGETS 2040)





Source: Data from Planares and SNIS)

National Waste Management Targets (Planares)

Specific target of 994 MWe for MSW thermal treatment (WtE) by 2040.

- Approved by Federal Decree No. 11,043, of April 13, 2022
- Global indicator 9 : **Increase energy recovery and utilization from MSW through thermal treatment.**
- TARGET 9: By 2040, the country will have an installed capacity of 994 MW, which would be enough to supply 27 million homes with electricity.

	2020	2024	2028	2032	2036	2040
Brasil	0	311	462	626	804	994

Equivalent to 50 WTE plants of 20 MWe or ~3 WTE plants of 20 MWe per year)

PLANARES, http://consultaspublicas.mma.gov.br/planares/wp-content/uploads/2020/07/Plano-Nacional-de-Res%C3%ADduos-S%C3%B3lidos-Consulta-P%C3%BAblica.pdf

WTE potential in Brazil

Potential of 130 WTE plants, requiring (private) investments in the RM of around U$ 36 billion

	28 Metropolitan Regions > 1 million inhab.
Municipalities / Regions	28 RM
MSW Generation / Electricity Capacity	39 M t/y (47%) / 2,6 GW
Potential number of WTE units of avg. size 20 MWe	**130**
Potential Investment	**~36 U$ billion**

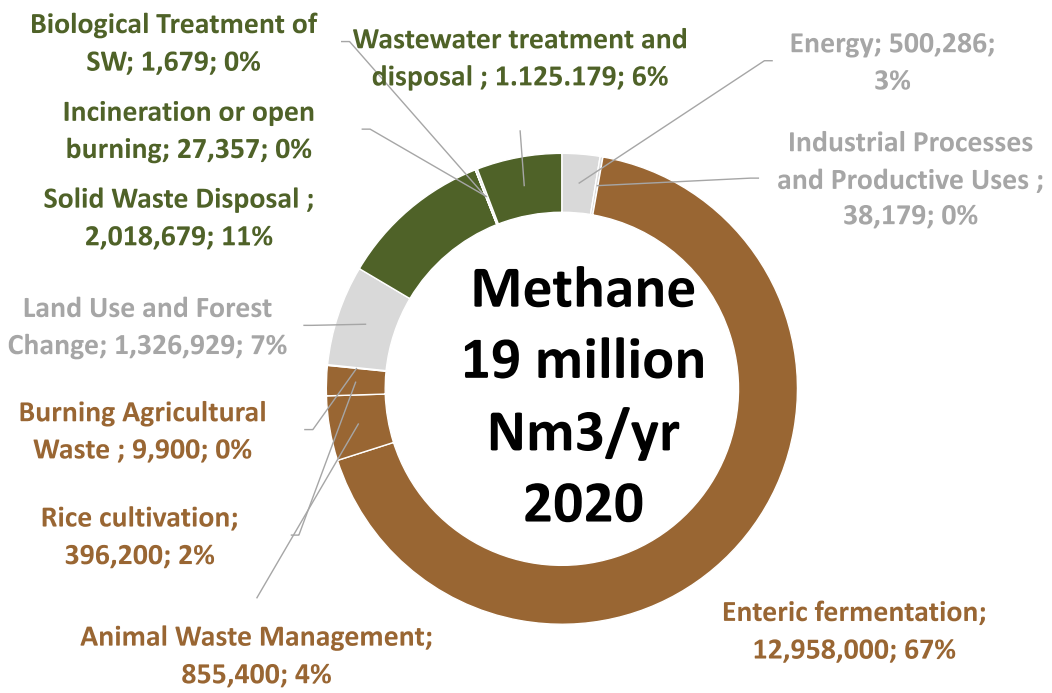
Source: Own calculation based on IBGE, SNIS data, and assumption investment equivalent to 1.5m€/Mwthermal (input)

Methane emissions in Brazil

Main sources of methane (CH4) emissions: **Enteric Fermentation: 13 million tons and Solid Waste Disposal with 2 million tons.**

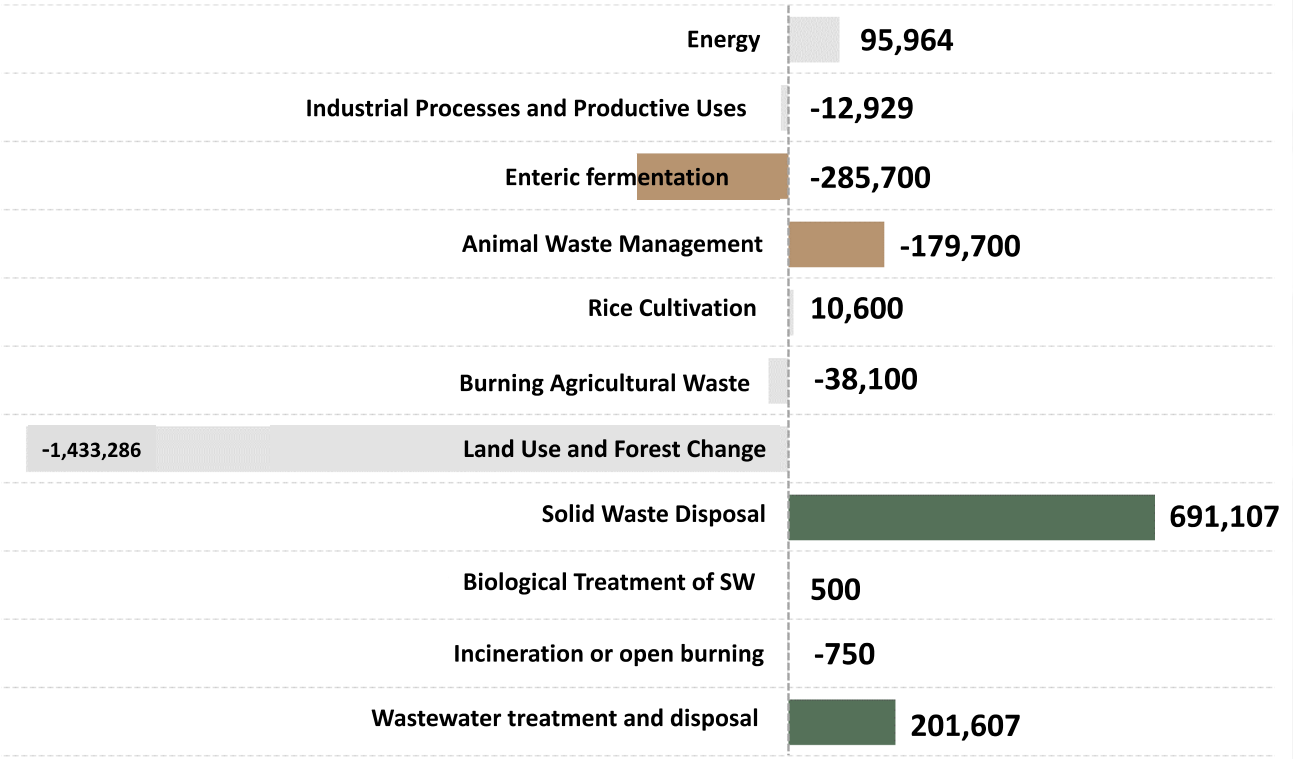
The largest relative increases between 2005 and 2020 correspond to **Solid Waste Disposal: an increase of 52%.**

