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ABOUT THE URBAN ELECTROMAGNETIC POLLUTION

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Abstract: This paper presents a brief statement of electromagnetic pollution generated by public sources of electromagnetic field, wich are distributed on the territory of City of Oradea, Bihor County, Romania. The Beginning of the paperwork is related to define and a general description of electromagnetic pollution. Followed by the description of the characteristics of public sources of electromagnetic field and finally the values of the electric field and magnetic induction in the vicinity of sources. These values were obtained by direct measurements made by the authors. With their help authors mapped and statistical analysis to prioritize city neighborhoods depending on the density of electromagnetic field sources and amplitude values for the electric and magnetic field.
Keywords: electromagnetic pollution, electric field strength, magnetic field density, electromagnetic map, electromagnetic field effects

INTRODUCTION

At present, due to the development of devices that operate on electricity, ambient electromagnetic field intensity has increased greatly. Thus appeared the concept of electromagnetic pollution. It occurs when the electric and magnetic fields through the characteristic parameters, become negative factors on technical and biological systems. These negative effects by impacts are called electromagnetic disturbances and ways of transmission from source to receiver are multiple [4],[5],[10]. Fears about the negative effects related to the use of electromagnetic devices have not ceased to occur in times [9], while the accusations relating to these issues occurring several decades [6], [8]. Among the most common electromagnetic devices are the mobile telephones. A further study on the internet, leads to the idea that the number of mobile telephones in use equates, to the population of the planet. Of course, there are countries where because poverty , their number is reduced but in developed countries almost everyone owns such a device. Although buying a mobile phone is optional, allowing the rapid transmission of information at distance it becomes a necessity.

A large spread have also the household electrical appliances that help facilitate the work of the house and increases the comfort in homes or at working places. Industrial and telecommunications equipment generates electromagnetic fields that cover the entire spectrum.

SOME OF THE ELECTROMAGNETIC FIELD EFFECTS ON THE HUMAN BODY

There is great interest from specialists on the effects of electromagnetic field exposure on the human body and its impact on different anthropogenic technical systems. Electromagnetic pollution, given by electromagnetic field parameters can be determined by calculation and simulation using digital techniques, or by measurement. The two-way results should be compared for appreciation the deviations between methods. The Multiple case studies available at worldwide, that shown the results of measurements on the electromagnetic field parameters for different sectors, can be compared as means for general guidance. [14]. Because of the specific of electromagnetic devices and also their physico-chemical characteristics degradation in time, electromagnetic compatibility tests that determine electromagnetic pollution, should be repeated periodically. As a general effects of electromagnetic field impact with the human body are cataloged thermal and non-thermal [8]. Depending on affections on the human body may be direct or indirect effects [16].

Among the direct effects is include [16]:

- vertigo and nausea caused by static magnetic fields;
- effects on the sensory organs, muscles and nerves caused by low frequency fields (up to 100 kHz) - shivering;
- heating the whole body or parts of it due to high frequency fields (10 MHz and above); above a

few GHz warming increasingly limited over the body surface;
» Effects on the nerves and muscles and heating as a result of exposure to intermediate frequencies (100 kHz-10 MHz).

That indirect effects are [16]:
» interference with medical electronic equipment and devices;
» interference with medical devices or active implanted devices such as pacemakers or defibrillators;
» interference with medical devices worn on the body, such as insulin pumps;
» interference with passive implants (artificial joints, rods, wires or metal plates);
» shrapnel effects, piercings, tattoos and body designs;
» design the risk of ferromagnetic objects in a static magnetic field
» unintentional ignition of detonators;
» fires or explosions caused by ignition of flammable or explosive materials;
» electric shocks or burns caused by contact currents.

