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# The Electromagnetic Mapping of the City of Beiuș

Marius Lolea, Andrea Amalia Minda*, Eva Barla,
Andrei Sărăcuț–Ardelean, Emeric Szabo

***Abstract.*** *The paper presents a method of the electromagnetic mapping for a locality - City of Beiuș from Bihor County. For this activity, it is first necessary to identify the public electromagnetic field sources. Then the measuring devices must be chosen and made the measurements. Finally, the values obtained for the electric and magnetic field sizes are integrated into a digital map that will be available to those interested. The authors have also taken photos of the sources for easier identification on in the city territory.*

***Keywords****: electric field, magnetic field, characteristic quantities*

## 1. Introduction

The electromagnetic field (ELMF), as a form of existence of matter, exists both in natural form (coming from the Earth's own geomagnetic and electrical field, extraterrestrial radiation - radioactive particles and cosmic electromagnetic waves) and in anthropogenic form (generated by electromagnetic devices developed by man). From the structural point of view the electromagnetic field has two components: the electric field and the magnetic field

The propagation by space of the electromagnetic field, is done through the waves or electromagnetic radiation or in the form of particles. Because it is invisible to humans, the electromagnetic field is evaluated, by its components, through its effects using characteristic quantities (CQ-ELMF) [3, 8].

With the large-scale development and spreading of anthropogenic sources of electromagnetic field, certain influences on the exposure of living organisms in the new artificially created environment have also been found. Thus, exposure of the biological to the electromagnetic field has been shown to have beneficial and harmful effects. Depending on the effects on the atoms the electromagnetic waves are ionizing and non-ionizing. The negative effects of ionizing radiation that can cause damage to living cells are easier to demonstrate. In medical therapies, these radiations have useful effects by destroying tumour cells in cancerous diseases. The non-ionizing radiations that are the object of the study in the paper have negative effects that are harder to prove and the results in this regard are controversial. [9]. A needed to Long-term studies and state-of-the-art technologies to demonstrate the negative effects on humans of electrical and magnetic exposure. However, among the negative effects on health in the dedicate literature [2, 7, 9] is mentioned: insomnia, vertigo, anxiety, reducing fertility, lack of concentration, slowing metabolism or chronic conditions (tumors, leukemia and other forms of cancers etc). Beyond controversies, certain allowable threshold values of CQ-ELMF have been taken into account and regulated, which should not be exceeded in order not to be dangerous to health and which should be taken into account when avoiding exposure. These are correlated with amplification of effects, with other characteristics of ELMF sources and exposure such as proximity to sources or duration of exposure.

In norms(Romanian and international), for the characterization of the harmful effects of exposure, are given the threshold admissible values of CQ(in general for E, B, S – power density of ELMF or electromagnetic wave strength[$W/m^2$], SAR – specific absorption rate[W/kg]), for general population and employees that work in electrical installations, on frequency ranges of ELMF[10, - 16]. Generally, threshold admissible values for workers are bigger like those for population, because this are protected by equipment against radiation (by variable ELMF and/or static electric and magnetic fields) or has means of access control in areas with intense fields. When in the natural environment, the values of CQ - ELMF are exceeded, is talk about the concept of electromagnetic pollution [7]. So, electromagnetic pollution also affects both technical and biological systems as it results from the results of various studies published by researchers.

The purpose of the paper is to experimentally determine the values of CQ and comparing them with the normed ones, for highlighting the level of electromagnetic pollution given by the sources distributed in the municipality of Beiuș. The admissible values of the CQ-ELMF considered in the paper come from the Romanian regulations or ICNIRP recommendations [11, 12, 16].

## 2. Public sources of ELMF

In this chapter, are described the public sources of ELMF along with some of their general characteristics. The data obtained together with the site are used by the authors for the elaboration of a digital electromagnetic map with the distribution of sources throughout the city. The ELMF sources investigated experimentally are: power stations (PS), power substations (power transformations points), overhead electricity lines(OEL or OPL) and mobile telecommunications base stations with antennas, noted SB-GSM( GSM sites).

### 2.1. Public energy sources in Beiuş

The City of Beiuş is located in the south of Bihor County, on the road that connects Oradea to Deva – naţional way DN 76 integrated into the European route E79 (at 62 km distance by the county seat - Oradea). The population of the city, which also includes the village of Delani, according to the 2011 census is 10667 inhabitants with a density of 494 inhab/km$^2$. As a relief area, the municipality is located in the Beiuş Depression known in the past as "Beiuş Country" (is also known as the Crişului Negru Depression, after the river that runs through the area). In Beiuş Depression, the average thermal values are around 10$^o$C, they gradually decrease towards contact with the mountain regions. Thus, at Beiuş, located at the altitude of 191 m above sea level, the average multiannual temperature is 10,5$^o$C, coldest month of the year, namely January, is characterized by the value of 1,5$^o$C, and the hottest month, July, by the value of 21,2$^o$C [4]. In Figure 1 is presented a panoramic image of the city.

