THE IMPACT OF OIL ACTIVITIES ON SOIL QUALITY AND ECOLOGICAL RESTORATION SOLUTIONS – CASE STUDY: WELL 560 MIHAI BRAVU, BIHOR COUNTY

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RESEARCH ARTICLE

Abstract

This study presents the assessment of soil quality in the area of well 560 Mihai Bravu Vest (Bihor County), abandoned after oil extraction and transport. The research aimed to identify the degree of contamination with total petroleum hydrocarbons (TPH) and to establish measures for the ecological remediation of the affected land. Five soil sampling drills were carried out (one located near the well casing and four at the main points within the well pad) at depths ranging from 0.05 to 0.90 m, with determinations performed in accordance with current standards.
The analysis results revealed localized exceedances of alert and intervention thresholds for less sensitive land uses, as established by MAPPM Order no. 756/1997, particularly at points P2 and P3. The distribution of TPH values suggests the migration of petroleum products into deeper layers and natural attenuation processes in clayey zones. Based on these findings, excavation of the contaminated soil was undertaken, followed by transport to authorized bioremediation facilities, along with the restoration of the land's morphology.
The study demonstrates the importance of post-abandonment monitoring of oil wells and provides a model of best practices for the ecological assessment and rehabilitation of sites affected by petroleum activities.

Keywords: contaminated soil, petroleum hydrocarbons (TPH), environmental monitoring, land remediation, abandoned oil wells.
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INTRODUCTION

The exploitation, transportation, and storage activities of crude oil carried out over time in Romania have generated a considerable number of potentially contaminated sites affected by petroleum hydrocarbons (Brejea et al., 2020; Ranieri et al., 2016). Soil represents one of the most vulnerable environmental compartments to this type of pollution, as it accumulates contaminants that can impact ecosystem quality, land productivity, and human health. For this reason, assessing the soil quality around abandoned oil wells is an essential step in environmental risk management and in implementing effective remediation solutions (Sabău & Şandor, 2014, 2015).

In Romania, the legislative framework for managing potentially contaminated sites is regulated by Law No. 74/2019 and Order of the Ministry of Waters, Forests and Environmental Protection (MAPPM) No. 756/1997, which establish alert and intervention thresholds for various pollutants, including total petroleum hydrocarbons (TPH), differentiated according to land use categories (Rusu et al., 2017). Compliance with these regulations is mandatory when abandoning oil wells, in order to ensure the restoration of the land to its initial condition and to reduce the risks of persistent pollution.

Well 560 Mihai Bravu Vest is located outside the built-up area of Mihai Bravu commune (Bihor County) and is part of the OMV Petrom S.A. perimeter. It operated between 1984 and 1998, serving for the extraction and transportation of crude oil, and starting in 2014, well abandonment works were carried out in depth based on the approval of the National Agency for Mineral Resources (ANRM). The land associated with the well, covering an area of approximately 900 m^2, falls into the category of "construction yards/permanent pastures," with its previous use being agricultural (Sabău & Şandor, 2013).

The purpose of this study is to evaluate the impact of oil-related activities on soil quality within the perimeter of Well 560 Mihai

Bravu Vest by determining the total petroleum hydrocarbon (TPH) content and identifying the most appropriate ecological restoration measures. The study contributes to understanding the spatial and vertical distribution of contaminants in the soil, as well as to substantiating technical remediation solutions, potentially serving as a model for other similar sites in Romania.

