ENVIRONMENTAL LEVELS AND DISTRIBUTION OF CARBON MONOXIDE IN BUCHAREST URBAN AREA CASE STUDY: 1. 07. 2006 – 31.03.2007

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ABSTRACT. – Environmental levels and distribution of carbon monoxide in Bucharest Urban Area – Case study: 1.07.2006 – 31.03.2007. Ambient concentrations of carbon monoxide in the vicinity of or inside urban and industrial areas can substantially exceed environmental background levels and can be detrimental to human health and welfare. In this period of analysis (July 2006 – March 2007), the maximum allowable concentration (MAC) was exceeded especially at Mihai Bravu and Cercul Militar. The accompanying diagrams showing the time evolution and charts revealing the spatial distribution of CO ambient air concentrations (based on GIS techniques) can be useful instruments in identifying the potential risk areas, like the important streets in the center of Bucharest.

Keywords: carbon monoxide, pollutant, emission sources, impact.

1. INTRODUCTION

Carbon monoxide is a primary pollutant, a combination of one atom of carbon and one of oxygen. It is a colorless, odorless and tasteless compound of the ambient air, either of natural or artificial origin. It is formed mainly by the incomplete combustion of fossil fuels. The natural sources of carbon monoxide are rather few: vegetation decay processes, volcanic eruptions, forest fires etc., while the artificial ones are extremely varied: steel and cast iron industry, oil refining industry, car traffic etc. Carbon monoxide from natural sources is rapidly dispersed over a large area, while the one from artificial sources may dangerously increase its environmental levels, becoming harmful for human health. It can actually accumulate in dangerous concentrations for people, especially on calm weather in winter or spring (it's much stable at low temperatures). High CO levels turn it into a toxic gas that can be quite lethal at high concentrations (over 100 mg/m^3). When CO combines with the hemoglobin, it forms the carboxy-hemoglobin, causing an acute oxygen deprivation (*anoxia)*. It also causes irritability, nausea, confusion and fainting.

2. DATA AND METHODS

The data used in the present study were collected from seven automatic monitoring stations of the Environmental Protection Agency in Bucharest. They are located in the following areas included in Bucharest's Metropolitan Area: Drumul Taberei, Lacul Morii, Măgurele, Cercul Militar Naţional, Mihai Bravu, Titan and Berceni.

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The CO hourly concentrations have been provided by all the above-mentioned monitoring stations only for the period of reference: 1 July 2006 – 31 March 2007. Daily and monthly averages were calculated to make graphs and tables that indicate the time and space variation of carbon monoxide. The maps were made using ArcGIS Desktop 9.3. Data and geographic coordinates for each monitoring station were introduced in a synthetic table and inserted into the program. In the end, using the Spline interpolation method, a raster resulted which indicated the spatial distribution of CO in Bucharest. The maps indicate the regions, which recorded high CO values that may be harmful to human health, especially those that exceeded the maximum allowable concentration (MAC) of 2 mg/m^3.

3. RESULTS AND DISCUSSIONS

Carbon monoxide values may vary from month to month and from day to day, depending on several factors such as weather conditions and human activities.

As regards the *monthly average concentrations* of CO, we considered that the most representative for the period of reference, were the months: July, November, December (2006) and February (2007).

As one can see in Fig.1, the highest values were recorded in autumn and in winter. This is due to the bad weather conditions, which determine an increasing activity of artificial heating systems and power stations. In Bucharest, there are five operating stations of such type: CET Sud, CET Vest, Progresu, Grozăveşti and Titan, most of them being located in the suburbs, near the residential areas. The central heating systems, which use natural gas and oil for combustion are also considered important sources of pollution. In Bucharest, there are many such power stations located in the suburbs (for example Industriilor and Sălăjan) but also in the center of the city (Calea Călăraşi - Unirii), in which almost every dwelling has its own central heating system. Because most of the stacks have a relative height between 5-12 m (Mănoiu, 2005), they are considered to have a high impact upon the nearby areas. Other important sources of pollution are ceramic and glass manufacturers (Stirom S.A.), which are also present in Bucharest. But the main source of pollution with carbon monoxide is the car traffic. In autumn and in winter, the traffic increases because of the bad weather conditions such as low temperatures, rain and snow. In this period, people would rather use their own cars instead of walking or using the public transportations which sometimes can have long delays or simply fail to cover the entire area of the city. As one can notice in Fig.2. and in Fig.4., the highest values of the monthly average concentrations of CO in July and in December were obtained at the two monitoring stations located in and near the midtown area, at Cercul Militari and Mihai Bravu. This fact can be well noticed in Fig.5. too; the monthly average concentrations recorded at these stations being the highest of all the months of the analyzed period. This is in a large proportion due to the traffic, which, on the Mihai Bravu – Obor Road, for example, recorded an average of 3,700 vehicles/hour, in the period 1999-2006 (Iojă, 2008). At both monitoring stations, the maximum allowable concentration of carbon monoxide of 2 mg/m^3 was exceeded: for Cercul Militar in July, September,

