Research on CO Pollution in Urban Areas

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The environment is an essential element to human existence and being the interference result of natural elements, soil-air-water-climate-biosphere, with elements created by human activity. The purpose of this study has been to monitor carbon monoxide (CO) immissions in the municipality of Targu-Jiu, and the towns of Rovinari and Turceni during 2017 and to interpret the generated data by reference to the limit value for the protection of human health (L.V.), according to Law no. 104/2011. From the analysis of the data generated during the monitoring it has been concluded that for the urban areas that are the subject of the present study, the CO pollutant is not a danger to the population and the environment.

Keywords: CO, pollution, air quality, human health, limit value

Urban air quality is influenced by industrialization, traffic intensity, urban agglomeration, geographic location and climate [1-3] and environmental health refers to those aspects of human health that include the quality of life determined by physical factors , biological, socio-economic and psychosocial environment [4]. Environmental legislation aims at preventing and reducing pollution, preserving the quality of the environment, managing natural resources, ecological reconstruction of areas affected by the pollution generated by human and natural activity [5, 6]. In Romania, the *air quality* domain is regulated by the Law no. 104/2011 on ambient air quality [7] which transfers into national legislation the provisions of Directive 2008/50 / EC of the European Parliament and of the Council of 21 May 2008 on air quality environment and cleaner air for Europe as well as Directive 2004/ 107/ EC of the European Parliament and of the Council of 15 December 2004 on arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air [8]. Pollution has been defined as a variation of the chemical composition of air by altering its physico-chemical properties with potentially hazardous potential [9] and is a local, regional and transboundary problem caused by pollutant emissions, either directly or through reactions chemical agents may have adverse effects on human health, the environment and the climate [10]. Carbon monoxide is a colorless and odorless, hard-to-detect gas [11, 12], resulting from the incomplete combustion of fuels (gas, liquid fuels, coal, wood) used in dwellings, heating installations, stoves, and without an adequate ventilation system, in machinery engines and in industry (kilns, furnaces, mines), the total emissions of this pollutant exceeding the sum of the emissions of all other pollutants [13]. This is a highly toxic gas that inhaled can be lethal because it binds to hemoglobin forming a stable carboxyhemoglobin (COHb) compound, thus blocking oxygen irrigation of internal organs [14] and is one of the main causes of death by poisoning for all ages throughout the world [15]. CO has both natural and man-made origin and is the most widespread air pollutant, its emissions exceeding the sum of all other pollutant emissions [10]. A characteristic of carbon monoxide produced from natural sources is that it disperses very quickly on large surfaces and does not endanger human health [16]. The quality of the population's health is directly influenced by the pollutant concentrations in the air, so that on the basis of this study we focused on the urban areas in the county where the highest concentrations of CO are registered and we identified the sources of pollutants, so we can propose the better scenarios and measures to maintain CO concentrations in the atmosphere, at least at the initial level, possibly reducing emissions. Urban background for Gorj County was estimated based on the selection of air quality monitoring stations and the dispersion of pollutants into the atmosphere, and the extraction of the results in urban background receivers and their accumulation with regional background concentrations, with an average concentration urban background [17]. In the case of Gorj County, this type of estimation was difficult to achieve because the air quality monitoring stations are industrial and not urban. Air pollution with carbon monoxide is mainly due to the production of heat and electricity, heavy traffic, urban agglomerations, weather conditions, residential heating. In Gorj County, the largest source of emissions is represented by the Turceni and Rovinari Thermoelectric Power Plants.

Because the pollutant emissions and considering the distance between the Rovinari and Turceni Thermal Power Plants (approximately 30 km), depending on the direction and speed of the air currents, the Rovinari Thermoelectric Power Plant influences the air quality in Turceni and vice versa.

