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ASSESSING THE QUALITY ON NATURAL ENVIRONMENT IN THE CONTEXT OF THE DRILLING EXPLOITATION AND MINING-SITE ABANDONMENT PHENOMENA. THE IALOMITA SUBCARPATHIAN AREA/ROMANIA

Florin Vartolomei[1], Răsvan Damian[2], Iuliana Armaş[3]

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Abstract. This paper is a short presentation of work field results on environment impact of drilling exploitations and mining sites abandoned in the Ialomita subcarpathian area. As a consequence of the industrial activities development, the quality of the environment elements was significantly influenced and modified, frequently exceeding the natural self-regulation capabilities. The environment has undergone many major transformations, especially within the mining and drilling areas within the subcarpathian landscapes, intensely morphologically fragmented and with potential slope instability. The subcarpathian area between the Cricov and Provita valleys comes forth with geologic information from the second half of the 19th century, the research being amplified after 1900, information related to the petroliferous importance of the area and to the presence of the energetic coals.

Introduction

The studied perimeter represents the western part of the Mio-Pliocene subzone of the Eastern Carpathians Foreland, developed upon the diapire folds subzone (Fig. 1).

The geological evolution of the area is related to that of the Dacian Basin, with an initial connection with the Tethys Sea, during which gypsum and salt deposits of Lower Miocene (Badenian) age accumulated.

The detailed geology (both surface and sub-surface) of the Moreni – Filipeştii de Pădure area is well-known, due to the geological studies and exploitation of the important geological resources of the region: the coal-fields of Filipeştii de Pădure

[1] Lecturer Ph.D., Spiru Haret University, fvartolomei@yahoo.con
[2] Conf. Ph.D., University of Bucharest, Bucharest, d.rasvan@yahoo.com
[3] Prof. Ph.D., University of Bucharest, Bucharest, iuliaarmas@yahoo.com

and, especially, the oil reservoir of the Moreni – Colibaşi – Ocniţa structure (Damian R., 2002).

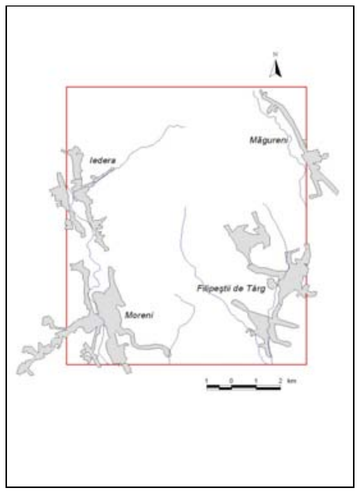

Fig. 1 - General overview on study area

1. Particularities of geologycal conditions in the study area

The coal formation starts in the Lower Dacian and it extended in the Ialomiţa – Prahova area in the Romanian interval. North of Siliştea-Dealului Anticline - with oil reservoirs - there is a large-scale structure, the east-west oriented, 12 km long Ruda Valley Syncline, developed between the Cricovul Dulce and Proviţa valleys. The geometric relationships and the paleontological support (Romanian fauna) from the Nisipoasa – Trestia – Cervenia – Palanga Valleys and the Siliştea-Dealului Anticline allowed refering the Ruda formation to the Upper Pliocene – Lower Pleistocene (Damian R, 2004).

The “Cândeşti Beds” represent the upper part of the east-west directed Ruda Valley Syncline structure that is drained to the east by the eastern Ruda Valley, a tributary of the Proviţa River and the better developed western Ruda Valley, confluent of the Cricovul Dulce River at the edge of the Edera settlement (north of Moreni town). The morphology of the area of origin of these two valleys is tectonically controlled by the Proviţa fault that has a northerly direction. The closure of the Synclinal occurs via a western axial dip, immediately west of the Cricovul Dulce River, while in the east, in the Prahova Valley sector, the Ruda Valley Syncline deposits are opened only in the valley slopes and are covered by terraces (Damian R., 2004).

The accumulation of the material occurred in a fluviatile system, in the form of partly submerged alluvial fans. The transport of the material took place from a nearby (10-30 km away) Carpathian source in north-to-south direction, inherited by the Cricov, Proviţa and Prahova rivers. Specific depositional features are due to the raising of the diapiric folds along a southern alignment (*Geography of Romania, 1992*).

The pebbles also indicate a remobilization of the sedimentary material in a west-east direction through a secondary hydrographic network.