October, November (Fig. 3) and December, with values which range between 2.16 – 3.35 mg/m^3 and for Mihai Bravu, in October, December, January and March, with values between 3.27 and 4.72 mg/m^3. Because of these high CO concentrations, we can infer that the population in these two regions of Bucharest were exposed to cardiovascular illnesses, effects of fibrinolysis and perinatal and neurobehavioral effects (Rojanschi et al., 2002). At Berceni, Drumul Taberei, Lacul Morii, Măgurele and Titan, the monthly average CO concentration ranged between 0.03 (in March 2007, Titan) and 0.93 mg/m^3 (in October 2006, Drumul Taberei), actually representing safe low values, which do not pose any health risks.

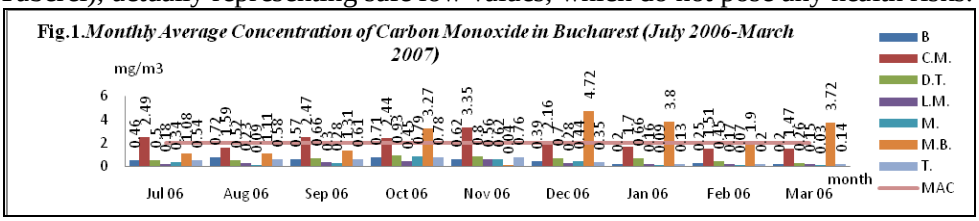


Fig.1. ***Monthly Average Concentration of Carbon Monoxide in Bucharest (July 2006-March 2007)***

Monthly Average CO Concentrations

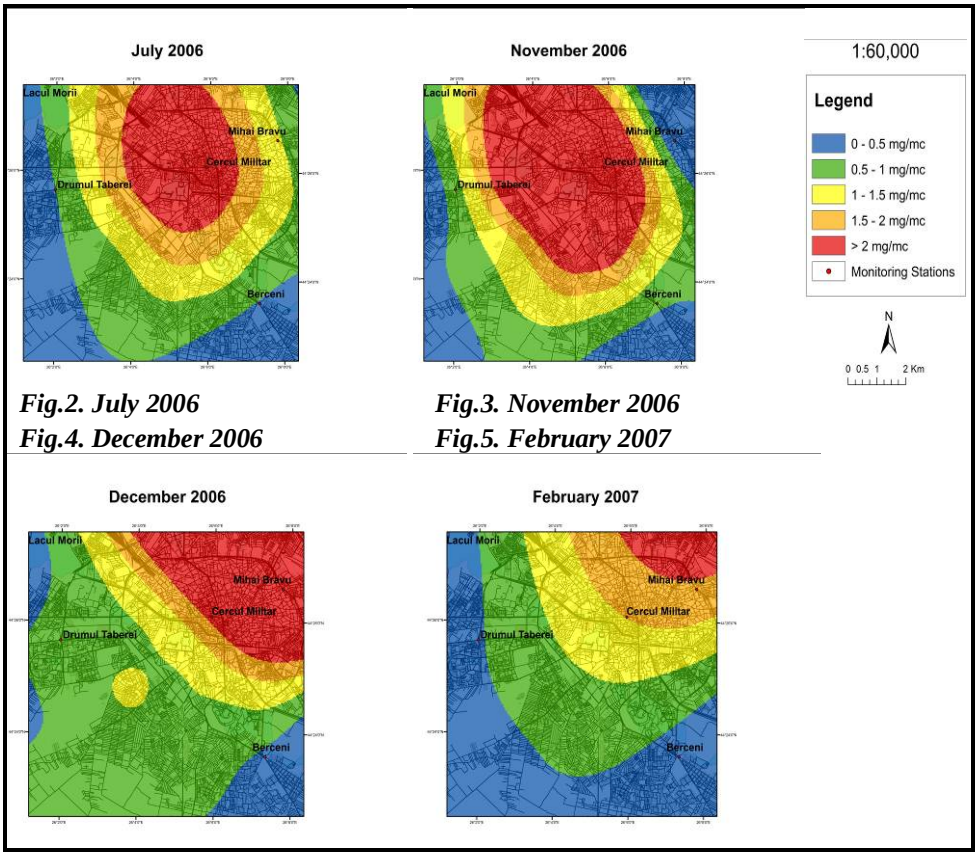


Fig.2. July 2006
Fig.3. November 2006
Fig.4. December 2006
Fig.5. February 2007

As the maps presenting the territorial distribution of the monthly average CO concentration in Bucharest over the four months of analysis, the highest values were recorded in the central and in the northeastern parts of the city and decreased constantly towards the south-west.

