Environmental monitoring of MSW Landfills

WEST Systems

Introduction

Every controlled MSW landfill is a potential source for the contamination of air, soil and water.

The main carriers of such contaminations are leachate and biogas, produced by the interaction with seepage water and by the processes of waste degradation. In case of ineffective containing systems, leachate can get in contact with natural systems and thereby be dispersed into existing aquifers.

Biogas, besides its usual constituents CO_2 and CH_4, is often characterized by a series of trace components whose toxicity and bad odor play a major role in assessing the environmental impact of a landfill and associated risks.

In the case of leachate, an effective sealing, drainage and collection system can prevent the occurrence of leakage.

Whereas, in the case of gas emissions, the presence of collection systems doesn't preclude leakages from the landfill cover, whether temporary or permanent.

Other sources of pollution besides leachate and biogas include emissions due to biogas combustion at cogeneration plants, biofilters and the movement of heavy vehicles.

The impact of a landifill affects different matrices such as water, air and soil, therefore it is necessary to set up an adequate monitoring, aimed at identifying the possible sources of contamination.

The 1999/31/EC directive establishes the operational and technical requirements for the management of MSW landfills, suggesting procedures and methodologies to reduce their environmental impact.

In the monitoring of environmental matrices we adhere to EC directive that includes a Surveillance and Control Plan (SCP) in which all parameters, monitoring frequency and methodology must be described in detail. The EC directive further describes all the environmental parameters to be monitored:

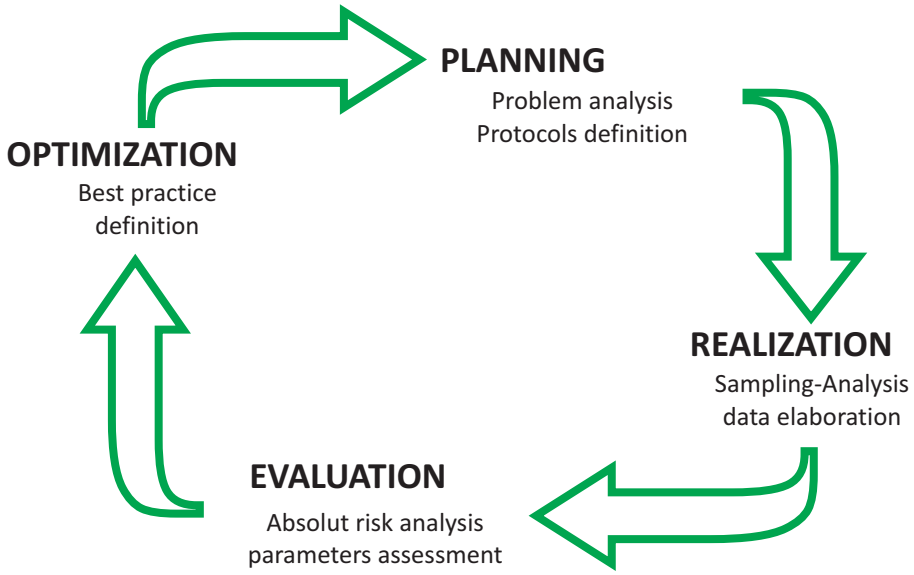
- Underground water
- Leachate
- Shallow water drainage
- Landfill gases
- Quality of air
- Weather Climate Parameters
- State of the landfill body

In order to optimize MSW landfill management and satisfy the requirements of all governing bodies, it is fundamental to adopt efficient protocols, providing the necessary guidelines to carry out all environmental analyses and to assess the thresholds of the various contaminants.

Such protocols include standard procedures for sampling, analysing and processing the chemical-physical parameters, aimed to characterizing MSW landfills activity and their environmental impact. This is a crucial step for the protection of the environment and for a proper management of a landfill.

For this purpose it is imperative to:

- **Recognize and quantify the diffused emissions of the main greenhouse gases, such as CO_2 and CH_4, from the landfill soil**
- **Assess the quality of air inside the landfill site and in the nearby areas (sensitive receptors)**
- **Determine leachate contamination in deep and shallow waters**



West Systems proposes a methodology which integrates the use of specific instruments, able to detect low concentrations of contaminants and to assess the outflows from the landfill cover, with advanced statistical techniques for the processing of all collected environmental data.

The company has over twentyfive years of experience in the design and implementation of specific equipment and a solid technical and scientific knowledge, developed through the collaboration with Research Institutions and Universities.