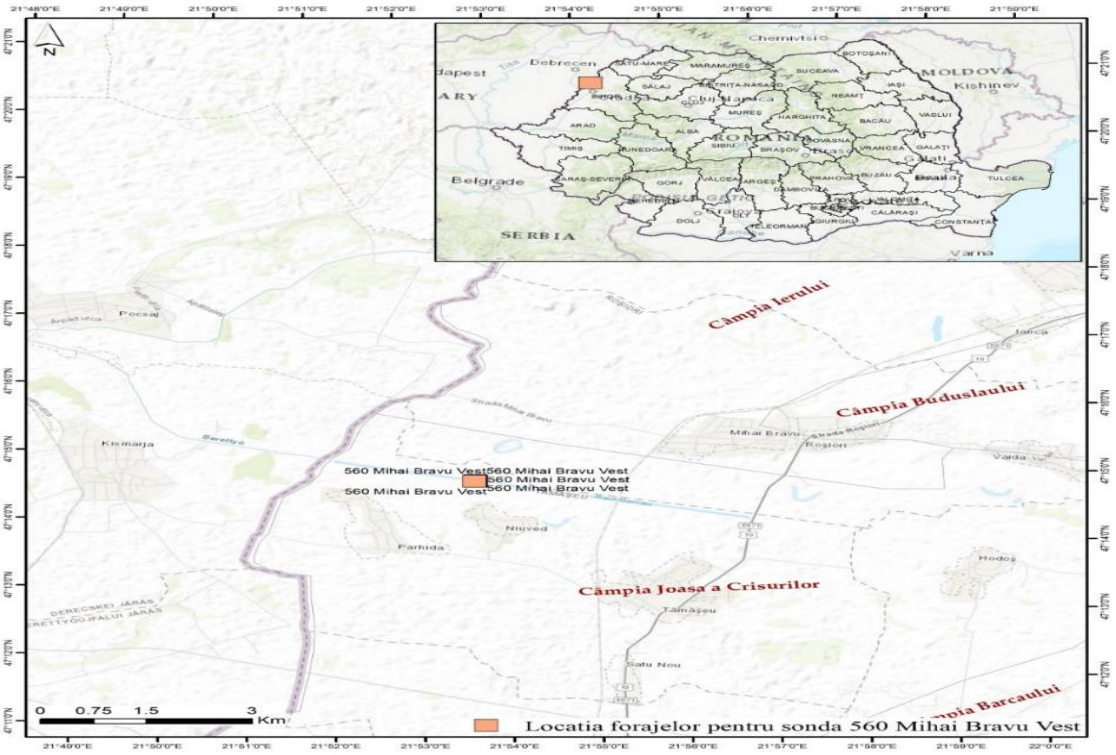

Figure no. 1.1. Geographical position of the well 560 Mihai Bravu Vest

MATERIALS AND METHODS

To assess the degree of soil contamination within the perimeter of Well 560 Mihai Bravu Vest (Bihor County), field investigations and laboratory analyses were carried out in accordance with current standards and regulations. The well site, located outside the built-up area of Mihai Bravu, covers a total area of approximately 900 m^2, classified as "construction yards/permanent pastures."

Five sampling points (P1–P5) were established: one located near the well casing (P1) and four distributed across the main zones of the well platform, depending on the pollution potential determined by past operational activities. From each point, soil samples were collected at four distinct depths—0.05 m, 0.30 m, 0.60 m, and 0.90 m—to capture the vertical distribution of contaminants.

Sampling, handling, labeling, and storage of the samples were performed in compliance with the requirements of SR EN ISO 10381 and applicable national legislation. The sampling points were georeferenced in the field using a high-precision GPS device (e.g., Stonex S9 GNSS). The soil stratification was visually described during sampling, revealing a brown topsoil layer (0–0.30 m) and a brown clay layer (0.30–0.90 m).

Table 1.

Data on TPH concentration of samples taken for well 560 Mihai Bravu Vest

Sample	TPH (mg/Kg s.u.)			
	Sampling depth A 0,05 (m)	Sampling depth B 0,3 (m)	Sampling depth C 0,6 (m)	Sampling depth D 0,9 (m)
S1	235	928	137	64
S2	8638	973	71	72
S3	866	361	1417	4315
S4	133	185	1799	144
S5	224	32	<27.1	<27.1

The analyses of total petroleum hydrocarbon (TPH) content in the soil samples were carried out in an accredited laboratory, using standardized methods for the determination of volatile and semi-volatile organic compounds. The analytical procedures included all the requirements of the applicable method and product standards, adhering to the minimum detection limits and reporting ranges.

The obtained results were compared with the reference values, alert thresholds, and intervention thresholds established by Order of the Ministry of Waters, Forests and Environmental Protection (MAPPM) No. 756/1997 – "Regulation on Environmental Pollution Assessment", corresponding to less sensitive land-use categories.