Further, the *daily averages* of CO concentrations, between July 2006 and March 2007 will be analyzed. The days with the highest values of carbon monoxide concentrations were 10.25.2006, 11.01.2006, 09.12.2006, 03.15.2007, for which a relevant spatial representation was given in Fig.6.- Fig.9.

However, if analyzing Table 1., which presents the variation of daily mean CO concentrations on July 2006, we can see that the maximum allowable concentration (2 mg/m^3) was exceeded only at Cercul Militar National. The highest value was recorded on 13 (over 4.5 mg / m^3). Its main cause is obviously heavy traffic as this station is located in Bucharest's midtown. In the first days of July 2006 (1 – 12 July) the MAC wasn't exceeded at any station. The same first 12 days of August 2006 (Table 2.) the MAC was exceeded nowhere in Bucharest town-area. However, there is a certain resemblance between August and July as regards the CO concentrations. On 13th August 2006, the Cercul Militar National automatic station recorded the highest value of this month (about 4.8 mg/m^3). The causes are similar to those in July. In summer, low values are generally being registered due to the fact that most inhabitants leave the town on vacation. If analyzing Table 3., in September 2006, the highest value was recorded at Cercul Militar on 17 (over 4 mg/m^3). The CO concentration limit was actually exceeded more often at Cercul Militar, but also at Mihai Bravu station. The main cause is heavy midtown traffic too. In October (Table 4.), the concentrations were higher at the end of the month. The place where the highest values were recorded was Mihai Bravu, on day 25 (10 mg/m^3). The main cause is rush traffic, but also increasing domestic heating, because of decreasing outdoor temperatures. The CO concentrations increase at the end of the month. Over-MAC concentrations were recorded at Mihai Bravu especially, Titan and Cercul Militar. Fig.6. represents a map of CO distribution in 10.25.2006 and it is evident that CO pollution is higher in the central and northeastern parts of Bucharest town-area, where it usually exceeds the maximum allowable concentration of 2 mg/m^3. In the southwestern parts of the city, an important source of pollution is represented, besides traffic (Antiaeriana Street, Calea Rahovei), by the numerous industrial units and the lack of green spaces (Ghinea, 2000). Low values are registered in southern and southeastern areas. In November 2006 (Table 5.), the highest value was recorded on day 1 (over 15 mg/m^3) at Mihai Bravu. This is the day that registered the highest concentration of the whole period of analysis. High values, exceeding the MAC, were also measured at Mihai Bravu and Cercul Militar in November. A possible cause of such rather atypical high values might be, besides traffic and domestic heating, a thermal inversion that brought gaseous pollutants near the ground. On 1st of November (Fig.7.), exceeding values have been recorded in the central and northeastern parts of Bucharest, and low values were recorded in the western and southern areas of the city. In December (Table 6.), values that exceed the

maximum allowable concentration of 2 mg/m^3 were measured at Mihai Bravu, Cercul Militar, but also in Drumul Taberei (day 6) and Titan. The highest CO concentration was reached on 9th December (10 mg/m^3). The causes are similar to those in November. As Fig.8. (December, 9, 2006) shows, the maximum allowable CO concentration was exceeded in the central, northeastern and southwestern districts (Rahova) and low values are recorded in the southeast and in isolated small areas in the south. In January 2007 (Table 7.), CO concentrations higher than the MAC were recorded at Mihai Bravu (highest value is above 10 mg/m^3) and Berceni (day 23). The causes of these very high values are traffic, industry, domestic heating and a possible temperature inversion. In February (Table 8.), CO levels keep lower than the other months of winter. Over-MAC concentrations were recorded in Mihai Bravu and Cercul Militar. The highest value was recorded on February 4 at Mihai Bravu (over 4 mg/m^3). In March 2007 (Table 9.), the last month of the present analysis, very high CO levels were recorded, especially at Mihai Bravu. 15th March is the day when the highest value was recorded (over 10 mg/m^3 at Mihai Bravu). The maximum allowable concentration was exceeded for several times at Mihai Bravu and Cercul Militar. The map representing the spatial distribution of CO concentrations on the 15th of March (Fig. 9.) indicates that the MAC of 2 mg/m^3 is exceeded in the central and northeastern town areas, while low values are specific of the central, southern and northwestern areas. One can also notice that, the first part of the period of analysis the higher values were recorded at Cercul Militar, while in the second part, very high values were recorded at Mihai Bravu. The four representative daily CO concentrations represented on maps, indicate that the higher CO levels are always to be found in the central and northeastern areas, while the lower values are especially characteristic of the southern areas of Bucharest.

According to Table 10., the frequency of CO levels over MAC concentrations varies from one station to another. The highest frequency was recorded in November 2006 when, MAC was exceeded every day. High frequencies were also recorded at Cercul Militar during the same month (90% of days). The Lacul Morii and Magurele stations had 0% for the entire period, instead.