CH4 emissions (t) in 2020 (MCTI)



Source: MCTI. https://www.gov.br/mcti/pt-br

Change in CH4 emissions (t) between 2005 and 2020 (MCTI)



GHG Emissions reductions

Decarbonization study in Brazil with WTE and RDF (BEP/UK, 2022)

Scenarios	Potential quantity of MSW used for energy generation	Decarbonisation potential through the use of MSW energy	% of NDC 2030 target	NDC - COP26 GWP-SAR	NDC - COP26 GWP-AR5
For the electricity generation scenario[1]	21,80 a 31,06 million t/year	23,83 a 59,39 MtCO2eq./year	1,98 to 4,84%	1,99 to 4,95%	1,83 to 4,57%
Co-processing + biodigestion scenario[2]	4,96 million t/year	14,08 MtCO2eq./year	0,82% and 1,17%	0,83% and 1,17%	0,76% and 1,08%

Target assumed by Brazil in the "Global Methane Commitment" at COP 26: 30% reduction

Global Methane Commitment	
Emissions 2020	20,2 million t CH_4
Reduction	6 million t CH_4

Electric energy scenario: avoids between 16.4 and 28.9% of methane emissions

Co-processing scenario: avoids 4.7% of methane emissions



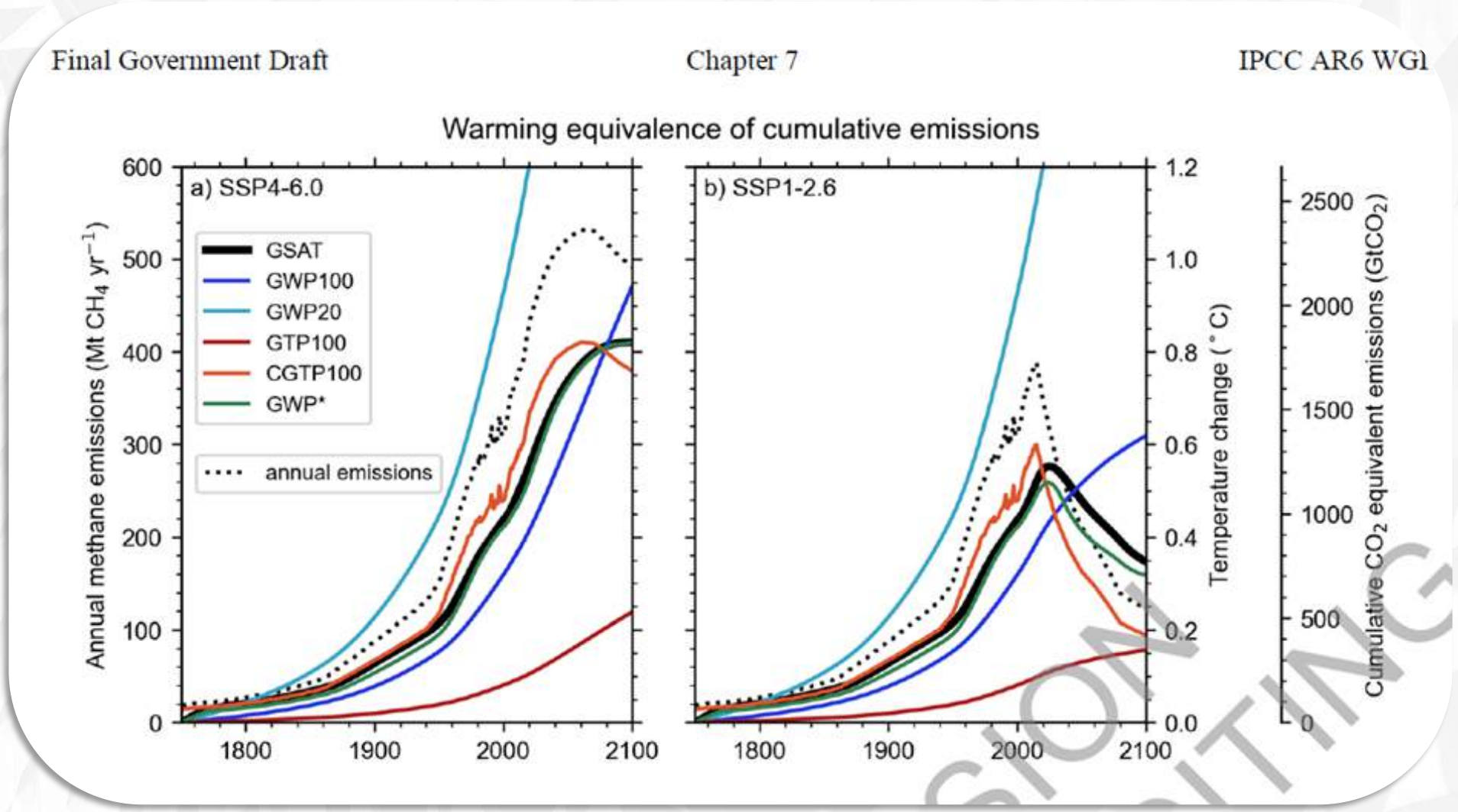
GHG Emissions reductions

- For each kg of waste treated in a WtE plant, approximately 1.5 to 1.7 kg of CO_2 equivalent can be avoided from landfills in Brazil (BEP/UK, 2022).
- Methane is today considered the second biggest driver of anthropogenic climate change, contributing to the formation of ground-level ozone, a toxic air pollutant (IPCC, 2021);
- Some countries consider methane to be a dangerous pollutant from the point of view of health and safety (UNECE/UN);
- 1 million people die prematurely every year due to exposure to ground-level ozone;
- UNECE/ONU: Brazil and other countries signed the Global Methane Pledge at COP 26 to reduce methane emissions by 30% by 2030;
- Landfills are an important source of methane, a powerful greenhouse gas that, according to the IPCC, has a global warming potential 86 times greater than CO_2 over a 20-year horizon (GWP20);
- WtE in the 28 Brazilian metropolitan regions with more than 1 million inhabitants have the potential to avoid the emission of about 86 million tons of CO_2 equivalent annually (ABREN WtERT, 2021).

