- ORAL PRESENTATIONS -

INVESTIGATION OF THE GEOLOGICAL ENVIRONMENT IN CASE OF THE ACCIDENTAL POLLUTION PRODUCED WITH OIL PRODUCTS. CASE STUDIES

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Abstract

The investigation of the geological environment is absolutely necessary in the case of pollution and more so in the case of the accidental pollution in order to determine environmental damages and in order to take the appropriate measures necessary to restore it to bring it to the acceptable quality conditions in accordance with the requirements of the legislation. This article presents the results of investigating the geological environment in two case studies, which allows a concrete analysis of the factors involved in oil pollution case. Distinguish a number of important factors such as the lithology and geomorphology of the land, mainly slope, the meteorological factors (rainfall, soil frost), depth of the underground water table level, land drainage, etc. The analytical results obtained are presented in details and the quantitative estimation of the soil affected by oil pollution related to land surfaces analyzed in the two specific cases studied.

Keywords: geological environment, pollution, oil products pollutions

I. INTRODUCTION

Oil plays a vast and vital role in our society as it is organized today. Oil represents much more than just one of the main energy sources used by mankind. Besides being an important energy source, petroleum products serve as feedstock for several consumer goods, thus playing a growing and relevant role in people's lives.

On the other hand, the oil industry holds a major potential of hazards for the environment, and may impact it at different levels: air, water, soil, and consequently all beings on our planet. Within this context, the most widespread and dangerous consequence of oil and gas industrtry activities is pollutions. Pollutions is associated with vitually all activities througout all stages of oil and gas productions, from exploratory activities to refining. Wastewaters, gas emissions, solid waste and aerosols generated during drilling, production, refining (responsible for the most pollutions) and transportations to over 800 different chemicals, among 800 different chemicals, among which, of course, prevail oil ans petroleum products.

The oil pipeline transport activities shows a negative impact on the environment through accidental spills that occur in situations of technological failure due to poor physical condition of the pipes, or, worse, as a result of thefts from the pipes.[1]

This paper presents the results obtained in the frame of assessment of the quality environmental components in two locations (with agricultural land use) that were accidentally contaminated with oil as a result of cracks in main pipelines: one site located in Dambovita county, Baldana village and another site located in Arges county, Barla village.
The pollution assessment is analyzed in the two case studies to highlight the pollution in close connections with other factors such as the lithological, geomorphological, meteorological, etc.

II. EXPERIMENTAL PART

Methodologies used to investigate soil and underground in two sites analyzed were:

- terrain investigations: from pollution source were identified visually polluted areas were potentially affected areas with GPS localization were set sampling points for soil and groundwater wells; were made control boreholes for soil and equipped wells for quality control of the groundwater, drilling operations and soil sampling was done with hand-operated drills, equipment produced by companies Eijkelkamp (Holland) and AMS (USA). Groundwater samples were collected with equipment type bailer, disposable, made-up from HDPE. Field investigations were made using methodologies well known in the literature.[2-4] Lithology identification and assessment of environmental pollution eologic were made by applying the most advanced knowledge in the field. [5-9]
- laboratory investigations: laboratory testings of the specific quality indicators by applying standardized test methods.

Case Study 1: land polluted with oil, located in the Baldana village, Dambovita county. Location in the area is visualized in Figure 1.