Table.1.July 2006

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.32	0.68	0.95	0.50	0.41	0.72	0.58	0.42	0.39	0.44	0.45	0.34	0.32	0.47	0.31	0.60	0.81	0.59	0.95	0.66	0.60	0.64	0.29	0.14	0.44	0.36	0.29	0.25	0.19	0.13	0.24
C.M.													4.62	1.72	1.58	2.18	1.40	2.03	1.74	3.01	2.92	3.65	1.60	3.40	2.58	4.17	2.10	3.35	2.76	2.47	1.82
D.T.	0.44	0.56	0.62	0.47	0.49	0.63	0.63	0.68	0.46	0.55	0.48	0.41	0.52	0.46	0.43	0.55	0.37	0.43	0.55	0.60	0.52	0.57	0.40	0.67	0.60	0.53	0.42	0.46	0.36	0.36	0.39
L.M.	0.07	0.09	0.14	0.11	0.13	0.11	0.22	0.24	0.19	0.10	0.14	0.15	0.12	0.15	0.19	0.15	0.15	0.23	0.26	0.14	0.15	0.17	0.17	0.26	0.35	0.28	0.31	0.31	0.19	0.26	0.34
M.	0.08	0.42	1.03	0.44	0.97	1.18	0.53	0.16	0.02	0.18	0.36	0.15	0.17	0.17	0.04	0.66	1.07	0.34	0.33	0.05	0.58	0.20	0.06	0.11	0.12	0.34	0.11	0.27	0.29	0.06	0.36
M.B.				1.39	1.50	0.97	0.92	0.79	1.29	1.36	1.08	1.01	1.44	1.12	0.72	0.81	0.74	0.74	0.81	1.07	1.02	0.99	1.02	1.65	1.10	1.08	1.18	1.62	0.82	0.96	1.51
T.	1.13	0.35	0.46	0.50	0.75	0.58	0.57	0.46	0.44	0.56	0.57	0.47	0.47	0.48	0.47	0.15	0.54	0.78	0.70	0.66	0.54	0.44	0.36	0.44	0.27	0.51	0.59	0.62	0.86	0.47	0.75

Table.2.August 2006

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.14	0.44	0.36	0.29	0.25	0.19	0.13	0.24																							
C.M.													4.62	1.72	1.58	2.18	1.40	2.03	1.74	3.01	2.92	3.65	1.60	3.40	2.58	4.17	2.10	3.35	2.76	2.47	1.82
D.T.	0.30	0.40	0.54	0.50	0.36	0.43	0.36	0.37	0.38	0.40	0.46	0.72	0.59	0.29	0.32	0.62	0.82	1.14	1.14	0.55	0.44	0.34	0.45	0.79	0.72	0.26	0.57	0.71	0.49	0.57	0.40
L.M.	0.20	0.31	0.36	0.14	0.06	0.16	0.21	0.10	0.23	0.27	0.08	0.18	0.20	0.23	0.32	0.38	0.44	0.35	0.22	0.12	0.09	0.21	0.49	0.37	0.35	0.28	0.21	0.21	0.11	0.21	0.26
M.	0.25	0.18	0.05	0.02	0.08	0.19	0.24	0.50	0.12															0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M.B.	0.80	1.09	1.28	1.25	0.66	0.59	0.92	0.69	0.48	1.45	1.47	0.94	0.74	1.60	1.40	1.55	0.84	1.41	2.34	1.75	1.20	0.72	1.38	0.90	1.70	1.26	0.90	0.72	0.89	1.05	0.71
T.	0.60	0.58	0.57	0.91	1.07	0.20	0.59	0.49	0.57	0.61	0.31	0.36	0.54	0.65	0.75	0.50	0.27	1.03	0.97	0.71	0.57	0.34	0.29	1.14	0.59	0.76	0.50	0.50	0.70	0.40	0.27

Table.3.September 2006

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.72	0.54	0.27	0.63	0.75	0.52	0.36	0.25	0.58	0.47	0.68	0.73	0.79	0.66	0.45	0.60	0.58	0.29	0.26	0.62	0.65										
C.M.	3.25	1.44	0.93	2.10	2.07	2.86	3.32	2.96	1.61	2.11	3.35	3.92	3.26	1.81	1.81	3.60	4.07	2.50	2.03	2.56	2.45	3.02	1.81	2.56	2.66	3.20	2.00	1.78	1.45	2.10	
D.T.	0.51	0.41	0.43	0.19	0.36	0.62	0.74	1.18	0.73	0.66	0.70	0.95	1.06	0.81	0.86	0.54	0.37	0.60	0.69	0.78	0.63	0.52	0.33	0.53	0.74	0.88	0.88	0.81	0.58	0.90	
L.M.	0.36	0.28	0.13	0.10	0.10	0.20	0.40	0.22	0.14	0.20	0.32	0.34	0.41	0.47	0.40	0.28	0.21	0.40	0.31	0.32	0.15	0.32	0.37	0.25	0.38	0.36	0.30	0.44	0.47	0.62	
M.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.43	0.41	0.16	0.45	0.74	0.70	0.87	1.05	1.16	1.29	1.24	
M.B.	0.53	0.86	1.05	0.92	0.58	1.00	1.90	1.60	1.18	1.30	1.64	1.70	1.40	1.13	1.61	1.89	1.10	1.26	1.74	0.98	0.81	1.61	1.35	2.19	1.66	1.42	1.85	0.53	1.39	2.46	
T.	0.70	0.22	0.61	0.30	0.27	0.81	0.67	1.09	1.08	0.19	0.44	0.61	0.98	0.60	0.39	0.28	0.10	0.37	0.72	0.83	0.87	0.44	0.89	0.64	0.47	0.85	0.70	0.67	0.77	0.74	

