4.03 AN APPLIED METHODOLOGY TO EVALUATE ODOUR IMPACT

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INTRODUCTION

The problem of the odour impact on the communities surrounding facilities, such as waste treatment plants, is becoming more and more important and often is cause of litigations between firms and population.

In Italy public authorities sometimes have to control and deal with communities odour problems, but currently no reference national laws exist. For this reason they must refer to other experiences or regulation rules.

This paper describes the methodology used to investigate the odour impact of a solid waste landfill placed near a town of the Northern part of Italy. The methodology integrates two different approaches: monitoring experimental data and modelling data to simulate the impact of odour emissions.

THE AREA OF STUDY

The solid waste landfill is placed in a flat area of the Po Valley. There are no obstacles near the landfill except for a little hill placed at about 2 km; for this reason it had been possible to use a mathematical model for no complex terrain. The landfill is about 100 meters away from the nearest houses of the town and about 1 km from the center.

The meteorological conditions are typical as for the Po Valley: cold temperature during winter, sometimes with fog, hot temperature during summer with poor rain, and variable intermediate seasons.

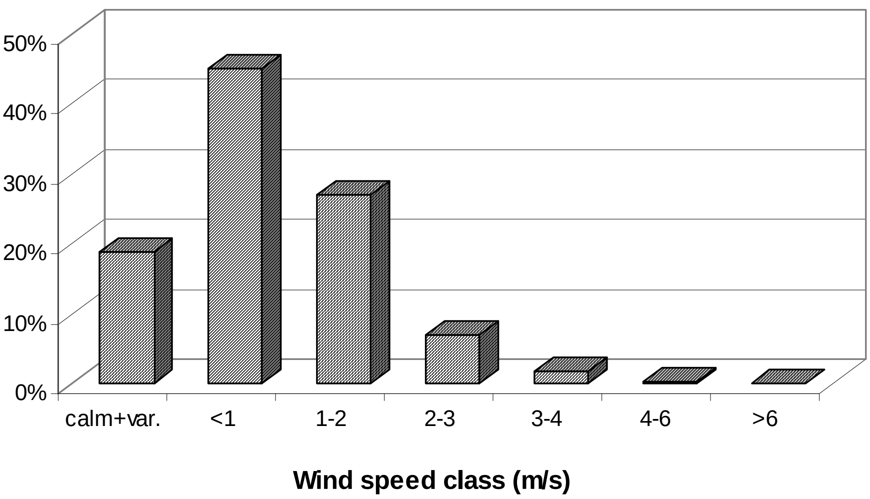

Figure 1. Distribution of hourly wind speed data measured near the area of study during the years 2000 and 2001.

The analysis of meteorological data measured by the nearest air quality monitoring stations of Environmental Protection Agency of Lombardia Region during the years 2000 and 2001 shows that the winds are generally very low (Figure 1), with more than 50% of 1-hour mean wind speed values lower than 1 m/s and, in particular, 10-20% of calms (i.e. wind speed lower than 0.3 m/s) or variable directions.

The winds generally blow from west during daytime and from north during the night (Figure 2). In the last case they are usually mountain breezes with speeds very low.