(source: https://www.thecable.ng/report-solid-waste-contributes-to-12-of-global-methane-emissions)

6th Report of IPCC

Annual methane emissions (Mt $CH_4 yr^{-1}$) vs Temperature change (°C)



Source: AR6. Climate Change 2022: Impacts, Adaption and Vulnerability, Sumary for Policy Makers. IPCC, 2022.

Global methane super-emitters using satellite data

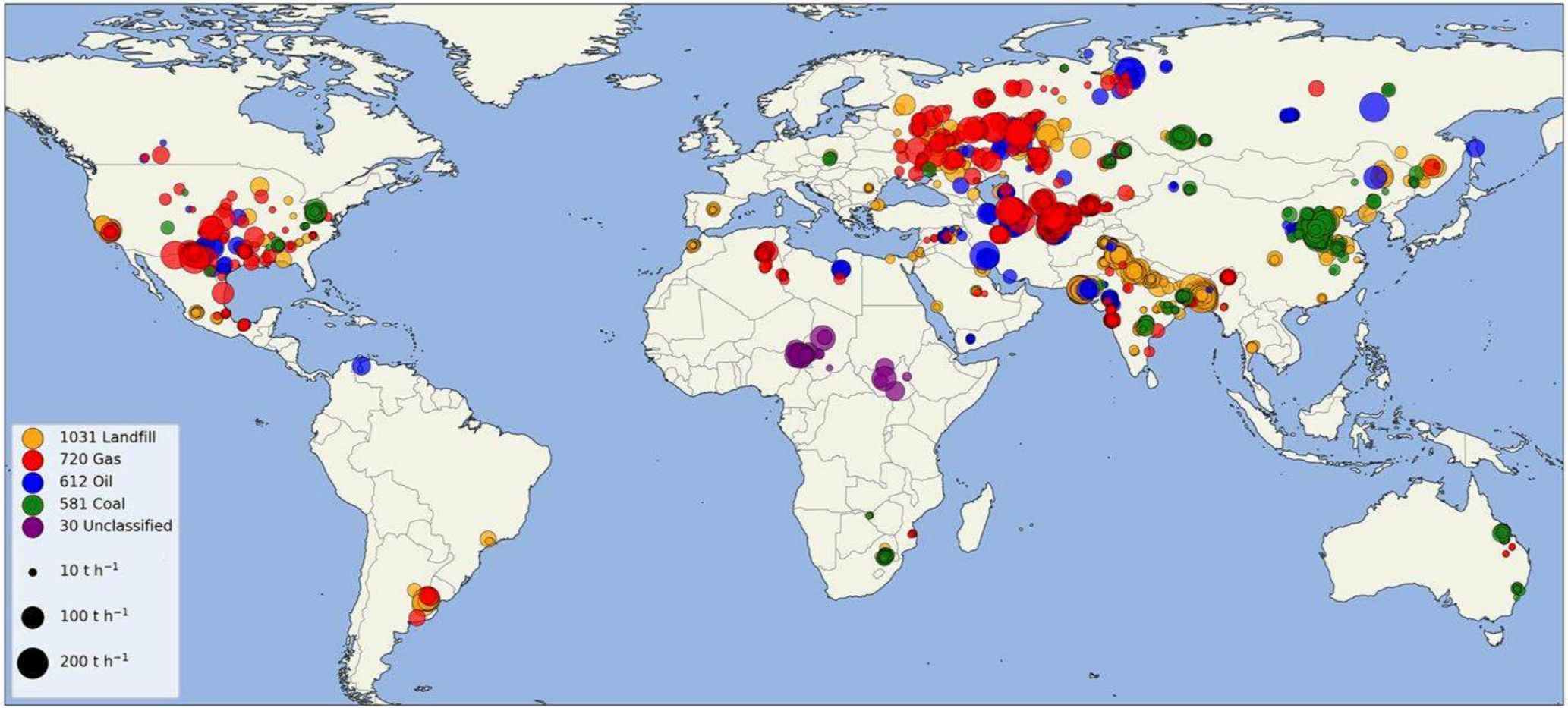


Figure 6. All 2974 confident plume detections for 2021, grouped into one of four dominant anthropogenic source types and sized by source rate, capped at 200 t h^{-1}. There are 30 detections in central Africa that are labeled as "unclassified".

Source: Automated detection and monitoring of methane super-emitters using satellite data. EGU, Set. 2023. https://acp.copernicus.org/articles/23/9071/2023/

USA methane super-emitters using satellite data

METHANE EMISSIONS

Quantifying methane emissions from United States landfills

Daniel H. Cusworth[1,2*], Riley M. Duren[1,2,3], Alana K. Ayasse[1], Ralph Jiorle[1], Katherine Howell[1], Andrew Aubrey[1], Robert O. Green[3], Michael L. Eastwood[3], John W. Chapman[3], Andrew K. Thorpe[3], Joseph Heckler[4], Gregory P. Asner[4], Mackenzie L. Smith[5], Eben Thoma[6], Max J. Krause[6], Daniel Heins[6], Susan Thorneloe[6]

Methane emissions from solid waste may represent a substantial fraction of the global anthropogenic budget, but few comprehensive studies exist to assess inventory assumptions. We quantified emissions at hundreds of large landfills across 18 states in the United States between 2016 and 2022 using airborne imaging spectrometers. Spanning 20% of open United States landfills, this represents the most systematic measurement-based study of methane point sources of the waste sector. We detected significant point source emissions at a majority (52%) of these sites, many with emissions persisting over multiple revisits (weeks to years). We compared these against independent contemporaneous in situ airborne observations at 15 landfills and established good agreement. Our findings indicate a need for long-term, synoptic-scale monitoring of landfill emissions in the context of climate change mitigation policy.

- Aerial imaging spectroscopy to evaluate more than 400 landfills in the United States between 2016 and 2022;
- Significant difference between methane (CH4) emissions reported in traditional inventories and those actually observed through measurements made by spectrometry cameras installed on satellites and aircraft;
- Methane emission rates were approximately 2.7 times higher than those reported in inventories;

Study published in the journal Science n. 383 on March 29, 2024;

USA methane super-emitters using satellite data

Methane From US Landfills 40% Greater Than Reported, Study Finds

More than half of the waste sites observed during aerial surveys showed clear signs they were a point source of emissions, a new report published in *Science* shows.