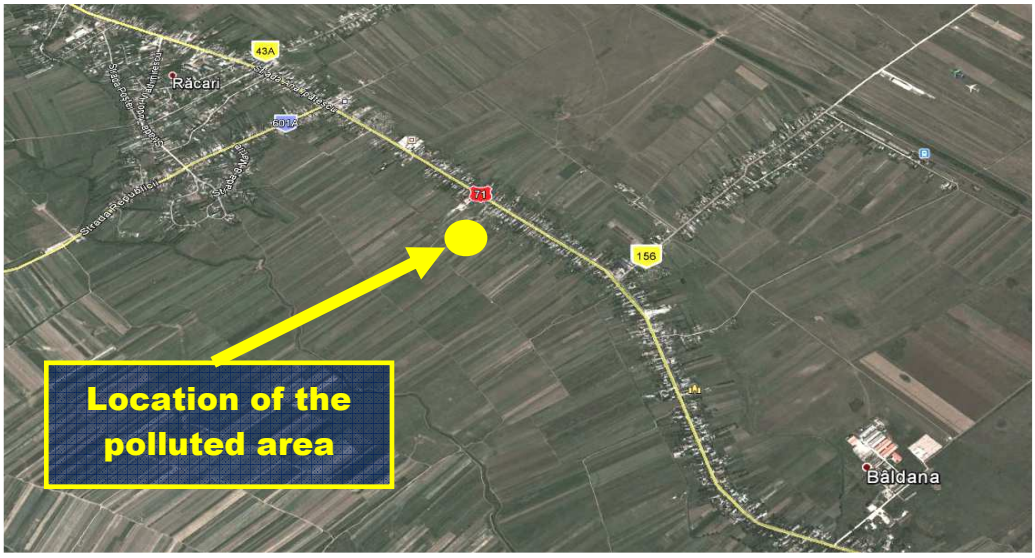


Figure 1 *- Location of the area of the land affected by oil pollution (image source: Google Earth,2013)*

Localization of the sampling points for soil and groundwater are shown in Fig. 2.

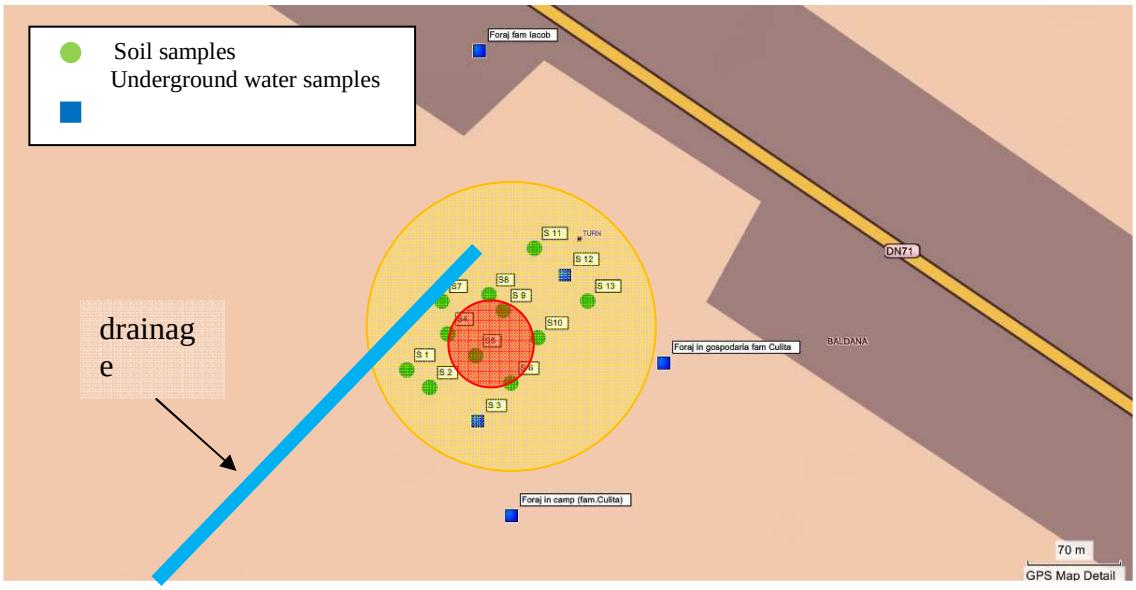


Figure 2 *- Sampling points for soil and groundwater (source: Garmin Map source)*

III. RESULTS AND DISCUTIONS

III.1. Terrain investigations – Case study 1

In-situ investigations have revealed the following issues:

- visual pollution is estimated to affect an area of ~ 16,000 sqm outside the polluted area estimated were visually identified ponds petroleum products, small ditches and oil absorbent materials which tried to limit the dispersion of petroleum products;
- the area where the damage occurred (marked with red colour in figure no. 2) is presented as a heavily polluted area, clearly marked by the absence of vegetation and the dominant black color, specific of the oil; the area was delimited by GPS and occupy of approximately 1100mp. The area shows evidence of intervention for pollutant discharge to be made by a drainage channel placed in the vicinity (marked with blue colour in figure no.2);
- in terms of the lithology, sedimentary formations have been identified (loess) with loam, clay dominated, with plastic properties in wet conditions, and sand intercalations are rarely. Textural differentiation from a profile to another are very small, basically shows the homogeneity of this point of view [5-9];
- area presents traces of the the excess of the moisture from melting snow and precipitation as rain, and this water should be viewed in corelation with the geomorphology of the area, a low area between fields that allow the accumulation of the water;
- the specific of the pollutant (oil) are immiscible with water and the specific density stands in contact with the water on top position.

III.2.Terrain investigations – Case study 2: land polluted with oil, located in the village Barla, Arges county. Location in the area is visualized in Figure 3.

