2.3 RESISTIVITY IMAGE OF LEAKAGE FROM ÇANAKKALE OLD OPEN WASTE DISPOSAL SITE

E. Ş. Uluocak[1], E. Ulugergerli[1*]

[1]Department of Geophysical Engineering, Canakkale 18 March University, Çanakkaler, Türkiye
**Corresponding author e-mail: emin@comu.edu.tr*

ABSTRACT

In this study, we focus on an environmental geophysical study of the former open waste disposal site of Çanakkale, Turkey, which was actively used between 1989 and 2009. We investigate the spatiotemporal variations of pollution from the unregulated landfill using direct current (DC) electrical resistivity method and in situ pH and electrical conductivity measurements in leachate-contaminated water. The results indicate the variation of pollution from the open waste disposal site, which is characterized by low resistivity values (≤ 10 Ohm-m) in the 2D resistivity sections, during the years of geophysical measurements (2004–2008–2009). We propose that geochemical analyses and geophysical measurements that provide a robust approach to subsurface contaminant diffusion can be highly effective in municipal solid waste management studies within the context of sustainable environmental policies.

KEYWORDS: Environmental geophysics, DC resistivity, Leachate, Environmental sustainability

INTRODUCTION

In the relatively shallow geophysical surveys for environmental purposes, the general steps can be defined as follows; i) identification of the phenomenon that may cause a potential environmental problem (e.g., a source of pollutants); ii) definition of the main physical processes that can be affected by source(s) (e.g., decomposition, gas released, heavy metal accumulation in the soil and water, etc.); iii) determination of the suitability and limits of the geophysical method(s) together with multidisciplinary approaches; iv) survey design; v) applications; and finally vi) interpretations.

Specifically, in an open waste site, the geological structures (e.g., type and thickness of strata, bedrock), water table and its relationship with possible fractures, and spatiotemporal variation of contamination in relation to leachate are investigated by using geophysical methods. Here, we show a case study to analyze the potential pollution hazard caused by Çanakkale old open waste disposal site that was used actively during 1989 to 2009. Our results give important insight into diffusion of the pollutant, sourced by the waste area, by means of resistivity variation.

METHOD and APPLICATION

Electrical conductivity, generally, depends on properties of the ground, such as temperature, pressure, porosity, permeability, saturation, and the distribution of fluid. Further, the salinization and resulting high ion concentration in the soil are important parameters that are affecting the electrical features of the medium. Gradual contamination of groundwater and soil over time, mainly owing to the leachate from chemical reactions with dissolved pollutants in the waste sites, increases the ion concentration and conductivity compared to their surroundings. Thus, it is possible to identify contaminated areas with geophysical methods that are sensitive to the

conductivity (or resistivity) contrast beneath the surface. Given its non-destructive nature, fast and highly accurate results, and relatively low cost, the DC resistivity method we used in this study (Figure 1a) is one of the most widely used geophysical methods to characterize contamination in the subsurface. Accordingly, the geophysical survey was designed based on the conceptual model (Figure 1a) showing the profiles in Figure 1b oriented in the groundwater flow direction depending on the slope.

In this study, for the first time we also present pH and conductivity changes from in-situ measurements in the water, including the samples in the creek which may have been mixed with leachate, to define the landfill-induced environmental pollution in the study region.

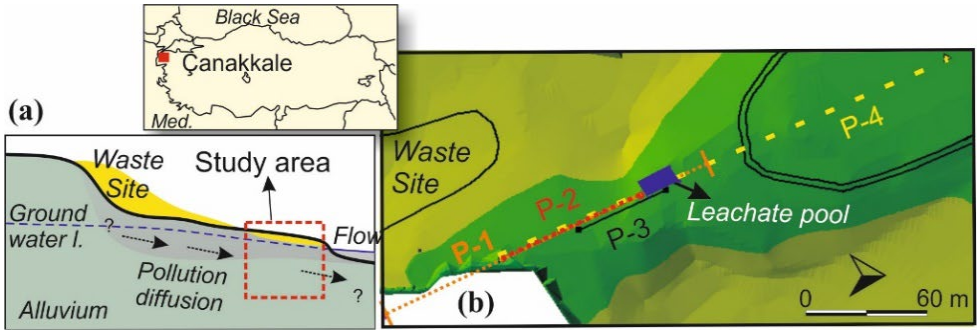

Figure 1. (a) Conceptual model of the study area (inset show location of Çanakkale). (b)Profiles for geophysical survey (Şengül Uluocak & Ulugergerli, 2023 and references therein).