Restrictions on exposure to electric fields, magnetic and electromagnetic variable over time which are based directly on established effects on human health and biological considerations are defined as basic restrictions [17]. Depending on the frequency of the field, the physical quantities used to describe these restrictions are the magnetic flux density (B), the current density (J), Specific Absorption Rate (SAR) and power density of electromagnetic waves (S) [17]. In [6]-[9] mentioned some possible long-term effects of exposure. Among these include visual disturbances, heart rhythm and blood pressure disturbances, various cancers, Alzheimer's disease, impaired humanitarian system, infertility, changing calcium metabolism in the brain, diminishing skin resistance, reduced cerebral blood flow, etc.Some people are more affected by the momentarily presence of electromagnetic field generating devices, effects which are generic called Electrosensitivity [6]. Even these, effects are uncertain or not, because of the precautionary principle, measures must be taken to protect against them. Regularly informing the population on those possible effects beyond the scope of the various relevant international fora, including the European Commission. This issue directives in this regard, they have access to all EU citizens. [14][16].

The European Directive 35/2013, issued by the European Commission to electromagnetic fields do not address suggested long-term exposure whereas it is considered that there is no scientific evidence establishing a well established relationship clearly influence health, possibly the future if they appear clearer scientific evidence, to consider the most appropriate methods to protect humans by such effects [16].For evaluating the interest of specialists in the effects of high frequency electromagnetic fields and their impact on biological environment, investigations may be carried within the international scientific databases, that manage articles of interest to this paper. The results of personal research, statistically processed using IEEE Xplore Database - Digital Library are shown in Figure 1.

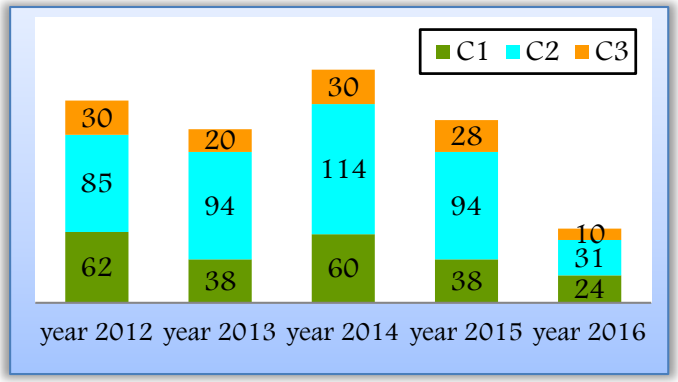


Figure 1. The statistic processing of the number of items identified on the criteria C1-C3
Explanation: C1- electromagnetic field of mobile phones, C2 - electromagnetic field of base station, C3 - electromagnetic field effects on human body

Figure 1 shows a breakdown by years of appearance of articles in the database accessed for three search criteria chosen by the authors, for the period of 2012-2016. The search criteria were formed by the juxtaposition of words that highlights the effects of electromagnetic field exposure (figure 1).

Thus, the results at the criterion by search called „Electromagnetic pollution" were generated 1056 results; at the criterion „Biological effects of electromagnetic fields" were generated 2082 results and for the criterion „Electromagnetic field of mobile telephones", the search results were 460 in number. At the time of the search in this database had recorded a total of 3,997,943 references. For the period under review, the first criterion C1, have generated a total of 222 titles. For criterion C2, they were generated a total of 418 titles. Criterion C3, 118 results are recorded for the same period.

Analyzing public opinion polling tools like the Eurobarometers, initiated by the European Commission, it can be deduced for example, what are the opinions of european citizens related to the various hazards that affect their lives. The Eurobarometer no. 347/2010, contain the answers and their statistical analyzes on health damage due to exposure to electromagnetic field of various electrical and electronic equipment [15].