A bulldozer moves trash at a landfill refuse site. *Photographer: Bloomberg Creative Photos/Bloomberg*

https://www.bloomberg.com/news/articles/2024-03-28/methane-from-us-landfills-40-greater-than-reported-study-finds

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Aerial surveys show US landfills are major source of methane emissions

By **Valerie Volcovici**

March 28, 2024 7:27 PM GMT-3 · Updated a month ago



Workers use heavy machinery to move trash and waste at the Frank R. Bowerman landfill on Irvine, California, U.S., June 15, 2021.Picture taken June 15, 2021. REUTERS/Mike Blake/File Photo *Purchase Licensing Rights*

https://www.reuters.com/world/us/aerial-surveys-show-us-landfills-are-major-source-methane-emissions-2024-03-28/

USA methane super-emitters using satellite data

The New York Times

'Garbage Lasagna': Dumps Are a Big Driver of Warming, Study Says

Decades of buried trash is releasing methane, a powerful greenhouse gas, at higher rates than previously estimated, the researchers said.

Share full article



Landfills are the third-largest source of human-caused methane emissions, according to the Environmental Protection Agency. Andri Tambunan for The New York Times

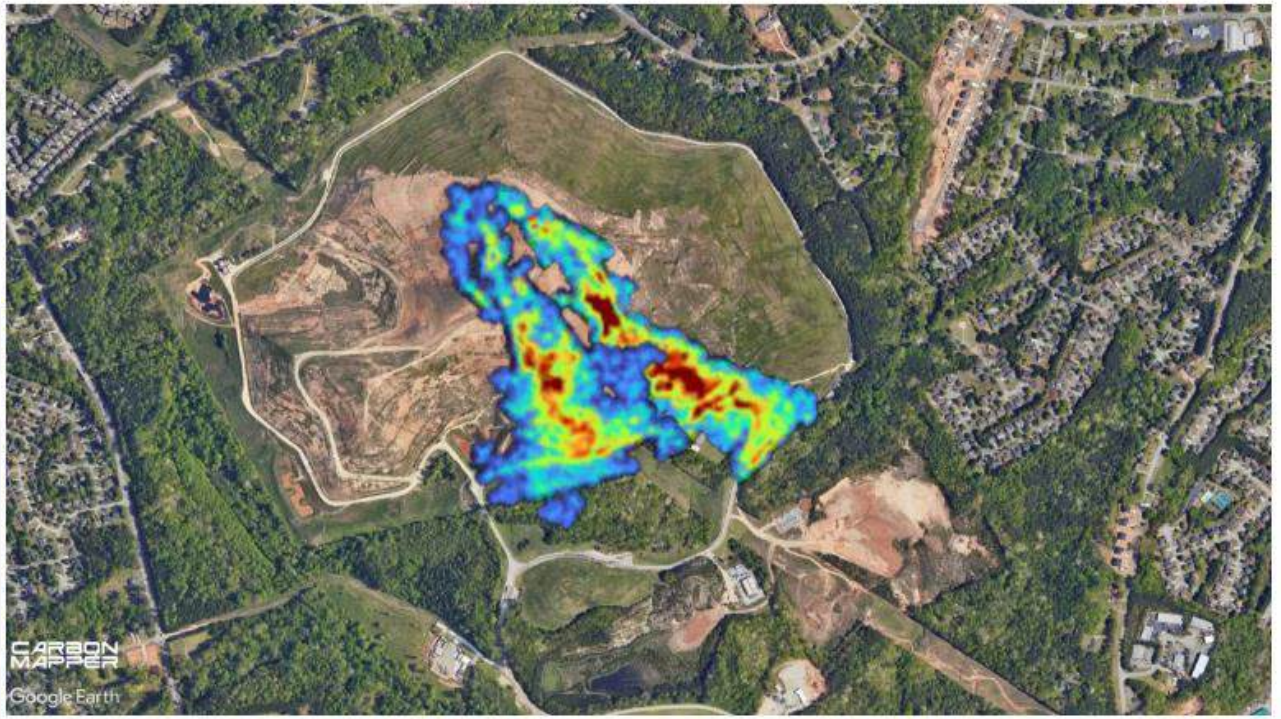
https://www.nytimes.com/2024/03/28/climate/landfills-methane-

CNN World Africa Americas Asia Australia China Europe India Middle East United Kingdom

A potent planet-warming gas is seeping out of US landfills at rates higher than previously thought, scientists say

