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Journal of Science and Technology

E-ISSN 2146-7706

Electromagnetic pollution analysis of Bitlis Eren University main and vocational school campus

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ARTICLE INFO

Article history:
Received 27 November 2021
Received in revised form 13 March 2022
Accepted 15 March 2022

Keywords:
Electomagnetic pollution
Electromagnetic field
Bitlis Eren University

ABSTRACT

In parallel with the development of technology, the increase in the number of devices emitting electromagnetic wave also increases the rate of electromagnetic pollution surrounding our environment. Determination of electromagnetic pollution level is of great importance for human health. In the present study, it was aimed to measure the electric field values of Bitlis Eren University main campus and vocational school campus in Turkey. Spectran HF60105 was used to perform the measurements at different 20 regions in different times. Based on the electric field values, the magnetic field and power density values were calculated for each location. Although, it is found that the electric field values are below the limits which are determined by international standards, those are generally higher for five regions correspond to institute, student hostel, stadium, guesthouse and engineering faculty. It can be also noted that the highest electric field value is measured as 0.201 V/m in guesthouse region on weekdays-July for UMTS. Additionally, the higher electromagnetic pollution is determined mostly in the stadium and in July measurements. The measured electric field values are generally low (<0.050 V/m) in vocational school campus.

1. Introduction

Depending on the development of industrialization and technology in the world, electric devices used in daily life are increasing day after day. Thus, all the electric devices produce electromagnetic waves based on the amount of voltage and current. Electromagnetic pollution (EMP) occurs as a result of electromagnetic waves emitted from both natural and man-made sources located around us and can be arrayed as electric current-carrying cables, radio and television transmitters and receivers, mobile phones, base stations, high voltage lines, transformers, all electrically powered devices, atmospheric discharges and sun.

The detection of EMP, whose negative effects on human health are widely discussed and researched, has been the subject of many scientific studies in Turkey as well as in the world. High frequency EMA for a region in Italy was measured by statistical methods and measurement protocols of sources generating EMF such as power lines were determined (Paolino et al., 2001). In a study conducted in Australia, radio frequency electromagnetic energy levels emitted by base stations attracted attention (Henderson and Bangay, 2005). Benjamin and Galaucio (2001) mounted broadband measuring devices on a vehicle and made measurements between streets in order to determine the electric field strength in Brazil. Cansız and Kurt (2012) measured the EMF level in the 100 kHz-3 GHz frequency band in Diyarbakır city center with the Drive Test Method and the results were shown on the digital map. Again, environmental EMP measurements were made in the areas where the population is crowded in Ankara city center, and also in Dikmen Çaldağı and Yenimahalle Şentepe regions, where radio-television transmitters and base stations are concentrated. In these regions, electric field strength measurement was carried out

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with the SRM 3000 device and isotropic probe in the frequency spectrum of 75 MHz-3 GHz (Genç, 2010). Seker et al. (1998) conducted studies on the measurement of EMP, which is constantly exposed to in the residential, workplace and hospital environment in Turkey, and compared the values obtained as a result of the measurement with the ICNIRP limit values. Ince (2007) made measurements with the EMR 300 device in the 100 kHz–3 GHz frequency region in the city center of Ankara. In this study, the total electric field strength value in the environment was measured in some regions. In the thesis study of Dilek (2014), the EMP in the Central Campus of Recep Tayyip Erdoğan University was examined. In this study, EMP measurements were made with a compact spectrum analyzer, SRM 3006, operating in the 400 MHz-6 GHz band at 21 different points in different time zones of the day. Similarly, EMF measurements were made at the Konya Selçuk University campus (Yaldız et al. 2015). The measurement results were compared with the standard values announced by ICNIRP and BTK. Karadağ et al. (2014) made an EMP analysis on campus of Inönü Unv. and evaluated the results. Keysan (2015) conducted a pollution analysis in Balıkesir city center and University campus in his thesis study. Etem and Abbasov (2016) studied EMP of the city center of Muş.

There are international standards and limits on the effects of electromagnetic radiation on human health. The International Commission for Non-Ionizing Radiation Protection (ICNIRP) is one of the organizations that set limit values for electromagnetic fields. The limit values given by this organization have been accepted by the world's leading organizations such as the World Health Organization (WHO) and the International Labor Organization (ILO). Each country has specified its own limits and for Turkey the limits are determined by ICNIRP and Republic of Turkey Information Technologies and Communication Authority (BTK).

In this study, our aim is to investigate the electromagnetic pollution, which can cause health problems like stress, headaches, insomnia, and fatigue in the short term and discomforts on the immune system or cell structure in the long term in Bitlis Eren Unv. central campus and vocational school campus. For this purpose, measurements have been taken at different regions and different times to see the dependence of pollution on population and time effect.

2. Illustrations

The measurements were performed by Spectran HF60105 in the range of 1MHz-9,4GHz frequency (Figure 1). It can be used effectively for the measurements of nonionizing radiation by its isotropic antenna. In the measurements made with isotropic antenna, the results can be taken in mW/cm2, W/m^2, V/m, A/m units both average and maximum or minimum values. The electric field strength E (V/m), is the sum of values taken from all directions. The same measurements can also be done for magnetic field or power density. In the study, we performed our measurements in V/m unit, and the magnetic field and power density values for each E were calculated.

Figure 1. Spectran HF60105

The relation between electric field and magnetic field is given in Eq. (2.1),

$$E/H=377 \quad (2.1)$$

Power density which is also known as Poynting vector is given in Eq. (2.2), where 377 is the value of space resistance,

$$S=E.H=E^2/377 \quad (2.2)$$

With the EMP meter used in the measurements, results can be obtained in ten different frequency ranges.