Table.4.October 2006

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.65	0.85	0.83	1.05	1.53	0.50	0.40	0.47	0.87	0.73	0.39	0.55	0.43	0.78	0.57	0.38	0.72	0.48	0.75	0.43	0.37	1.04	0.82	1.14	0.78	1.35	0.62	0.47	0.36	0.83	1.15
C.M.	2.18	2.21	3.12	2.13	1.87	2.18	2.11	1.95	1.13	1.33	1.73	1.97	1.78	1.57	1.26	2.96	1.72	2.15	2.26	3.38	4.49	3.99	2.93	3.50	3.29	3.01	2.46	1.87	2.67		6.86
D.T.	0.73	0.81	0.91	1.38	1.34	0.47	0.71	0.75	0.95	1.02	0.79	0.70	0.86	0.91	0.51	0.68	0.59	1.05	1.23	0.83	0.78	1.16	1.40	1.67	1.25	1.18	1.35	1.24	0.50	0.72	0.51
L.M.	0.50	0.59	0.61	0.63	0.15	0.09	0.23	0.39	0.58	0.36	0.32	0.37	0.32	0.39	0.22	0.29	0.53	0.67	0.75	0.34	0.43	0.66	0.80	0.54	0.44	0.70	0.63	0.44	0.25	0.31	0.55
M.	1.24	1.37	1.46	1.66	1.73	1.61	1.57	1.62	1.68	1.79	1.56	1.38	1.26	1.00	0.87	0.52	0.32	0.04	0.42	0.06	0.03	0.03	0.19	0.37	0.43	0.31	0.07	0.12	0.00	0.02	0.04
M.B.	2.01	1.94	2.06	2.70	2.37	0.45	0.57	1.29	1.47	2.24	0.77	2.13	1.98	1.72	0.76	2.17	1.77	1.80	2.77	3.19	2.58	2.99	6.55	8.59	10.00	8.97	2.99	5.26	7.32	5.60	4.63
T.	0.56	0.74	0.93	0.96	2.11	0.32	0.70	0.84	0.59	0.85	0.43	0.31	0.41	0.79	1.07	0.55	0.77	0.57	1.37	1.06									0.80	0.53	0.64

Table.5.November 2006

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.30	0.21	0.71	0.70	0.30	0.44	0.76	0.82	0.46	0.77	0.70	0.41	0.49	0.36	0.44	0.44	1.49	0.53	0.35	0.65	0.66	0.53	0.63	0.95	0.68	0.56	0.66	1.05	0.70	0.87	
C.M.	5.39	4.95	5.01	2.81	2.47	3.23	3.41	5.42	2.13	2.76	4.31	3.52	4.24	2.61	3.91	2.44	6.10	2.57	5.72	3.04	1.72	1.93	4.28	2.45	1.97	2.65	2.20	2.08	2.60	2.86	
D.T.	0.37	0.31	0.67	0.47	0.30	0.61	0.78	1.55	0.65	0.61	0.72	0.51	0.73	0.56	1.01	0.57	3.17	1.41	0.62	0.70	0.68	0.95	1.24					0.47	0.72	0.50	
L.M.	0.43	0.33	0.58	0.63	0.65	0.46	0.64	0.72	0.31	0.29	0.62	0.68	0.60	0.51	0.65	0.42	1.42	0.65	0.29	0.42	0.64	0.51	0.83	0.57	0.40	0.71	0.56	0.61	0.32	0.42	
M.	0.02	0.01	0.03	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.21	0.59	0.80	1.15	1.82	0.62	0.64	0.62	0.45	0.81	1.69	0.95	0.77	0.75	0.85	0.99	1.00	
M.B.	15.37	6.78	6.78	6.60	2.61	5.05	6.38	5.75	3.13	6.28	6.28	3.12	5.50	5.81	4.95	6.90	4.47	4.75	2.55	3.71	4.21	5.53	7.49	10.84	6.60	7.07	4.97	7.02	7.55	7.22	
T.	0.99		0.60	0.57	0.10	0.80	1.48	1.30	0.56	0.56	0.52	0.54	1.18	0.54	1.23	0.81	1.74	0.83	0.18	0.33	0.58	0.27	1.03	1.32	0.61	0.96	0.65	0.51	0.89	0.68	