CO emissions occur in densely populated cities due to car fleet and traffic, with the highest concentration being in heavy traffic stations than residential areas [18] and depends on traffic flow, speed, vehicle characteristics such as be the type, size, age of a vehicle, engine condition, control systems, vehicle maintenance and weight, weather conditions, season, topography, long-range transboundary transport [19]. The waving of car tax in 2017 has led to massive imports of used vehicles, resulting in huge pollution damage and a high medium and long term risk in terms of health effects (at the end of 2017 the fleet has increased by 9% compared to 2016, but also by a higher percentage of old vehicles and diesel engines). The greatest effect on the health of the population is represented by the case of minibuses, buses and vans which are used for transportation mainly in urban areas [20]. Carbon monoxide can accumulate at a dangerous level, especially during the cold weather in winter and spring (which is much more

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chemically stable at low temperatures), when the burning of fossil fuels reaches a maximum. CO disposal mechanisms are slow and rare, mainly due to carbon dioxide oxidation and contribute to global warming (greenhouse effect).

The case study proposed for this paper aimed at analyzing air pollution with CO in urban areas: Targu-Jiu,Turceni, Rovinari. According to the urban classification, Targu-Jiu municipality is a 2nd rank town with an area of 161 km^2 and a population of 96852 inhabitants (population density of 601.56 inhabitants per km^2), and also the residence of Gorj County. The Rovinari and Turceni towns are ranked 3rd according to the same classification, Rovinari having an area of 26.32 km^2 and 13655 inhabitants (population density of 518.86 inhabitants per km^2), respectively Turceni an area of 77.36 km^2 and a population of 8114 inhabitants (population density of 104.886 inhabitants per km^2) [26].

It can be seen that the highest population density is in Targu-Jiu, due to the metropolitan area of Targu-Jiu municipality is characterized by a strong economic and social dynamism. Vegetation plays an important role in its ability to reduce gaseous pollutants and aerosols, but green areas are continuously decreasing in cities, so that in Targu-Jiu this area represents 0.68%, Rovinari 0.49% and Turceni 1.25% of the total area.

Experimental part

The analysis of the CO pollution level was carried out in the urban areas of Targu-Jiu, Rovinari and Turceni, with the help of the monitoring system of the ambient air quality comprising the automatic industrial stations located in Târgu-Jiu (GJ-1 station), Rovinari (GJ-2 station) and Turceni (GJ-3 station), included in the National Air Quality Monitoring Network and measures concentrations of sulfur dioxide (SO_2), nitrogen oxides (NO / NO_2 / NO_x)), ozone (O_3), suspended particulate matter (PM_{10} fraction), as well as a series of meteorological parameters: temperature, precipitation, wind direction and speed, relative humidity, pressure, solar radiation [10]. The monitored pollutants, the measurement methods, the limit values, the alert and information thresholds as well as the criteria for the location of the monitoring points are set by the national legislation on atmospheric protection and comply with the requirements of the European regulations [21- 24]. To determine the carbon monoxide concentration, air quality monitoring stations in Targu-Jiu, Rovinari and Turceni are comprised of a CO-monitor Europe ML 9830 analyzer, the reference method for measuring carbon monoxide is the standard SR EN 14626 and the standardized method for measuring concentration is non-dispersive infrared spectroscopy [18].

The ambient air quality law provides for a CO value for a maximum limit of 8 h (average) averages of 10 mg/m^3 and the maximum daily average of 8 h was chosen after examining 8h slides based on updated hourly data hourly [25]. In order to have a clearer picture of the level of CO pollution in agglomerated urban areas, Targu-Jiu, Rovinari and Turceni, a concentration of concentration values recorded during 2017 and comparison with the limit value (L.V.) view the negative effect of the pollutant on human health and the environment.

Results and discussions

Research activity on air pollution with carbon monoxide in urban areas was carried out during 2017 by making measurements of CO concentrations during the year, ie the maximum daily and hourly concentration during December 2017. By centralizing the data obtained during the monitoring CO in the cities of Targu-Jiu, Rovinari and Turceni, table 1 showed a statistic on the number of measured and validated hourly averages, the maximum value of 8 h average (mg/m^3), the number of samples exceeding the limit value (10 mg/m^3) and the annual average CO concentrations for 2017 [16].

