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ASPECTS OF MONITORING BY GIS TECHNIQUES OF THE QUALITY OF GROUND WATER FROM A SPECIFIC TERRITORY CASE STUDY.

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Abstract: The objective of the paper is to highlight the facilities of using Geographical Information System (GIS) techniques in monitoring space - temporal quality of the groundwater within a certain zone. Assessing the quality of groundwater (mainly groundwater) have been based on the content of organic substances, according on appreciated chemical oxygen consumption (CCO), necessary for oxidation of the organic substances without the intervention of bacteria. The spatialization of punctual information on concentrations of organic substances in 45 hydrogeological drillings has been made using an appropriate software (Surfer 8) and Kriging interpolation method.

Key words*: monitoring, groundwater quality, GIS techniques*

Introduction

In Romania, the activity of awareness of the quality of groundwater is carried out at major river basins, morphological units, and within them, on underground water structures, through hydrological stations, including one or more hydrogeological observation drillings of belonging to the national hydrologic network.

The quality of groundwater is determined by the quantities of various substances in these waters. These lists organic substances too.

The source of these substances is due to natural causes, erosional leaking on agricultural land in slope but especially antropic causes: discharge wastewater from human settlements, especially from zoo technical sectors. The influence of these substances is remarkable in drought seasons. Increasing quantities of organic substances over certain admissible limits means water pollution and is even a hint of the presence of germs that frequently accompany these substances.

The objective of the paper is to highlight the facilities of using Geographical Information System (GIS) techniques in monitoring space - temporal quality of the groundwater within a certain zone.

Case study. Physical, geographical and hydro geological characterization of the studied area.

The geographical space limits in which we proposed to forge a study on the quality of groundwater caused by the presence of organic substances in

different concentrations was basin of the Prut river, situated on the territory of Romania (the right part of the basin).

Prut River springs from the Ukraine's Carpathians (Pădurosi) ,flows eastward, but much of the course takes the southeast direction forming the border between Romania and Moldova. It flows into the Danube in Giurgileşti locality (near the city of Galati).

Total length of the river from source to river mouth is 953 km, of which in Romania, 742 km.

The total area of the river basin is 27.500 km^2, of which in Romania are 10967 Km^2, on the administrative territory of the: Botosani, Iasi, Galati and Vaslui districts.

Groundwater in the Prut river basin are stored in sandy deposits of Quaternary age, with intercalation of clay of minor hydrological importance. In these circumstances exploited reserves are found in poorly permeable deposits of river meadows .For example, in the Plain of Moldova under pressure underground water layers are stored in sandy and gravel deposits on the basis of the terraces and plains , having a sweetish taste .Forming conditions of groundwater exist on large areas and at the bases of deluvial – coluvial deposits when they support on impermeable layers .In this case, ground water are situated on very different depths and have properties in terms of quality and thickness of deposits.

The free groundwater accumulates in the first horizon of permeable rocks and it get supplied from precipitation, from hydrological units of the area and locally from river mouth.

The supplying of the under pressure groundwaters is made from the hydrogeological superior units, from the highest point of the layer and the drainage is made from the lower point of the layer.