**Figure 1.** Panoramic view of Beiuş

**Figure 2.** PS of Beiuş

Heat power supply of large consumers (blocks of flats, administrative institutions, hospitals, schools but also private houses) is made in centralized system by geothermal energy. The geothermal water is extracted through two production wells and re-injected through a third well. There are also individual consumers or small consumers who hold for heating and the production of domestic hot water, stoves and biomass or little electric power stations. Electricity is obtained from power station (PS) Beiuş, connected to the electricity system (PWS) Bihor through an OPL by110 kV which has links with electric stations in Oradea, Sudrigiu, Ştei and Vaşcău. A photograph of PS Beiuş can be seen in figure 2. The city is connected at a PS from Salonta town through a power line (PL) by 20 kV. A portion of the Oradea - Beiuş - Vaşcau OPL is shown in figure 3.

The distribution of electricity is made through aerial and underground medium voltage lines, power substations (MT/JT) and low voltage lines. On the city territory are installed (to moment of study) about 5 km HV OPL, approximately 27 km of electricity lines (EL) by MV and 18 transformation points (PSS). From the city's electric station starting more EL by MV for supplying the rural localities in the vicinity.

Terrestrial surface of the municipality is of 21,593 km$^2$. On this territory, for the cover of signal level, are placed five GSM sites. With the exception of the flats block with eight floors from the centre of the city, which is tallest building and is shown in figure 4, other three antennas mounts are upon separated pillars or on water reservoir tower.

**Figure 3** .110 kV OPL Beiuş - Vaşcău

**Figure 4**. Building with GSM antennas

The distribution and supply of electricity in the public system is made by the Bihorean department (local branch) of the company S.C. Electrica SA Transilvania North, with the headquarters in the city of Cluj-Napoca. For the supply of heat and domestic hot water in centralized system, on the territory of the Beiuş municipality operates the Company Transgex, from Oradea. Mobile telecommunication services are provided by operators who also operate on the international market: Orange, Vodafone, Telekom and Digi (RDS&RCS).

### 2.2. Electromagnetic field sources distribution on the territory of Beiuş

Images of the detectors devices of ELMF is shown in the figure 5 –a, for E and B of low frequency, respectively 5 – b, for high frequency.

**a.** **b.**

**Figure 5.** ELMF devices

The device EMF Tester ME3030 B (fig.5.a) for frequency range 16 Hz÷100 kHz, produced by Gigahertz Solution - Germany, measures both the electric field and the magnetic field, has domains of measurement of 1÷ 5000 V/m and respectively 1÷1999 nT. The device Tenmars TM-195(fig.5.b) made in U.K.(Seeit/ RS Components Ltd), measures in the frequency range of 50 MHz ÷ 3,5 GHz , having recording time by 2,5 values/sec and resolution of 0,001 $\mu W/m^2$.

For additional checks and determining deviations between measured sizes, have also used the device Spectran 5035, made by Aaronia Company from Germany. The distances to the sources were measured with the BOSCH PLR 50 laser telemeter. Temperature, atmospheric pressure and humidity, were recorded with a TFA Faktum type (Germany) portable weather micro-station with external sensor.

### 3. Schemes and measuring devices. Experimental results

This chapter briefly describes the measurement schemes adopted and the devices used. It is the experimental part of the work that determined the CQ-ELMF values. In the period of measurements, the weather was sunny, with outdoor ambient temperatures in range of 3÷7 $^{o}$C, during mouth of February.

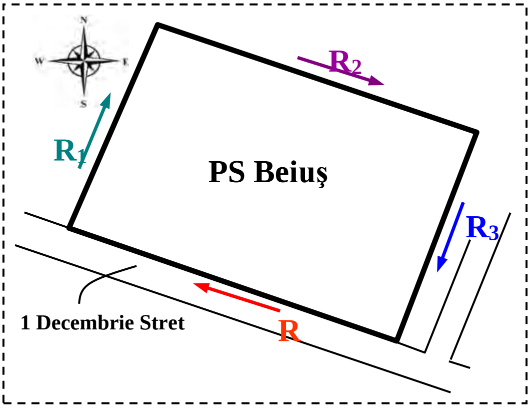


**Figure 6.** Measure scheme for Beiuş PS

For PS by distribution of electricity, which is the only from Beiuş, is considered a measure scheme with four routes outside the fence ($R_1$÷$R_4$), according to the figure 6. On each way are allocated 10 measure points at the quotas (heights to the ground) $h_1$=1m şi $h_2$=1,7 m, located at a distance d = 1 m from the fence. There will be 20 measurements for each route and 80 values for the entire perimeter of the station. The results are given in table 1. For the Power transformers points (noted PSS), which are low power transformer stations on MT / JT voltage levels and relative symmetrical constructive structures, the adopted measurement scheme is shown in Figure 7. Are adopted the same quotas like in case of PS. The distances and the results of measurements are given in table 2 and table3.With the measured values, classifications of the sources can be prepared according to the electromagnetic pollution produced in the public space. For example, in the figures 8÷11 is presented in graphic form, a synthesis of the results obtained for five PSS and five OPL – MV.