Table.6.December 2006

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.79	0.70	0.29	1.08	1.24	0.79	0.74	0.55	0.74	0.57	0.68	0.29	0.20	0.66	0.05	0.07	0.05	0.16	0.31	0.28	0.59	0.13	0.11	0.05	0.10	0.22	0.21	0.10	0.13	0.14	0.25
C.M.	3.17	2.11	0.99	2.46	5.31	3.30	2.46	2.32	3.95	2.48	2.48	2.82	2.04	1.07	1.23	1.55	2.25	2.00	2.39	1.80	2.23	1.43	1.14	1.27	1.22	2.13	1.86	2.39	2.18	1.43	1.77
D.T.	0.68	0.91	0.69	1.08	1.73	2.76	1.02	0.94	1.57	0.95	0.79	0.91	0.16	0.96	0.19	0.53	0.61	1.29	0.00	0.14	0.13	0.07	0.37	0.58	0.05	0.29	0.44	0.29			0.40
L.M.	0.43	0.61	0.24	0.46	0.59	1.04	0.50	0.62	0.78	0.62	0.52	0.20	0.30	0.19	0.04	0.05	0.21	0.09	0.00	0.12	0.23	0.23	0.12	0.04	0.06	0.12	0.24	0.13	0.10	0.07	0.06
M.	0.78	0.71	0.61	1.05	1.03	1.64	1.59	0.98	1.37	1.12	0.87	0.98	0.55	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.44
M.B.	5.03	5.93	6.26	9.46	7.66	4.78	3.36	8.32	10.06	3.91	5.07	3.85	3.41	5.58	5.08	6.33	3.49	6.50	4.33	3.87	6.07	4.80	4.68	1.66	1.66	3.25	3.20	1.42	2.96	1.76	2.73
T.	0.81	0.80	0.24	0.83	2.01	0.69	0.97	0.92	0.86	0.68	0.38	0.03	0.04	0.05	0.10	0.00	0.10	0.03	0.00	0.07	0.10	0.06	0.31	0.00	0.08	0.00	0.20	0.07	0.01	0.42	0.06

Table.7.January 2007

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.09	0.04	0.20	0.22	0.13	0.42	0.09	0.11	0.24	0.10	0.05	0.05	0.06	0.06	0.17	0.04	0.75	0.13	0.15	0.29	0.02		2.20	0.56				0.41	0.40	0.43	0.36
C.M.	1.82	1.59									1.36																				
D.T.	0.15	0.33	0.22	0.72	0.51	0.87	0.29	0.81	1.65	1.18	1.76	0.42	0.42	0.44	1.21	1.01	1.44	0.35	0.03	0.24	0.33	1.13	1.72	1.36	0.21	0.36	0.17	0.13	0.13	0.55	0.36
L.M.	0.05	0.10	0.18	0.28	0.14	0.26	0.15	0.25	0.23	0.21	0.13	0.08	0.10	0.10	0.04	0.07	0.27	0.11	0.01	0.25	0.24	0.37	0.39	0.17	0.03	0.16	0.17	0.13	0.16	0.12	0.18
M.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.97	0.20	0.00	0.00	0.03	0.19	0.65	0.46	0.01	0.07	0.04				
M.B.	2.43	2.99	1.52	2.27	3.42	4.34	2.77	2.84			9.52	9.53	10.63	5.69	4.84	5.08		1.87	2.35	1.68	2.46	3.23	3.69	3.92	3.92	2.66	3.57	3.51	3.95	2.37	4.16
T.	0.01	0.27	0.01	0.17	0.08	0.59	0.00	0.40	0.03	0.31	0.03	0.00	0.00	0.15	0.54	0.02		0.00	0.02	0.16	0.04	0.04	0.29	0.14	0.40	0.07	0.05	0.00	0.11	0.06	0.21