The succession is dominated in the base by alternations of clays, marls and sands that gradually acquire a cross-stratification, followed by a succession of predominantly thick-bedded, alternating gravels and sands, with torrential stratification. In the slopes, there are levels of cementing that led to a mixed aspect.

2. Methodologycal approach

The repeated reorganizations in this field, after 1979, and the department re-organizations after 1992 made it so that the geologic research activity declined. This activity was to a certain point the only one in this area that offered a cartographic support with environment elements deciphering. To be noted that the exploitation for petrol always represented a type of privileged activity, in which any environmental approach was performed discriminatory.

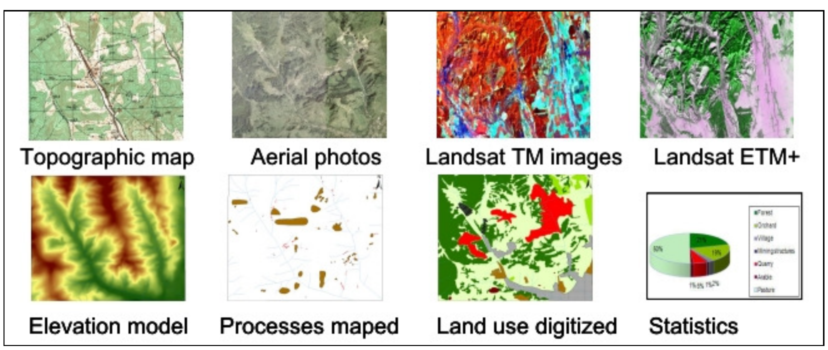

Fig. 2 - Main type sources for research

The research focuses on the understanding of causes and mechanism of structures and the quality components of the environment deteriorations under human impact, based on an evaluation of the landscape transformations that took place in the last decades, in parallel with mine and drilling exploitation. The research is based upon a modern methodological basis, through the use of dynamic terrain analysis and database integration of large scale aerophotograms, alongside probability calculations in the establishment of slope system vulnerability levels.

Also, the main sources for this research were: topographic maps on 1:25000 scale, aerial photos on 1:25000 scale, etc. (Fig. 2). We also used Geographical Information Systems and Digital Elevation Models in Environmental Studies (Pykonen M., 2001).

One of the anthropogenic impact aspects lies in the exploitation of hydrocarbon deposits by extraction with wells. To analyze the impact, we proceeded to GPS mapping elevations for inventorying, mapping and positioning of wells in the area between the settlements Moreni and Filipeştii de Pădure.

Measurements were made by GPS equipment, using a Garmin76 appliance-type. During the field work, the main task was to build a database on well extractions and their environmental impact.

3. Results and discussions

Transformation of these measurements in GIS environment has been achieved through the vectorized themes-layer of information type, differentiated by type of targets, with the map support for guidance - ortophotoplan in Stereo 70 projection (www.geo-spatial.org). Lectures-layer of information type created in GIS are: "wells", "roads" (the operation), "ruins", "power poles", "oil tankers", "pipeline". In addition, a number of topics type layer of information were created in GIS, general, for guidance or for different correlations: "roads" (the public), "household rubbish", "Release" "Hydrogeological drillings, hydrographic network." The projection used for these issues is Stereo 70 (www.gisdevelopment.net/glossary).

The database was created in compliance with a Legend with a number of 11 categories with their subcategories like in Table no. 1.

Tab. 1 Description of the legend codes

Category no.	Category code	Description of the legend code	Subcategory code	Description of subcategory
I	**S**	Oil derrick (for hydrocarbon extraction-points of primary production)	**Sf**	Functional oil derrick
			Sn	Non-productive oil derrick (out of service)
II	**R**	Ruins (traces of former extraction wells, related buildings, etc.)	**Rs**	Former oil derrick (cork type)
			Rc	Ruin of buildings
			Rp	Ruins-pillar of oil derrick
III	**C**	Pipelines (network of crude oil transport)	**Ca**	Water pipe
			Cp	Oil Pipelines
			Cg	Gas pipes
IV	**D**	Roads (public roads and	**Dp**	Land roads

		operating roads)	**Da**	Arranged roads
V	**G.S.M.**	Telecommunications relays	**-**	-
VI	**E**	Electricity columns (power distribution)	**Ef**	Working columns (with adapter current)
			En	Broken columns (which no longer carry electricity)
VII	**A**	Landslides	**As**	Stabilized sliding
			Aa	Active sliding
VIII	**T**	Tank oil (oil reservoirs, pits)	**-**	-
IX	**P**	Oil spot (areas affected by crude oil discharged from the extraction source)	**-**	-
X	**G**	Garbage (household waste, garbage deposits)	**-**	-
XI	**F**	Hydrogeological drill	**-**	-

During these field trips, a detailed database was prepared related to current land use for observations and correlations with human impact. These data were centralized and analyzed and then processed by mapping and charting, as we identified 11 main types of land use (Fig. 3).