**Table 1.** Measured values of E, for PS. Measured values of B, for PS Beiuş

| HeightsT$_1$ | Values of E[V/m] on route 1 Measure points $P_1 \div P_5$ | | | | |
|---|---|---|---|---|---|
| $h_1$ = 1m | 210 | 230 | 245 | 260 | 310 |
| $h_2$ = 1,7 m | 320 | 410 | 430 | 460 | 370 |
| Heights T$_1$ | Values of E[V/m] on route 1 Measure points $P_6 \div P_{10}$ | | | | |
| $h_1$ = 1m | 300 | 295 | 225 | 210 | 200 |
| $h_2$ = 1,7 m | 340 | 325 | 260 | 250 | 220 |
| Heights T$_2$ | Valoues of E[V/m] on t route 2 Measure points $P_{11} \div P_{15}$ | | | | |
| $h_1$ = 1m | 110 | 130 | 145 | 160 | 110 |
| $h_2$ = 1,7 m | 220 | 210 | 230 | 260 | 270 |
| Heights T$_2$ | Values of E[V/m] on route 2 Measure points $P_{16} \div P_{20}$ | | | | |
| $h_1$ = 1m | 200 | 195 | 125 | 110 | 110 |
| $h_2$ = 1,7 m | 240 | 225 | 160 | 150 | 150 |
| Heights T$_3$ | Values of E[V/m] on route 3 Measure points $P_{21} \div P_{25}$ | | | | |
| $h_1$ = 1m | 510 | 630 | 845 | 960 | 850 |
| $h_2$ = 1,7 m | 620 | 710 | 930 | 1060 | 980 |
| HeightsT$_3$ | Values of E[V/m] on route 3 Measure points $P_{26} \div P_{30}$ | | | | |
| $h_1$ = 1m | 810 | 695 | 525 | 410 | 300 |
| $h_2$ = 1,7 m | 950 | 725 | 670 | 540 | 410 |
| Heights T$_4$ | Valoues of E[V/m] on pentru route 4 Measure points $P_{31} \div P_{35}$ | | | | |
| $h_1$ = 1m | 520 | 630 | 740 | 550 | 420 |
| $h_2$ = 1,7 m | 610 | 710 | 850 | 670 | 560 |
| Heights T$_4$ | Values of E[V/m] on route 4 Measure points $P_{36} \div P_{40}$ | | | | |
| $h_1$ = 1m | 320 | 255 | 205 | 220 | 210 |
| $h_2$ = 1,7 m | 380 | 330 | 250 | 240 | 230 |

| Heights T$_1$ | Values of B[μT] on route 1 1 Measure points $P_1 \div P_5$ | | | | |
|---|---|---|---|---|---|
| $h_1$ = 1m | 2,15 | 3,15 | 3,20 | 3,30 | 4,20 |
| $h_2$ = 1,7 m | 2,65 | 3,45 | 3,55 | 3,60 | 4,50 |
| Heights T$_1$ | Values of B[μT] on route 1 Measure points $P_6 \div P_{10}$ | | | | |
| $h_1$ = 1m | 3,10 | 2,60 | 3,30 | 3,15 | 3,10 |
| $h_2$ = 1,7 m | 3,25 | 2,75 | 3,40 | 3,25 | 3,15 |
| Heights T$_2$ | Values of B[μT] on route 2 Measure points $P_{11} \div P_{15}$ | | | | |
| $h_1$ = 1m | 2,25 | 3,35 | 3,25 | 3,40 | 4,20 |
| $h_2$ = 1,7 m | 2,75 | 3,55 | 3,55 | 3,65 | 4,40 |
| Heights T$_2$ | Values of B[μT] on route 2 Measure points $P_{16} \div P_{20}$ | | | | |
| $h_1$ = 1m | 3,20 | 2,50 | 3,35 | 3,10 | 3,05 |
| $h_2$ = 1,7 m | 3,35 | 2,60 | 3,45 | 3,20 | 3,10 |
| Heights T$_3$ | Values of B[μT] on route 3 Measure points $P_{21} \div P_{25}$ | | | | |
| $h_1$ = 1m | 9,15 | 9,15 | 9,20 | 8,30 | 9,20 |
| $h_2$ = 1,7 m | 11,65 | 12,45 | 10,55 | 9,60 | 10,50 |
| Heights T$_3$ | Values of B[μT] on route 3 Measure points $P_{26} \div P_{30}$ | | | | |
| $h_1$ = 1m | 7,10 | 6,60 | 5,30 | 4,15 | 3,80 |
| $h_2$ = 1,7 m | 8,25 | 7,75 | 6,40 | 5,25 | 4,15 |
| Heights T$_4$ | Values of B[μT] on route 4 Measure points $P_{31} \div P_{35}$ | | | | |
| $h_1$ = 1m | 10,15 | 13,15 | 13,20 | 12,40 | 11,20 |
| $h_2$ = 1,7 m | 12,65 | 14,45 | 14,55 | 13,50 | 12,55 |
| Heights T$_4$ | Values of B[μT] on route 4 Measure points $P_{36} \div P_{40}$ | | | | |
| $h_1$ = 1m | 10,10 | 9,40 | 7,30 | 5,15 | 4,20 |
| $h_2$ = 1,7 m | 11,15 | 9,75 | 8,45 | 6,20 | 4,85 |