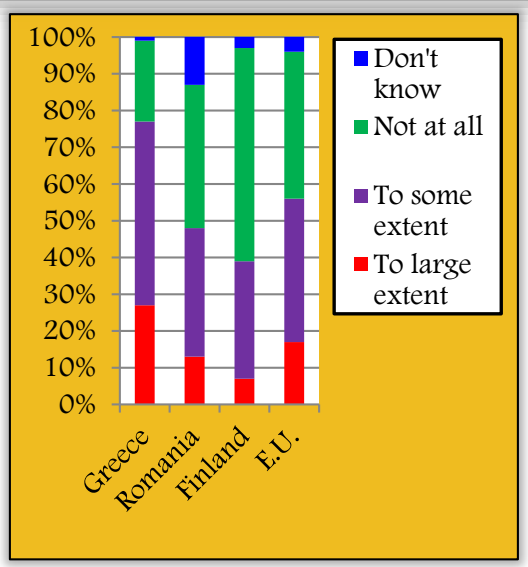


Figure 2. Types of sources: household electrical equipment (adapted by[15])

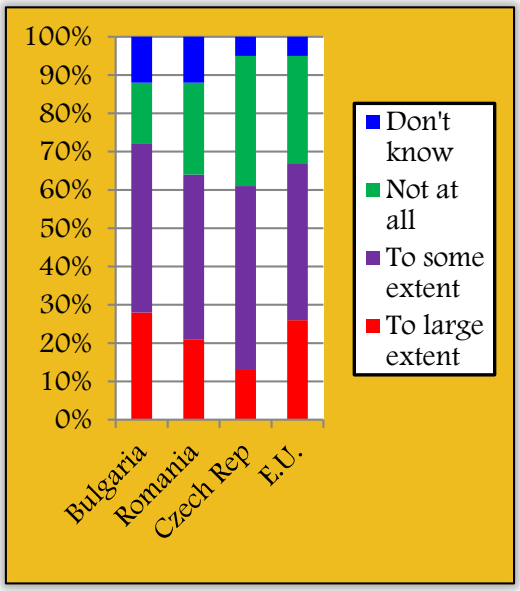


Figure 3. Types of sources: mobile telephones (adapted by[15])

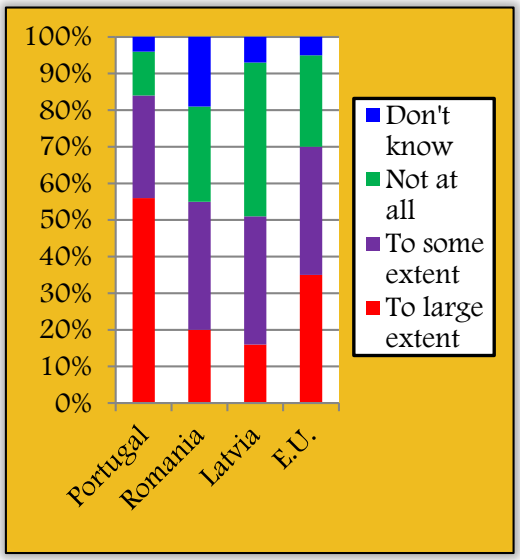


Figure 4. Types of sources: hight voltages power lines (adapted by[15])

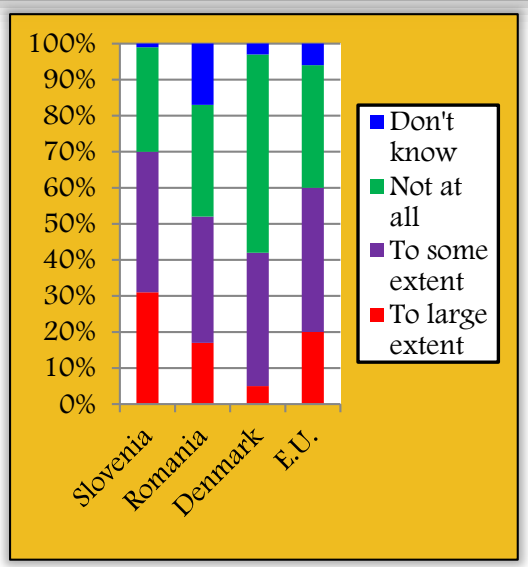


Figure 5. Types of sources: computers (adapted by[15])

Even if there is not a global consensus against risks caused by electromagnetic field exposure, the European population has some worries about the health effects generated by the operation of electrical devices, as can be seen from the responses investigations presented in [15]. By source of electromagnetic field, the answers of europeans citisens are presented in four situations in Figures 2-5.