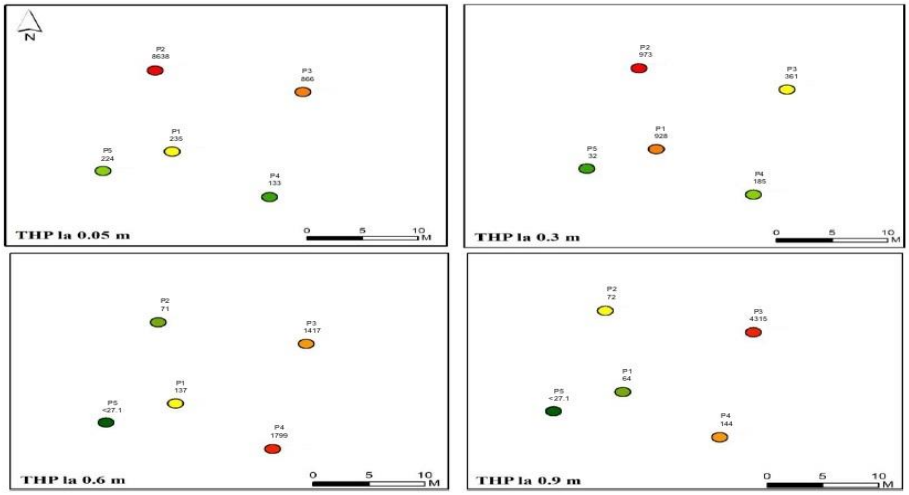

Figure 2 **The values of TPH concentrations identified at different depths for probe 560 Mihai Bravu Vest**

Figure .3 ***Leveling the replaced soil in the vicinity of well 560 Mihai Bravu Vest***

Figure 4 ***Excavation of polluted soil in the vicinity of well 560 Mihai Bravu Vest***

RESULTS AND DISCUSSIONS

The determinations of total petroleum hydrocarbon (TPH) content in the soil samples collected from the area of Well 560 Mihai Bravu Vest are presented in Table 1.1. The obtained values were compared with the alert and intervention thresholds for less sensitive land-use categories, as established by Order of the Ministry of Waters, Forests and Environmental Protection (MAPPM) No. 756/1997.

The analysis of TPH concentration distribution by depth and sampling point highlights the following:

In boreholes P1 and P5, TPH values at all depths (0.05–0.90 m) are below the alert threshold, indicating a low level of contamination.

In borehole P2, the TPH concentration at 0.05 m exceeds the intervention threshold, while at greater depths the values drop below the alert threshold, suggesting superficial contamination with natural attenuation in the lower soil layers.

In borehole P3, values up to 0.30 m are below the alert threshold; at 0.60 m, the alert threshold is exceeded, and at 0.90 m, the intervention threshold is exceeded, indicating migration of petroleum products toward the deeper clay layers.

In borehole P4, TPH values are below the alert threshold at 0.05 m and 0.90 m, but exceed the alert threshold at 0.60 m, while still remaining below the intervention threshold.

The results show a significant variability in contamination levels, influenced by the location of sampling points and the stratigraphic characteristics of the soil. The presence of a brown clay layer between 0.30–0.90 m contributes to the retention of petroleum products and natural attenuation through physicochemical processes.

To reduce the risk of secondary contamination, the excavation of polluted soil was carried out in areas with significant exceedances (particularly P2) and the excavated material was transported to authorized bioremediation facilities. The affected areas were backfilled with clean soil, leveled, and prepared for the reestablishment of natural vegetation.

These results confirm the necessity of post-abandonment monitoring of oil wells and the implementation of rapid corrective measures to prevent the spread of pollution into the geological environment or groundwater systems.

CONCLUSIONS

The investigations carried out within the perimeter of Well 560 Mihai Bravu Vest revealed the presence of total petroleum hydrocarbon (TPH) concentrations that locally exceed the alert and intervention thresholds established for less sensitive land-use categories.

The vertical distribution of TPH indicates both surface contamination and migration of pollutants into the lower clay layers, where natural processes contribute to the partial attenuation of pollution.

Areas with significant exceedances were subjected to excavation works and the transport of polluted soil to authorized bioremediation facilities, while the site was morphologically restored through backfilling with clean soil and leveling.

The implemented measures have contributed to reducing the risk of further contamination and improving the ecological restoration conditions of the site.

This study provides a model of good practice for the assessment and ecological rehabilitation of sites affected by oil-related activities, emphasizing the importance of post-abandonment monitoring and timely intervention.

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