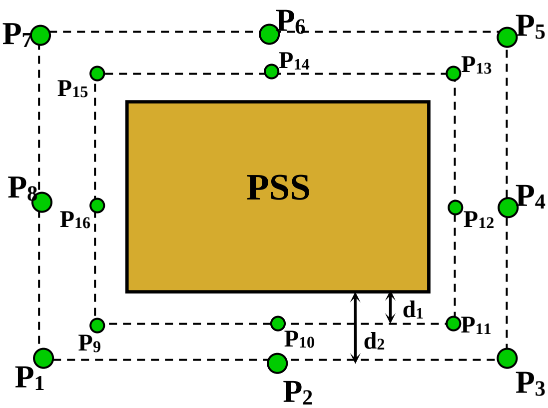


**Figure 7**. Measurement scheme for PSS

There are given minimum and maximum values obtained directly by measurements and calculated average values for all measurement points in the vicinity of the sources and with reference to the magnetic induction and the intensity of the electric field. That five PSS are named after the streets on which they are located and the power lines, depending on the interconnection points.

The graphs above refer to the distribution of PSS on the streets: PTA Habitat (PSS1), PTZ Pandurilor(PSS2), PTab Bihorului(PSS3), PTZ Ciordaş(PSS4) and PTZ Independenţei(PSS5).

**Table 2.** Values of E for PSSb Pandurilor

| Distances | Values of E[V/m]for measure points ($E_iP_j$, i=j) | | | |
|---|---|---|---|---|
| $d_1$=0,5 m | $E_1P_1$ =120 | $E_2P_2$ =110 | $E_3P_3$ =135 | $E_4P_4$ =120 |
| $d_2$ = 1 m | $E_9P_9$ =90 | $E_{10}P_{10}$ =85 | $E_{11}P_{11}$ =95 | $E_{12}P_{12}$ =90 |
| $d_1$=0,5 m | $E_5P_5$ =115 | $E_6P_6$ =125 | $E_7P_7$ =110 | $E_8P_8$ =115 |
| $d_2$ = 1 m | $E_{13}P_{13}$ =90 | $E_{14}P_{14}$ =95 | $E_{15}P_{15}$ =80 | $E_{16}P_{16}$ =85 |

**Table 3.** Values of B for PSSb Pandurilor

| Distances | Values of B[µT]for measure points ($E_iP_j$, i=j) | | | |
|---|---|---|---|---|
| $d_1$=0,5 m | $B_1P_1$ =0,25 | $B_2P_2$ =0,22 | $B_3P_3$ =0,33 | $B_4P_4$ =0,45 |
| $d_2$ = 1 m | $B_9P_9$ =0,10 | $B_{10}P_{10}$ =0,09 | $B_{11}P_{11}$ =0,06 | $B_{12}P_{12}$ =0,07 |
| $d_1$=0,5 m | $B_5P_5$ =0,15 | $B_6P_6$ =0,25 | $B_7P_7$ =0,14 | $B_8P_8$ =0,15 |
| $d_2$ = 1 m | $B_{13}P_{13}$=0,04 | $B_{14}P_{14}$ =0,11 | $B_{15}P_{15}$ =0,03 | $B_{16}P_{16}$ =0,05 |