Location of boreholes for soil quality control can be viewed in Figure 4.

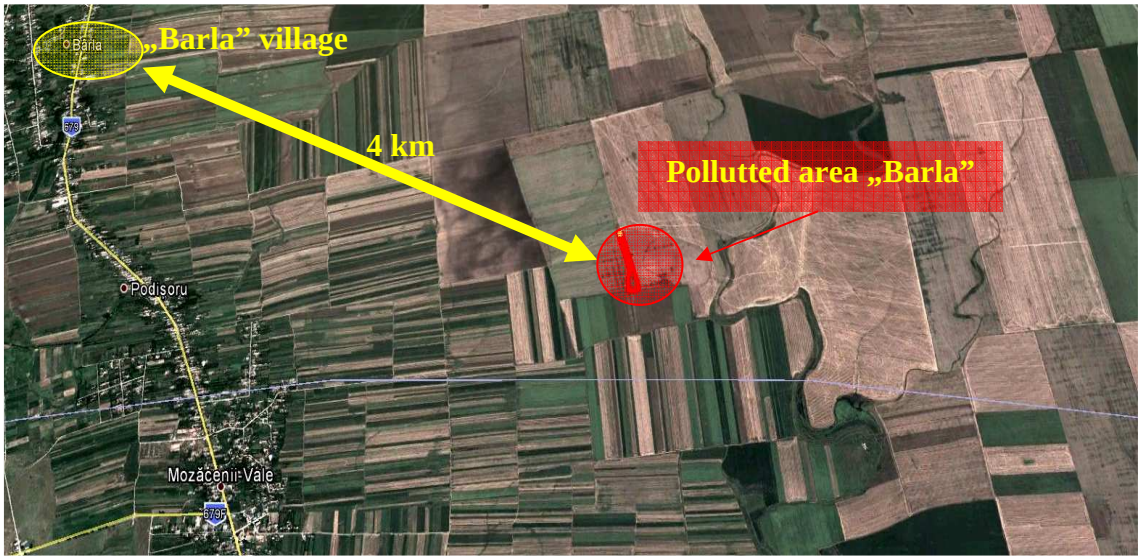
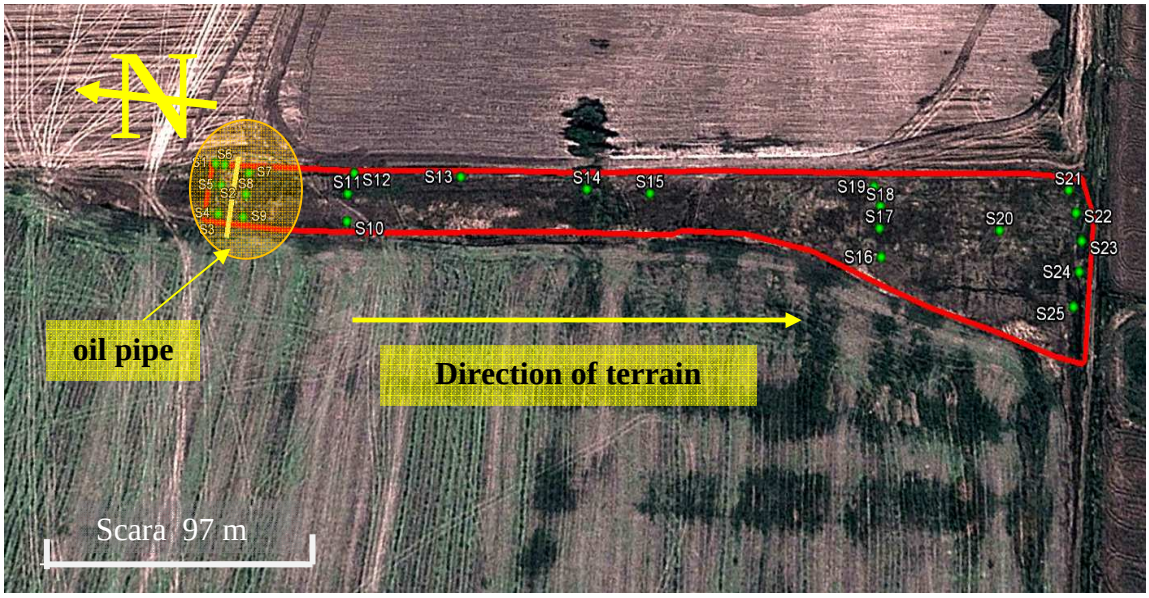