By Rachel Ramirez, CNN

3 minute read · Updated 2:23 PM EDT, Thu March 28, 2024

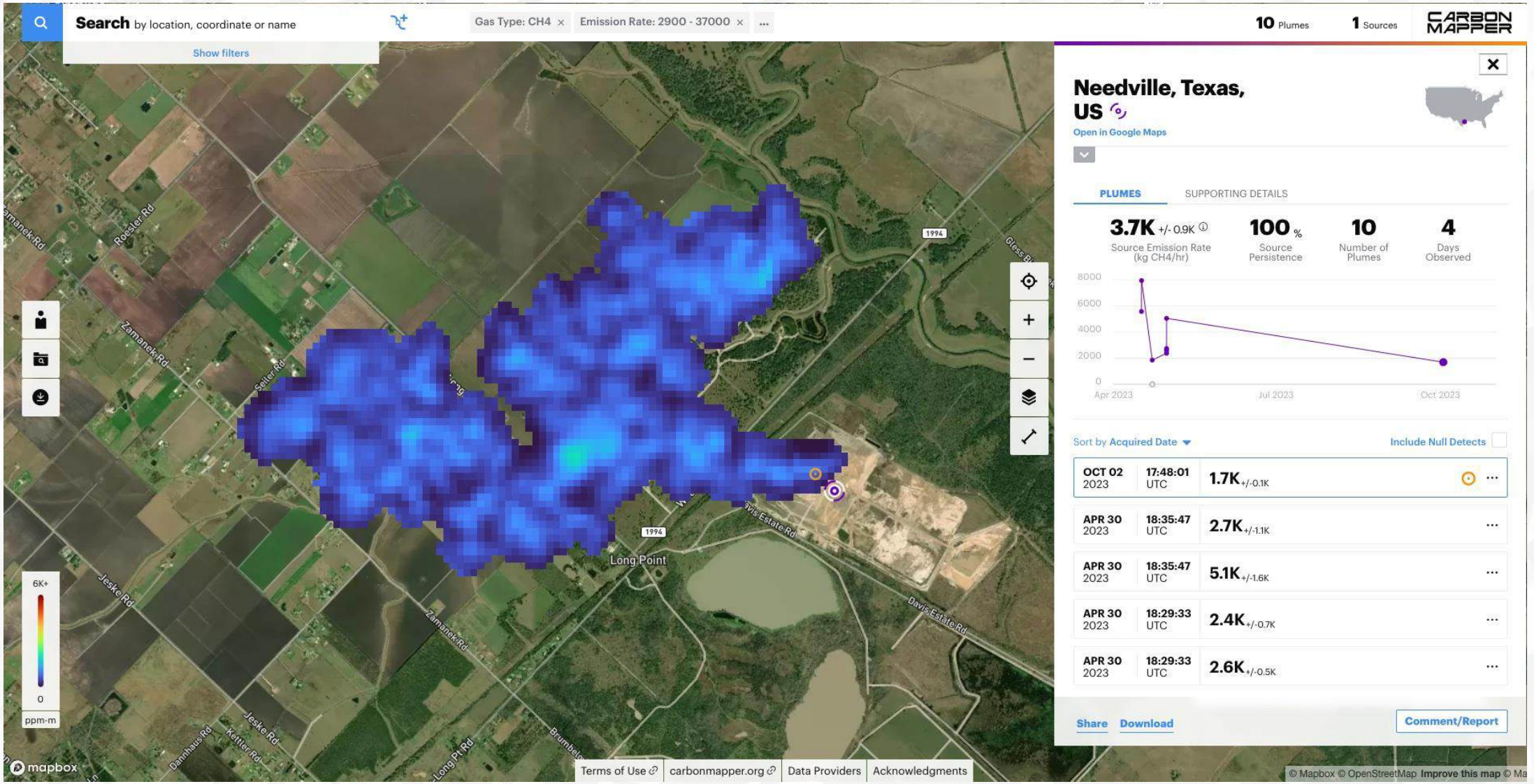


Methane plumes observed by Carbon Mapper during aerial surveys at a landfill in Georgia. Carbon Mapper

https://www.cnn.com/2024/03/28/climate/us-landfills-methane-pollution-climate/index.html

Methane emissions from landfill using satellite images

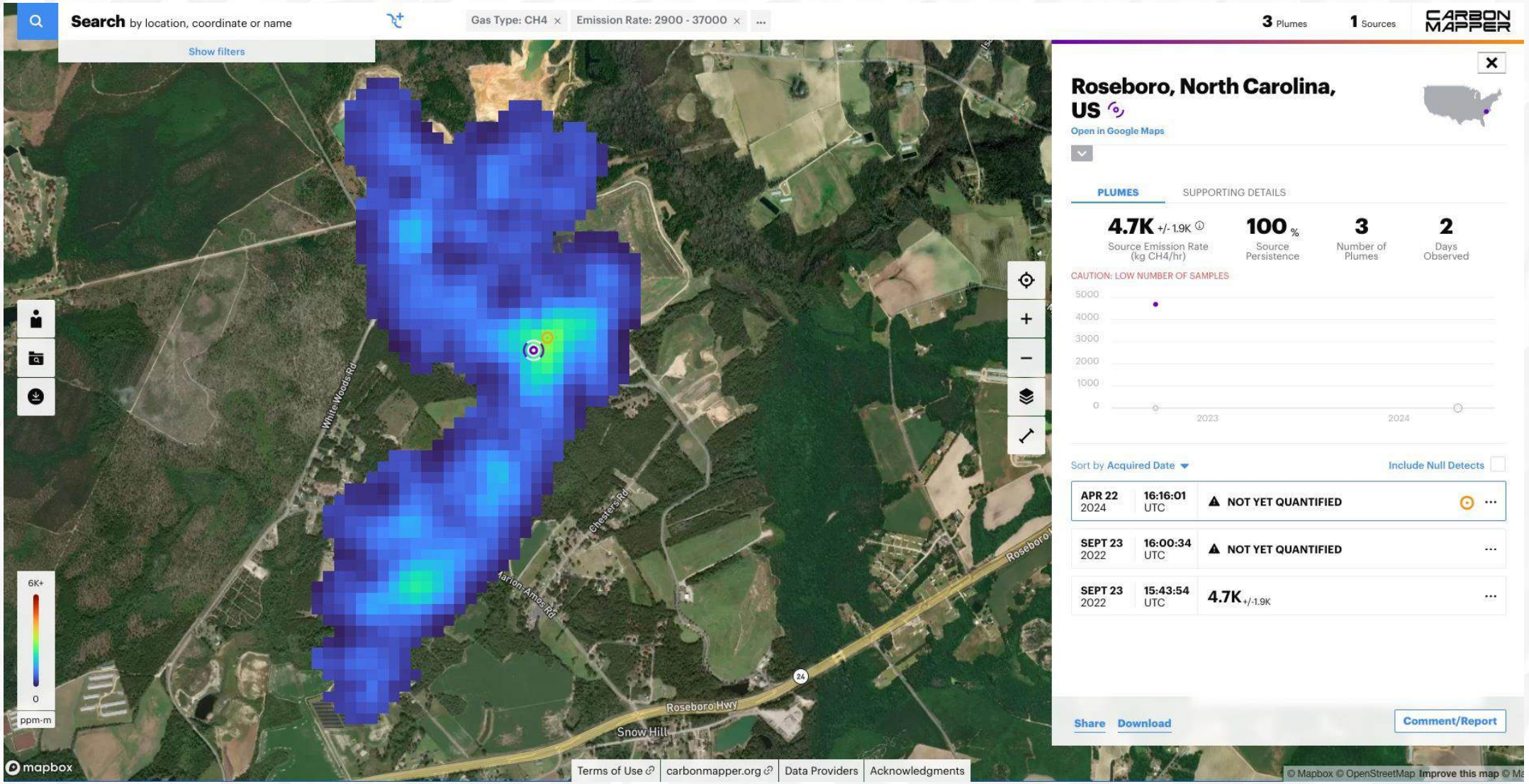
Satellite images of the methane plume from Needville, Texas, USA: 3.7 ton/h of CH4 (average) – (5.1 2023)