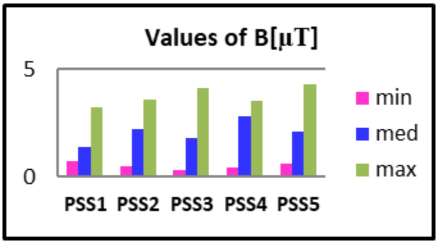


**Figure 8.** Variation of B for PSS

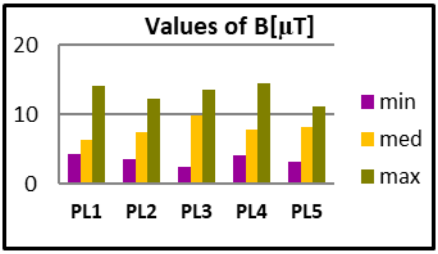


**Figure. 9.** Variation of B for OPL (MV)

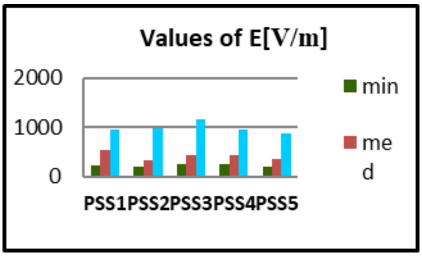


**Figure 10.** Variation of E for PSS

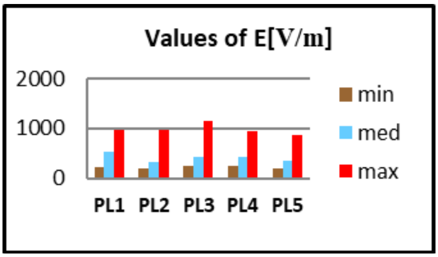


**Figure 11.** Variation of E for OPL (MV)

The results from figures 9 and 11 include the overhead MV lines: Beiuş-Drăgăneşti (PL1), Beiuş – Remetea (PL2), Beiuş – Nimăeşti (PL3), Beiuş – Tărcaia (PL4) and Beiuş – Pocola (PL5). In figure 12, through the side view and in figure 13, through the image from above, is presented the measurement scheme for the overhead power lines (OPL), for both high and medium voltage. The first and last measuring points in the center of the line are in the axis of the pillars at the end of each aperture. It is considered three measurement paths, under each conductor of the three-phase line at heights above soil level $h_1$= 1,7 m (considered at head level of the human by medium height), respective $h_2$ = 1 m. On each opening is considered 10 measurement points, the total number being 60 measurements between two consecutive pillars.

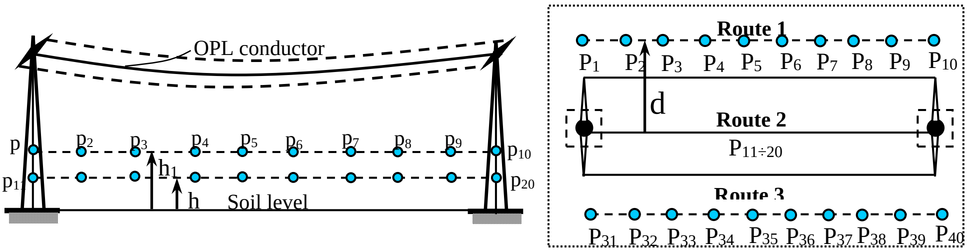


**Figure 12.** Measure scheme for OPL – size view(a) from above(b)

The measuring process results of E şi B, in case of aperture no. 2 of OPL by 110 kV (started from PS Beiuş), are given under graphic form, in figures 13 .

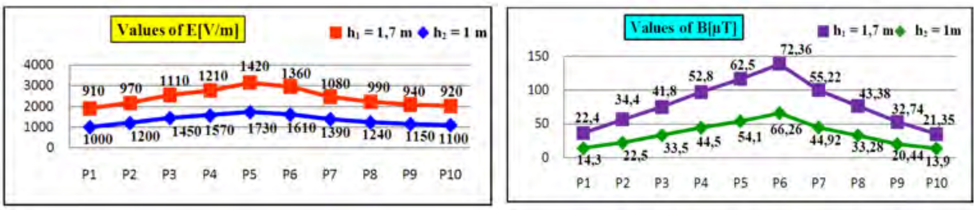


**Figure 13.** Results of E, B measurements for 110 kV OPL

In the case of telecommunications systems, for the measurement schemes were considered two situations, such us the antennas with additional facilities are mounted on buildings or pillars.

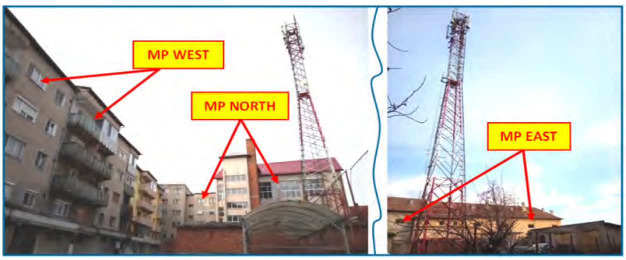


**Figure 14.** Places of measurements for GSM case

In the only case of placement on a block, the registration points were integrated into (inside) four flats located to the last floor, under BS-GSM. Also, in this case, measurements were made and in four points located on the building, over considered apartments. In the second situation, the measurements were made in four directions (N, W, S, E) in rooms from the buildings closest to the pillars.