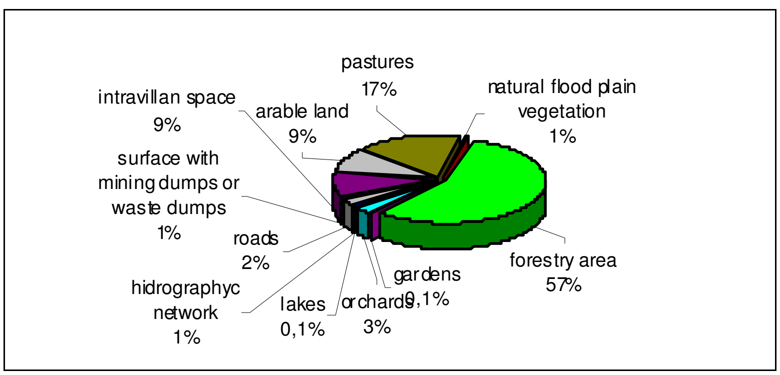

Fig. 3 - Shares of land use types in the studied area

Thus, we conclude that of the total studied area of 118.45 ha, a 67.59 ha area (i.e. 57%) is covered with forests of various types and compositions, and 30 ha are occupied by pastures (17% of the total) and arable land (9% of the total). Human impact on land use has been highlighted by areas occupied by: gardens (0.093 ha), orchards (3.55 ha), roads (2.56 ha), areas with waste dumps or mining dumps (0, 72 ha) and built area (11.09 ha). (Fig. 4).

The points raised by coordinates with the GPS on the field represent the position of each objective, to which we made a series of observations on how they influenced the quality of the environment in the local horizon. We wrote down the information that relates to:

-expanding oil stains on the ground (Fig. 5);

-height of the electricity poles; if they are functional or not, and the material of which are built (wood, reinforced concrete);

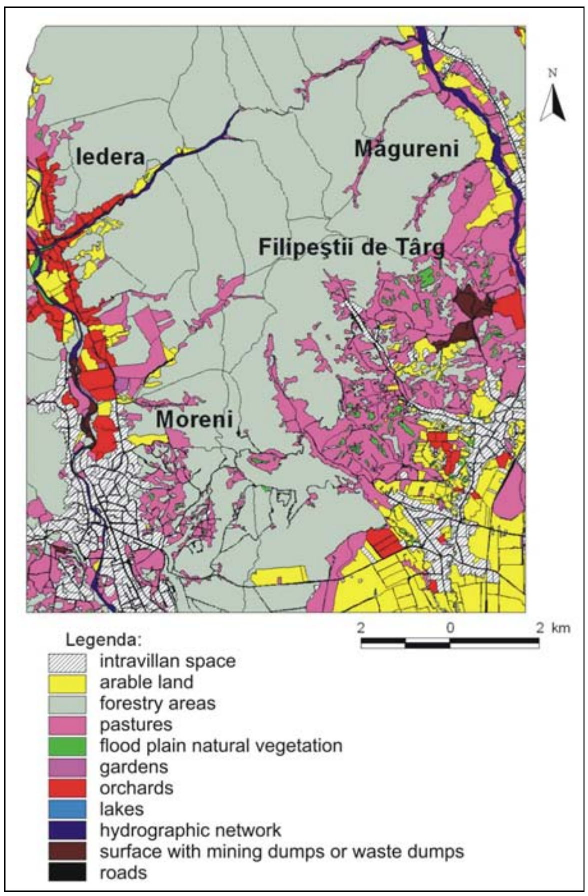

Fig. 4 - Land use in the studied area

-area occupied by the concrete pillars of the former extraction wells;
-presence of areas of landslides in the drill extraction vicinity;
-pits' area and the affected area around (Fig. 6);

Fig. 5 - Oil spot (areas affected by crude oil discharged from the extraction source) in the eastern hills on Moreni city, in the E sector on the map presented in Fig 7 (*Photo source: Florin Vartolomei)*

Fig. 6 - Tank oil (oil reservoirs, pits) in the eastern hills of Moreni city, in the H sector on the map presented in Fig 7 (*Photo source: Florin Vartolomei)*

-visible length of oil pipes;
-state of the extraction wells;
-width of roads operating and material pavement;

All this information has been linked with the reality on the ground by carefully writing down the serial number assigned by the GPS in the observation cards completed on the spot, and in the GIS environment by referencing the point downloaded from the GPS memory and viewed on the ortophotoplan with the number automatically assigned by the GPS, which is unique for every point scored in the field.