Analyzing the same sources [15], it appears that fears highest against the negative influence of power lines high tensiunese recorded in Italy (78%), as exposure to the electromagnetic field of mobile phones (69%), personal computers (60%) and household appliances (53%). Lowest fears at european level were recorded by the answers given by dutch citizens who accounted for 13% to the influence of high voltage power lines, 7% to 5% of mobile phones and computers connected influence. Danish citizens stated at a rate of just 3% that appliances have large negative influences on health.

PUBLIC SOURCES OF ELECTROMAGNETIC FIELD

A public source of electromagnetic field is that installation or device accessible to anyone and is located on the public domain or direct border with the public area. Thus,the humans or any other type of receiver will be affected by electromagnetic radiation emitted outside the domain of location of the source. A private or occupational of electromagnetic field source is accessible to only one person, a group or a family property which is or included in the area of property and in a particular workspace where access of unauthorized persons it is prohibited or restricted. Within public sources are included in the context of the work the following: telecommunication installations with mobile base stations (BS) transceivers antennas, and additional electrical installations, recovery stations (RS) for urban electric traction and contact

wires with injection points, electrical distribution stations(power substation - PS) and transformer substations (TS) and high-voltage (HV) overhead power lines (PL). Since this paperwork refers to electromagnetic pollution will interest only urban sources which are located in the city.

To assess the electromagnetic pollution produced by these public domain have the following steps: identifying the sources of electromagnetic field and analyze their technical characteristics, design schemes extent and choice of the measuring points, setting measurement equipment and determining how to use in land, assessment practical quantities that characterize electric and magnetic field, noting obtained data, statistical data processing, statistical analysis, comparing the values obtained with the permitted limit of normative and determining the level of electromagnetic pollution. The Sizes of electromagnetic field of low frequency networks easily measurable are the electric field strenght E[V/m] and magnetic induction B[μT].

ELECTROMAGNETIC POLLUTION SITUATION IN CITY OF ORADEA. METHODOLOGY AND RESULTS

The current paragraph is meant to answer the question, what are the benefits of a study on the level of electromagnetic pollution of a city. There are many preoccupations about electromagnetic pollution assessment urban and natural environment in general. [1]-[3][11]-[13].

Usually, empirical research based on measurements of electromagnetic field around public sources and comparing the values obtained with those considered dangerous to humans, utilities and electronic or digital devices. In case of human exposure on long term, the limits for sizes of electromagnetic field for the general population provided the normative[17], are: electric field strength E_{lim} = 5000 V/m, magnetic induction B_{lim} = 100 μT, S.A.R. = 2 W/kg, power density at high frequency of electromagnetic waves, S = 1 mW/m^2.

Following similar directions but with personal contributions, in the current paragraph we present the results of investigations to identify public sources of electromagnetic field and electromagnetic pollution levels generated by them in the territory of city of Oradea, from Bihor County, Romania. The original elements consists of designing measure schemes, statistical processing of data, applications created and case studies initiated and presented.

On the date conduct of the study, the type and number of public sources of electromagnetic field located in the city of Oradea, was: 8 power substations (PS1 Oradea center, PS2 Oradea east PS3 Mecanica, PS4 Sinteza, PS5 CET II, PS6 ERA park, SE7 Industrial park Eurobussines Borsului, SE8 Crişuri), 744 transformer substations (TS), 43 GSM sites comprising base stations (BS) and antennas, 5 recovery stations (RS), 13 high-voltage power lines (HVPL) single and double circuit on the 110 kV level, 19.21 km tram lines with 14 injection points. In figures 6 and 7 is presented two types of this installations.