DISCUSSION and RESULTS

2D resistivity sections in Figures 2a and 2b show low resistivity zones (≤ 10 Ohm-m) that can be interpreted as contaminated areas caused by diffused leachate beneath the region. In the SE, a zone closest to the waste site, the penetration of pollutants is characterized by very low resistivity values of ≤ 2 Ohm-m. Similarly, high conductivity zone obtained towards the NW in P-1 (Figure 2a) indicates the pollution that leaks from the artificial leachate pool and cannot be observed from the surface during the survey.

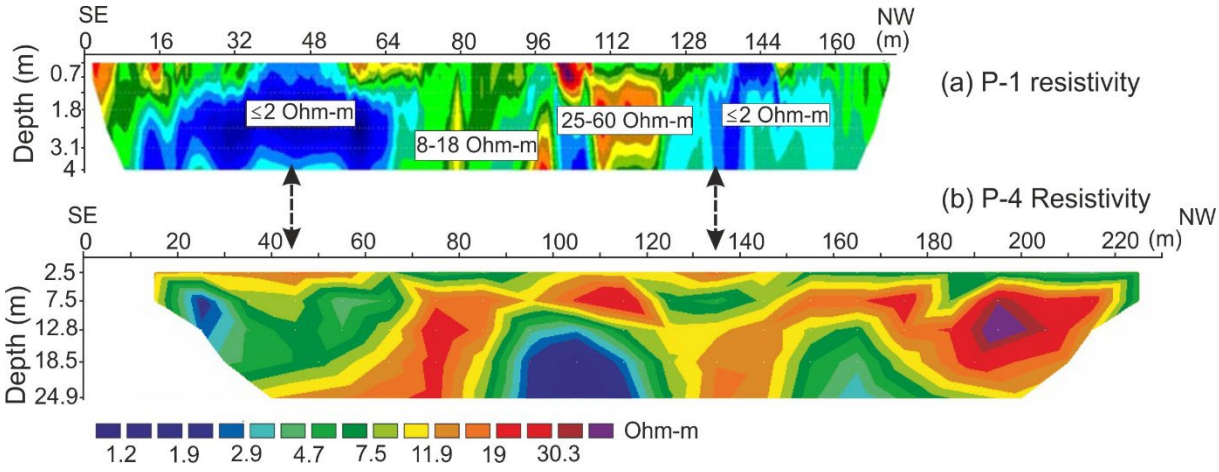

Figure 2. 2D resistivity section obtained from electrical measurements in (a) P-1 (in 2004, Şengül, 2004; Kaya et al., 2007) and (b) Profile P-4 (2009, Beşkardeş, 2009).

Our water analyses support the studies suggesting a linear relationship between the age of a landfill and leachate's pH values (Özkıdık, 1995). The locations of in-situ measurements made in

the years of 2004 and 2009 are shown in Figure 3. Accordingly, both pH and electrical conductivity (Ec) variations (Table 1) resulted from the pollutant concentration in the samples are considerably higher than those recommended for meteoric waters and/or the inland water quality standards (e.g., Öz & Ertaş, 2016). Conductivity values, as expected, decrease in 2004 (Table 1) following the decreasing pollutant concentration especially in the samples of 1 and 2 mixed with surface water in the creek. However, same samples (1 and 2) appear to have become more contaminated over years (i.e., from 2004 to 2009, Table 1) due to the ongoing leachate transport from the waste site.

