The status of leachate monitoring programmes on selected landfill sites in Serbia

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Abstract

The disposal of waste on landfill sites has increasingly caused concern about possible adverse health effects for populations living nearby, particularly in relation to those sites where potentially hazardous waste is dumped. There are 3582 identified landfills in Serbia, of which 165 are municipality landfills, 5 are sanitary landfills and rest are open dumps. Also there are 5 regional sanitary landfills in construction progress.

The big lack in Serbia is low involvement of stakeholders which is very important for achieving sustainable municipal solid waste management practice. The National legislative prescribe the time frame for the monitoring of leachate during active and passive phase of landfill but does not provide the comprehensive information about the parameters needed for monitoring.

This paper represents the overview of leachate monitoring practice on selected landfill sites in Serbia. Sampling campaigns which results are discussed were conducted from November 2008 till February 2009, on 4 selected sampling sites. Based on the obtained values it can be concluded that even though that formed leachate from non-sanitary municipal solid waste landfills have a large impact on groundwater and surface water quality, the continuous monitoring programmes are not conducted and further investigations should be carried out in order to meet the requirements of national and EU legislative as well as to develop the rich data base needed for risk assessment processes, modelling of pollution and prediction of future pollution pathways.

Keywords: monitoring, waste, landfill, leachate

Introduction

Leachate is produced from water which has percolated through disposed waste that have undergone aerobic and anaerobic microbial decomposition (Mukherjee et al., 2015). The composition of leachate depends on the type of waste (biodegradable or non-biodegradable, soluble or insoluble, organic or inorganic, liquid or solid, and toxic or non-toxic), the age of landfill, weather conditions and hydrogeology of the site (Slack et al., 2005). Leachate is produced throughout landfill's working life and for several hundred years after it is decommissioned (Wang, 2013). Leachate production and management has been recognized as one of the greatest problems because it can cause significant pollution problems by contacting the surrounding soil, groundwater and surfacewater (Baccini et al., 1987). The pollution caused by leachates is even worse by the fact that many landfills are still operating without an appropriate impermeable bottom liner and an effective collection and treatment systems (Lema et al., 1988).

The Landfill Directive and the Waste Framework Directive 2008/98/EC (EC, 2008) regulate leachate management practices, specially leachate collection and disposal routes, which, in turn, influenced leachate chemical oxygen demand (COD), 5-day biochemical oxygen demand (BOD5) and ammonium-nitrogen (NH4-N) concentrations and loading (Brennan et al., 2015).

Serbia as a developing country with GDP of 0, 8% (2015) and poor waste management practice is significantly vulnerable regarding the impact that produced leachate from landfill sites have on the surrounding environment. As a country in transition, Serbia still needs to harmonize the regulations even though the harmonization has begun in 2009. and to achieve adequate waste management system such as EU member countries have (Batinic et al., 2011).

Until recently waste management in Serbia was based only on collection and waste disposal at non- sanitary landfills, and often on small open dumps. Until 2009, landfill sites have not been constructed according to European standards and they did not meet minimum technical requirements which protect the environment and public health. They have been built without bottom liner and leachate collection and treatment systems, often located on a location outside the city where some sort of excavation was done. Hence, collected waste is disposed at inadequate landfills on which in most cases there is no waste selection before landfilling and daily covering at landfills and closure after usage is missing or is inadequate. Monitoring of leachate, groundwater and surface water quality is carried out occasionally or not carried out at all.

There are about 3500 identified landfills in Serbia, of which 165 are municipality landfills, 5 are sanitary landfills and rest are open dumps. Also there are 5 regional sanitary landfills in construction progress. The National legislative prescribe the time frame for the monitoring of leachate during active and passive phase of landfill but does not highlight the parameters that should be monitored in leachates as well as the permitted values.

This paper represents the overview of leachate monitoring practice on selected landfill sites in Serbia as well as the estimation of degradation phase based on the analysed in order to get the full picture of the parameters that should be monitored in future. Sampling campaigns which results are discussed were conducted from November 2008 till February 2009, on 4 selected sampling sites, Subotica, Novi Sad, Zrenjanin and Sombor.

Materials and Methods

The selected landfills are municipal landfills and according the local waste management plans they contained household waste, industrial waste, construction and demolition waste and even medical waste. The sampling sites were selected as locations from which leachate may leak into the environment. Leachates were collected from channels and lagoons on landfills. The overview of sampling localities is given in Figure 1.