West Systems proposes specific protocols for the monitoring of gas emissions from MSW landfills, special waste disposals and composting plants. The impact of biogas and leachate on the environment can be assessed by innovative techniques and methodologies, consistent with current legislation.

Diffuse emission

Diffuse emission monitoring

An efficient cover on a MSW landfill's body and a good biogas collection system are not enough to guarantee the absence of uncontrolled gas flux from the surface, both during the operative and in the post-closure phases.
The monitoring of diffuse emissions from a landfill body is a crucial process that can provide information about:

- environmental impact: methane generates a greenhouse effect 21 times higher than CO_2
  Both VOC and H_2S can cause odor problems
- Landfill management: functioning of the biogas collection system, identification of areas with higher soil biogas emission, and presence of fractures on the cover and consequent leakage

The diffuse biogas emission from the landfill body is measured by means of the accumulation chamber technique, which allows a direct, timely and inexpensive quantification of the gas flux.

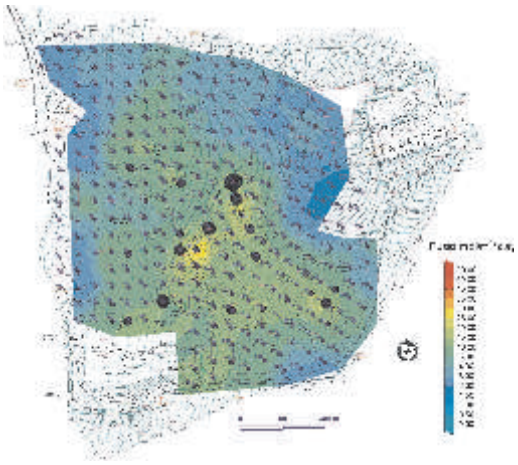
Such procedures involve geo-referenced flux measurements, on a regular grid, of the entire landfill body.
A further processing of the acquired data by geo-statistical methods allows the creation of isoflux maps in relation to the various measured contaminants and the quantification of the total biogas emission from the landfill body. These maps, showing the spatial distribution of soil biogas emissions, play a fundamental role in the planning of every management intervention such as:
biogas collection, coverage of the landfill body, identification of areas with anomalous degassing activity, efficiency of the anaerobic digester, calibration of the production model.

The instrument used to perform the measurements on site is a flux-meter, designed and produced by West Systems, based on the static non-stationary technique. The flux-meter performs real-time measurements of the gas concentrations inside the accumulation chamber allowing an immediate assessment of growth rates. The obtained results are reliable regardless of the knowledge of soil composition and flux regime.
The reliability of global emission estimates is given by the comparison between these results and the measurements carried out by the landfill management.

Theoretical production = Captured quantity + diffused quantity

In almost all cases, the global production estimate is significantly higher than the amount of captured biogas, due to the atmospheric dispersion of uncontrolled emissions.