Source: https://carbonmapper.org/

Methane emissions from landfill using satellite images

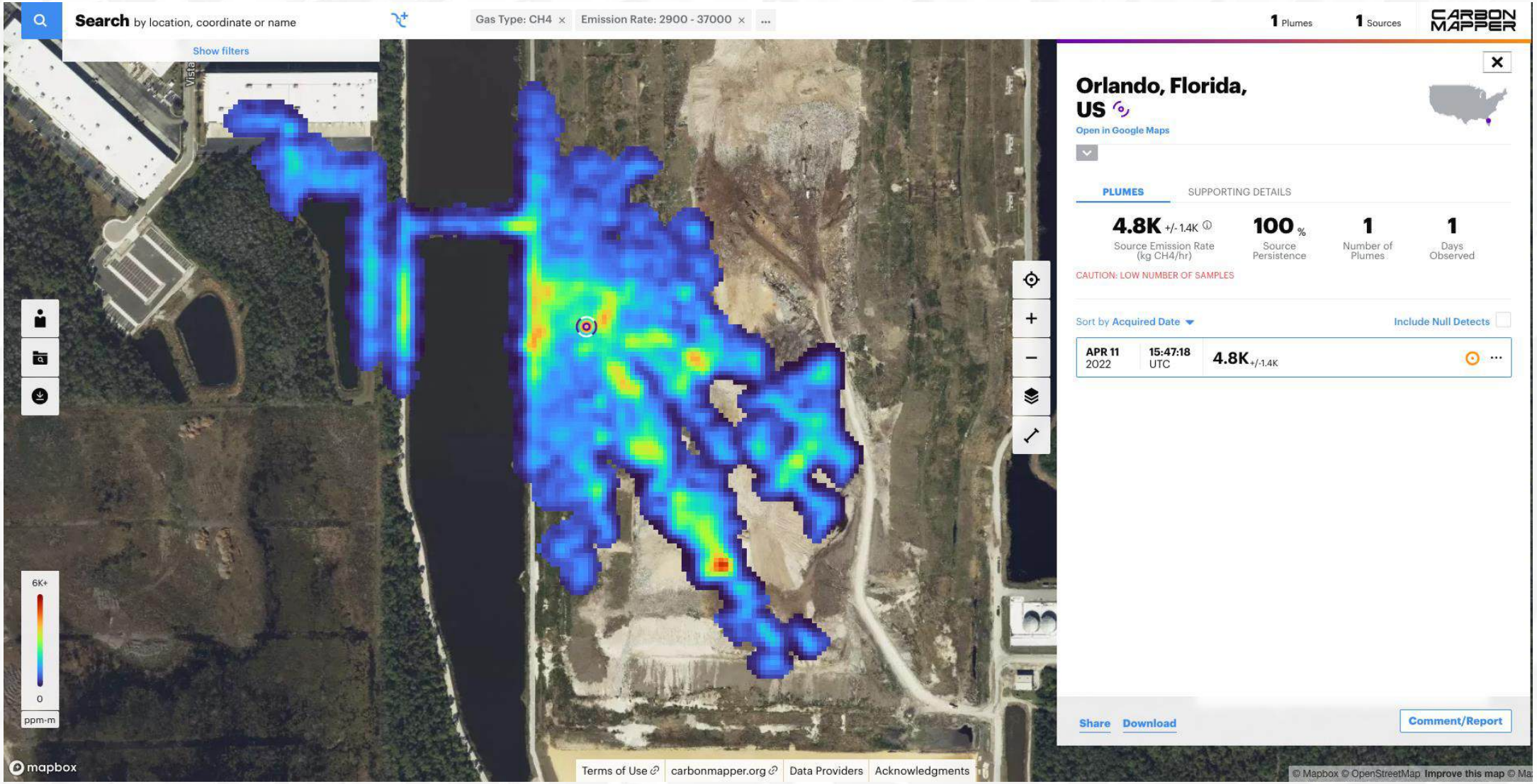
Satellite images of the methane plume from Roseboro, North Carolina, USA: 4.7 ton/h of CH4



Source: https://carbonmapper.org/

Methane emissions from landfill using satellite images

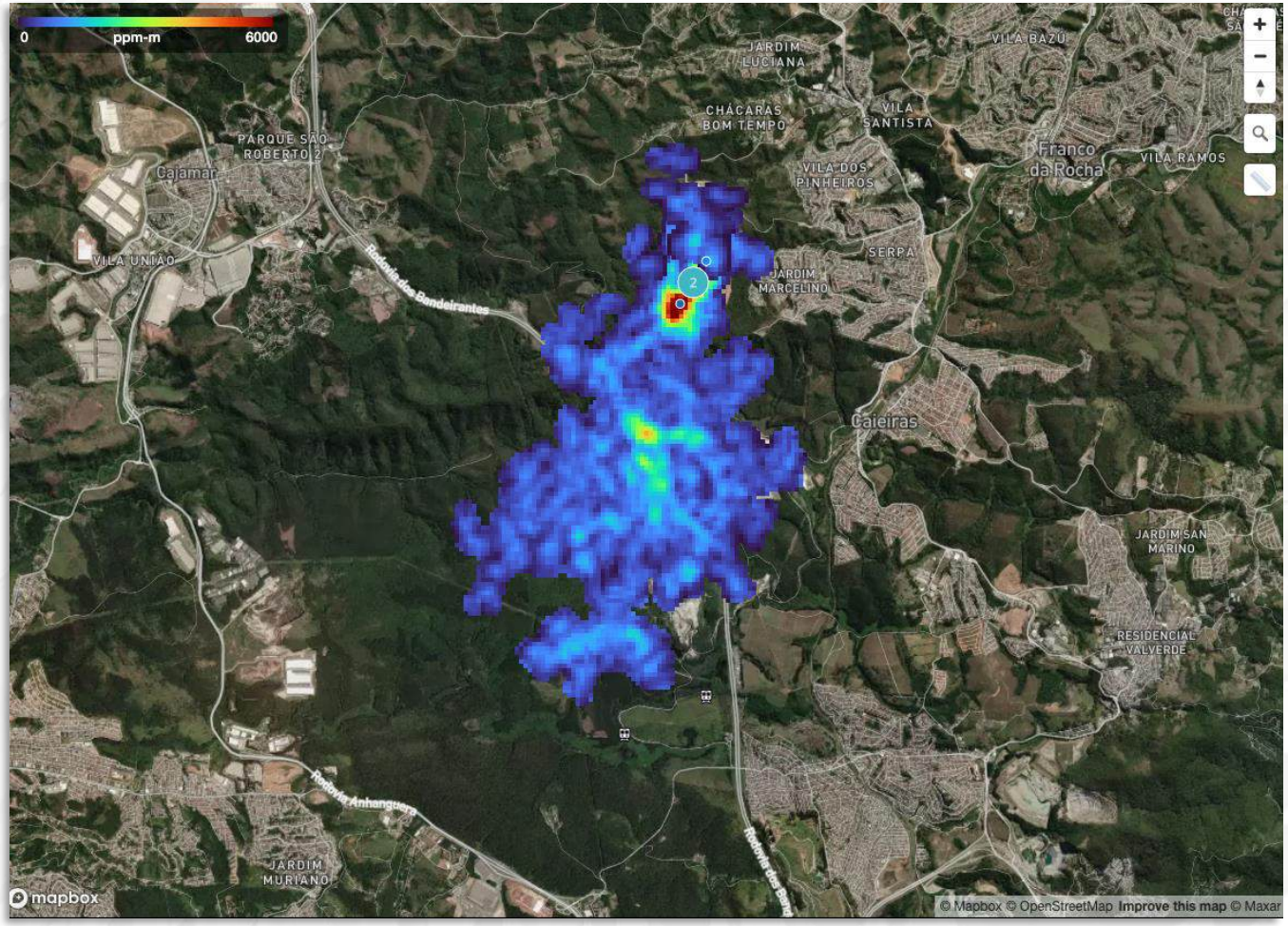
Satellite images of the methane plume from Orlando, Florida, USA: 4.8 ton/h of CH4