For each cardinal point two maximum values identified in the two measuring rooms were taken and for scoring the results were used indexes, thus: position 11,12 → North point; position 21,22 → West point; position 31, 32 → South point; position 41,42 → East point; finally, 8 cases were obtained. For the apartments from the vicinity of a GSM pillar placed inside of the public institution yard, the measuring points (MP), are indicated with red arrows in figure 14. The results of measurements are presented in table 4.

**Table 4.** Results of measurements near GSM sites

| GSM places | Values of Power density[mW/cm$^2$] (averaged over 30 min) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Measure points | | | | | | | |
| | $P_1$ | $P_2$ | $P_3$ | $P_4$ | $P_5$ | $P_6$ | $P_7$ | $P_8$ |
| Case 11 | 2,2 | 1,3 | 2,4 | 1,8 | 3,8 | 2,7 | 2,5 | 1,6 |
| Case12 | 1,4 | 1,2 | 1,5 | 1,7 | 4,2 | 1,7 | 2,6 | 1,4 |
| Case 21 | 3,3 | 3,2 | 1,3 | 2,1 | 2,2 | 2,5 | 3,5 | 2,6 |
| Case 22 | 1,5 | 1,3 | 1,4 | 2,7 | 3,2 | 3,7 | 1,5 | 3,6 |
| Case 31 | 1,2 | 2,3 | 1,6 | 2,3 | 3,5 | 3,2 | 2,5 | 4,3 |
| Case 32 | 3,1 | 1,5 | 2,2 | 3,4 | 2,6 | 2,7 | 3,1 | 1,1 |
| Case 41 | 1,6 | 1,6 | 2,5 | 4,7 | 4,2 | 3,7 | 2,4 | 1,8 |
| Case 42 | 1,7 | 2,3 | 1,7 | 2,7 | 3,2 | 2,8 | 2,6 | 2,1 |

To highlight the territorial distribution of ELMF sources, the authors created a map called “Beiuş Electromagnetic Map” (abbreviated: M - ELMF Beiuş).


**Figure 15.** ELMF Map of Beiuş

The map was developed using the Google Maps software utility. On the map, in addition to marking the position of the sources, the following facilities are also offered: spotting GPS coordinates of sources and of the distance between them, technical features, average values of CQ- ELMF obtained experimentally, images of the sources. From the map you can easily identify the neighborhoods and streets where the objects of interest are located. The map is useful especially for employees in energy and telecommunications service companies (for those who do not know the area) which in case of damage or other incidents can be oriented and reach the required location more easily. A sector from M - ELMF Beiuş can be observed in figure 15.

