EVALUATION AND REMEDIATION OF SOIL POLLUTION WITH PETROLEUM HYDROCARBONS IN THE AREA OF WELL 682 SUPLACU DE BARCĂU COMMUNE, BIHOR COUNTY, ROMANIA

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Abstract. *The Suplacu de Barcău area, which has been heavily exploited for petroleum resources since the 1960s, shows significant soil contamination as a result of crude oil extraction, transport, and storage activities. The present study aimed to assess the level of total petroleum hydrocarbons (TPH) contamination within the perimeter of Well 682, which has been decommissioned and abandoned since 2018. Four soil profiles were collected at depths between 0.05 m and 0.9 m, and laboratory analyses revealed exceedances of the alert and intervention thresholds established by national legislation (Order MAPPM No. 756/1997), particularly in boreholes P1 and P3. Based on the interpretation of the results, the excavation of contaminated soil was proposed over a total area of 175 m², resulting in approximately 155 m³ of polluted soil requiring remediation measures. The study highlights the need to implement bioremediation strategies tailored to local conditions in order to restore soil quality.*

Keywords: Soil contamination, Total Petroleum Hydrocarbons (TPH), bioremediation, oil extraction impact, Suplacu de Barcău

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1. Introduction

Soil pollution with petroleum hydrocarbons represents one of the most persistent and challenging forms of environmental contamination, having significant effects on the quality of terrestrial ecosystems, groundwater resources, and, indirectly, on human health [2, 3]. Industrial activities such as the extraction, transportation, and storage of petroleum products are among the most common sources of pollution, particularly in regions with a history of oil exploitation [6, 8].

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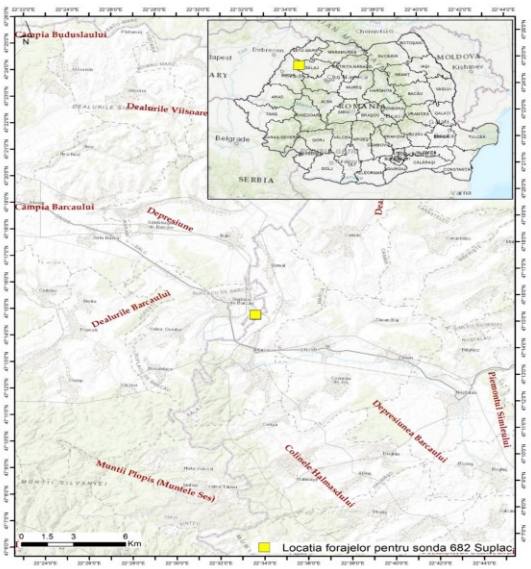
A relevant example in this regard is the Suplacu de Barcău area, located in northwestern Romania, where petroleum activities began in the 1960s following the discovery of an asphaltic crude oil deposit [1, 9]. Intensive exploitation led to the development of a complex infrastructure — wells, tank farms, a refinery, waste disposal sites, and bioremediation stations — but also to negative impacts on the soil and groundwater [1, 4, 7].

Well 682 Suplacu de Barcău, active between 1970 and 2002, was officially abandoned in 2018 in accordance with A.N.R.M. regulations [5, 10]. Due to its location in an active industrial area with a high potential ecological risk, it was necessary to assess the contamination status of the nearby soil [3].

The aim of this study was to identify the level of total petroleum hydrocarbons (TPH) contamination in the area of Well 682 and to propose appropriate remediation measures, in compliance with current national legislation. The results obtained provide a clear picture of the extent of environmental degradation and highlight the importance of monitoring and intervention in such post-industrial sites (Map 1) [12, 13].



Map 1. Geographical location of probe 682 Suplacu de Barcău

Materials and Methods

The study was conducted within the perimeter of Well 682 Suplacu de Barcău, located outside the built-up area of Suplacu de Barcău, Bihor County, in an industrial-use zone that was formerly arable land. The investigated area covered approximately 600 m², corresponding to the well's grid.

To determine the degree of soil contamination, four soil profiles (P1–P4) were collected from points evenly distributed within the well perimeter. Samples were taken at four depth levels: 0.05 m (A), 0.3 m (B), 0.6 m (C), and 0.9 m (D) for each profile (Photo 1). The samples were manually collected using portable drilling equipment and sterile containers, and were subsequently transported under controlled conditions to the laboratory [14, 11].

Photo 1. Sampling of soil from the well of the well 682 Suplacu de Barcău

The laboratory determinations focused on identifying the concentration of total petroleum hydrocarbons (TPH), expressed in mg/kg of dry substance. TPH analysis was carried out according to standardized methodology for the determination of volatile and semi-volatile organic contaminants in soil, using gas chromatography [15].

