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The Impact of Dangerous Waste from Oil Sites in the Context of Natural and Anthropic Phenomena Duality

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Abstract

This paper outlines the impact of dangerous waste resulted from oil sites, through the composition complexity, the storage modality, the singular or synergic effects they bring to the environment and implicitly to the human factor. An integrated management of the waste implies stability and firmness of legislation/ regulations as well as a superposition of technical opinions on the entire cycle that includes the pollution source and the means to eliminate/revalue the waste. The biggest part of the dangerous waste from the oil sites has a historical character, resulted from the duality of natural and anthropic phenomena. The internal concerns on choosing the optimal management options of oil waste are relatively new, partially arranged, due to public debates, in an ascendant dynamics, but have startled the interest of superior education facilities, research – development, the specialized advising firms with a wide range of specializations: geology, drilling – extraction, oil equipment, chemists, pedologists, work medicine, HSEQ specialists, economists, etc.
Through the presented case study the impact brought on the environmental elements is outlined (the analytical determinations refer to WATER) through the persistence of the polluting phenomenon in the oil industry.

Key words*: oil, pool water, soil, subsurface, subterranean water, pollution, impact, pit.*

The Pollution Sources from the Oil Sites

The oil and gas extraction industry has induced through the used methods, but especially the human factor careless, decided to permanently increase the recovery factor, the polluting phenomenon called “historical pollution”. The categories of *organic* pollutants (oil and its derivates), *inorganic* (mercury, lead, asbestos, mineral acids, basis, salts), *biological* (pathogenic micro-organism) and *radioactive* (radio-nucleus) are responsible for polluting the geological environment, this leading to the necessity of adopting some ecological reconstruction and repair measures on these infected sites. The soil pollution with oil products is part of the biggest environment problem Romania has been facing in the last years, taking into account the more accelerated and intensive rhythm of these resources usage (specific to developing countries) to satisfy the needs of equity and energy. The vast care of international specialists concerning the pollutants eco-toxic effects led to statistic data that show cancerous and mutageneous effects due to some prioritary dangerous compounds (ex. biphenyl polichloride

compounds, benzene, benzo-pyrene), that are persistent or released from different chemical synthesis, uncontrolled burning processes (the case of some dioxin and furan species).

Drilling – extraction operations (ex. the incorrect management of oil fluids, uncontrolled deposit of detritus, slam and other waste from the intervention operations, PR – RK, inhibition), oil treating and transport (through pipes, auto, CFR, ships), improper maintenance of surface/depth installations/equipment, lack of management of corrosive phenomena or used chemicals, salt water intrusions in the aquifer, diggings at the soil surface, incorrect drainage of pluvial waters, lack of filter stations for wastewater etc. represent potential pollution sources.

In addition, there are encountered accidental polluting situations with deposit and/or oil water, other oil derivates, due to some erosion phenomenon, landslides, compaction, eruptive phenomena, earthquakes, fissures/unsealing of transport pipes, corrosive phenomena in deposit/vehicular equipment of oil products, collision between means of transportation, vandalism etc.

Worth mentioning is the fact that, besides biological and physic-chemical polluting elements, there are also radionuclid emissions (one of the main radioactive elements that interfere with the background oil level is radon). The radioactive polluting sources in the extraction – drilling activities are natural, but also anthropic. Besides radionuclid U^{238}, isotopes like Ba^{140}, I^{131} can be present. The presence through detection of Isotope Cs^{137} indicates a radioactive pollution due to the Cernobil accident.

Inventory and Sorting of Contaminated Sites

In 2007, according to The National Agency for Environment Protection, there have been identified **232 contaminated sites from the oil industry, with a surface of 2665 ha,** according to the questionnaires (annexes to HG no. 1408/2007 concerning the modalities of investigation and evaluation of soil and subsurface) addressed to the involved economic agents and the regional authorities. The zone distribution is shown in figure 1.