Figure 3 *- Location of the land affected by oil pollution-Barla village (image source: Google Earth)*



- Location of the land affected by oil pollution (image source: Google Earth)

In-situ investigations have revealed the following issues:

- in all 25 boreholes carried to a depth of 4 meters for soil sampling the local lithologies reveal clay to a depth of -1.5...-1.8 meters, dark reddish-brown color, with plastic properties in wet conditions, folowed by a sandy clay layer, yellowish, at depths -2... - 2.3 meters found a carbonate horizon in the form of deposits; the texture differentiation from borehole to another are very low, practically shows the uniformity in this regard;
- there are areas where the vegetation studied spontaneous installed on land is rare, a land that has been developed agricultural work for years, there are restricted areas where vegetation is lacking;
- in the Northern area of the site where there is buried oil pipeline after cracking it and where to intervene to repair it there are still traces of excavation, because the area lacks vegetation;
- visual surface were identified land areas where the soil has a dark color, specific hydrocarbon pollution (oil) in some boreholes was felt and a strong smell of hydrocarbons;
- during periods of rainfall or snow melting, the geomorphological conditions of the area due to a lower area between fields, drainage is done from North to South, being imposed by slope.

III.3 Laboratory investigations – Case study 1

To assess the pollution, the results obtained were compared with reference values specified by national legislation - MAPPM Order no. 756/1997 - to approve the legislation on environmental pollution assessment. If we refer to investigations made reference values for most sensitive land use shown in Table 1.

Table 1 – Reference values Order MAPPM 756/1997 – soils with sensitive land use

Indicator	**Soils with sesitive land use**		
	Normal values	Alert threshold	Intervention threshold
THP	**<100 mg/kg d.s.**	**200 mg/kg d.s.**	**500 mg/kg d.s.**

The results for Case study 1, Baldana, Dambovita are presented in Table 2.

Table 2 - Analytical results for samples of soil collected from the site polluted with crude oil in Baldana village, Dambovita county

Nr. crt.	Simbol proba / adancimea de recoltare	pH (unit. pH)	Umiditate (%)	THP (mg/kg s.u.)
1	2	3	4	5
1	S1 (0-10cm)	6.90	21.2	1456.88
2	S1 (30-40cm)	6.85	15.6	88.52
3	S1 (1 m)	8.06	18.9	156.27
4	S1 (2 m)	7.15	15.6	56.84
5	S1 (3 m)	8.06	18.8	159.85
6	S1 (4 m)	7.94	19.9	60.98
7	S2 (0-10cm)	6.53	23.7	852.85
8	S2 (30-40cm)	7.14	14.4	90.94
9	S2 (1 m)	6.78	20.5	144.30
10	S2 (2 m)	7.75	15.7	55.18
11	S2 (3 m)	7.90	15.9	65.81
12	S2 (4 m)	8.15	17.7	84.55
13	S3 (0-10cm)	6.33	19.3	165.68
14	S3 (30-40cm)	7.11	17.7	145.66
15	S3 (1 m)	7.25	20.4	65.92
16	S3 (2 m)	7.37	17.0	80.78
17	S3 (3 m)	6.81	16.3	189.51
18	S3 (4 m)	6.48	19.1	82.69
19	S4 (0-10cm)	7.35	18.9	66.53
20	S4 (30-40cm)	7.64	18.17	106.18
21	S4 (1 m)	6.77	20.0	39.14
22	S4 (2 m)	6.93	16.5	109.73
23	S4 (3 m)	6.15	15.9	60.50
24	S5 (0-10cm)	6.92	21.4	4373.77
25	S5 (30-40cm)	7.36	20.1	154.42
26	S5 (1 m)	6.80	18.8	4075.82
27	S5 (2 m)	7.35	17.1	21542.47
28	S5 (3 m)	7.70	16.1	4306.47
29	S6 (0-10cm)	6.63	21.1	227.27
30	S6 (30-40cm)	6.47	19.2	98.27
31	S6 (1 m)	6.75	17.0	35.54
32	S6 (2 m)	6.38	14.5	100.15
33	S6 (3 m)	7.10	14.6	56.37
34	S6 (3,5 m)	7.14	16.1	55.60
35	S7 (0-10cm)	6.99	22.4	115.55
36	S7 (30-40cm)	6.40	20.9	38.68
37	S7 (1 m)	6.30	13.8	24.86
38	S7 (2 m)	6.40	17.2	98.45
39	S7 (3 m)	6.63	17.4	72.37
40	S7 (4 m)	7.10	17.5	27.55
41	S8 (0-10cm)	7.85	19.8	260.36
42	S8 (30-40cm)	8.70	19.0	139.12
43	S8 (1 m)	6.38	16.6	37.12
44	S8 (2 m)	6.82	16.2	38.79
45	S8 (3 m)	6.45	16.7	27.38
46	S8 (4 m)	6.86	17.6	51.97
47	S9 (0-10cm)	7.67	20.6	4025.31
48	S9 (30-40cm)	8.22	20.4	280.12
49	S9 (1 m)	7.10	19.5	81.89
50	S9 (2 m)	6.82	17.9	28.43
51	S9 (3 m)	7.10	17.5	103.56
52	S9 (4 m)	6.16	18.1	60.26
53	S10 (0-10cm)	7.36	18.0	889.21