Table.8.February 2007

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.17	0.14	0.26	0.03	0.13	0.16	0.23	0.40	0.91	0.13	0.24	0.18	0.12	0.19	0.24	0.35	0.45	0.17	0.06	0.43	0.33	0.05	0.62	0.64	0.16	0.04	0.07	0.12			
C.M.																3.38	1.02	0.82	0.81	1.53	2.75	1.69	1.86	1.38	1.29	1.96	1.48	1.23			
D.T.	0.09	0.36	0.22	0.53	0.36	0.46	1.41	1.37	1.90	0.55	0.37	0.55	1.18	0.09	0.16	0.11	0.11	0.03	0.00	0.68	0.91	0.18	0.07	0.14	0.11	0.20	0.25	0.48			
L.M.	0.15	0.09	0.20	0.12	0.17	0.12	0.32	0.29	0.48	0.29	0.08	0.04	0.04	0.10	0.39	0.17	0.07	0.12	0.22	0.40	0.24	0.06	0.14	0.22	0.07	0.04	0.10	0.27			
M.	0.02	0.03	0.01	0.07	0.03	0.01	0.07	0.17	0.23	0.01	0.00	0.05	0.17	0.12	0.19	0.03	0.00	0.00	0.00	0.37	0.42	0.00	0.01	0.00	0.00	0.00	0.00	0.01			
M.B.	1.94	1.22	3.03	4.10	1.70	3.11	1.50	1.56	2.44	1.58	1.82	1.48	2.06	1.75	1.94	0.91	3.10	2.73	3.77	1.52	0.91	0.88	1.53	1.13	1.09	1.43	1.51	2.88			
T.	0.03	0.04	0.18	0.41	0.21	0.14	0.31	0.15	0.05			1.83	0.10	0.00	0.20	0.03	0.11	0.09	0.07	0.66	0.15	0.27	0.06	0.17	0.29	0.14	0.30	0.40			

Table.9.March 2007

St./Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
B.	0.05	0.04	0.48	0.35	0.29	0.32	0.03	0.09	0.16	0.07	0.07	0.14	0.30	0.24	0.22	0.18	0.07	0.17	0.26	0.03	0.10	0.13	0.21	0.49	0.45	0.36	0.42	0.25	0.16	0.01	0.32
C.M.	1.21	1.44	0.68	0.90	1.37	2.13	1.78	1.53	1.56	1.36	1.08	1.20	1.58	1.61	2.01	1.38	0.84	0.91	1.93	1.20	0.97	1.89	2.01	1.54	1.15	1.85	1.76	2.11	1.76	1.72	1.47
D.T.	0.60	0.58	0.05	0.16	0.30	0.92	0.23	0.14	0.35	0.11	0.06	0.31	0.24	0.40	0.67	0.12	0.02	0.02	0.65	0.38	0.41	0.30	0.02	0.05	0.14	0.05	0.40	0.30	0.31	0.06	0.08
L.M.	0.11	0.11	0.30	0.32	0.16	0.45	0.10	0.15	0.27	0.04	0.12	0.26	0.11	0.22	0.26	0.04	0.09	0.23	0.17	0.01	0.07	0.22	0.00	0.01	0.09	0.14	0.22	0.15	0.24	0.16	0.09
M.	0.02	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01	0.03	0.00	0.00	0.02	0.32	0.44	0.01	0.04	0.01	0.08	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00
M.B.	1.04	1.84	1.97	1.78	0.45							7.33	7.18	5.64	10.76	3.01	3.85	4.47	4.91	7.36	5.69	2.09	2.85	1.37	3.42	1.88	3.78	1.72	5.13	1.97	2.09
T.	0.10	0.05	0.02	0.58	0.06	0.28	0.00	0.05	0.21	0.00	0.06	0.13	0.01	0.03	0.40	0.16	0.06	0.07	0.42	0.17	0.01	0.11	0.13	0.07	0.15	0.13	0.47	0.19	0.04	0.08	0.27