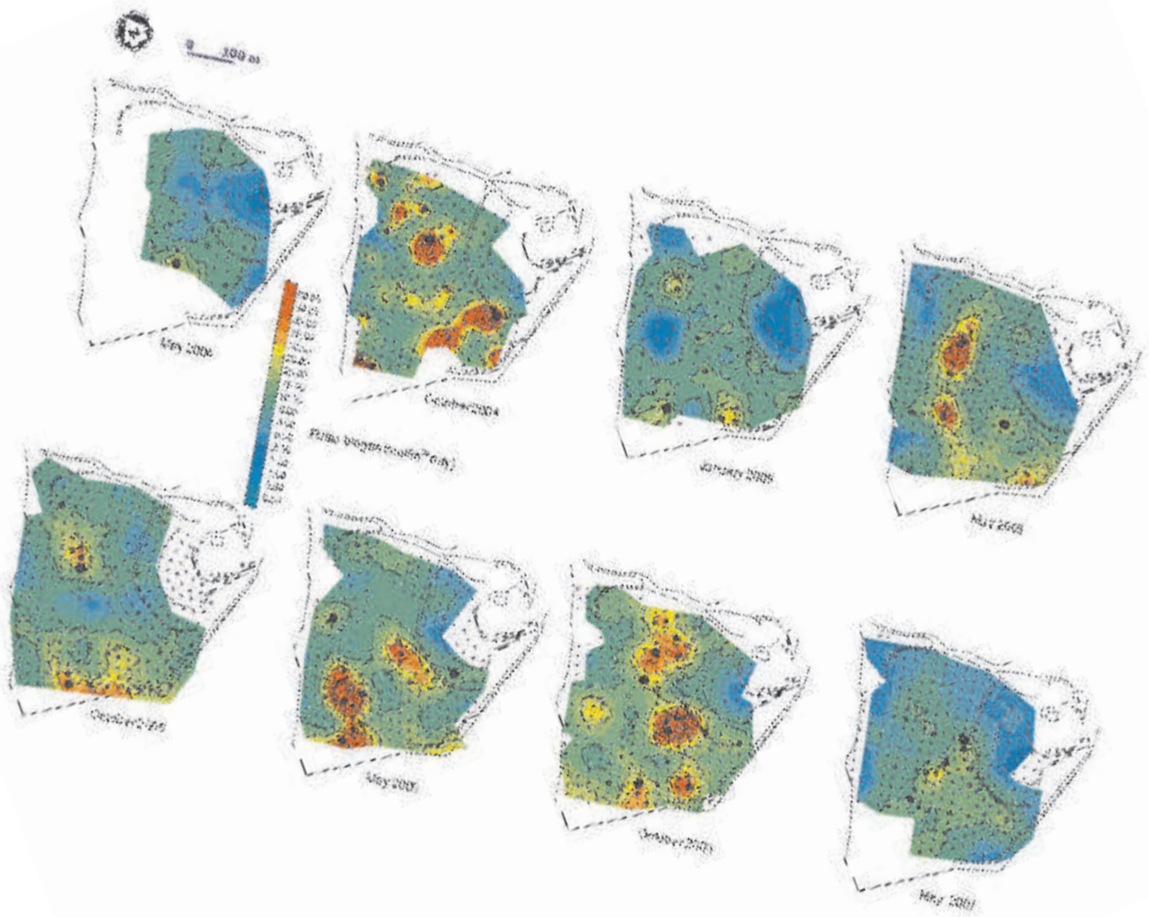
This methodology provides different results:



1) Estimation of the global amount of each gas species in the investigated area;
2) Highlighting the spatial variations of methane and carbon dioxide emissions in terms of isoflux maps.

Such instrumentation allows investigation on various gas emissions such as methane, carbon dioxide, hydrogen sulfide and VOC by means of the analytical techniques reported in the following table:

	Methodology	LDL [moli/m^2/ Day]	F.S. [moli/m^2/ Day]
CH_4	IR Spectrometry based on TLD Tunable Laser Diode with multipass cell	0.001	750
CO_2	IR Spectrometry	0.001	600
VOC	PID - Photo Ionization detector	0.01	0.5
H_2S	Electro-chemical cell	0.05	0.5



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Air quality

Monitoring of air quality (AQ) and odor emissions

Gaseous emissions produced by MSW landfills are due both to internal and external sources. Such emissions, produced by organic matter degradation, are characterized by high concentrations of greenhouse gases, dangerous for environment, and by many other components that generate bad odor, even at low concentrations. The impact of such polluting substances affects the areas near a landfill, where the population often complains about the discomfort.

To assess the air quality and the effective impact of a MSW landfill on nearby territory, specific surveys should be carried out to detect the presence of major contaminants, without limiting it to just what is required by law.

The study on air quality includes preliminary actions aimed at the definition of the affected area:

- Geographical and environmental characteristics of the territory
- Urban development of the area;
- Identification of the main routes;
- Identification of industrial plants in the area and localization/quantification of the main sources of emission

The monitored contaminats are:
- CH_4, CO_2
- NH_3 ed H_2S
- VOC (Volatile Organic Compounds)
- Aldehydes e Ketones
- Mercaptans
- PM_{10} e $PM_{2.5}$

A detailed chemical speciation allows the use of advanced Source Apportionment techniques: the so called “receptor” diagnostic models able to identify the sources and their contribution to gas concentrations, starting from the measurement of each sampled chemical species at the sampling site (receptor). Furthermore, a deterministic approach is used to calculate the concentration of the main soil pollutants emitted by the landfill, starting from the features of each source and from the atmospheric conditions, and describes the plume trend. **The combined use of both deterministic and receptor models allows to assess a landfill impact on air in the nearby territory.**

Characterization of conveyed biogas: Collection wells and cogeneration system

The qualitative and quantitative characterization of biogas collected in a MSW landfill is an efficient tool to judge its management, providing important information about the gas mixture composition and on the efficiency of the biogas collecting systems. In the case of energy recovery plants, it is also essential to minimize the uncontrolled degassing from a landfill body and to maximize biogas extraction thus avoiding air intake into the system.