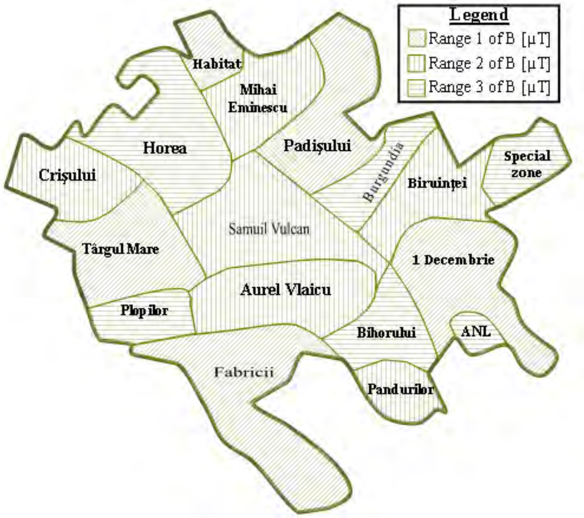


**Figure 16.** Neighbourhoods B ranking map

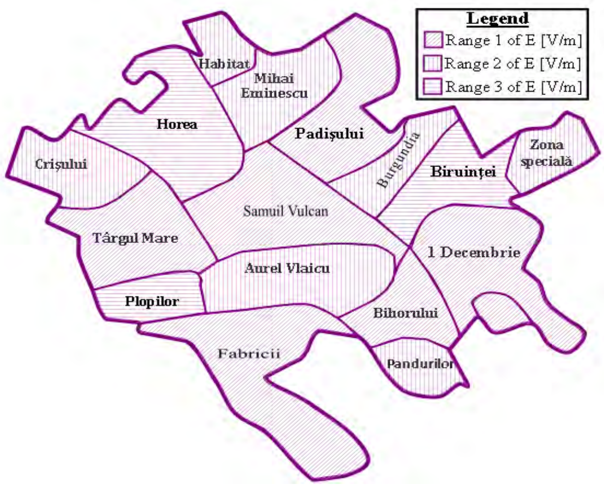


**Figure 17.** Neighbourhoods E ranking map

Urbanistic, the territory of the city has divided in 15 districts with a total streets number of 93. There were also created two graphic maps, represented in the figures 16(with B values) and 17(with E values), with the framing of neighbourhoods by value domains (average values) of CQ - ELMF. The establishment of these domains (ranges) was done as follows: a).in case of B values. Range 1: 0÷ 1,50 [μT]; Range 2: 1,51÷10,5 [μT]; Range3: > 10,5 [μT], b). In case of E values. Range 1: 0÷120 [V/m]; Range 2: 121 ÷ 600 [V/m]; - Range 3: > 600 [V/m].

For comparison and testing of electromagnetic pollution, the allowable values of CQ – ELMF extracted from the literature [1,11,12,16], are:

- For general public (index 1):

- $E_{adm1}$= 5000 [V/m], low frequency (50 Hz);
- $B_{adm1}$ = 100 [μT], low frequency (50 Hz);
- $S_{adm1}$ = f/200(10) [mW/cm$^2$], high frequency (Rf);
- $SAR_{adm1}$ = 0,08 [W/kg], high frequency (Rf)/whole body; 2 [W/kg]/head level.

- For occupational (index 2):

- $E_{adm2}$= 10000 [V/m], low frequency (50 Hz);
- $B_{adm2}$ = 500 [μT], low frequency (50 Hz);
- $S_{adm2}$ = f/40(50) [mW/cm$^2$], high frequency (RF);
- $SAR_{adm2}$ = 0,4 [W/kg], high frequency (RF)/ whole body; 10 [W/kg]/head level.

If only the experimental values obtained for population testing are taken into account, it can be stated that none of the CQ-ELMF exceeds the normed limit values and therefore the electromagnetic pollution in the investigated areas is reduced. From the statistical analysis of the electromagnetic map, on the whole of the districts (neighbourhoods), results the weight of the ranges of values of the field quantities (fig. 18).

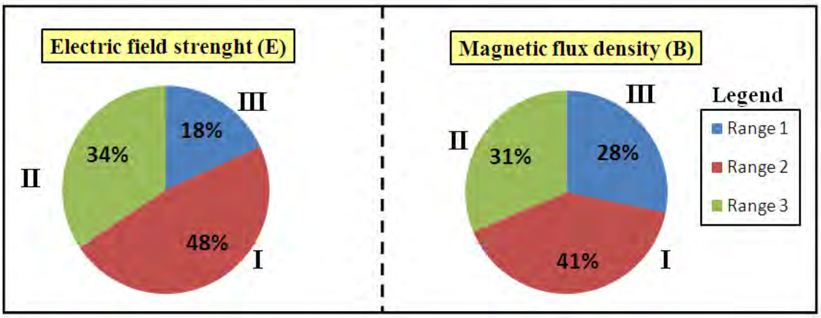


**Figure 18.** CQ-ELMF ranges percentage

Figure 18 shows the classification of the districts (the top three in the ranking) according to the number of ELMF sources.

The hierarchy presented in figure 19, includes each category of ELMF sources and their sum. Knowing the intensity of the electromagnetic field by the public can lead to decisions to avoid those areas, even if the value limits of the CQ indicating the exposure harmfulness are not exceeded. It is possible that some people are more sensitive to the action of the ELMF [2].