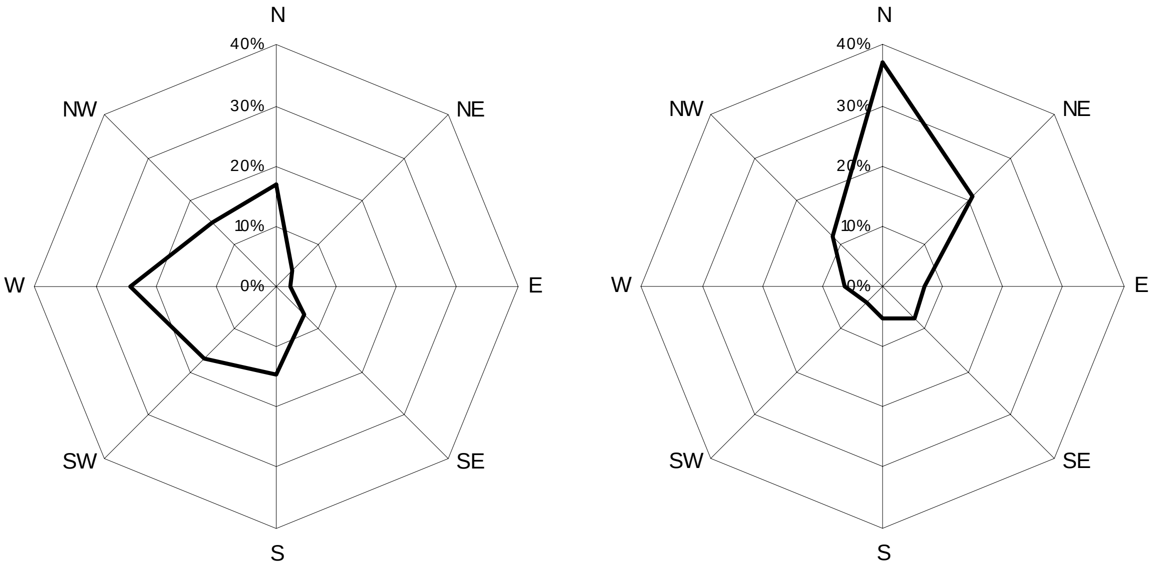

Figure 2. Distributions of 1-hour mean wind direction data measured near the area of study during the years 2000 and 2001. The daytime directions are on the left, the nighttime directions on the right.

The waste landfill is a plane area of about (370 x 240) m^2 (Figure 3). At the moment of this study, its surface was covered by a thick clay layer almost everywhere except for a little area in the northern part of the landfill.

THE MONITORING ACTIVITIES

To characterize the actual landfill emissions and the impact outside the fence some parameters were monitored, mainly gas emissions (CO_2, N_2O, NH_3, CH_4, H_2O) and, at the same time, the most important meteorological data at ground level (wind speed and direction, temperature). The gas emission values were measured in several points of the study domain both inside and outside the landfill area. Besides, an olfactometric analysis of the odour emissions released from different parts of the plant was carried out to characterize the emission contribution of each part, mainly landfill areas (with and without clay layer) and the two percolation collection systems. With reference to the landfill areas an odour "wind tunnel" sampling system (*Schmidt, D.R.et al*, 1999; *Meisinger, J.J et al*., 2001) was used placed over the area source.

In this way the monitoring data gave the emissive conditions of the landfill and the percolation system, and also the emissions impact outside the landfill fence in terms of gas concentrations and odour. The olfactometric analysis gave the possibility to express emission and concentration data directly in odour units per cubic meter (ou/m^3) or odour units flux ($ou/(s*m^2)$).

The results of the monitoring activities showed that the main odour emission sources were the percolation collection systems, and that the clay layer was an efficient odour abatement way.

THE MODELLING ACTIVITIES

After the experimental characterization of the odorous gas emissions, a computer based dispersion model was used to estimate the extent of the area involved in the odour impact near the landfill. The case study analysis by means of a mathematical model offer the possibility to estimate the spatial dispersion of the odorous gases everywhere near the emission sources and to evaluate possible different future scenarios.