Measurements were made at the height of 1 m and 1, 7 m from the ground (the average height of people in Romania is 1.61 m for women and 1.74 m for men) at the level of two sensitive body areas corresponding to head and the confluence to under abdominal and above inguinal areas

Figure 6. P.S. Oradea Center

Figure 7. GSM Antennas on living block in civic center

For P.S. and T.S. as well as the RS for urban electric traction urban, the measure routes correspond of sides where the public has access. The model of the measure routes for P.S. Sinteza situated in the neighborhood Ioşia, is shown în Figure 8.

For telecommunications antennas and BS, measurements were performed at the door of access to the site and in living places or similar from immediate vicinity thereof. For tramlines, the measurements were carried out at a height of 1 m above the ground in the middle of the track rails, at the level of the injection point. The following model is shown in Figure 9.

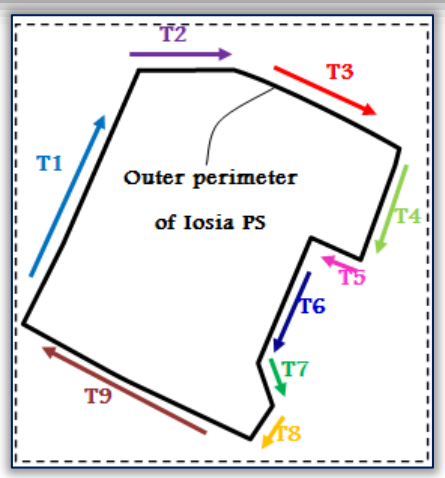


Figure 8. Measurement scheme for a P.S.

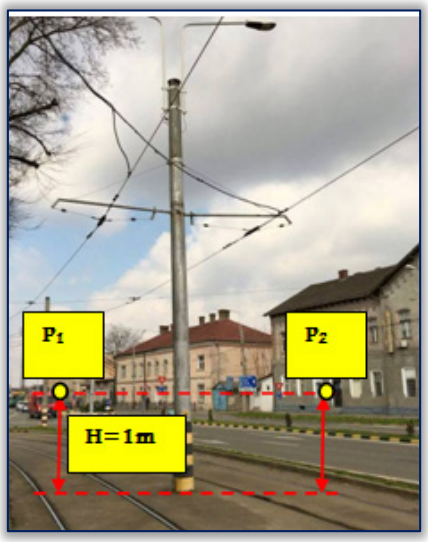
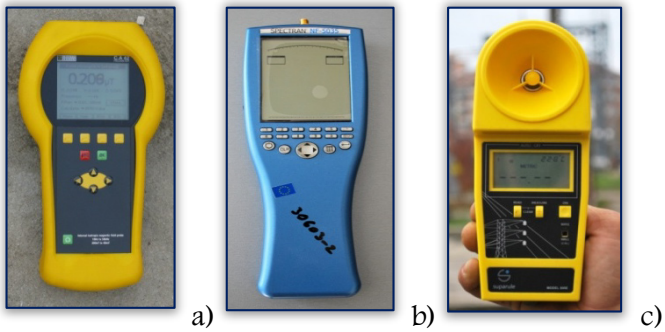


Figure 9. Measuring points for tramways

In case of PL, the routes extent correspond to the longitudinal axis thereof. For measuring routes from the PS, RS and PL, measuring step(distance between two consecutive points) as noted Δp is equal to 3 m. In case of TS, measuring step is Δp = 0,5 m(at the same height from the ground as in the case of PS). At injection points for electric traction and BS or transceiver antennas, was considered just a point in central position where values were identified maximum values of electromagnetic field quantities. Measure distance to hedge or the external wall of installations analyzed, is d = 1 m. Measuring devices used were: for the magnetic field of low frequency electric and magnetic - CA 42 Meter; the electric field and magnetic high frequency – the device SPECTRAN 5035 and for the height of the suspending wires or their gauge their, the device SupaRule 600 E. Images of the measuring devices used is shown in the Figure 10.