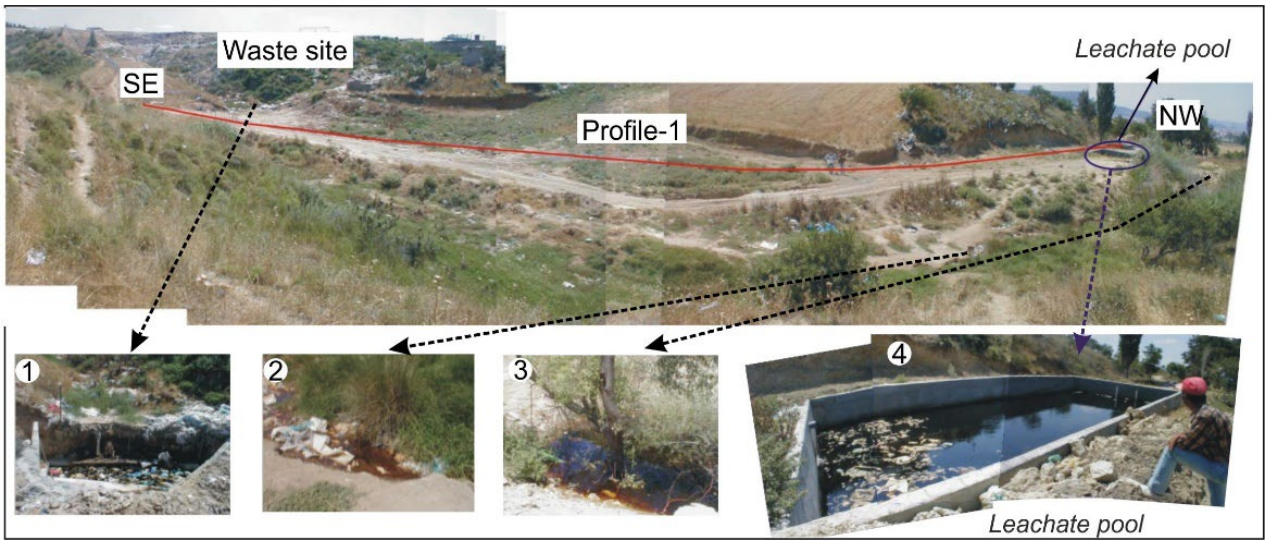

Figure 3. Study area, the locations of water samples for the in-situ pH and conductivity measurements (Şengül, 2004, Aksakal, 2008).

Table 1. PH and the electrical conductivity variations obtained in water samples in the years of 2004 and 2009 (during the survey periods-summer 2004 and 2009, the average temperature of the samples is 30,9 ˚C and 25,32 ˚C, respectively, Şengül, 2004, Aksakal, 2008).

Sample #	***2004-*** pH	***2009-*** pH	***2004*** Conductivity(mS/cm)	***2009*** Conductivity(mS/cm)
1	7,91	8.61	33,4	23.4
2	7,13	8,47	7,03	31,8
3	7,75	8,06	8,49	35,5
4	8,38	8,83	22,5	50,5

CONCLUSION

Geophysical results reveal that pollution from leachate characterized by low resistivity zones continued over years during the geophysical survey in 2004–2008–2009. Water analyses also show that conductivities increased from 22,5 mS/cm to 50,5 mS/cm in the pool (Table 1) over time due to pollutant concentration.

Overall, our findings provide important insight into the long-lasting effects of environmental pollution caused by open waste disposal sites. As shown here, geophysical research in

collaboration with water analyses can be highly functional in urban solid waste management studies within the context of sustainable environmental policies.

ACKNOWLEDGEMENT

We would like to thank Sevgi AKSAKAL and Didem BEŞKARDEŞ, and our undergraduate students of the 2004-2009 academic years who contributed to geophysical measurements.

REFERENCES

Aksakal, S. (2008). Katı atık depolama sahalarından toprak ve yeraltı suyuna olan sızıntıların elektrik özdirenç ve yapay uçlaşma yöntemleri ile araştırılması. Lisans Tezi/Undergraduate Thesis, ÇOMÜ Mühendislik Fakültesi, Jeofizik Müh. Bölümü (in Turkish).

Beşkardeş, G.D. (2009). Çanakkale katı atık depolama sahası için yeraltı suyu kirliliğinin modellenmesi. Uluslararası Deprem Sempozyumu (özet bildiri-poster, s. 89), 17-19 Ağustos, 2009, Kocaeli, (in Turkish).

Kaya, M. A., Özürlan, G. & Şengül, E. (2007). Delineation of soil and groundwater contamination using geophysical methods at a waste disposal site in Çanakkale, Turkey. Environ Monit Asses. 135, 441–446.

Öz, Ü., & Ertaş, E. (2016). Arılı Deresi (Rize)'nin fiziko-kimyasal açıdan su kalitesinin tespit edilmesi. Aquatic Sciences and Engineering, 31(1), 30-39, (in Turkish).

Özkıdık H.Ö., 1995. Katı Atık Yönetimi ve Belediyeler, Devlet planlama Teşkilatı Müsteşarlığı (Uzmanlık Tezi) Ankara, (in Turkish).

Şengül, E. (2004). Çanakkale düzensiz katı atık depolama sahası yüzey ve yeraltı sularına etkisinin uygulamalı jeofizik yöntemlerle araştırılması. Yüksek Lisans Tezi/Master Thesis, ÇOMÜ Fen Bilimleri Enstitüsü, (in Turkish).

Şengül Uluocak, E. & Ulugergerli, E. (2023). Yer Bilimlerinde Modellemeye Genel Bir Bakış; Çevre Jeofiziği Uygulamalarından Çıkarımlar. Türkiye Jeoloji Bülteni, https://doi.org/10.25288/tjb.1325550