Annual monitoring

The analysis of the data measureaments during the 2017 shows that for the GJ-3 station in Turceni the criterion regarding the required proportion of valid data for the calculation of the annual average (due to technical failures) was not met, and for Targu-Jiu and Rovinari the 94.65 and 95.17% valid dates respectively, there were no exceedances of the limit value. In the cities of Targu-Jiu and Rovinari, the annual average for the CO pollutant was very low, with values of 0.45 mg/m^3 and 0.40 mg/m^3 respectively, representing 4.5 and 4 % of the limit value, respectively the CO pollutant is not a hazard to the environment and the population. From the centralized data analysis for the daily maximum values of the mobile

Table 1
CARBON MONOXIDE - STATISTICAL DATA 2017 [16]

The station	Nr. measured hourly averages	Valid data %	Maximum 8-hour average (mg/m^3)	Nr. samples exceeding the limit value (10 mg/m^3)	Annual average mg/m^3
GJ-1	8294	94.65	5.28	0	0.45
GJ-2	8357	95.17	4.77	0	0.40
GJ-3	2456	27.77	2.36	0	*

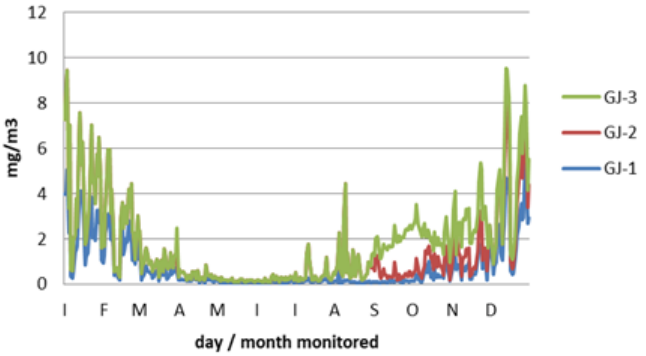

Fig.1. Evolution of CO concentration (maximum daily average of 8 h), between 01.01.2017-01.01.2018, in towns Targu-Jiu (blue), Rovinari (yellow) and Turceni (red)

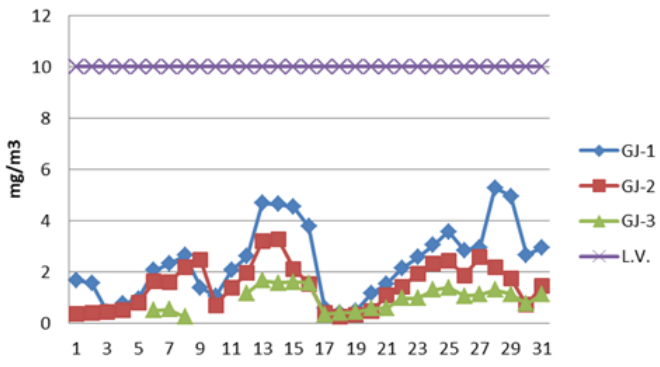

Fig. 2. Evolution of CO concentration (maximum daily average of 8 h) during December 2017, Targu-Jiu (blue), Rovinari (red) and Turceni (green)

environments registered for the CO pollutant during the year 2017 (fig. 1), in the towns of Targu-Jiu, Rovinari and Turceni, it has been noticed that the limit value was not exceeded.

The highest daily maximum value of 8h averages was measured in the town of Targu-Jiu, 5.28 mg/m^3. It should be seen that from the three monitored urban areas in the city of Targu-Jiu, the CO pollutant has the highest concentration value due to the intense traffic, the apartment units, the high density of the population, the lack of green spaces, the industry.

Month monnitoring

From the analysis carried out in 2017 for the carbon monoxide pollutant in urban areas, it was observed that the highest concentration values were in December and it was considered appropriate to carry out an analysis of CO concentrations (maximum daily average of 8 h), during December 2017, taking into account the factors that influence the CO emissions (season, traffic, thermoelectric power plants, residential heating). For the analysis of carbon monoxide pollution in urban areas, during December 2017, measurements were made determining concentration values, and by data centralization, figure 2 shows the evolution of CO concentration (maximum daily average of 8 h), for the cities of Targu-Jiu, Rovinari and Turceni.