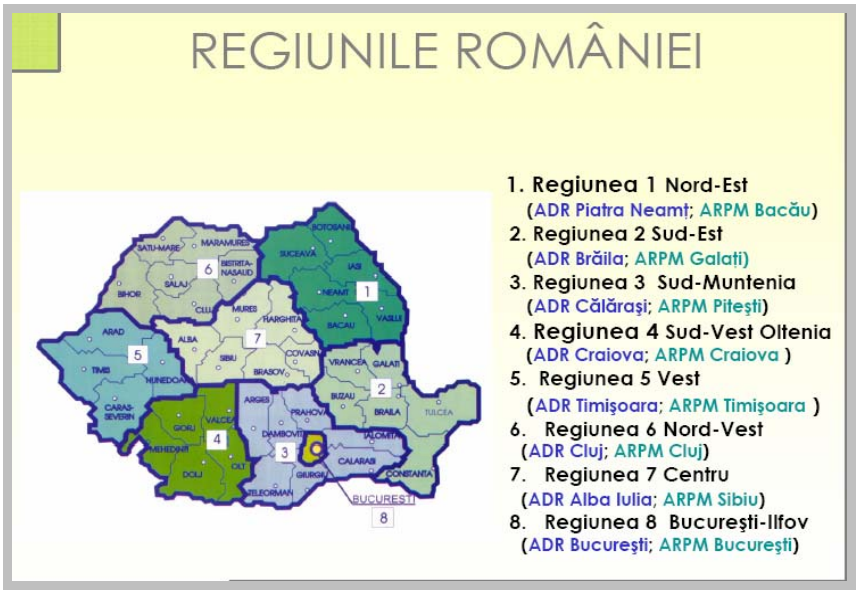

Fig.1. The regional distribution of oil products pollution (Source: ANPM, 2007)

The most critical zones, from the point of view of oil industry pollution, are in region 1 North – East, region 3 Muntenia, region 4 South – West Oltenia. In our country, 44 non-conform deposits (also called pits) coming from the oil industry are in closure procedure, with legally

established periods. These pits represent a permanent threat over the environment, bio-diversify and human health elements.

The fast localization and time – space monitoring methods of areas polluted with hydro-carbides are based on *geophysical prospects* (electrometrical, radiometrical), but also on *physic – chemical analysis* (fixed or mobile laboratories, based on the instrumental technique specific to this field).

Case Study: the Impact of Dangerous Waste from Moinesti Oil Area on the Environment and Human Factor

This study was made in Region 1 North – East, Moinesti oil area (which has the main locations: Zemes, Modarzau, *Gazarie*, Moinesti Sarmatian) as it is suggested on the map, in figure 2.
Sampling subsurface and surface water, analytical investigations and interpretation of the polluting phenomena have been made for Gazarie location. Two surface water samples have been taken from different points in Tazlaul Sarat, and the subsurface water sample has been taken from a well, near the oil waste deposit in Gazarie. The purpose of these analytical investigations and evaluation of some parameters, in connection with the internal and community legislation is to demonstrate if the toxic waste, through a mix of natural and anthropic factors, affect or not the quality of environmental elements (in this case WATER). For a complete understanding of the polluting phenomenon on an extended oil area, like Moinesti, data concerning the topography, geology and hydro – geology will be briefly presented.

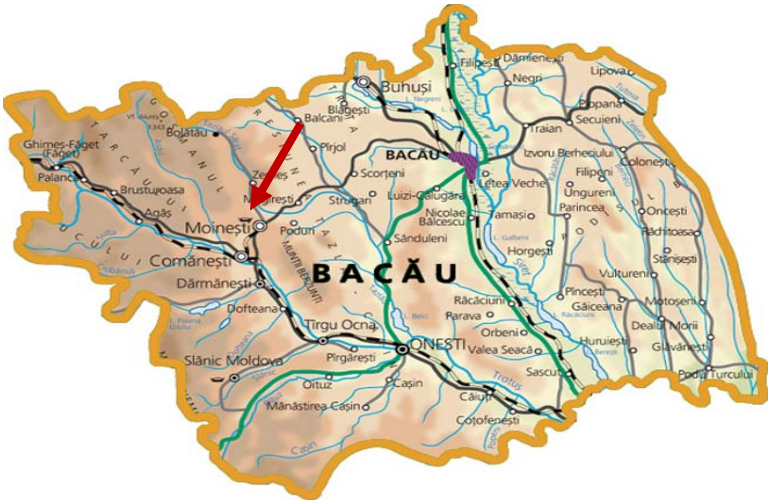

Fig. 2. Map of Bacau district, Moinesti oil area

The topography, geology and hydro – geology from Moinesti administrative area[1]

The topography of the area has a structure determined by tectonics, the petrographic construction and the external agents` action – especially flowing waters. The mountain heights from west and south – west (Gosmanu Mountains) and then northern – western part of Berzunti Mountains are over 700 m or even 800 m high on the west of locality, while in the plane of river Tazlaul Sarat, at Gazarie (a city`s neighborhood), the altitude drops to approximately 430 m. This difference of level explains the powerful topography fragmentation.

