Method Development for Detection of Methane Emissions from Landfills

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GOALS

- Develop a cost-effective method to scan landfill and detect methane emissions (background and leakage sources)
- Validate laser measurements by comparison with another technique
- Try to combine both techniques to derive a quantification of methane emissions

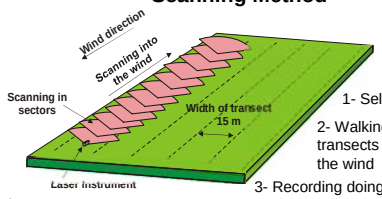
MATERIALS AND METHODS

TESTING OF A LASER INSTRUMENT

Siemens AG, CT PS 8 Remote Natural Gas Leak Detector Field Unit :
Measurement of CH_4 concentrations along the beam (data in ppm x m)

Operative wavelength range	1,651 nm
Time response	100 ms
Detection range gas concentration	0 - 1,000 ppm x m
Lower detection limit	10-20 ppm x m, depending on reflected laser strength
Operative battery capacity	3-5 hours, depending on ambient temperature
Operative temperature range	-10 – +40° C
Operative distance/range	>10 - 30m, depending on reflected backscatter surface; the range can be extended to 200 m using reflector

Scanning Method

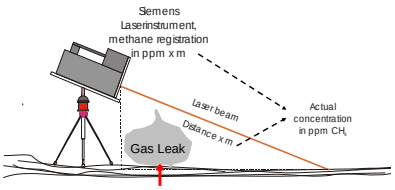


1- Selecting a zone

2- Walking along transects against the wind

3- Recording doing sweeping motion back and forth (beam hitting ground surface at 15-20 m)

Pinpointing Method



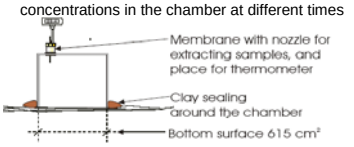
Supplementary Field References

- Pressures (landfill, atmospheric)
- Temperatures (gas, surface, ambient)
- Wind velocity
- Wind direction

USING STATIC CHAMBERS

(Lulea University)

Derivation of a flux from measurements of CH_4 concentrations in the chamber at different times



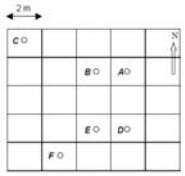
Volume V	10 L
Covered area A	0.15 m^2
Gas sampling frequency	t = 2, 4, 8, 16, 32 min after sealing
Gas analyser	Gas chromatograph within 40 hours

Determine flux Q_{CH4} assuming a linear trend of the concentration change dC : $Q_{CH4} = \frac{V}{A} * \frac{dC}{dt}$

Chamber Survey Method

-2 x 2 m grid on 100 m2 areas

- 6 chambers randomly placed



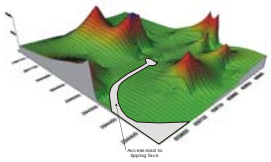
RESULTS

7 landfills in Sweden, 2 landfills in France

TESTING LASER PERFORMANCES IN DIFFERENT CONFIGURATIONS

Site topography, waste age, type of cover, type of biogas management, season climate

3D mapping of a laser survey



→ Quick scan over every type of surface area (1ha /h)

→ Easy to operate in different conditions

→ Generally accurate to indicate the occurrence of gas emission and to localize methane leakages sources

Needed improvements :

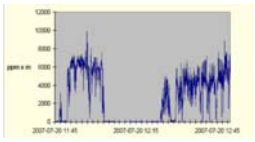
→ Integration of GPS, beam length measurement, data registration

→ Make the instrument more user friendly (battery, weight)

→ Increasing beam length using reflectors

KNOWING MORE ABOUT EMISSION PATTERNS

Evidence of high temporal variations at one location (60 min)

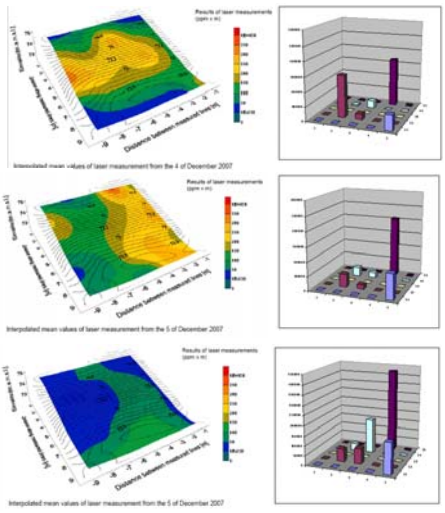


Identification of different typical zones of emission

	Final cover EU standard	Covered	Plastic sheet cover	No cover
Top surface	Low emission	Low emission	Medium risk of emission	
Slope	Low emission			
Leachate, gas recovery system	High risk of emission			
Tipping face				
Old zone	Low emission	Low emission	Medium risk of emission	

Evidence of high spatial and temporal variations
Simultaneous surveys on a 100 m2 area at 12 h interval

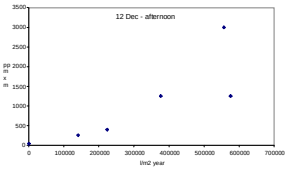
Laser | Static chambers



The large variation in both time and space confirms former studies about the non suitability of using chamber method on landfills

COMPARING LASER AND STATIC CHAMBERS RESULTS

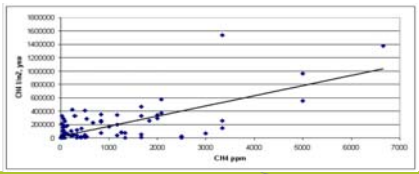
Results of 5 simultaneous surveys on a 100 m2 area at 12 h interval



Date	Correlation coefficient	Correlation coefficient when one outlier has been removed
Dec 04 AM	- 0,27	0,72
Dec 04 PM	0,85	No outlier
Dec 05 AM	-0,15	0,78
Dec 05 PM	-0,16	0,79
Dec 12 PM	0,83	No outlier

CH_4 concentrations along the laser beam as a function of flux derived from static chambers survey for 6 simultaneous measurements

- High variation in correlation coefficient
- More consistency removing outliers from the data sets



ATTEMPTS TO QUANTIFY EMISSION

- Combined laser and chamber method measurements at 18 "100-m^2-areas" on 7 landfills
- At spring, summer and fall
- 690 gas sampled analysed

- No clear correlation between static chambers and laser results
- No direct derivation of a flux from the laser concentration measurements
- Difficulty to quantify emissions for the whole landfill

CONCLUSIONS

LASER INSTRUMENT

→ Scanning rapidity (1ha /h) allows repeated measurements to increase reliability

→ Easy to operate in different conditions

→ Generally accurate to indicate the occurrence of gas emission and to localize methane leakages sources

→ Survey cost including report : 550 $ / ha

MAIN FACTORS AFFECTING EMISSIONS

→ Factors greatly vary between landfills

→ Slopes more frequent area of emissions

→ Influence of type of cover and settlement

→ Important temporal variations

KEY ISSUES:

ESTIMATION OF METHANE EMISSION FROM LANDFILLS

→ No clear correlation between static chambers and laser results that would allow to derive a flux from the laser concentration measurements

→ Extreme temporal and spatial variations : non suitability of small surface static chamber survey

→ What is the relevancy of annual derivation from one single laser survey ?

→ How many surveys for reliability ?