

METHODOLOGY FOR HEALTH-ECOLOGICAL RISK ASSESSMENT OF A MUNICIPAL LANDFILL, SOFIA CITY, BULGARIA

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Abstract

Outside the south-west suburbs of Sofia city, about 700m away from Suhodol district is functioning the biggest municipal landfill site in Bulgaria, accepting the entire household waste stream coming from the capital. The landfill is spread on 330 decares land with treatment of 1000 tons waste/day. The facility operates since 1984 with additional enlargement in 2001. The territory around the landfill is organized in active private agriculture. Created was methodology for investigation of the ecological conditions and health status of the population, living in Suhodol village. Measured were the heavy metals content and the concentrations of usually presented in municipal landfills environmental organic pollutants – methane, vinyl chloride, 1,2-dichloroethane, benzene, toluene, ethylbenzene, xylenes, PCBs, PAHs. The concentration of the substances was investigated in the area between the landfill and the village, on the soil surface and in 1m depth. Applied was equipment allowing determination of the above mentioned substances in soil gas, with parallel testing in plant cultures. Analogous investigations were executed in private yards in Suhodol village. Interpreted were results from a mobile air pollution monitoring system. Studied was the health status of children (1-7 years old) in search of possible correlation between the environmental conditions (soil, air and water with increased content of organic and inorganic substances) and the health indices of the population.

Introduction

Landfills are vital component of any well-designed and integrated system for management of municipal solid wastes (MSW). When carefully sited and well managed within the context of the local infrastructure and available resources, landfills can provide safe and cost-effective disposal of a city's MSW(1). The safe and effective operation of landfills depends on the sound planning, administration, and management of the entire MSW treatment system.

In many cases, like in the city of Sofia, the landfill is the only MSW management option available after the MSW is collected. The Sofia landfill, situated about 20 km from the center of the capital near the village of Suhodol is with the biggest capacity in the country. Up to now, excluding the landfill monitoring system, no investigation is executed for assessment of the health-ecological risk connected with the functioning of the landfill.

The proposed methodology is unique for the Bulgarian hygienic practice and for the first time applied in the country. It consists of several separate investigations, aiming at research of all possible vectors for transmission of hazard factors from the landfill site towards the population. Comprised estimation of the health risk for the people living in Suhodol village is given after a subsequent analysis of the separate studies.

Methods and Results

The basic steps of the methodology and the results obtained are presented as follows:

1. *Choice of representative points for soil and plant sample collection in the area around the landfill. Laboratory analysis for heavy metal and arsenic content in the collected soil and plant samples.*

The biggest part of the soil samples are collected in east direction from the landfill, towards Suhodol. Probes are taken on the soil surface, from 30 cm. depth and from plant cultures growing on the same point(2). More than 50 samples are collected from each type.

The comprised analysis and the obtained laboratory results prove absence of heavy metal soil pollution and migration processes into plant cultures. The exact laboratory values for heavy metal presence also exclude cumulative negative effects. The presence of single results slightly above the limit values for heavy metal content (lead and cadmium) is connected with closely situated roads to those particular points of sample collection.

2. *Search for volatile organic compounds (VOCs) in soil and soil gas samples in the area between the landfill site and Suhodol village.*

The territory around the landfill is investigated for presence of 9 VOCs, which are the most frequently met near municipal landfill sites VOCs over the past 20 years. These are benzene, ethylbenzene, o-,m- and p-xylenes, styrene, toluene, 1,2-dichloroethane, vinyl chloride.

The results from the chromatography prove, that the concentrations of all 9 VOCs are under the detection limit of the apparatus and within any international standarts for clean soil(3). The absence of volatile organic pollutants in soil near the landfill makes impossible their presence also in any contacting environment-surface and underground water flows, air and vegetation.

3. *Collection of representative soil samples from private yards in Suhodol village.*

About 30% from the private yards in the village are investigated. An appropriate for the occasion method of collection is applied. The yards are organized into 2 groups-those neighboring the landfill are compared to those situated on the other side of Suhodol. The results concerning heavy metal content are presented in specialized forms. Executed are experimental studies for presence of mobile forms of heavy metal pollution.

The results do not reveal any soil pollution with heavy metals. Separate cases of abnormal presence of copper are explained with insecticide application in the same yards, confirmed also from the landowners.

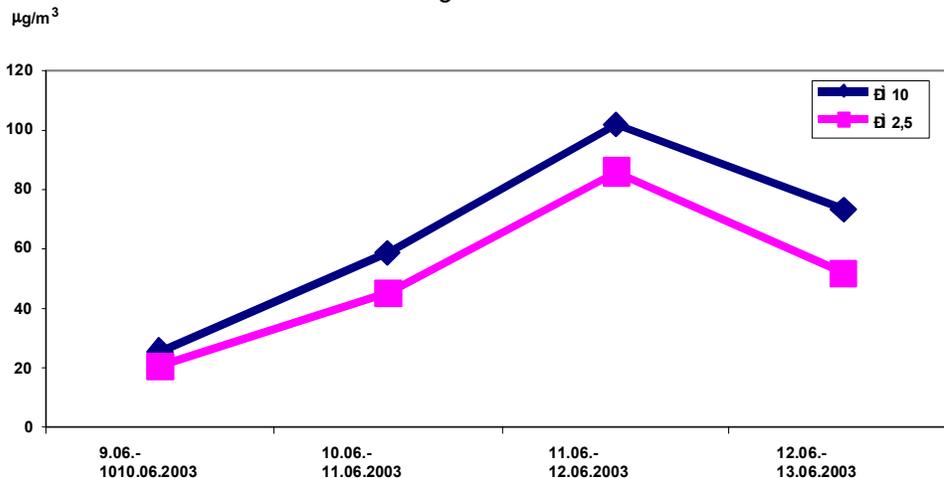
4. Determination of PM10 and PM2,5 fractions of suspended particulate matter in ambient air.