Daily Average CO Concentrations

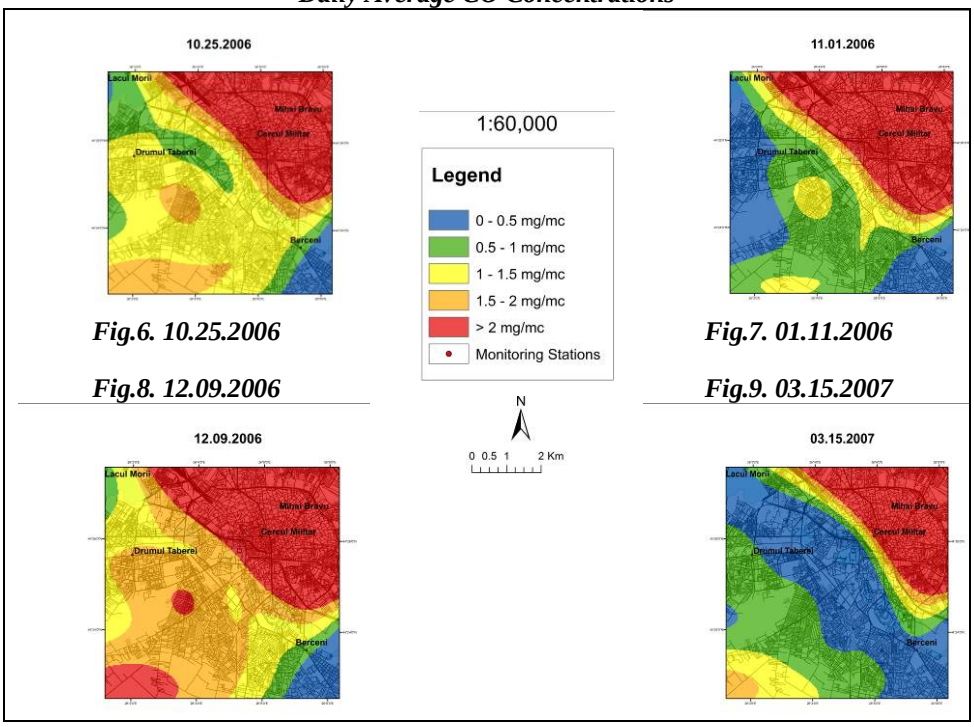


Fig.6. 10.25.2006 ***Fig.7. 01.11.2006***

Fig.8. 12.09.2006 ***Fig.9. 03.15.2007***

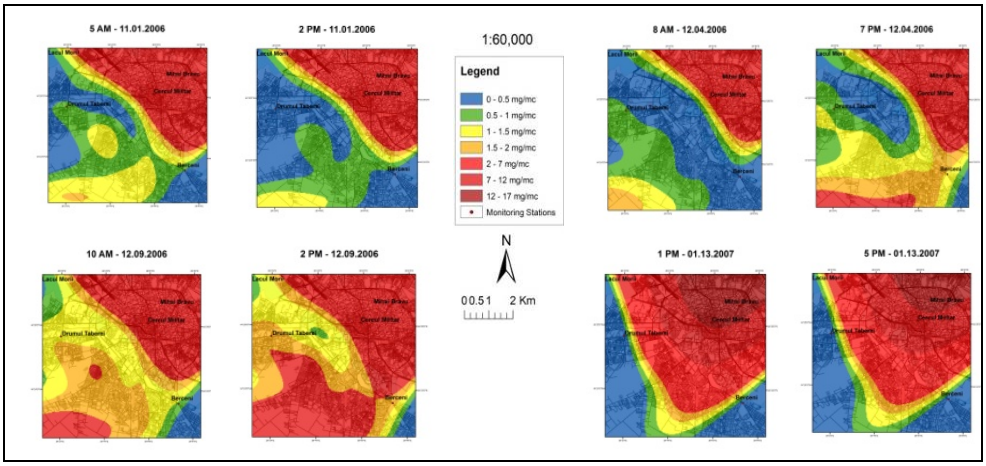
Table.10.*Frequency Exceeding the Maximum Allowable Concentration (2mg/mc) of CO in Bucharest (July 2006-March 2007)*

	Berceni	Cercul Militar	Dr. Taberei	Lacul Morii	Megurele	Mihai Bravu	Titan
July	0%	41.93%	0%	0%	0%	0.00%	0%
August	0%	32.25%	0%	0%	0%	3.22%	0%
September	0%	70.00%	0%	0%	0%	6.45%	0%
October	0%	61.29%	0%	0%	0%	64.51%	3.22%
November	0%	90.00%	3.22%	0%	0%	100%	0%
December	0%	61.29%	3.22%	0%	0%	87.09%	3.22%
January	3.22%	0%	0%	0%	0%	80.64%	0%
February	0%	7.14%	0%	0%	0%	25%	0%
March	0%	12.90%	0%	0%	0%	48.38%	0%

Next, four days with *significant hourly values* have been analyzed: 11.01.2006, 12.04.2006, 12.09.2006 and 13.01.2007. Their corresponding CO values were represented spatially on maps. Therefore, at 5 am, at Mihai Bravu, on November 1, a value of 19.44 mg/m^3 was recorded, the cause of this high CO level being a very low air-temperature that maintained pollutants near the ground, and at 3 pm, a value of 19.17 was recorded at the same station, a cause of this high CO level being the traffic rush. The rest of the stations recorded very small values. Two peaks were registered in December 4, also at Mihai Bravu: at 8 am and 2 pm, but with lower values than those measured on November 1. On December 9, the two peaks were recorded at 10 am and 2 pm at Mihai Bravu station, exceeding the MAC. On January 13, 2007, there were similar values at Mihai Bravu and Cercul Militar

stations, with high values recorded at 1 pm and 5 pm. The rest of the stations recorded low values. According to the corresponding maps (Fig.10.), the spatial distribution of CO levels varies from hour to hour. We can notice, however, that high values are dominant especially in midtown areas (over 2 mg/m^3).

Fig.10.Significant Hourly Values of CO in Bucharest



4. CONCLUSIONS

The present study made an episodic survey of environmental CO levels in Bucharest own-area, showing that the main cause of CO pollution is mainly heavy traffic. Low-lying relief forms greatly favors carbon monoxide accumulation and dispersion in the vicinity of emission sources. High values, over the MAC (2 mg/m^3) were recorded especially in the central and northeastern parts of the city, where important avenues are transited by a large number of vehicles. As a result of prolonged exposure to carbon monoxide, sensitive persons may suffer from cardiovascular, respiratory diseases or neuro-behavioral effects.

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