In addition, for measurement were also used the electromagnetic field meter Tenmars TM-196 for high frequency, triaxial isotropic type, to evaluate the electromagnetic field in the vicinity of mobile telecommunications installations and laser rangefinder Bosch PLR 50 for measuring distances from the source in the horizontal direction or obliquely.



a) b) c)

Figure 10. Measuring devices used: a- CA42; SPECTRAN 5035; c- SupaRule 600 E

With the results of investigating the sources and values of the measurements revealed the following applications: the map of territorial distribution on neighborhoods and streets of the sources of electromagnetic field, the map of the most polluted neighborhoods depending on the value of electric field strength, the map of electromagnetic pollution of neighborhoods depending on the value of magnetic induction and pollution map on the neighborhoods depending by the power density of high frequency electromagnetic waves generated by telecommunications systems. For example, the figure below shows the density map of public sources of electromagnetic field in the city of Oradea.

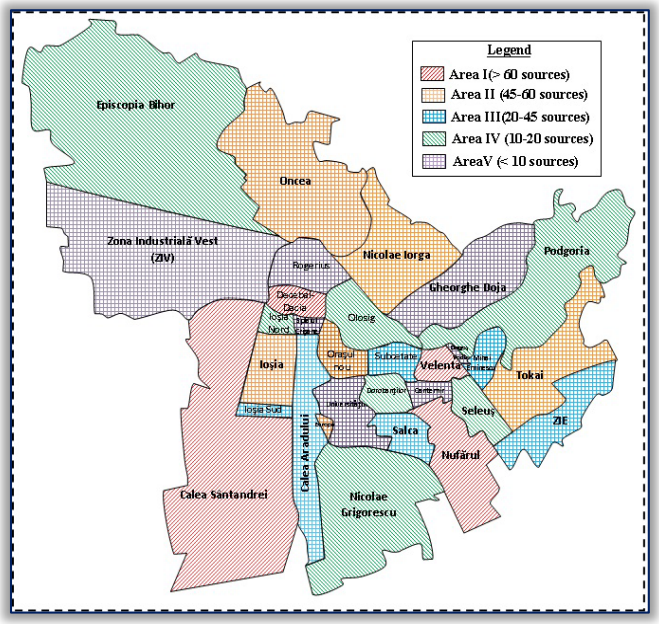


Figure 11. The density map of Electromagnetic field poublic sources on City of Oradea territory

The results of measurements fall into the following intervals:

» for RS, B = 0.016-0.082 μT and E = 60-120 V/m;
» for tram lines, B = 2.37-6.15 μT and E = 240-360 V/m;

» for BS and GSM antennas, B = 0.212-0.325 μT, E = 2.5-6.5 V/m and S = 0.256-0.885 mW/m².

Based on processing and statistical analysis of the values obtained by measurement was performed and a hierarchy on the neighborhoods according to criteria mentioned above. Thus, the figures 12 and 13 show two of statements obtained.

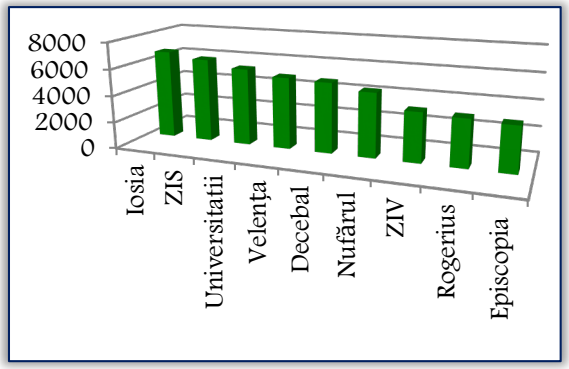


Figure 12. Hierarchy of neighborhoods by values of E [V/m]