The data processing has revealed that the highest values of CO concentrations (maximum daily average of 8 h) during December 2017 were measured on 28.12.2017 in Targu-Jiu as having the value of 5.28 mg/m^3, at Rovinari on 14.12.2017, the concentration being 3.29 mg/m^3 and in Turceni on 13.12.2017, 1.29 mg/m^3. Also in this case it was observed that there were no exceedances of the limit value and the highest value, of the monitored areas, was also recorded in Targu-Jiu.

Daily monitoring

From the analysis carried out during the month of December 2017, it was observed that on 28 December 2017 the value of the carbon monoxide concentration had the highest value in the city of Targu-Jiu, and in view of this it was made an analysis of the CO concentration (hourly mobile media) for this day. On the basis of the hourly average hourly values, measured on December 28, 2017, the evolution of CO, presented in figure 3, was obtained for the towns of Targu-Jiu, Rovinari and Turceni.

Regarding the analysis of data measured on December 28, 2017, it was observed that the highest hourly average value was recorded in Targu-Jiu, 5.28 mg/m^3 at 24 o'clock, and the smallest values in the town of Turceni. In this case,

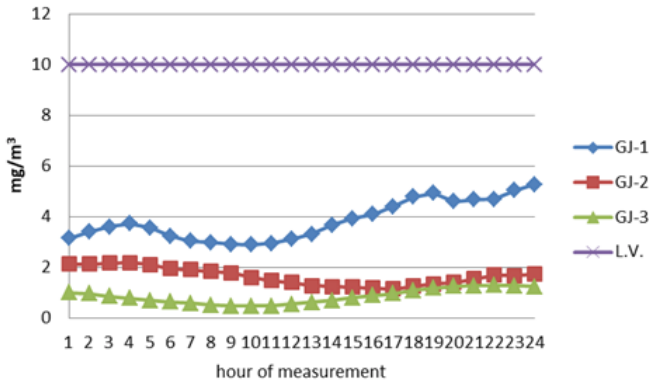

Fig. 3. Evolution of the CO concentration (mobile hourly average) on December 28, 2017 in Targu-Jiu (blue), Rovinari (red) and Turceni (green)

the values of the mean hourly average concentration recorded by the continuous monitoring stations in Targu-Jiu, Rovinari and Turceni were below the limit value.

Conclusions

From the analysis of the experimental results obtained during the monitoring of the CO pollutant, in the year 2017, in the urban areas Targu-Jiu, Rovinari and Turceni, it was found that the values of the concentrations were below the limit value (L.V.). The highest value recorded for the CO pollutant during 2017 was measured in Targu-Jiu on 28.12.2017, 24 h, and represents 50.1% of L.V. According to previous studies, a strong pollution caused by thermal power plants and mainly carbon monoxide has been observed, yet the research has shown that the CO concentrations are not high in the Rovinari and Turceni thermal power plants and the maximum CO concentration in the area of Targu-Jiu. This has shown that the main sources of carbon monoxide emissions, with significant potential for environmental damage, are in the proximity of urban agglomerations.

The value of the CO concentration is higher in Targu-Jiu compared to the other analyzed areas due to the fact that the degree of CO pollution is directly proportional to traffic intensity and population density. The continuous growth of the car park (public and private) and implicitly the economic, urban and urban transformations, intense traffic on the main access roads of Targu-Jiu Municipality, the demographic dynamics associated with the real estate dynamics and the management of the public spaces with the decrease of the green spaces, lead to a dynamic of emissions that can not be controlled, with effects on air quality and implicitly on human health. The purpose of this study was to show the situation of CO pollution in urban areas of Gorj County in order to approach an ecological policy at the level of the local public administration and other bodies empowered for this purpose.

In order to limit CO emissions, it is proposed the improvement and the renewal of the local transport fleet, the extension of road infrastructure around the Targu-Jiu Municipality in order to streamline the transport traffic, the extension of green spaces in dwelling areas, the preservation and extensions and increase number of public gardens, the identification of the environmental threatened in order to protect them and extend the vegetation and green area in order to improve the climate and air quality for the benefit of population and nature.

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