West Systems offers a high quality service based on specific instruments and sampling methodologies for the monitoring of conveyed biogas. The characterization of gases is performed by means of highly reliable portable analyzers such as Geotech and Dräger X-am ® 7000, designed for the online measurement of the main gas components (O_2, CH_4, CO_2, H_2S and water steam) and through sampling lines provided with selective supports to determine **odor components** even at low concentrations.

The characterization takes place in the collection wells of the landfill body, on the direct torch biogas sampling lines, and, if present, on those of the cogeneration system. Each monitoring survey is planned in agreement with the client and according to the characteristics of the system.

West Systems performs all analysis and processing of data collected during the survey, providing a complete screening of the sampled biogas and advice on the collecting system functioning. This allows the identification of different biogas compositions at each sampled well, revealing eventual critical situations.

Confined spaces and biofilters

Characterization of odor emissions from confined spaces and biofilters

Characterizing the various emissions coming from specific sources in a MSW landfill is crucial to verify its conformity to the law, but also to ensure an efficient management.

West Systems provides a complete service for the characterization and evaluation of gas emissions from confined spots, such as reception, processing and composting rooms and biofilters areas.

The biogas characterization includes both macro components (O_2, CH_4 and CO_2) and trace components (such as VOC, Mercaptans, aldehydes, NH_3) typical of organic degradation processes and responsible for the bad odor usually associated with landfills collecting and processing organic waste.

The monitoring survey includes the use of units with specific sampling supports to detect the major gas components and the typical odor compounds in contaminated air. West Systems methodology allows to determine a cluster of markers and trace the characteristic plume.

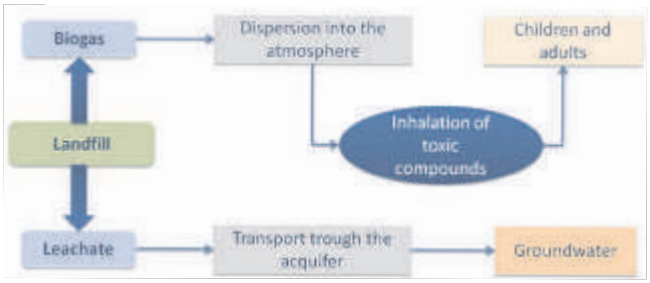
A detailed characterization of both major gas components and odor compounds is obtained trough the use of specific sampling supports.

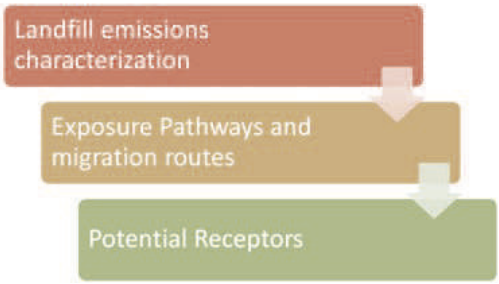
West Systems approach allows a joint analysis of biogas samples coming from biofilters and from confined spaces, in order to assess a proper functioning of the system for the reduction of odor emissions from the biofilters.

Sanitary Risk Assessment

Sanitary Risk Assessment is an important technical tool to evaluate the impact of a landfill on human health and to decide how to reduce the risk for population who lives close to waste plant.

Risk Assessment is carried out following US EPA Superfund procedure, based on a detailed definition of a conceptual site model necessary to identify the potential migration routes of Landfill Gases LFG and leachate and to assess the hazards of present contaminants. In particular LFG is a mixture of several gases, as methane, carbon dioxide, hydrogen sulphide and trace amount of other organic compounds VOC which are one of the major air pollutants due to their malodorous and hazardous properties.