In most cases mineral deposits conditions are favourable for mineralization

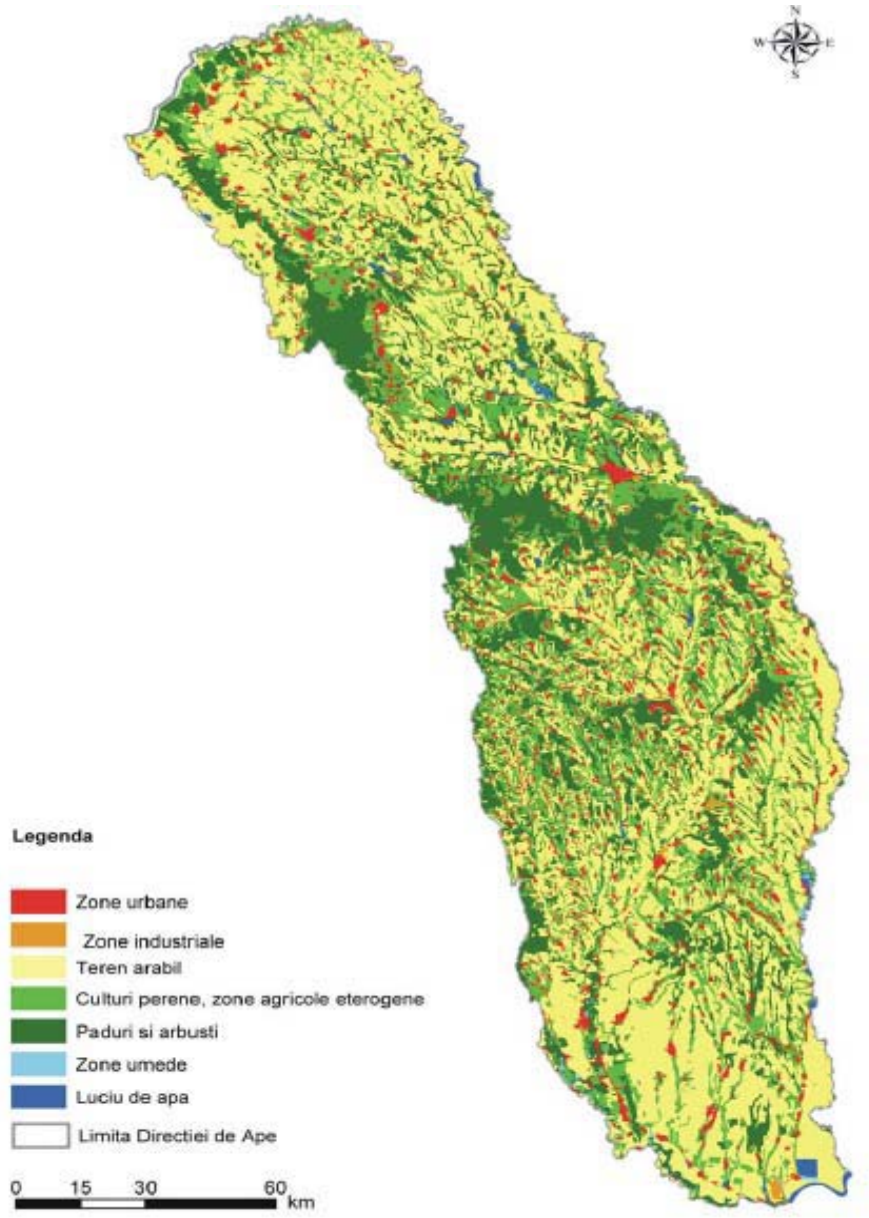

Figure 1. *Hydrographical basin of Prut river: land use*

The research method used. Processing and interpretation of results

Assessing the quality of groundwater (mainly groundwater) have been based on the content of organic substances, according on appreciated chemical oxygen consumption (CCO), necessary for oxidation of the organic substances without the intervention of bacteria.

Table no. 1. *The concentrations of CCO-Mn, determined by the laboratories of the "Direcția de Gospodărire a Apelor Prut-Iaşi" for water samples taken from 45 hydrological drillings*

Current number	Indicative Drilling	Location of drillings in STEREO'70		CCOMn (mg/l)		
		X	**Y**	**2004** year	**2005** year	**2006** year
1	F1 (R-P)	634150,562	751325,439	4,76	5,975	6,0
2	F2 (R-P)	633863,404	750817,791	4,38	5,57	14,7
3	F1 (SA)	658289,763	722926,687	5,61	9,16	4,4
4	F1 (ST)	667731,251	701856,350	6,82	5,57	5,0
5	F2 (ST)	667133,890	701741,096	4,40	4,375	3,4
6	F3 (ST)	665339,264	701495,313	8,02	9,165	14,1
7	F1 (CI)	696082,457	653053,352	25,00	22,00	15,5
8	F2 (CI)	693880,402	653097,634	44,00	27,00	83,9
9	F3 (CI)	690868,400	653521,559	17,50	21,00	17,4
10	F5 (CI)	691156,982	650027,408	48,00	38,00	19,2
11	F1 (C-R)	710883,965	637421,058	41,00	20,00	17,4
12	F5 (CR)	706655,705	634513,032	36,50	38,50	17,0
13	F1 (CO)	720455,610	622856,785	44,50	69,00	51,2
14	F3 (CO)	717542,139	619381,882	89,00	78,50	37,0
15	F3 (RA)	740100,524	589639,041	6,55	3,7	4,2
16	F1 (LB)	747776,891	570825,278	40,00	11,4	3,8
17	F1 (V)	748618,872	557241,570	12,05	15,4	10,5
18	F3 (F)	743885,527	538616,078	4,25	5,7	3,7
19	F4 (F)	742680,849	546232,553	4,40	4,2	3,5
20	F1 (RI)	739858,249	611963,055	5,00	6,6	4,8
21	F2 (SIV)	739933,046	602851,455	9,39	4,33	3,1
22	F4 (SIV)	738730,885	591281,232	26,40	4,64	7,7
23	F1 (SIV)	615773,355	714936,515	25,43	16,705	12,2
24	F1 (SIV)	646264,066	708012,499	6,41	9,595	9,3
25	F2 (SIV)	646069,205	707807,432	4,40	3,99	6,1
26	F3 (SIV)	645874,343	707602,365	4,80	10,78	6,5
27	F2 (SIV)	653634,901	693593,688	6,00	14,35	6,5
28	F1 (SIV)	659898,363	683348,529	15,55	7,525	9,3
29	F3 (SIV)	658908,750	682923,178	10,04	12,355	20,2
30	F1 (SIV)	637665,861	688184,548	4,365	5,55	13,8