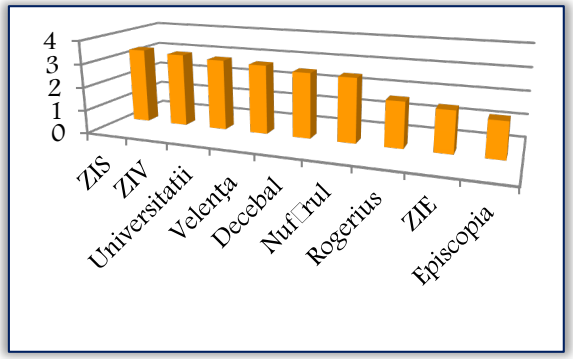


Figure 13. Hierarchy of neighborhoods by values of B[μT]

Also, with all the data, including the location on the streets of sources of electromagnetic field, their technical characteristics and the values of the field around them, was compiled a Database using Excel software from the Office suite.Figures 14 and 15, indicates the maximum and average values of the electric field intensity and magnetic induction, for common portions of the power lines crossing in the city. These lines have a nominal voltage of 110 kV and are the type of double circuit.

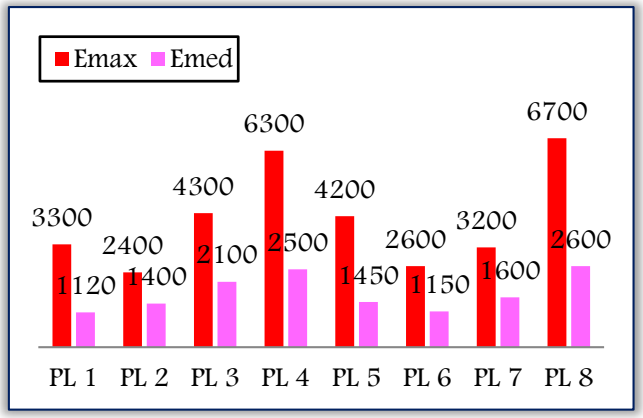


Figure 14. The Values of E[V/m] for HVPL

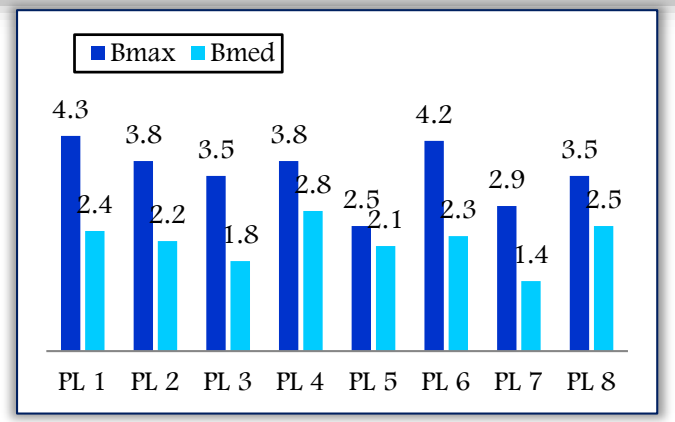


Figure 15. The Values of B[μT] for HVPL

The maximum and average values of the electric field intensity and magnetic induction, for PS are prezented in figures 16 and 17.

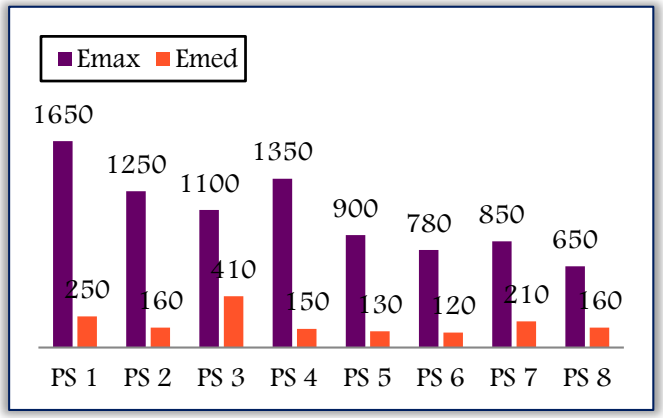


Figure 16. The Values of E[V/m] for P.S.