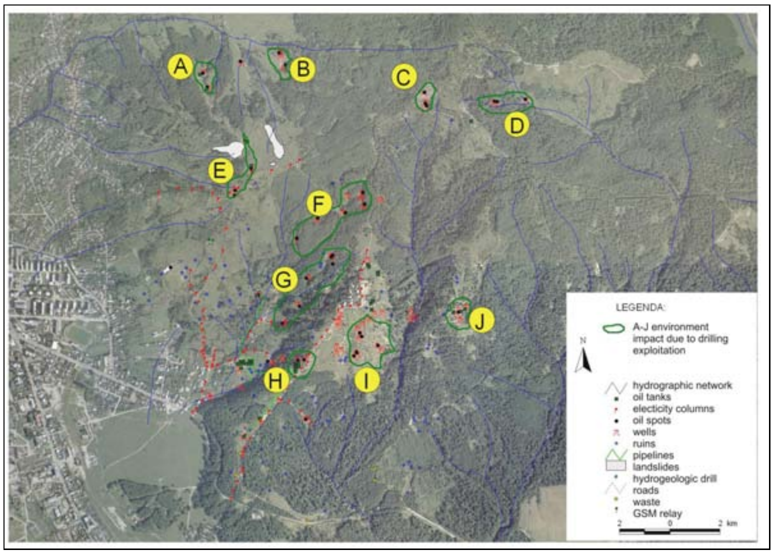

Fig. 7. Spatial distribution of sectors resulted from the analysis of the environmental impact of oil extraction activities in the studied area (impact concentration areas)

In the sector which was proposed for research, the occasional coal exploitation began over 100 years ago. The greatest petrol exploitation was made in the Moreni area (Fig. 7). The energetic coal need made it so that the minefield in Filipestii de Padure was continually extended through research and geologic exploitation. Several mines were successively started within this perimeter that was organized on different levels. Evidently, as the reserves diminished, some sectors were closed down or abandoned, through controlled flooding or accidental crashing of the ceiling. Such fortuitous abandons did not allow controlling and managing the surface and subterranean environment disorganization processes. Through legislation and notifications, the mining exploitation gave back the surfaces to the environment.

In the studied area, 10 sectors were identified with major problems related to the impact on the environment by oil exploitation, numbered from A to J and mapped on the aerial photo shown in Fig. 7.

For this grouping, we took into consideration especially the density and size of oil spots, the presence of tankers and catch pits with damage, the presence of wells, ruined columns and other forms of activity related to oil, condition and type of pipe alignments, the impact of roads exploitation on pastures and forests and the presence and size of waste pits.

Of the 10 sectors, we exemplified by a brief analysis of the situation, sectors G and I detailed in Fig. 8.

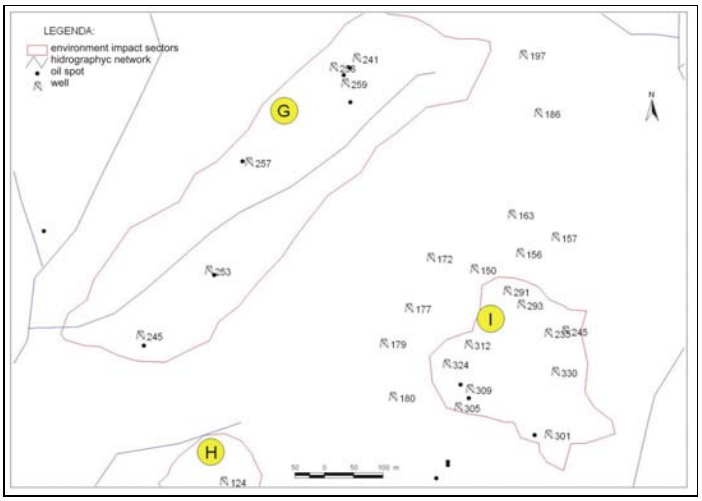

Fig. 8 - Spatial distribution of extraction wells and oil spots in the G and I sectors in the studied area

In the G sector, located along one of the left side tributaries of Valea Seacă, east of Moreni city, 6 wells were mapped in field with the following serial numbers assigned by GPS: 245, 253, 257, 241, 258, 259 (Table no. 2). These serial numbers were used as benchmarks for correlating the field observations and GIS mapping results of measurements made by GPS.