Current number	Indicative Drilling	Location of drillings in STEREO'70		CCOMn (mg/l)		
		X	**Y**	**2004** year	**2005** year	**2006** year
31	F1 (SIV)	646075,989	683997,085	12,355	9,39	8,5
32	F1 (SIV)	646222,338	658591,021	17,30	33,00	6,3
33	F8 (SIV)	711030,507	631622,380	42,50	24,00	29,8
34	F2 (SIV)	649494,205	651871,758	22,60	27,50	10,7
35	F1 (SIV)	655811,718	647330,530	18,50	18,30	11,4
36	F2 (SIV)	655421,985	646920,496	28,00	19,00	36,6
37	F3 (SIV)	657439,168	646271,449	21,50	18,00	10,0
38	F4 (SIV)	657113,880	647263,549	18,50	17,00	9,1
39	F1 (SIV)	637851,363	720103,554	5,08	8,765	10,1
40	F1 (SIV)	670722,327	674719,812	74,00	55,00	23,6
41	F1 (COR)	745319,914	580868,538	28,59	36,20	36,6
42	F3 (BR)	745945,104	546232,553	26,03	44,55	21,1
43	F3 (BR)	745845,131	557225,907	14,96	12,86	12,4
44	F12 MA(BR)	749219,143	602851,455	11,70	11,92	8,6
45	F13 MA(BR)	746924,780	592018,866	16,24	18,42	17,8

Water samples analyzed in the period 2004 -2006 were taken from 45 randomly distributed drillings in the area of research.

Starting from a relatively small number of drillings and samples examined, it wasn't possible to appreciate exactly but to approximate the spatial-temporal distribution of organic substances in groundwater from the large territory considered, in which case it is difficult to develop on time useful intervention measures especially in the overrun critical thresholds case.

In the context of the above was done through GIS techniques the spatialization of punctual information on concentrations of organic substances in the hydrogeological 45 drillings and has been highlighted the evolution of this parameter. For this purpose has been using an appropriate software (Surfer 8).

From all 12 interpolation methods provided the Surfer has chosen to analyze the evolution of the content of organic substances in groundwater using Kriging interpolation method.