Concerning the soil types in the territory of Moinesti, there is a majority of brown and podzolic soils, as well as rendzine and alluvial soils, in a smaller proportion. A serious problem is the soil

[1] Moinesti Durable Development Strategy, for period 2007 – 2013.

degradation resulted from break ups, oil works and the pollution coming from these. An example is the degraded soil from the northern – eastern versant of Dealul Osoiu, where strong torrential eruption exists. In the future the restoration of natural balance through break-ups limitation, torrential flow regularization, grazing rationalizing and pollution elimination is going to be imposed.

The hydrographical regime is placed in the fourth zone of the Oriental Carpathian, characterized by the absence of winter high floods, with big water flow from March to May. The rivers are mainly supplied from precipitations, so that the supply from underground zones is at most 40%. The phreatic zones have variable heights and, generally, are not rich in quantity.

The Moinesti administrative territory is placed on two hydro-graphical basins: the N and N – E part belongs to Tazlaul Sarat, and the S and S – V part to river Lunca (Urmenisul Mare), an affluent of Trotus.

Tazlaul Sarat, which has a length of 42 km, springs from top Geamana, goes through Zemes, Modarzau, Lucacesti, collects the purged waters from the municipal canalization station, then goes through Gazarie, Ardeoani, and in front of Tescani locality it unites with Tazlaul Mare, being tributarily to Trotus.

The case, distinct from the field`s stability point of view, is presented for Moinesti oil area, commune Zemes, located about 15 km N of the municipality. The field stability is weak, the terrain slidings from 1992 (the most persistent in amplitude), and then the floods in 2000 and 2002 have drastically affected Bolatau, Pietrosu and Dealul Humaria. The slidings[2] were produced in the argyle layer mass, due to the water infiltrations, which have reduced the inner friction. This phenomenon, conjugated with the high slope inclination led to some earth masses collapse, but also to oil and strongly mineralized deposit water pollution (rich in ions and iron), polluting the subterranean and surface water sources, affecting the aquatic and terrestrial bio-diversify, the forest fond and relocation of over 160 houses in the affected area. The land sliding type is very hard to predict, because the water infiltrations have a sinuous path and most of the time it is undetectable from the surface. The images in figures 3 and 4 outline the natural factors' effect over the geological environment, from Zemes.

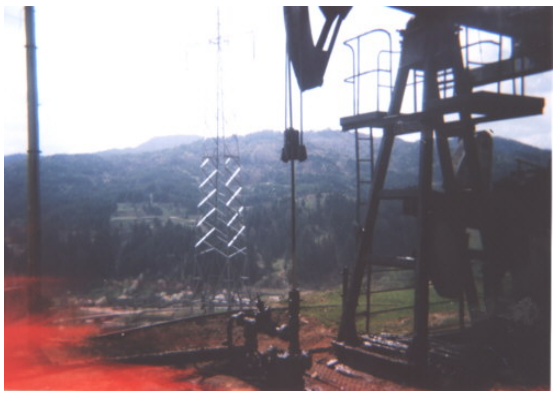

Fig. 3. Massive pollution with deposit water

Fig. 4. Pipe breakings

The main historical pollution sources in Gazarie:

It is well known the fact that, as far as Moinesti oil area is concerned, by Government Decsision no. 349/2005 on waste depositing, regarding closure of the non-conform deposits from the oil extraction industry, since 2006 the activity from the following places has been stopped:

[2] S.C. GEOPETROL S.A. – Level I environment medium balance and rapport concerning Level I environment medium balance for Schela Moinesti, Schela Modarzau and Schela Zemes – Schela Zemes (2000)

- Gazarie (deposit with surface 0,0635 ha, not impermeable);
- Albotesti (deposit with surface 0,9 ha, impermeable);
- Moinesti Sarmatian (deposit with surface 0,25 ha, impermeable).