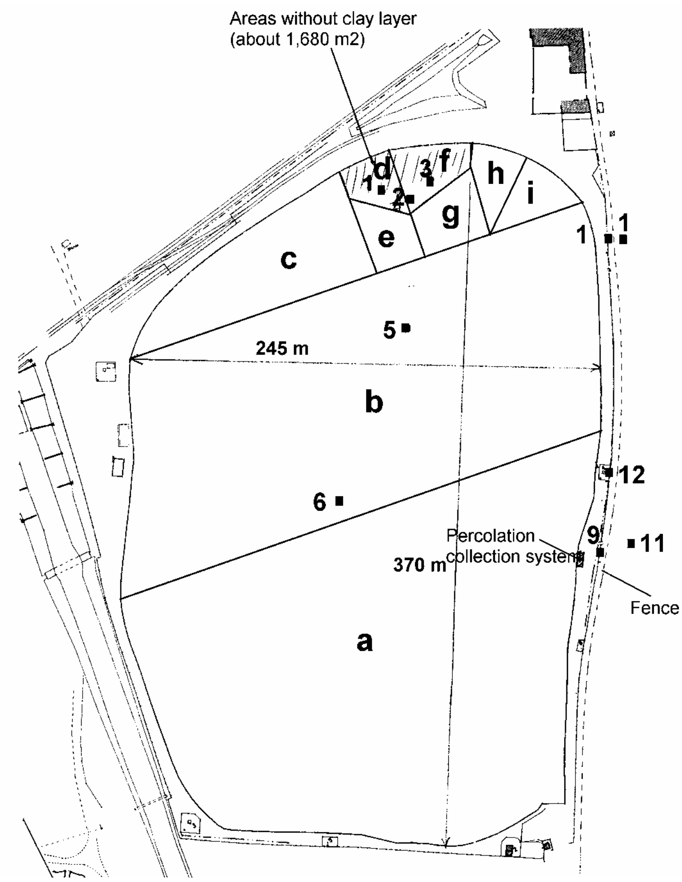

Figure 3. Map and schematization of solid waste landfill.

Besides, because of the lack of national definitions about the odour problems and impact, recently in the Northern part of Italy some environmental compatibility evaluations were carried out (*Bonura, A. et al.*, 2000) referenced to the current German legislative framework (*VDI 3881*, 1986 and *VDI 3882*, 1994).

In that context the environmental plant compatibility with residential or industrial areas is defined on the base of "maximum odour frequency", i.e. the ratio between number of hours during which the odour is discernable and the total hours of the period. It's clear that the application of an adequate mathematical model, provided for the German directives, to determinate this value is easy to use and cheaper than experimental measures.

For these reasons and in the frame of this study, the CALPUFF mathematical model (*Scire, J.S. et al.*, 2000) was used to carry out the evaluation about the odour nuisance. In particular the probability of odour detection, defined as the exceedance of 1 ou/m^3, was estimated for each point of the study area by means of the long-term (one average year) model simulations on the base of hourly meteorological data.

First of all the model has been calibrated and validated on the base of the experimental data measured during the monitoring phase. The model was applied to the emission rates found in the different part of the landfill and the actual meteorological conditions observed during the emissions measured in the landfill area. The landfill was described as a number of area sources and the percolation collection wells as point and volume sources.

The validation was carried out comparing the gas and odour concentrations measured in five points outside the landfill with the corresponding values estimated by the model. In particular it was used methane like a "gas tracer", because it is typically produced by the waste landfill and not by other sources in their neighborhood and the concentration levels are high enough to be measurable The results of the validation procedure showed a good agreement with the experimental data concerning the methane (see Table 1) but a probable overestimation of the model concerning the odour levels. The uncertainty about this overestimation is due to the few odour measures available (only two receptors).

Table 1. Comparison between observed and estimated methane mean concentrations.

Receptor	Mean observed concentrations (mg/m^3)	Mean calculated concentrations (mg/m^3)
9	392,3	344,8
11	125,3	102,1
12	36,6	18,5
13	12,2	19,3
14	20,8	17,2

Finally the modelling simulations were carried out for the current situation and several odour reduction scenarios in relation to possible improvement actions, like the removal of the percolation collection system gases or the increase of the clay layer thick. But because of the results obtained during the validation phase, the scenarios analysis took into account of the possible model overestimation of the odour levels.

In this way the model results gave interesting information about the action effectiveness in terms of impact area extension and odour nuisance levels. Figure 4 shows an example of spatial distribution of the odour detection probability (i.e. the exceedance of 1 ou/m^3) estimated by the model.

CONCLUSIONS

This paper describes an example of compatibility evaluation of the odour emission levels produced by a solid waste landfill placed in Italy. Apart from the results obtained, the focus is pointed at the methodology used.