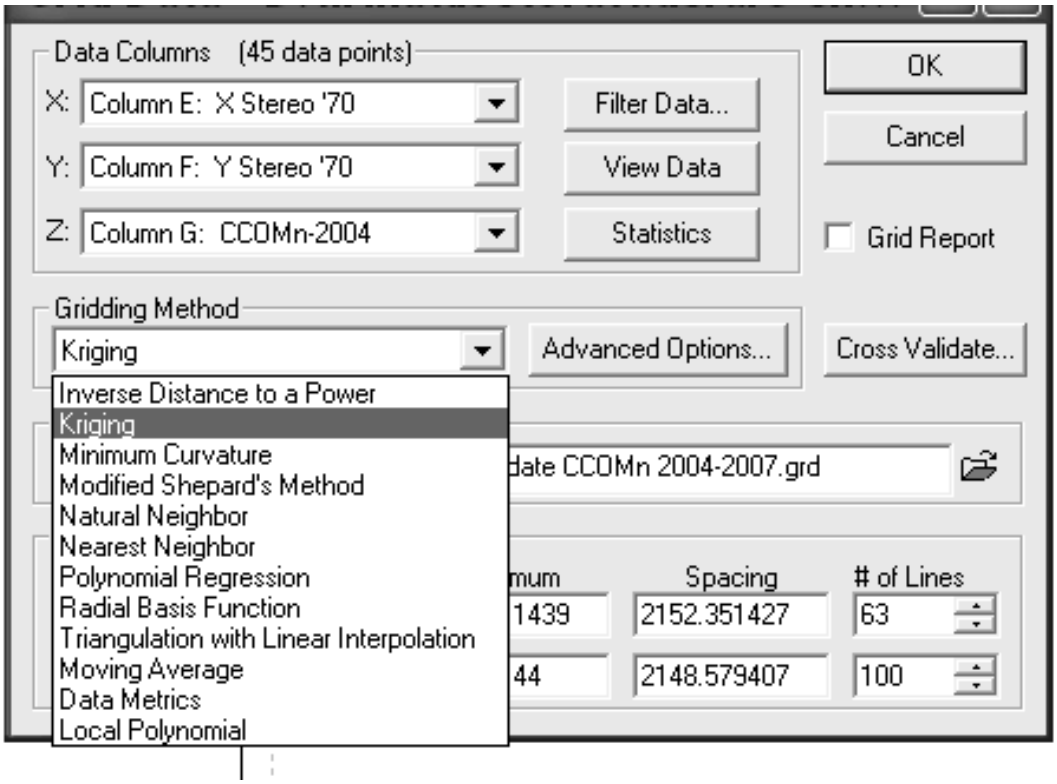

Figure 2. *Surfer software detail - the election of the interpolation method and determining the size of the pixel*

After the interpolation using Kriging method of the concentrations values of CCO-Mn (Consumption of Chemical Oxygen determined by the method with permanganate), made in the laboratories of Direcția de Ape-Prut Iaşi for the water samples taken from 45 drillings ,have been obtained the concentrations in 6300 points raster , located in the centre of cells (pixels), having the dimensions of 2150 x 2150 m.

In table 2 are selectively presented the CCOMn concentrations from the automated processing using Surfer 8 software (located by X and Y coordinates) after interpolation.

Table no. 2

Pixel number	**X** Stereo '70	**Y** Stereo '70	**CCOMn (mg/l) 2004**	**CCOMn (mg/l) 2005**	**CCOMn (mg/l) 2006**
1	615773,355	538616,078	25,45733259	14,49905799	12,83103197
2	617925,706	538616,078	25,52958364	14,48505191	12,76320121
3	620078,058	538616,078	25,59949774	14,46717341	12,69091528
4	622230,409	538616,078	25,66663355	14,44511795	12,61402846
5	624382,761	538616,078	25,73051275	14,41855795	12,53239822

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2375	708324,466	618113,516	71,750918	58,92437483	29,35562784
2376	710476,818	618113,516	75,10447696	62,36687852	31,02703737
2377	712629,169	618113,516	78,89755603	66,43872189	32,64136433
2378	714781,521	618113,516	83,05465153	70,98634617	34,06331277
2379	716933,872	618113,516	85,98821123	74,94982079	35,24304725
2380	719086,223	618113,516	77,62770774	73,19681511	37,09139208
2381	721238,575	618113,516	64,62151712	67,58609433	37,98143821
2382	723390,926	618113,516	54,12007126	60,9694019	36,7773936

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6294	736305,035	751325,44	4,795423119	7,940129663	8,024725426
6295	738457,386	751325,44	4,717940237	7,974083838	8,123039135
6296	740609,738	751325,44	4,63589522	8,006875166	8,217509434
6297	742762,089	751325,44	4,54973557	8,038638569	8,308169399
6298	744914,441	751325,44	4,459895732	8,06950533	8,395066039
6299	747066,792	751325,44	4,366794991	8,099601742	8,478258169
6300	749219,143	751325,44	4,270835871	8,129048082	8,55781452

Results obtained and their interpretation

For interpretation of the results were compared CCOMn values measured in laboratory tests on water samples collected during 2004 - 2006 from the 45 drillings taken in the study from Prut river basin with the maximum allowed values given by Law no. 458/2002 Law amended and supplemented by Law no. 311/2004. maximum allowed concentration for oxidable organic substances is 5 mg / l.