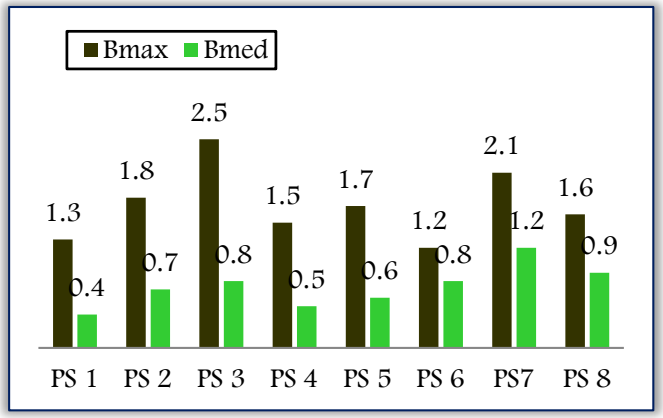


Figure 17. The Values of B[μT] for P.S.

The significances of overhead power lines from Figures 14 and 15 are: PL1 Oradea South - Sudrigiu, PL2 Mecanica - Săcueni, PL 3 Oradea South - Velenţa, PL4 Oradea West - Ioşia, PL 5 Oradea South - Alesd, PL 6 Oradea West - Mecanica, PL7 Oradea South - Nufărul and PL 8 Oradea Oradea South - Oradea West.

DISCUSSIONS

The instantaneous values of the electromagnetic field quantities depend on the operational status of installations from power substations, recovery stations and power lines, more accurate by voltages and currents values existent during measurement.

For tram lines, sags and currents absorbed depend on the number of trams in traffic and loading them with people. In each case measured values are highly variable, with a strong dynamic. In case of power lines, the fluctuations of values of field characteristics, largery depend on the land configuration and the type of road crossings and installation of utility that influences suspension height of the conductors and the choice of optimal pillar. Multiple cases are reported in the literature in which individuals or organizations have initiated legal proceedings to prove the harmfulness of mobile phones on humans [6]. And in Romania are few conclusive cases. Thus, in Oradea, a notable case is that of the university professor Ph.D. Mudura Pavel, who proved that cerebral diseases they contacted due to antennae mounted on the block where he lived, obtaining as a result of his actions, a judicial sentence that obliged the mobile operators concerned to change their location. Is the case of telecommunication facilities from the Figure 8. In the experimental researches conducted, were initiated and measurements at different distances from energy objectives advised, but since sizes field envisaged are inversely proportional to distance, to varying degrees, these have resulted lower than in areas reference and thus were not considered for this paper. They will be subject to an analytical study in the future.

CONCLUSIONS

In terms of the number of sources of electromagnetic fields and their territorial spread, Oradea is a polluted town. In few places normalized values of electric and magnetic field strengths were exceeded. This is due to low height suspension of conductors or proximity to roads and utilities in residential areas or commercial places, where expanded after the construction of high voltage power lines or electricity distribution stations. For High voltege power lines, these points with exceedances are more numerous. In cases of power stations the points with higher values coincide with the areas of power lines input, on the high-voltage for electric field intensity or where equipment or power transformers are closer to the fence and connections are above the heights of the outside fence.

If global trends are maintained to reduce the allowable values for the parameters of the electromagnetic field considered dangerous it is possible that and other locations in Oradea, to transform into some with high electromagnetic pollution generated by exceeding the new threshold values in the environment. The companies in the domain of mobile telecommunications services after installing antennas and related equipment of base stations are required to take measurements for determining values for the electromagnetic field in and around places of assembly. If these quantities are not below the permissible limit should not receive authorization to operate. But, given the degradation in time of functional characteristics and structure of material equipment used, the need arises more frequent repetition periods of such measurements. Same happens with mobile stations or cell phones. Most times the interest for periodic checks of antennas and base stations is dropped from specialized companies.Lodgers or residents of the buildings that are mounted telecommunication installations are the ones who must insist on these periodical checks.

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