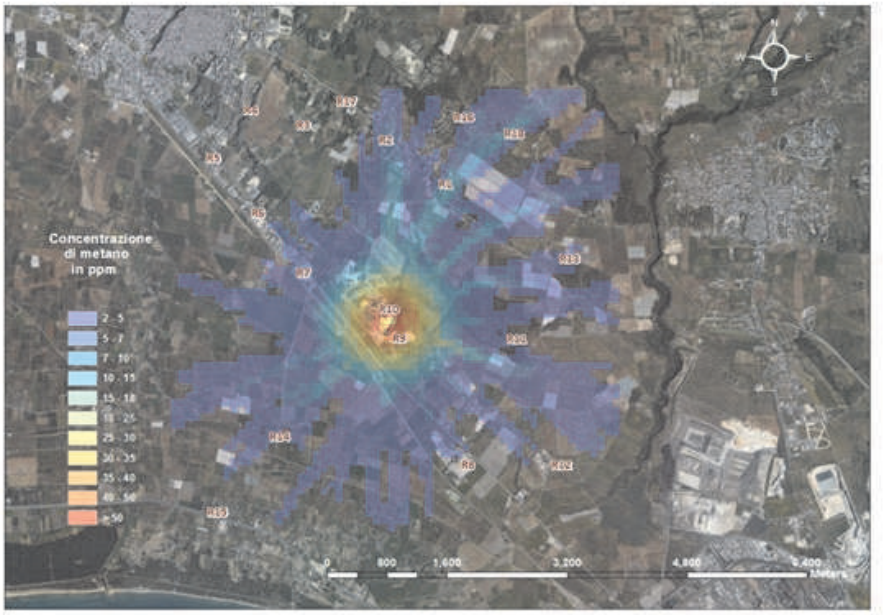




The conceptual site model is based of:

- a deeply knowledge of waste plant construction and management
- a detailed characterization of LFG emissions
- a chemical characterization of leachate
- a groundwater survey in order to detect possible leachate spills
- an advanced modeling of groundwater and air dispersion plume
- the hazard of exposed population for carcinogen and non carcinogenic contaminants

The evaluation of the MSW impact on environment, as groundwater and air, is carried out by advanced dispersion model Calpuff and Modflow, in order to trace the contamination plume and to individuate the critical areas, this permit to estimate with high precision the risk for human health.



Sanitary Risk Assessment

Termography

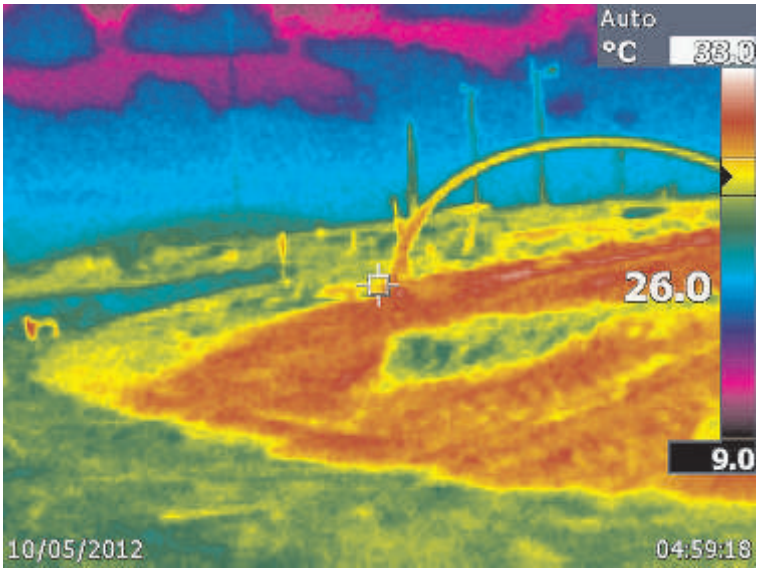
Thermography is a non-destructive testing technique based on the physical principle that all bodies with temperature different from the absolute zero (-273°) emit infrared electromagnetic radiation.

A thermocamera (infrared thermometer in the US) is an instrument able to detect infrared (or thermal) energy at distance, and to convert it into an electronic signal. The signal is then processed to create images in which each color corresponds to a different temperature value, to make the infrared radiation visible. The heat, measured by a thermocamera, can be quantified allowing the monitoring of a system thermal performance and the identification of thermal anomalies.

In the case of MSW landfill monitoring, thermography allows a quick detection of thermal anomalies caused by leakage of biogas, stagnation, surface runoff, shallow leachate leakage.

The main goal of the thermographic approach proposed by West Systems is to provide a first zonation in support of technical field surveys, by detecting thermal anomalies and identifying potentially dangerous areas.

Thermography is an inexpensive surveillance technique. Thanks to its fast image acquisition and processing, it allows a first qualitative approach to landfills monitoring by revealing their thermal anomalies, and is therefore very useful forplanning further quantitative monitoring surveys.



Date	Site
Present	

Notes

WEST Systems

info@westgroup.eu / www.westgroup.eu