Tab. 2 Characteristics studied at the extraction wells in the G sector

GPS order no.	**STEREO 70 Coordinates**		**Subcategory code**	**Area**	**Tripod?**	**Oil spot?**
	X	Y				
245	552,563.90	387,264.09	Sf	25 sqm	Yes	60 sqm
253	552,847.37	387,663.84	Sf	30 sqm	Yes	50 sqm
257	552,738.34	387,549.28	**Sf**	30 sqm	Yes	55 sqm
241	552,949.12	387,552.11	**Sf**	30 sqm	Yes	30 sqm
258	552,553.00	387,271.35	**Sf**	25 sqm	Yes	35 sqm
259	552,632.95	387,416.72	**Sf**	25 sqm	No	10 sqm

It appears that the extracted area for the location of wells, most of them functional, is 25-30 sqm, almost all equipped with a tripod for support. Oil spots which surrounded the wells had areas ranging from 10 to 60 sqm, inducing their presence and influence on the phreatic table.

It should be noted that the impact areas for each hole do not join each other in any of the 10 sectors defined, although some probes were positioned on a radius less than 50 m apart. Drainage of the spots, where it exists, it was found to be in different directions due to the micro-topography, without confluences, but in most cases, after about 10 m of draining it stopped (Fig. 9).

Fig. 9 –GPS.259 point: Oil derrick for hydrocarbon extraction - points of primary production in the G sector (left) and GPS.309 point: Oil spot (areas affected by crude oil discharged from the extraction source) next to the 309 Oil derrick in the I sector (right) (*Photo source: Florin Vartolomei)*

In the I sector, limited on the SE by the G sector, 10 wells were mapped on the field with the following serial numbers assigned by the GPS: 291, 293, 235, 245, 301, 305, 309, 312, 324, 330. (Table no. 3).

A greater density of oil derrick for hydrocarbon extraction - points of primary production, was found, generating an increased density of the access roads. Extracted areas from the natural environment for the location of wells, most of them functional, is 25 sqm, almost all are equipped with a tripod for support. Oil spots surrounding wells, far fewer than in the other analyzed sectors, had surfaces reduced below 50 sqm, in 30% of the cases, only traces of oil stains were identified. The ecological condition is much improved in this area, probably due to the higher degree of accessibility. The sector is surrounded by pipelines carrying the oil to tanks and ponds in the H and J sectors (phenomenon favored also by the geographical position on the anticline between the two mentioned sectors, see Fig. 7) and functional wells without oil spots in the east and west and by a pipeline network to the storage tanks in the northern part lining the access road that crosses the top of the anticline.

Tab. 3 Characteristics studied at the extraction wells in the I sector

GPS order no.	**STEREO 70 Coordinates**		**Subcategory code**	**Area**	**Tripod?**	**Oil spot?**
	X	**Y**				
291	552,879.59	387,130.96	***Sf***	25 sqm	Yes	No
293	552,884.38	387,139.57	***Sf***	30 sqm	Yes	traces
235	552,876.72	387,015.25	**Sn**	20 sqm	No	No
245	552,863.34	386,987.51	**Sf**	25 sqm	Yes	traces
301	552,770,57	387,047.76	**Sf**	25 sqm	Yes	30 sqm
305	552,798.30	387,023.85	**Sf**	25 sqm	Yes	55 sqm
309	552,765.79	387,010.46	**Sf**	25 sqm	Yes	50 sqm
312	552,777.27	387,155.83	**Sf**	25 sqm	Yes	No
324	552,914.98	387,168.26	**Sf**	25 sqm	Yes	No
330	552,940.80	387,200.78	**Sf**	25 sqm	Yes	traces

Conclusion

On the general background of the transition to the market economy, the mine abandon phenomenon gave the environment a particular quality, perturbed by the presence of some specific industrial constructions, extraction devices, abandoned quarries and access roads to the abandoned economic objectives and so on. These new elements affect the natural circuits and generate, through their physical-chemical noxiousness, generating processes with a continuous development, such as sliding. On important areas, the respective processes are unmonitored and uncontrolled, affecting transportation networks (roads, pipes, etc), the slopes' stability, the protection of the construction and of the water sources, and disorganizing the ecologic and socio-demographic systems.

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