For an easier perception of space-time distribution of the content of organic substances in groundwater from Prut river basin has been achieved in 2D graphics representation (with isoline maps concentration in CCO) figure 3,4,5 respectively in 3D, separately for the years 2004, 2005 and 2006 (figure 6, table 3).

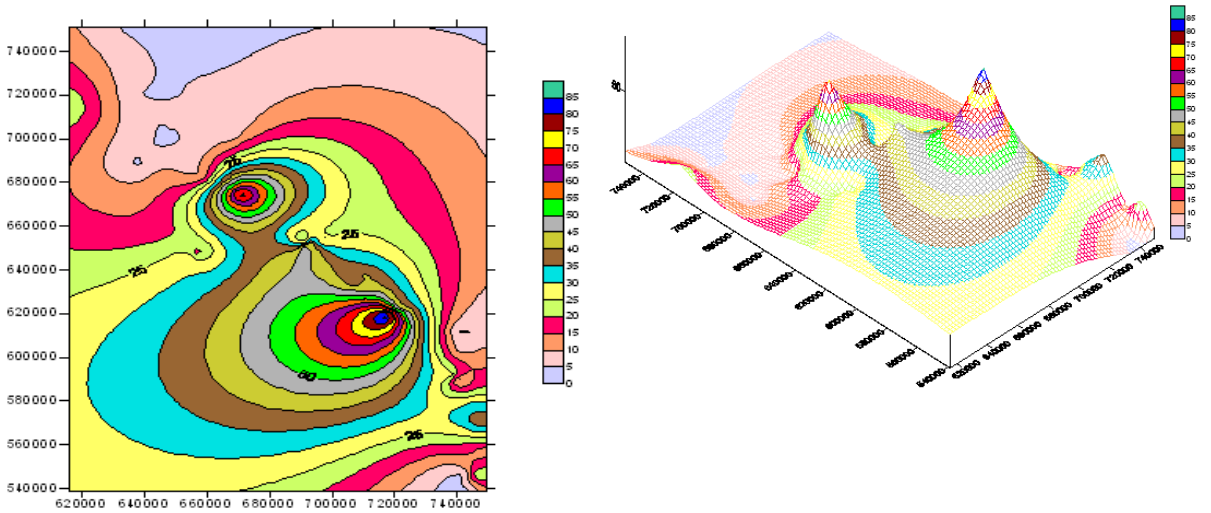


Figure 3. *The CCO-Mn distribution in the Prut river basin in 2004 (2D and 3D representations)*

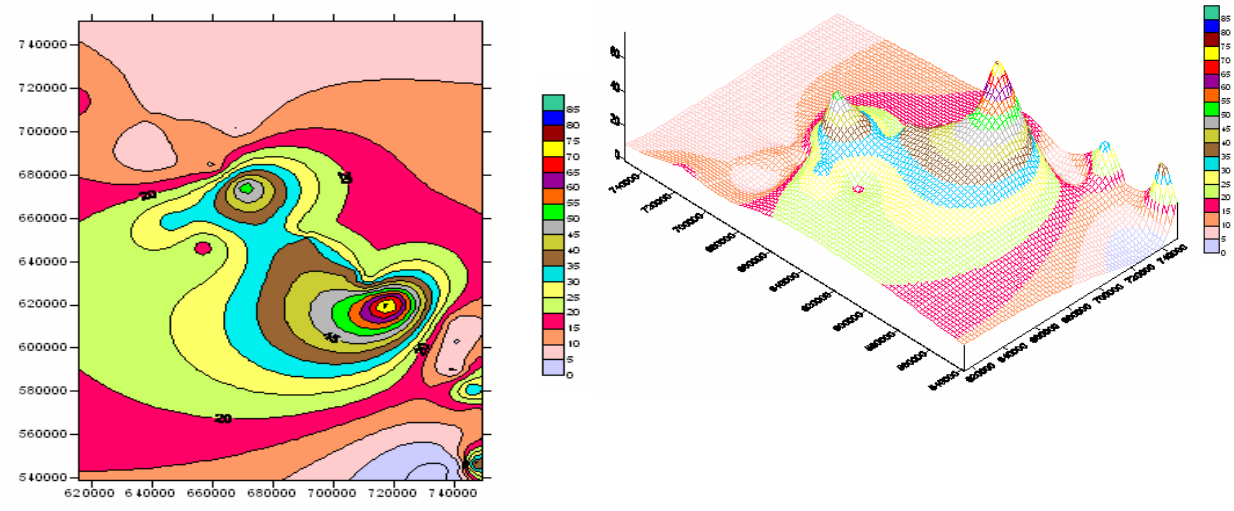


Figure 4. *The CCO-Mn distribution in the Prut river basin in 2005 (2D and 3D representations)*