Table 2 – continued

1	2	3	4	5
54	S10 (30-40cm)	7.83	17.2	158.24
55	S10 (1 m)	7.10	18.9	74.17
56	S10 (2 m)	6.32	25.6	87.54
57	S10 (3 m)	7.10	20.9	99.59
58	S11 (0-10cm)	7.97	16.0	104.67
59	S11 (30-40cm)	7.63	18.7	110.98
60	S11 (1 m)	6.84	20.0	44.04
61	S11 (2 m)	6.78	18.1	38.95
62	S11 (3 m)	6.80	18.7	173.99
63	S11 (4 m)	6.84	18.8	64.49
64	S12 (0-10cm)	7.10	18.6	116.81
65	S12 (30-40cm)	7.94	17.7	528.15
66	S12 (1 m)	6.98	19.5	38.56
67	S12 (2 m)	7.80	17.7	40.07
68	S12 (3 m)	6.82	16.6	32.18
69	S12 (4 m)	6,78	22.7	48.90
70	S13 (0-10cm)	6.91	22.3	5218.45
71	S13 (30-40cm)	7.37	20.9	54.69
72	S13 (1 m)	7.87	19.8	40.73
73	S13 (2 m)	7.77	17.6	45.01
74	S13 (3 m)	7.67	16.9	37.63
75	S13 (4 m)	7.80	16.8	37.61

The pollutant distribution analysis (THP) on levels of depth highlight a significant pollution from surface to 10 cm depth, except where pollution was recorded S5 profile and depth with maximum values located in the 2m, this profile is located to limit the area where intervened to remedy the damage, which explains the identification of pollutant to the level of 3 meters.

In terms of physico-chemical characterization of groundwater in the 6 wells located both upstream and downstream of the production of the damage, to reveal the existence of THP, the values measured were 0.17 and 0.76 mg / liter. The characterization of the water from the drainage channel where to drain spilled crude oil showed a pH of 7.7 and an oil content of 0.20 mg /l.

III.4 Laboratory investigations – Case study 2

The results for Case Study 2 Barla viilage, Arges county are shown in Figure 5.