PM10 and PM2.5 are among the most harmful of all air pollutants. When inhaled these particles evade the respiratory system's natural defenses and lodge deep in the lungs. Exposure assessment is based on several 24 hour measurements of PM10 and PM2.5 in the school yard of Suhodol village. Sampling of PM10 and PM2.5 is carried out with Harvard impactors. The analysis of PM10 and PM2.5 is performed by gravimetric, using microbalance techniques. The collection filters are weighed (using a microbalance) before and after use to determine the net weight (mass) gain due to the collected particulate matter.

The concentrations of PM10 (MCL- 50 microgr/m³) and PM2,5 (MCL- 40 microgr/m³) in some of the measurements are exceeding the MCL values (Fig. 1). Speeded up social activities in the days from Monday till Thursday lead to regular increase of suspended particulate matter. During the weekend, the measured values fall under the MCL for both PM10 and PM2,5. For comparison, analogous investigations made in central parts of Sofia city register values for PM10 and PM2,5 above 250-300 microgr/m³.

Fig. 1

Concentration of suspended particulate matter PM10 and PM2,5 in ambient air in Suhodol village



5. Questionnaire study within the population of Suhodol, neighboring the municipal landfill.

In the questionnaire participate people from different parts of the village according to their distance from the landfill with total of 135 persons inquired.

Included are 18 questions concerning typical problems for people living near landfill sites. The average age of the questioned is 56 years.

The results from the analysis reveal, that more than 85% of the inquired determine the smell from the landfill as the only embarrassing factor, with different intensity in summer and winter. For about 10% of the population only the closure of the landfill will resolve their health problems. Attention needs the fact, that more than 95% of the population is using coal as a heating source and thus is regularly exposed to additional pollution with smoke and particulate matter.

6. Specialized study of the physical development and parameters of children (7-11 years old) living in the Suhodol village

Investigating the impact of different environmental pollutants on the human health, basic place takes the physical examination of children and students. Founded in stage of quick growth and immature functional development they present highly sensitive group to register negative influence from the environment. Analyzed are height, body mass, body mass index (BMI), skin thickness and chest measurements in 102 students (7-11 years old) from the school in Suhodol.

The results are compared with those from schools in Sofia city. The indexes height, body mass, BMI and skin thickness on the triceps are lower than those for Sofia but within “-1 standart” norm, so they could not be reliable to prove any connection with pollution from the landfill.

7. Investigation of the morbidity rate within different population groups in Suhodol for retrospective periods compared to average data for Bulgaria

The tasks of this specialized research are:

- To investigate the health status of the population in Suhodol through demographic indices for retrospective periods and analyze it through comparative characteristic with the indices for Sofia city.
- Statistical research of the Suhodol population through common morbidity rate for a 3 year retrospective period.
- Characterization of the health status of the children population through analysis of the dispensary illnesses registered in Suhodol for a 13 year period (1990-2003).
- Recommendations for creation of a health-ecological monitoring system in the village.

The demographic indices for Suhodol do not differ considerably from those for Sofia city. The birth-rate is lower for Suhodol but the results are statistically inessential to prove any correlation.

The morbidity rate is investigated for the years 1990-1992 and 1997-1999. The results do not reveal any sudden change in the infectious morbidity of the population. For other groups diseases the results are analogous. For example, the common morbidity rate in 1999 for Suhodol is 1100,1 for 1000 residents. In Sofia city this ratio for the same year is 1219,2 /1000.

In the children dispensary book for Suhodol the biggest is the number of the respiratory illnesses. For Bulgaria, the registered bronchial asthma in children is

2,5%. In Suhodol this percentage is 0,3%. In the world practice, the increase of asthma incidence in areas near landfill sites is one of the basic indicators for possible hazardous influence (4).

Conclusions

1. The results from the complex investigation do not prove any negative influence of the municipal landfill in Suhodol village on the common health status of the residents. Each individual case of suspected harm must be investigated thoroughly to diagnose and prove the etiology of the illness.
2. The results from the experimental work with samples from soil, soil gas, plant cultures, air and particulate matter prove the normal ecological balance in the region and the presence of undamaged environment.
3. Created is methodology for municipal landfill investigation, both applicable for environmental and health preventive studies. This complex specialized study is original for the Bulgarian hygienic and ecological practice and for the first time applied in the country.

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