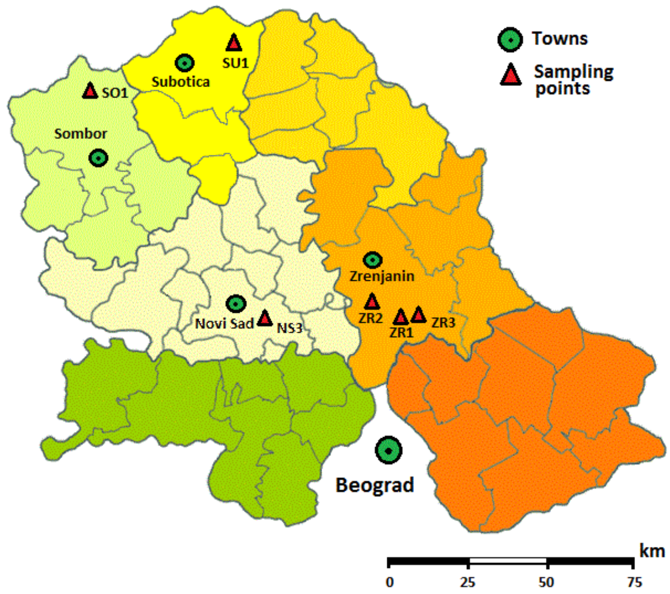

Fig.1 Sampling locations

The leachate water samples intended for the chemical analysis, were collected, in cycles of 2 hours at each location, in the glass and plastic bottles of 2 L. All samples were stored in the refrigerator at 4°C until preparation for the analysis.

Quantitative analysis of selected parameters in the leachate was carried out in accredited Laboratory for monitoring of landfills, wastewater and air using Multi 340i Wissenschaftlich technische Werkstatten GmbH, BOD Trak HACH, UV-VIS spectrophotometer HACH DR 5000 and atomoc absorption spectrometer S2Series Thermo Scientific. Parameters such as pH value, BOD5, COD, iron end zink were determined in order to estimate the degradation phase which is necessary in order to develop further suggestions for monitoring programmes. Most of the parameters are expressed in milligrams per litar (mg/L), except pH value.

Results and discussion

The comparation of obtained results for selected parameters with the medium values for different degradation phases according to Kruse is presented in Figure 2 – 6.

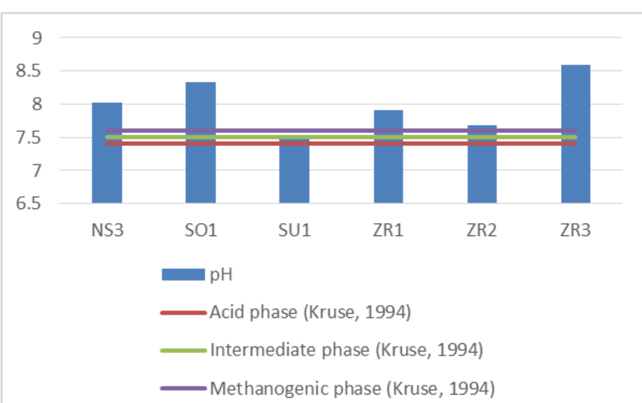

Fig. 2 Estimation of degradation phase in relation to literature values for pH.

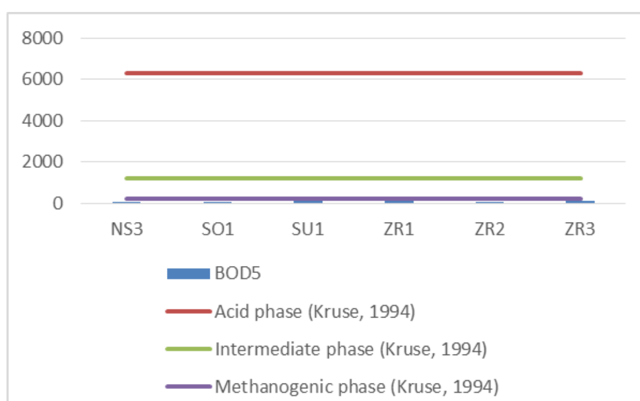

Fig. 3 Estimation of degradation phase in relation to literature values for BOD5.