Source: https://carbonmapper.org/

Methane emissions from landfill using satellite data

Satellite images of the methane plume from the Caieiras/SP with measurements of around 7,7 ton/h of CH4 (even with biogas collection)

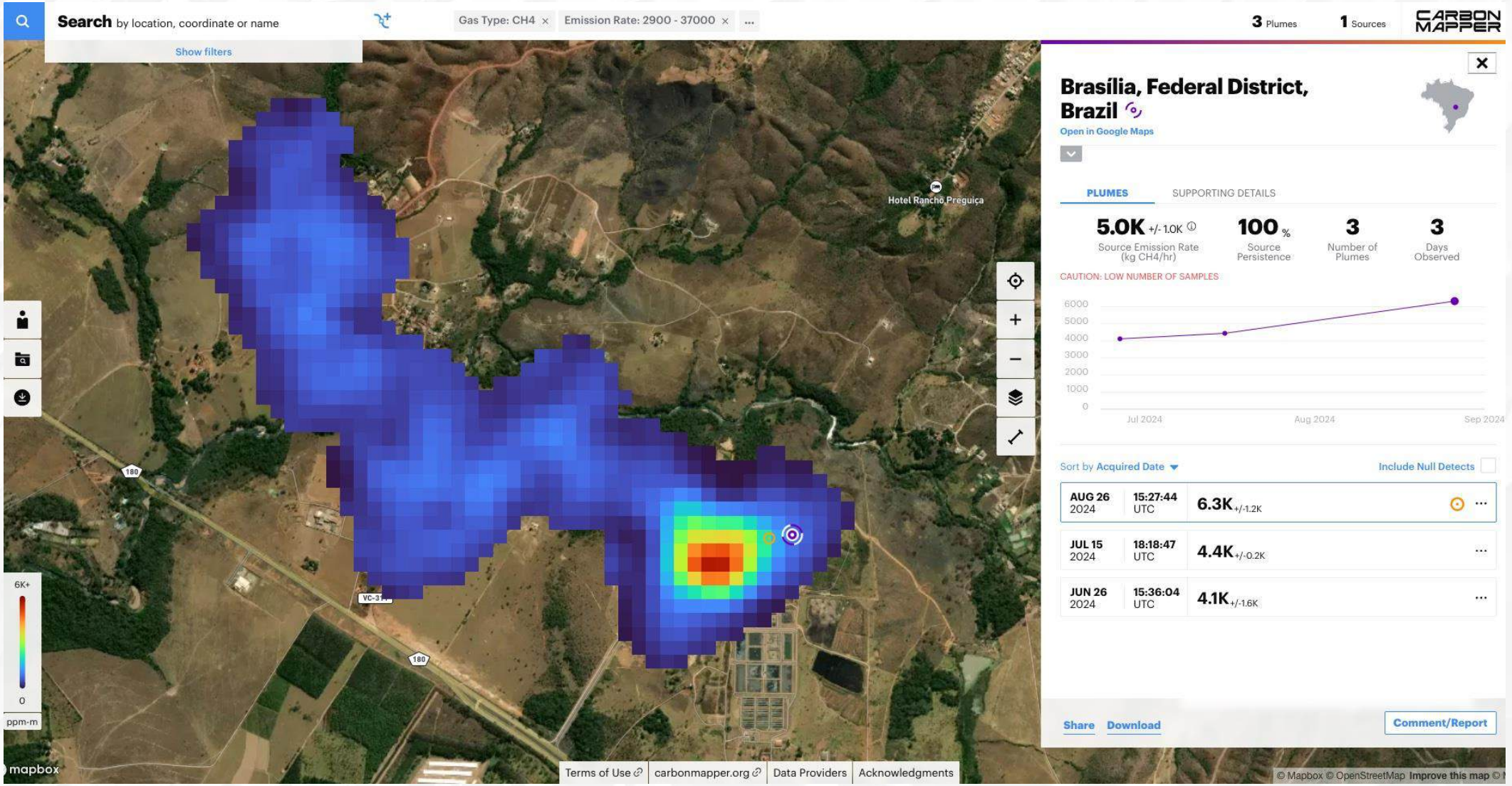


Date	May 4, 2023 13:54
Published	Jun 13, 2023 18:18
Emission	7798 ± 2214 kg/hr
Lat/Lon (Decimal)	-23.350266, -46.775292
Lat/Lon (DMS)	23°21'0"S, 46°46'31"W
Source ID	N/A
Plume ID	emi20230504t135454p09002-B
Instrument	emi
Platform	ISS
Data Provider	NASA-JPL EMIT