To evaluate the problems that concern the neighbouring odour sources and their solutions the integration of monitoring and modeling techniques could be an interesting decision support methodology for odour impact situations. It could allow a limitation of the monitoring activities, that imply lower costs, and the possibility to analyze a lot of improvement scenarios before their putting into effect.

Due to the very interesting possible applications, including the compatibility analysis carried out by the local authorities, and because of the lack of Italian definitions about the odour impact and of the different definitions for other European Countries, it could be important that specific and consistent directives will be released at European level concerning both odour nuisance and modelling references.

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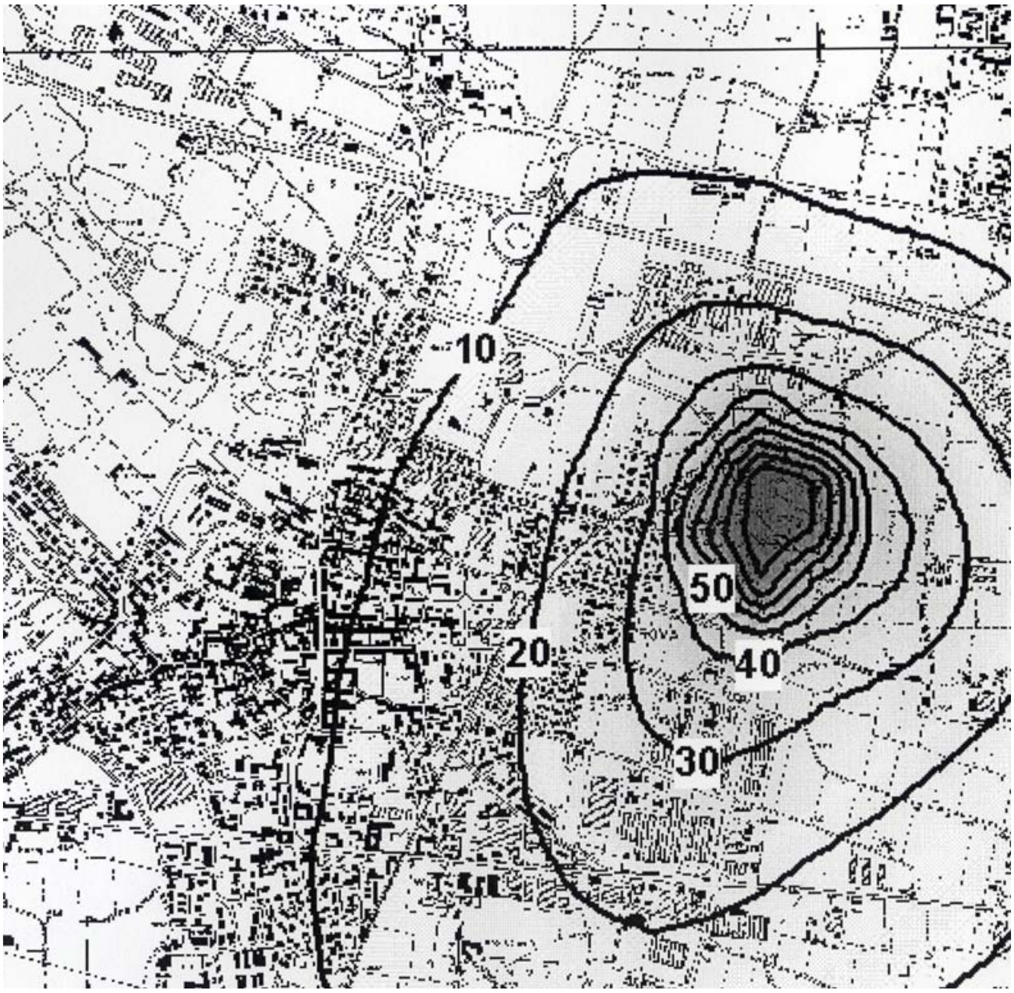

Figure 4. Example of probability of odour detection spatial distribution map.

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