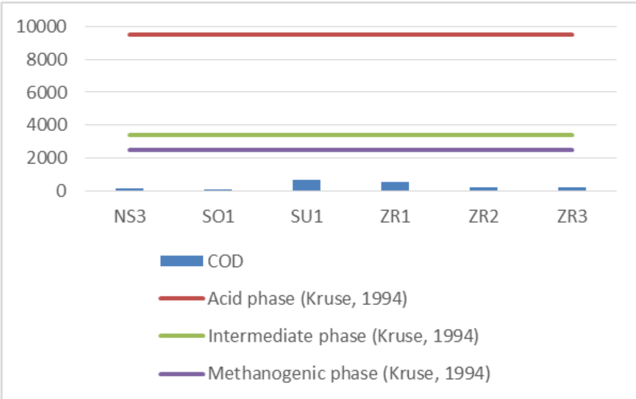

Fig. 4 Estimation of degradation phase in relation to literature values for COD.

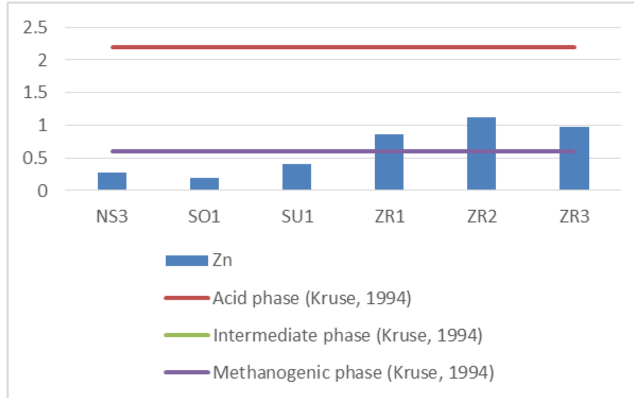

Fig. 5 Estimation of degradation phase in relation to literature values for Zn.

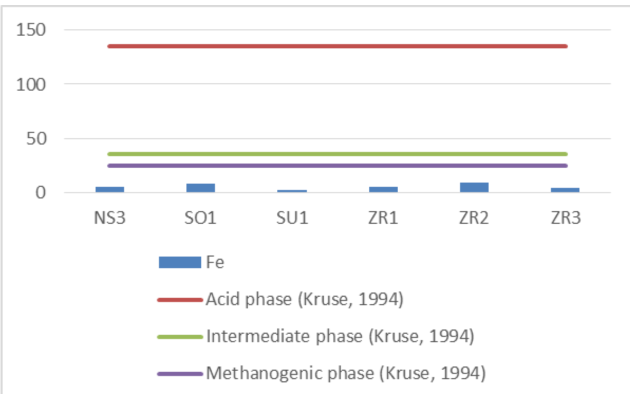

Fig. 6. Estimation of degradation phase in relation to literature values for Fe.

Obtained results has shown that all selected sampling sites are in methanogenic phase of degradation. In the methanogenic phase, the content of dissolved organic matter decreases and the composition of the organic matter changes. The content of heavy metals in the leachates is generally very low as a result of sorption and precipitation processes that take place within the disposed waste (Kjeldsen et al., 2002).

The concentration levels of selected metals in collected leachate samples was affected by the initial amounts that existed in disposed solid wastes, but they can also be present due to degradation processes in the landfill body. With increasing of the landfill age it is expected to have the increasing in pH value which will cause decreasing in metal solubility. Also, the lower concentration levels of metals can be caused due to adsorption and precipitation reactions. Since the leachate from selected sites are not collected and treated properly it is suggested to monitor this metals in future. Moreover, it is suggested to include groundwater and soil as well.

During the period of methanogenic phase is expected to have increasing of ammonia nitrogen especially if produced leachate is not treated or/and removed regularly like it is in Serbia. So further investigations should include this parameter as well.

Conclusion

It can be concluded that leachate samples collected on selected sites in Serbia include compounds which can be hazardous to human health and the environment. The presence of hazardous compounds in landfill leachates, many of which have not yet been identified, could have a significant impact on landfill risk assessments and the development of leachate treatment methods. Considering the degradation phase of selected landfill sites as well as that metal and organic compounds may be hazardous and that mobilization of heavy metals from landfills is expected through the interaction of these compounds, it is suggested that these compounds should be more seriously addressed in the future. The current regulations in Serbia does require the continuous monitoring programmes which are not being conducted regularly or at all and as it can be seen the urgent interventions in current leachate management practice and implementation of effective and sustainable methods for pollution reduction and prevention are needed.

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