For all three non-conformable deposits (also called pits) closing orders have been given from The Regional Agency for Environment Protection Bacau, and these impose to the holders from the oil domain to start the remedy actions based on the technical project and implicitly on the environment treaty. Remedy treatments and technology will target disaffecting and re-managing the momentarily contaminated sites, the agro-forest circuit, while the water sources, besides natural attenuation, will imply permanent monitoring.

The sampling, physical – chemical analysis and results evaluation for two surface water samples:

The sampling of surface water samples from river Tazlaul Sarat has been made: i) at about 500 m downstream from Moinesti purging station, ii) close to Gazarie pit.

The analytical determinations and results evaluation are presented in table 1.

The physical – chemical parameters in Order MMGA no. 161/2006 are divided into 5 main groups:

- group ***"oxygen regime"*** that contains: dissolved oxygen, CBO_5, CCO – Mn, CCO – Cr;
- group ***"nutrients"*** with: ammonium, nitrites, nitrates, total nitrate, orthophosphates, total phosphorus, chlorophyl "a";
- group ***"general ions, salinity"*** with: dried filterable residue at 105^oC, sodium, calcium, magnesium, total iron, total manganese, chlorides, sulphates;
- group ***"metals"*** with: zinc, copper, total chrome, arsenic. The metals plumb, cadmium, mercury, nickel have been placed in group ***priority substances***;
- group ***"organic and inorganic micro-pollutants"*** with: phenols, detergent, chloride hydro-carbide, oil hydro-carbide. Other substances like polinuclear aroma hydro-carbide (PAH), biphenyl polichorides compounds (PCB_s), pesticide, halomethanes etc. are placed in ***priority group***.

Other records:

- From the analytical investigations that have been made on the two water samples and the evaluation of the results obtained with the legislative imposing from Order MMGA no. 161/2006, it is established that on the analyzed section, the final placement category after quality indexes obtained at Tazlaul Sarat is V;
- On the river Tazlaul Sarat accidental polluting with oil products is frequently encountered, due to the transport pipes corrosion, whose life cycle is exceeded, but also due to the infiltrations from dangerous products accumulation in the non-permeable pit. The polluting phenomenon is amplified when natural phenomena occur, such as: field derails specific to Zemes or floods like the ones from last year, that produce massive changes in the minor river bed and waterside;
- Dysfunctions specific to the municipal filtering station (when the biomass from the station`s bio-filter is compromised – an example is the ammonium high degree) lead to rich in nutrients zones, and the fish species like chub, barbell are almost extinct.

Table 1. Values of analyzed and evaluated parameters for the surface water samples

No. crt.	Sample prelevation place	Analyzed phisical-chemical parameters	Obtained value *-measurement unit-*	Order 161/2006[3] *Quality class*				
				I	II	III	IV	V
1	Downstream Purging Biological Station Moinesti	Chlorides	485 *mg/l*	25				>300 *mg/l*
		Oil product (TPH)	0.614 *mg/l*	0.200				
		CCO-Mn(O_2) (oxidability)	6.8 *mg/l*	5	10 *mg/l*			
		Iron	0.5 *mg/l*	0.3	1 *mg/l*			
		Ammonium	0.8 *mg N/l*	0.4	0.8 *mg/l*			
		Dried filtrable residue at 105°C	980 *mg/l*	500		1000 *mg/l*		
		pH	7.5	6.5-8.5				
2	Gazarie pit proximity	Chlorides	1500 *mg/l*	25				>300 *mg/l*
		Oil product (TPH)	1.100 m*g/l*	0.200				
		CCO-Mn(O_2) oxidability	23.5 *mg/l*	5		20	50 *mg/l*	
		Iron	0.7 *mg/l*	0.3		1.0 *mg/l*		
		Ammonium	0.9 *mg N/l*	0.4	0.8	1.2 *mg/l*		
		Dried filtrable residue at 105°C	2155 *mg/l*	500				> 1300 *mg/l*
		pH	7.9	6.5-8.5				

The sampling, physical – chemical analysis and results evaluation for subsurface water sample (well water):

The sampling of the subsurface water sample was realized from a well, found downstream the Gazarie pit, at a distance of about 1 km. The physical – chemical and microbiological analytical data are evaluated according to the specific national legislation for the drinkable water quality, as well as to the Dutch List 2000, acknowledged by the whole European community (table 2).