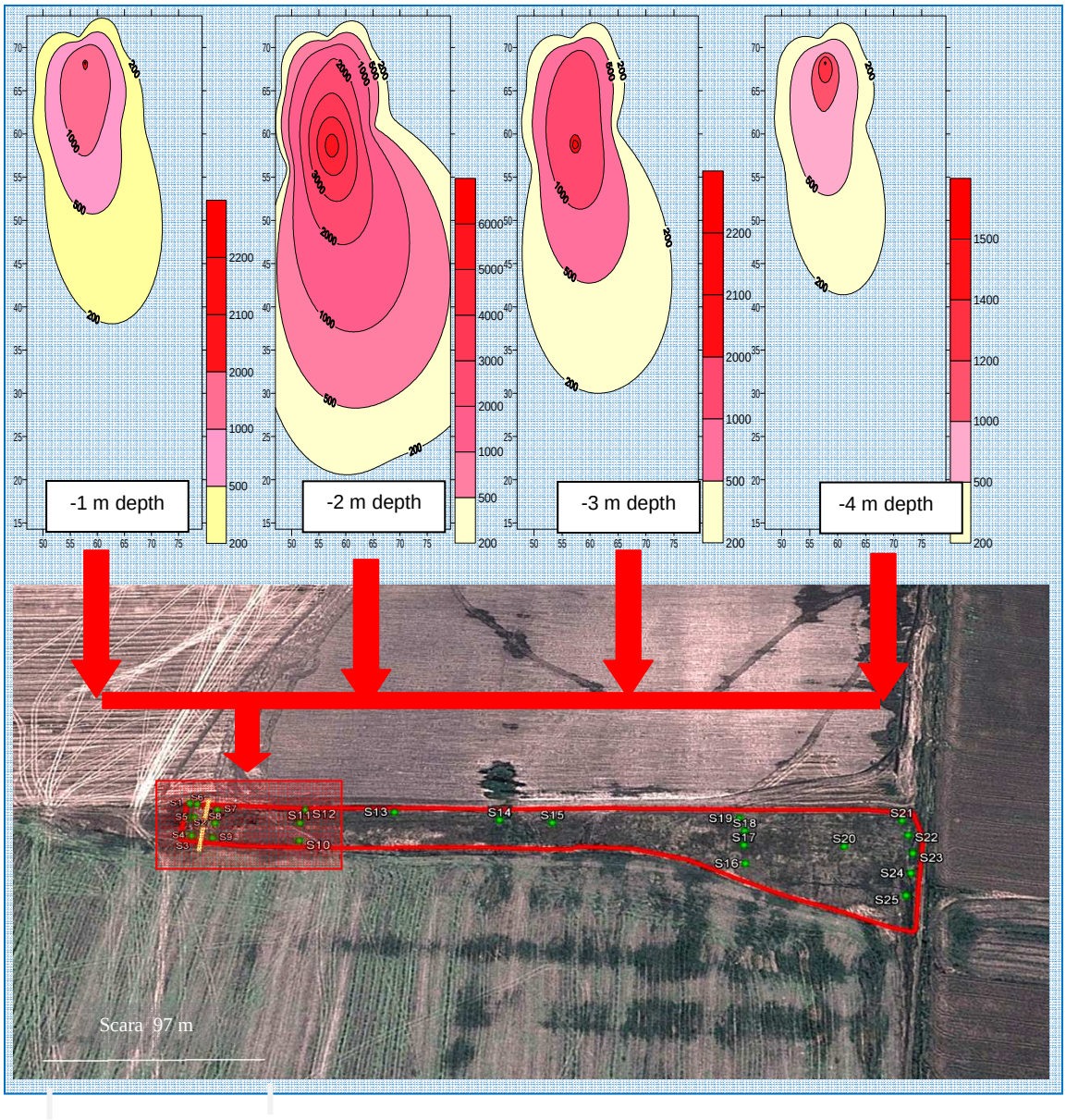


Figure 5 *- Distribution of THP content on levels of depth in the proximity of the oil pipeline, Barla polluted area*

Distribution highlights a significant pollution with oil products (THP),with the maximum territorial expansion at the surface at 0-10 centimeters up to 4 meters depth have significant pollution occurs, but with a higher or lower expansion , located in close proximity to transport crude oil pipeline where damage occurred. The model of the distribution of THP concentrations in the soil for the entire study area (12280mp) allowed estimation of the volume of soil affected by oil pollution, which is estimated at 2930 cubic meters, noting that an area by 8050 sqm is only affected on surface layer that soil up to 10 centimeters.

IV.CONCLUSIONS

The study of the geological environment pollution assessment for the 2 sites accidentally polluted with oil as a result of damage occurring to the transport pipelines can draw some conclusions:

- in the first case, the location Baldana found the existence of a area of approximately 16 000 sqm. polluted, pollution is visible outside this surface (the households in the vicinity of the site). Close to local pipeline failure was identified an area heavily polluted, visibly marked by the absence of vegetation, estimated 1100 sqm. Identified lithological structure has low permeability, thus a low potential for migration of the pollutants in soil. However this deep groundwater levels near the surface (less than 4 meters) had the consequence that the pollution affect growndwater. The presence in the vicinity of a drainage channel allowed to pollutant to be conducted in this one, limiting in some measure dispersion at ground level;
- in the second case, the location Barla, the geomorphological and lithological factors have caused a significant pollution with the oil products, mostly remain located on the first level of the investigation (0-10 centimeters), the affected area is estimated at 8050 sqm, respectively 65.6% of the entire land surface analysis. Significant pollution on depth direction remained localized predominantly in the vicinity of the oil pipeline transport (in the Northern area of the land analised), the pollution is extended to the depth 4 meters, the rest of the site pollution occurs deep point and only up to the sampling depth of 1 meters. The total volume of the soil estimated to be affected by significant pollution with oil products (THP) is 2930 cubic meters. Groundwater at levels greater depth (estimated at 9-10 meters depth) was not intercepted, with minimal posibilities to can be affected.

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