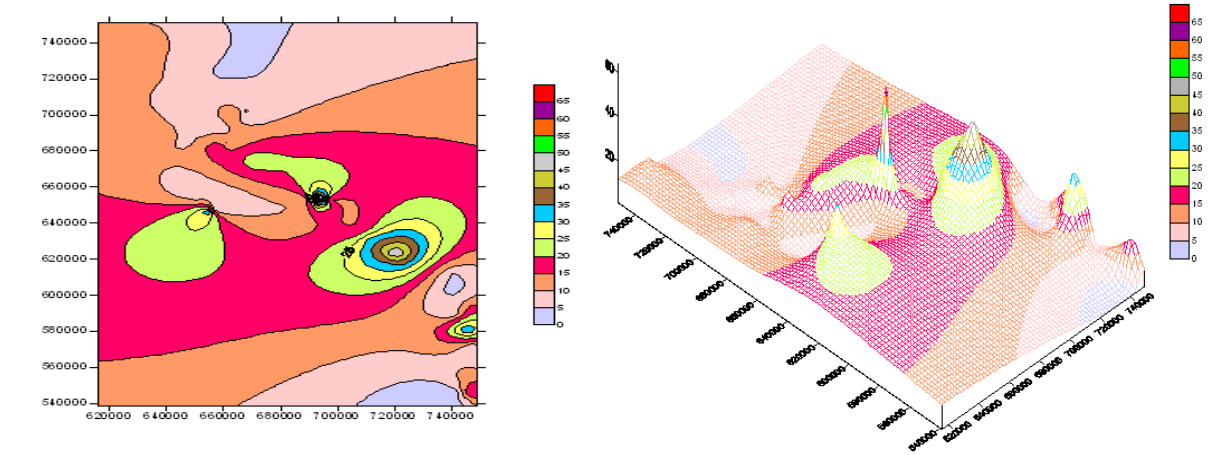
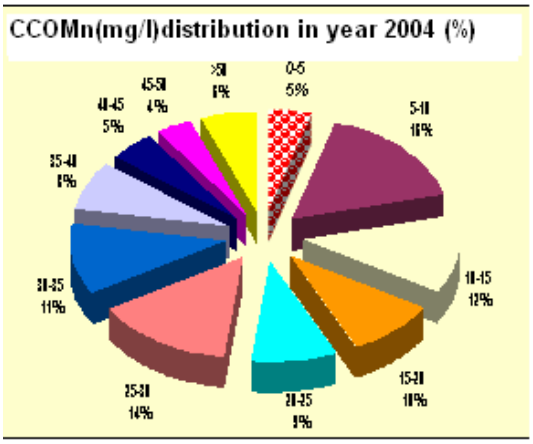
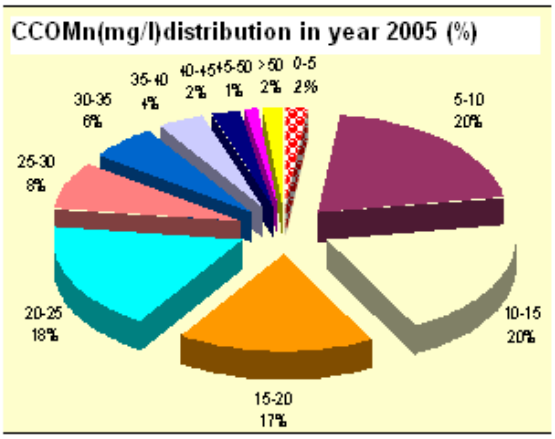


Figure 5. *The CCO-Mn distribution in the Prut river basin in 2006 (2D and 3D representations)*

Table no. 3

Concentration intervals (mg/l)	**Year 2004 (%)**	**Year 2005 (%)**	**Year 2006 (%)**
0-5	4,51	1,86	3,76
5-10	16,62	20,70	23,40
10-15	12,40	19,56	32,62
15-20	9,62	17,17	27,92
20-25	8,70	17,59	8,68
25-30	14,59	8,22	1,92
30-35	11,40	5,70	0,87
35-40	7,62	3,87	0,51
40-45	5,06	2,43	0,22
45-50	3,76	1,29	0,06
>50	5,73	1,62	0,03