Comparing the obtained analytical data with the admissible values, it is obvious that the well water is not drinkable, an aspect imposed also by the Public Health Safety Bacau. The well is used only in domestic purposes, having written on it "The water is not to be used for human consumption". Evaluation of this subsurface water according to the Dutch List 2000, indicates exigency on some analyzed parameters compared to the national legislation (that has transposed

[3] MMGA Order, no. 161/2006 for Normative approval concerning the surface water quality classification in order to establish water body ecological state. This commands orders elements and biological, chemical, physic – chemical, microbiological quality standards for establishing the rivers and lakes ecological state. The ordering is made on 5 quality classes, quality I taken as a reference measure (CMA), and quality V that represents the highest pollution degree for a surface water.

Directive 98/83/CEE concerning the drinkable water quality), only at chlorides being allowed the 100 mg/L limit, on TPH and Fe being under the instrumental detection limits;

Table 2. Values of analyzed and evaluated parameters for the well water samples

No. crt.	Analyzed phisical-chemical parameters	UM	Obtained value	Admissible values conform Law 458/2002, modified and completed by Law no.311/2004	DUTCH LIST 2000
1	Chlorides	mg/l	650	250	100
	Oxidability	mg/l	32	5	
	TPH	mg/l	1.2	0.02	
	Nitrates	mg/l	65	50	
	Turbidity	Unit.	6	< 5	
	Min. total durability	German degrees	12	5	
	Sulphates	mg/l	370	250	
	Iron	mg/l	0.8	0.2	
	Conductivity	S/cm	3600	2500	
	pH	Unit. pH	7.6	6.5-8.5	
2	Analyzed microbiologic quality parameters				
	Escherichia coli (E.Coli)	nr/100 ml	0	2	
	Enterococci	nr/100 ml	0	3	

The microbiological and physical – chemical quality parameters variation in accordance with the admissible limits comes from a *mixture* of causes resulted from the strong polluting activity of the zone with oil products, deposit water (high values of TPH, chlorides, sulphates, iron, conductivity and oxidability), of some nitrate remains due to a highly exploited agriculture with synthesis chemicals, as well as a bad placement of ranches, septic tanks, etc. that lead to pathogen bacteria colonies.

Conclusions

1) It is notable the fact that stopping the oil slams depositing action in the non-conform spaces has begun, and through the perspective of a future soil directive, legislative acts will be nationally transposed and implemented determining the stakeholders that took over and the historical pollutions as well, to begin the contaminated sites remedy actions;

2) All the specified pollution sources in this study, as well as the other not mentioned potential sources, need permanent monitoring, as well as strict improving programs for the filtering technologies, efficiency of the transport and production installations;

3) To avoid the risk of accidental polluting, and also of hydra infections, a series of measures that involve the oil activity stakeholder is imposed, the basin authority, the public health authority, which besides the technical – economic measures, impose public and water users permanent informing on the major problems caused by water pollution.

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Impactul deşeurilor periculoase din şantierele petroliere în contextul dualităţii fenomenelor antropice şi naturale

Rezumat

Lucrarea evidenţiază impactul deşeurilor periculoase provenite din şantierele petroliere, prin complexitatea compoziţiei, modului de depozitare, efectelor singulare sau sinergice pe care le induc mediului şi, implicit, factorului uman. Un management integrat al acestor deşeuri impune o stabilitate şi o fermitate a legislaţiei /reglementărilor, alături de o suprapunere a opiniilor tehnice pe întreg ciclul ce include sursa de poluare şi modalităţile de valorificare/eliminare a deşeurilor. Cea mai mare parte a deşeurilor periculoase din şantierele petroliere au un caracter istoric, provenind din dualitatea fenomenelor antropice şi naturale. Preocupările pe plan intern privind alegerea unor variante optime de gestionare a deşeurilor petroliere sunt relativ noi, parţial reglementate, supuse dezbaterilor publice, într-o dinamică ascendentă, dar care au stârnit interesul instituţiilor de învăţământ superior, cercetare – dezvoltare, firmelor specializate de consultanţă cu o paletă amplă de specializări: geologie, foraj-extracţie, utilaj-petrolier, chimişti, pedologi, medicina muncii, specialişti HESQ, economişti etc.
Prin studiul de caz prezentat se subliniază impactul indus asupra elementelor de mediu (iar determinările analitice fac referire la APĂ), prin persistenţa fenomenului poluant din industria petrolieră.