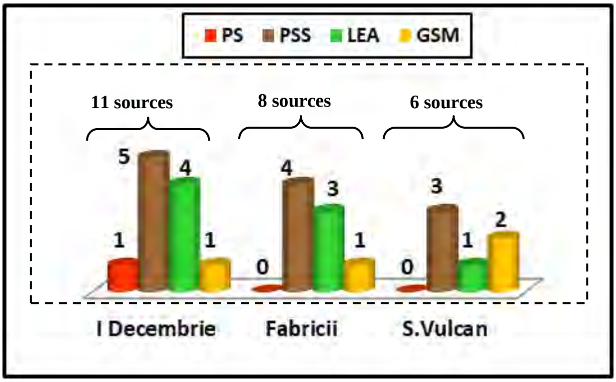


**Figure 19**. Neighbourhoods ranking by sources number

## 4. Disscusion

The sources of high freqvency electromagnetic field are considered most dangerous. Perhaps the fact that alarmist articles which appear regularly in the mass - media about the harmful effects of telecommunication antennas leads to a higher interest of them. There have even been public calls signed by scientists, specialists and researchers from several fields, against wireless data transmission systems. It is the case of International Appeal against 5G technology [17], named: ”Stop 5G on Earth and in Space”, which had 231,326 online signatories from 214 nations and territories (in April 11$^{th}$, 2020). In the case of the GSM telecommunication installations investigated, the highest values of the intensity of the electromagnetic waves were recorded in the places inside the cone (cylinder) or the emission bulb of the antennas (in the direct visibility of the antennas). From the specific measurement conditions mentioned in [6], it follows that the power density of GSM 900 signals coming from the sectoral antennas of the base stations (at the frequency of 947.5 MHz,) at a certain source distance, changes their cylindrical character of radiation and turns into a spherical one. The importance of the spectral analyzer settings in accurately reproducing the radiation levels must be appreciated [6]. The pointed and momentary values of the CQ-ELMF, recorded in the paper, are not relevant enough in the assessment of the electromagnetic pollution, considering the alternative and dynamic character of the electromagnetic field generated by sources. Thus, as in [1], the monitoring of the electromagnetic field (in radio frequency) must be done with the input of fixed monitoring systems, which will collect data for a longer period of time. The monitoring of the electromagnetic field for three consecutive months for sources distributed on the territory of the city of Iaşi, showed that the highest value recorded for the intensity of the electric field represented a percentage of less than 40% of the imposed limit [1]. Even if the current Romanian regulations do not provide in some situations, measurements of the power density of electromagnetic waves but just of SAR (and also E or H), as are the cases of the changes from [10] compared to [11] and [12], we did not want to determine the pathological effects of the exposure but only the situation of possible electromagnetic pollution. That's why we determined the values of S for GSM frequencies.

## 5. Conclusions

The measurement schemes initiated by the authors are original and the values obtained are difficult to compare exactly with results from other researchers. However, on a larger scale, by extrapolation, these can be confirmed, but the operating conditions of the sources, which are alternating current, vary in time. Although they are of great importance in generating electromagnetic pollution (when exceeding the allowable values of CQ-ELMF) and they are present in greater number on the territory of cities, the sources by high power within the electrical grids do not arouse among the population the same interest as the mobile telecommunications systems.

In the measuring areas, the admissible values of CQ-ELMF were not exceeded. This thing does not exclude the possibility that, at certain distances from the sources, the threshold values are exceeded. In addition to the installations investigated in the paper, both the public and the workers from various domains of activity, use other devices that are sources of ELMF. These include electro-technical, electronic and office equipment or energy-technology systems: PCs, printers, faxes, electric hobs, refrigerators, televisions, automation systems, electrolysis installations, generators and electric motors, induction and microwave ovens etc. Certain economic entities grant salary increases to employees working in spaces with outdated values of CQ-ELMF. As general recommendations for protection and limitation of exposure we have identified: keeping an optimal distance from sources, limiting access in spaces with intense fields, signalling the presence in areas with ELMF, using protective equipment against static or variable electric and magnetic fields, using of electromagnetic shields, limiting the duration of exposure. From the data analysis, results a density of 0,26 ELMF sources per $m^2$ on the surface of the city. For the population number, results an allocation of 0,12 sources / inhabitant. The total number of ELMF sources is 55(identified at the study time). Measurements for GSM sites were performed in only four cases, because a pillar and the base station were located outside of the city and far from buildings. Created maps with CQ-ELMF values and implicitly with the distribution of sources, can be integrated into a specialized web-site and thus will become public and useful to those interested. In apartments or other enclosures where there are active ELMF sources, must be stopped during measurements process because they further disturb the environment and is difficult to appreciate the frequency range or the direction of the electromagnetic waves, due to overlaps that appear. Therefore, is need high-performance field analyzers that measure on 3 axes (with isotropic probes) or spectrometers that will be tuned (make the selection) to the frequency of the ELMF sources if this is known.

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*Addresses:*

- Dr. Eng. Lolea M., MAs, University of Oradea, str. Universității, nr.1, 410087, Oradea, Romania
  mlolea@yahoo.com
- Lect. Dr. Minda A.A, Babeș-Bolyai University, Faculty of Engineering, Piaţa Traian Vuia, nr. 1-4, 320085, Reşiţa, Romania
  andrea.minda@ubbcluj.ro
  (*corresponding author*)
- Dr. Barla E., University of Oradea, str. Universității, nr. 1, 410087, Oradea, Romania
  ebarla@uoradea.ro
- Eng. Sărăcuț-Ardelean A., University of Oradea, nr.1, 410087, Oradea, Romania
  saracut_alm@yahoo.com
- Eng. Szabo E., University of Oradea, str. Universității, nr.1, 410087, Oradea, Romania
  emericremus@gmail.com