The results obtained were compared with the limit values established by Order MAPPM No. 756/1997, for land with less sensitive use. Both the alert threshold values and the intervention threshold values were used to assess the ecological risk and the need for the application of remediation measures [16].

Results and Discussions

Laboratory analyses conducted on the four soil profiles collected from the area of Well 682 Suplacu de Barcău revealed the presence of total petroleum hydrocarbons (TPH) in varying concentrations, depending on the depth and location of each sample. The data are summarized in Table 1.

Tabel 1. TPH concentration data of samples taken for well 682 Suplacu de Barcău

Sample	TPH (mg/Kg s.u.)			
	Sampling depth level A 0.05 (m)	Sampling depth level B 0.3 (m)	Sampling depth level C 0.6 (m)	Sampling depth level D 0.9 (m)
P1	2,070	1,890	931	741
P2	479	35	35,1	57.8
P3	2,610	6,540	5,800	9,129
P4	1,000	254	73.7	82.2

According to Order MAPPM No. 756/1997, the alert and intervention threshold values for land with less sensitive use are as follows:

• Alert threshold TPH: 500 mg/kg dry substance (s.u.)

• Intervention threshold TPH: 2,000 mg/kg dry substance (s.u.)

▪ Borehole P1

The values recorded at all depths were high, with a maximum of 2,070 mg/kg at 0.05 m, exceeding the intervention threshold. At greater depths, concentrations decrease progressively but remain above the alert threshold.

▪ Borehole P2

This borehole shows the lowest values in the entire perimeter, with all concentrations being below the alert threshold, indicating a relatively unpolluted area.

▪ Borehole P3

This borehole records the highest values, significantly exceeding the intervention threshold at all levels, with a peak of 9,129 mg/kg at a depth of 0.9 m. These values indicate severe soil contamination and require immediate intervention.

▪ Borehole P4

At a depth of 0.05 m, the TPH concentration (1,000 mg/kg) exceeds the alert threshold, but at greater depths, the values fall below this threshold, suggesting surface-level contamination (Fig. 1).

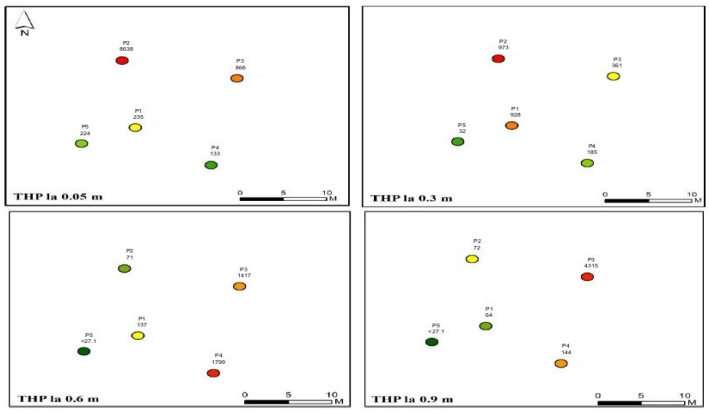


Fig. 1. TPH concentration values identified at different depths for Probe 682 Suplacu de Barcău

Based on these results, it is observed that the areas corresponding to boreholes P1 and P3 are heavily contaminated and require remediation through excavation and/or bioremediation. Borehole P4 requires intervention only at the surface layer, while area P2 can be considered unaffected.

The estimated volume of contaminated soil amounts to approximately 155 m³, calculated as follows:

• P1 and P3: 150 m² x 1 m depth = 150 m³

• P4: 25 m² x 0.2 m = 5 m³

Photo 2. Excavation of polluted soil in the area of well 682 Suplacu de Barcău

Photo 3. Replacement of polluted soil in the area of well 682 Suplacu de Barcău

The proposed remediation measure consisted of excavating the contaminated soil (Photo 2) and replacing it with clean soil (Photo 3), in order to restore the ecological functions of the land. Additionally, periodic monitoring of the site is recommended, along with the implementation of further bioremediation methods where necessary.

Conclusions

(1) The study conducted within the perimeter of Well 682 Suplacu de Barcău revealed significant soil contamination with total petroleum hydrocarbons (TPH), directly resulting from historical oil extraction, transportation, and storage activities in the area. Among the four boreholes analyzed, P1 and P3 clearly exceeded the intervention threshold set by Order MAPPM No. 756/1997 for land with less sensitive use, indicating severe soil pollution.