Source: https://carbonmapper.org/

Methane emissions from landfill using satellite images

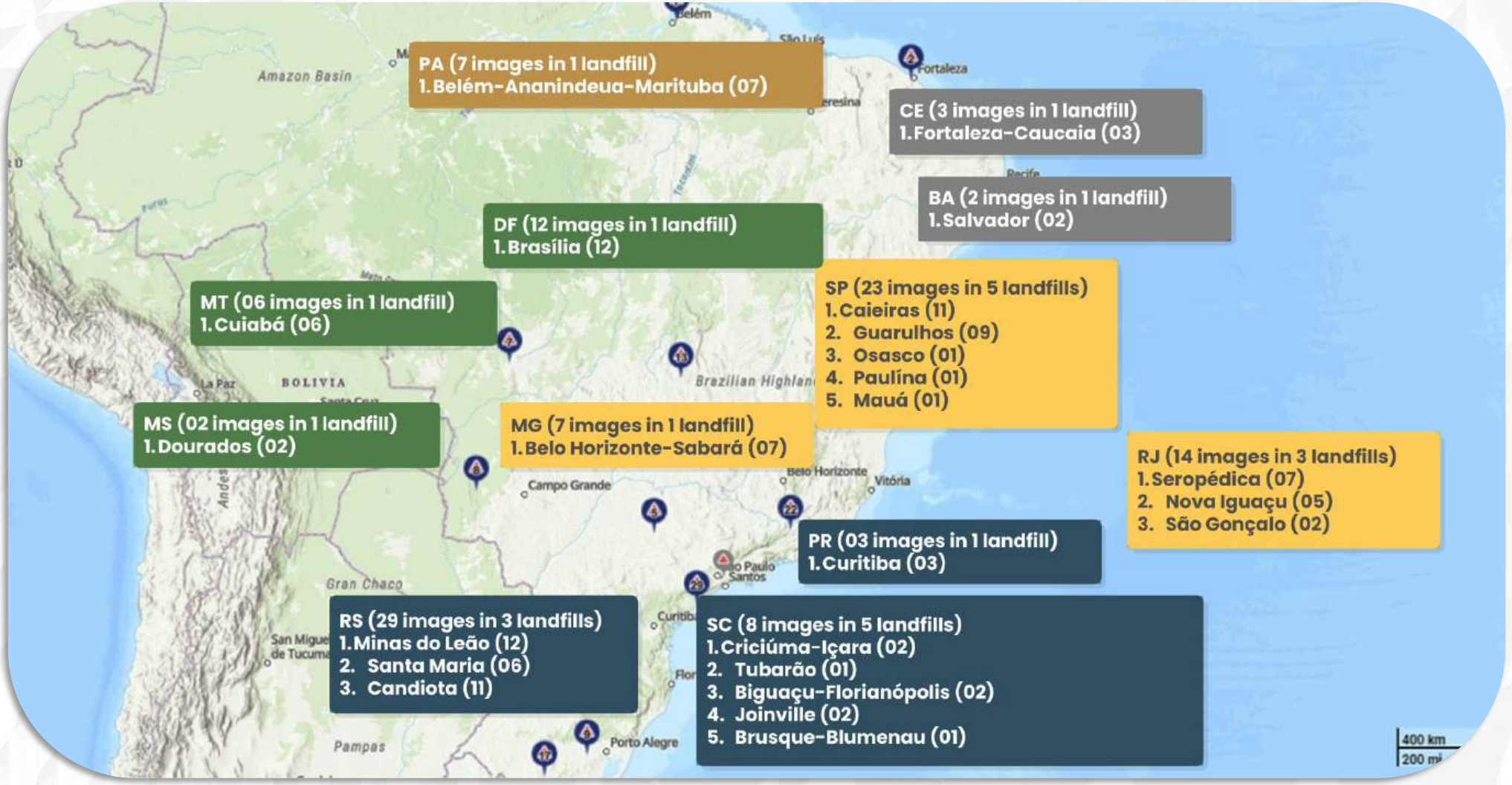
Satellite images of the methane plume from Brasília, Distrito Federal, Brazil: 5.0 ton/h of CH4



Source: https://carbonmapper.org/

Methane emissions from landfill using satellite data

113 Measurements via Satellite in 22 Landfills in 12 Brazilian States (ABREN WtERT study with GHG Sat)



Methane emissions from landfill using satellite data

Table 31 - Main comparative parameters between satellites and CDM data declared to the UNFCCC.

Landfill		Average fugitive emissions in 2023 ($kgCH_4$/hour)		
		CDM	Satellite	Satellite / CDM ratio
1	Minas do leão	215.0	6,155	28.6
2	Biguaçu	450.0	1,153	2.6
3	Criciúma/Içara	302.0	909	3.0
4	Sabará	1,327.0	3,785	2.9
5	Nova Iguaçu	650.0	5,494	8.5
6	São Gonçalo	1,340.0	2,762	2.1
7	**Caieiras**	935.0	7,798	8.3
8	Guarulhos	359.0	4,974	13.9
9	Mauá	328.0	15,544	47.3
10	Paulínia	407.0	1,240	3.0
11	Salvador	278.0	1,719	6.2
12	Fortaleza	1,863	2,094	1.1
13	Belém	104.0	1,663	16.0

- 13 Brazilian landfills investigated: satellite observations suggest actual emissions on **average six times higher** than those reported to the UNFCCC.
- This discrepancy covers a margin of error **ranging from three to ten times greater than the theoretical estimates**.

Methane emissions from landfill using satellite data

7 of the 13 landfills in the sample declare a biogas capture rate of 92.8% for the CDM

Figure 80- Summary of Landfill Methane Emission Measurements in Brazil

Comparison of GHG Sat and Carbon Mapper (Nasa) vs CDM UNFCC (base 2023)



Final Considerations

- **Commitment to sustainable development**: ABREN has dedicated itself to advancing WtE solutions as a key strategy for sustainable waste management in Brazil, in line with global efforts to reduce greenhouse gas emissions.
- **Progress and legislative challenges**: ABREN has supported the approval of a regulatory framework to encourage WtE, such as the recent bills that oblige the recovery of energy from waste.
- **Technological and economic potential**: There are initiatives to nationalize the production of machinery and equipment and reduce costs to implement WTE
- **Benefits for public health and the environment**: WTE brings great benefits for public health and in the reduction of methane emissions resulting from the detour of waste from landfills.
- **Future directions and policy recommendations**: Academic research, press publications, policy adjustments and investments are needed to optimize the use of WtE.
- **Enhanced international collaboration**: Necessary to share best practices, seek technological innovations and bring funding opportunities that can accelerate the implementation of WTE facilities, especially in developing regions where there is no waste management infrastructure.
- **Call to action**: There should be broad and integrated actions to engage stakeholders, government bodies, private investors and international partners to collaborate closely to promote a robust WtE infrastructure for a greener and more sustainable future.

E-mail:

yuri@abren.org.br

Websites:

www.abren.org.br

wtert.org

Phone (WhatsApp):

Yuri: +55 (61) 98206-4694