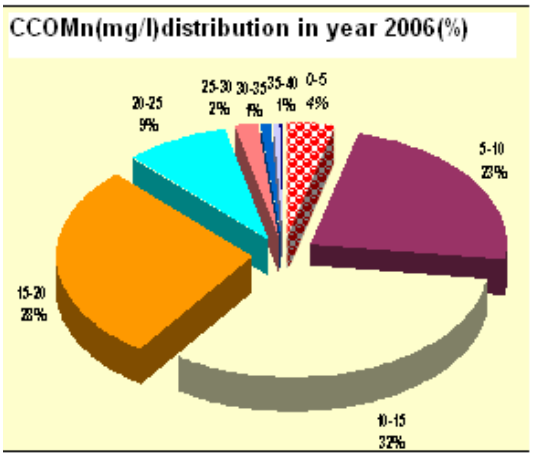


Figure number 6 – The percentage of CCOMn on values intervals during 2004, 2005, 2006, in the area studied

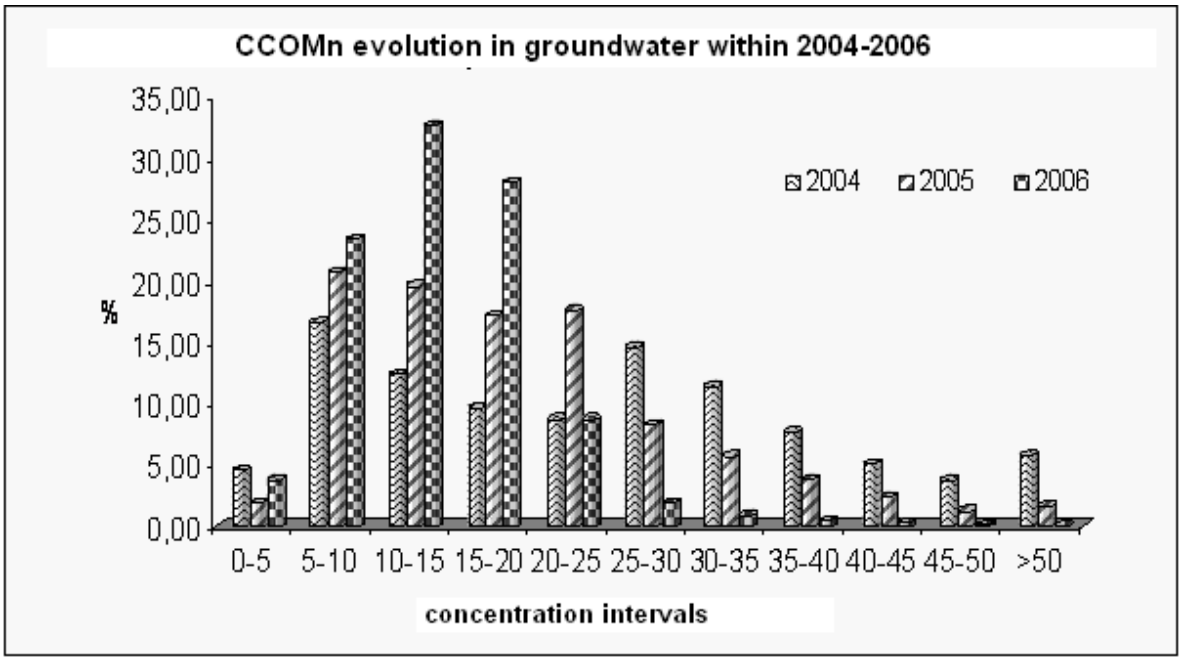


Figure 7. *CCOMn evolution into groundwater within 2004 -2006, the area studied*

Conclusions

From analysis and information resulting from the processing of data with software that could also notes:

a.) an increase in the content of organic substances from west to east (to the Prut River and from north to south).

b.) as regards developments in time of the concentrations in organic material in groundwater.

Overall, during the period we refer, although for 90% of the monitored drillings the maximum limit of the organic substances which ensures potability has been exceeded, could find a slight weakening of the content of organic substances in the groundwater from Prut basin, data presented in table 3 and figures 6 and 7, on concentration values that highlights other tendencies of this parameter period from 2004 to 2005.

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