(2) Borehole P4 recorded surface contamination above the alert threshold, while P2 was below the alert limits, confirming localized and uneven contamination within the site.

(3) As a result of the findings, a remediation intervention was carried out, consisting of the excavation and replacement of contaminated soil over a total area of 175 m^2, totaling approximately 155 m^3 of affected soil. This measure helps reduce the ecological risk and rehabilitate the ecological functions of the soil.

(4) For effective and lasting environmental restoration, the following actions are recommended:

• Periodic monitoring of the site to detect any reoccurrence of contamination;

• Implementation of additional in situ bioremediation technologies, especially in areas with deep contamination;

• Continued research to assess the impact on groundwater and local biodiversity.

(5) The results of this study highlight the need for careful management of abandoned industrial sites and the importance of a coherent remediation plan for environmental protection.

R E F E R E N C E S

[1] Brejea, R., Nistor, A., & Martin (Boros), A. M. Evaluation and microbiological characterization of the peat and some soils contaminated with petroleum products from Salonta Municipality, Bihor County. Annals of the University of Oradea. https://doi.org/10.5281/zenodo.4362307 (2020).
[2] Mishra, R. K., Mohammad, N., & Roychoudhury, N. Soil pollution: Causes, effects and control. Van Sangyan, 3(1), 1–14. (2016).
[3] Ontel, I., Petrescu, M. G., & Nistor, A. Assessment of soil moisture anomaly sensitivity to detect drought spatio-temporal variability in Romania. Sensors, 21(24), 8371. (2021).
[4] Panov, A. V., Troshev, A. I., & Frolov, Y. G. Influence of soil pollution on the composition of a microbial community. Microbiology, 82(2), 241–248. (2013).
[5] Pinedo, J., Ibáñez, R., Lijzen, J. P. A., & Irabien, Á. Assessment of soil pollution based on total petroleum hydrocarbons and individual oil substances. Journal of Environmental Management, 130, 72–79. (2013).
[6] Puia, C., Duca, M., & Fărcaș, A. Bioremediation of oil polluted soils by indigenous bacteria at Suplacu de Barcău, Romania. Mechanization in Agriculture & Conserving of the Resources, 62(4), 30–32. (2016).
[7] Ranieri, E., Gikas, P., & Akratos, C. S. Soil pollution prevention and remediation. Applied and Environmental Soil Science, 2016. https://doi.org/10.1155/2016/6179358 (2016).
[8] Roșca, S., Pop, A. I., Moldovan, M., Brejea, R., & Bungescu, S. Land capability classification for crop and fruit product assessment using GIS technology. Notulae Botanicae Horti Agrobotanici Cluj-Napoca, 43(1), 235–242. https://doi.org/10.15835/nbha4319860 (2015).
[9] Rusu, T., Moraru, P. I., & Ioana, C. M. Effect of tillage systems on soil properties, humus and water conservation. Agricultural Sciences, 4(5), 35–39. (2013).
[10] Rusu, T., Ioana, C. M., & Bogdan, I. Impact of climate change on agro-climatic indicators and agricultural lands in the Transylvanian Plain between 2008–2014. Carpathian Journal of Earth and Environmental Sciences, 12(1), 23–34. (2017).
[11] Sabău, N. C., & Șandor, M. The influence of the fertilization systems on production in the last years of agrochemical improvement of a crude oil polluted soil. Natural Resources and Sustainable Development, 3, 415–422. (2013).
[12] Sabău, N. C., & Șandor, M. (2014). The influence of fertilization on wheat yield losses achieved during the agrochemical melioration of a soil, under control polluted with crude oil, from Oradea. Annals of the University of Oradea, 23. (2014).
[13] Sabău, N. C., & Șandor, M. Correlations between the yield differences on spring wheat obtained on a polluted haplic luvisoil with crude oil. Natural Resources and Sustainable Development, 5, 143–154. (2015).
[14] Șandor, M., Brejea, R., & Domuţa, C. Research regarding the reconstruction of the polluted soil with oil from Suplacu de Barcău, Romania. Natural Resources and Sustainable Development, 3, 423–432. (2013).
[15] Sarkar, D., Datta, R., & Sand, K. Management of increasing soil pollution in the ecosystem. Advances in Research, 12(2), 1–9. https://doi.org/10.9734/AIR/2017/36491(2017).
[16] Sorana Oț, S., Mălinaș, M. L., & Ciobanu, F. Effects of oil pollution on seed germination and seedling emergence toxicity. Romanian Biotechnological Letters, 25(1), 1194–1201. (2020).