1. Tetra (380 – 400 MHz)
2. ISM434 (433 – 434.8 MHz)
3. LTE800 (4G) (780 – 862 MHz)
4. ISM868 (868 – 870 MHz)
5. GSM900 (921.2 – 959.6 MHz)
6. GSM18k (1800 – 1880 MHz)
7. UMTS (3G) (2110 – 2170 MHz)
8. WLan (2400 – 2490 MHz)
9. LTE2.6 (4G) (2500 – 2690 MHz)
0. DECT (1880 – 1900 MHz)

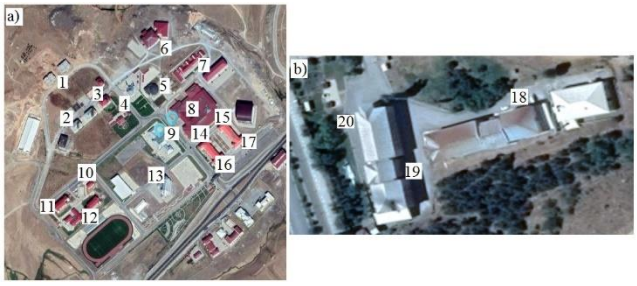

Figure 2. Bitlis Eren University measurement regions a) central campus and b) Vocational School campus

Before starting the measurements, 20 points were determined at regular intervals to surround the two campuses. The measurement points are shown in Figure 2. Measurements were made on weekdays and weekends, where the population density may be different, as well as in the summer period (July-2020) and the education-training period (October-2021). The recorded E values were taken by five measurements for each location and the average values were calculated.

3. Results and Discussion

The E limit values determined by ICNIRP and BTK for Turkey is given in Table 1 and 2. In our measurements, no values were recorded for the frequency ranges Tetra (380 – 400 MHz), ISM434 (433 – 434.8 MHz), ISM868 (868 – 870 MHz).

Table 1. The E limit values determined by ICNIRP and BTK.

Frequency (MHz)	Electric Field Strength (V/m)	
	ICNIRP	BTK
0.010-0.15	87	65.25
0.15-1	87	65.25
1-10	87/f½	65.25/f½
10-400	28	21
400-2000	1.375f½	1.03f½
2000-60000	61	45.75

Table 2. The limit values determined for GSM 900 and GSM 1800.

Frequency	900 MHz	1800 MHz
Electric field strenght	41.25 V/m	58.33 V/m
Magnetic field strenght	0.111 A/m	0.157 A/m
Power density	4.5 W/m²	9.0 W/m²

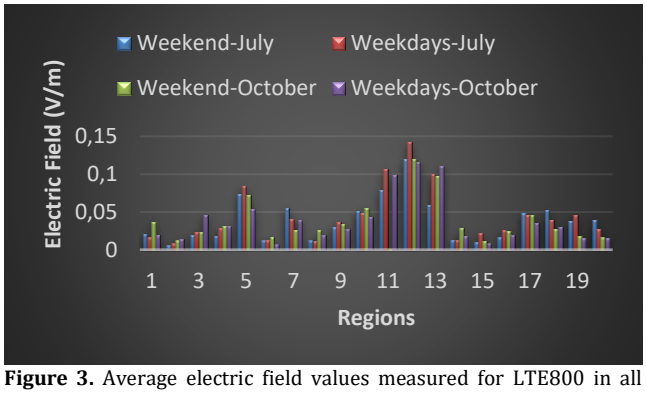

Figure 3. Average electric field values measured for LTE800 in all regions during the weekdays and weekends in July-2020 and October-2021.

According to the measurements taken on weekdays and weekends in July-2020 and October-2021 periods, it has been observed that the electric field values measured in all regions are less than the upper limits determined by ICNIRP and BTK. The measured E values for each frequency range are clearly seen in Figs. 3-9. The general results are also shown in Figs. 10-12.

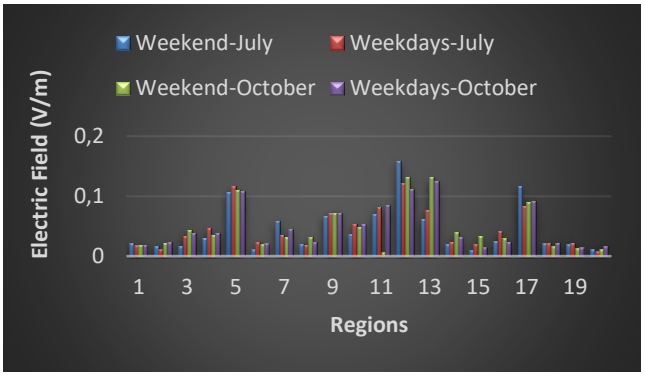

Figure 4. Average electric field values measured for GSM900 in all regions during the weekdays and weekends in July-2020 and October-2021.

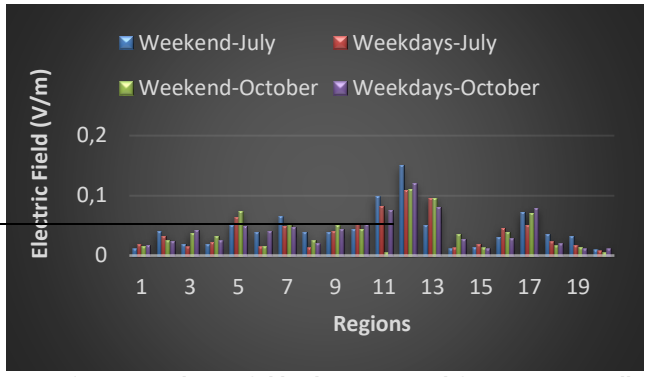

Figure 5. Average electric field values measured for GSM1800 in all regions during the weekdays and weekends in July-2020 and October-2021.

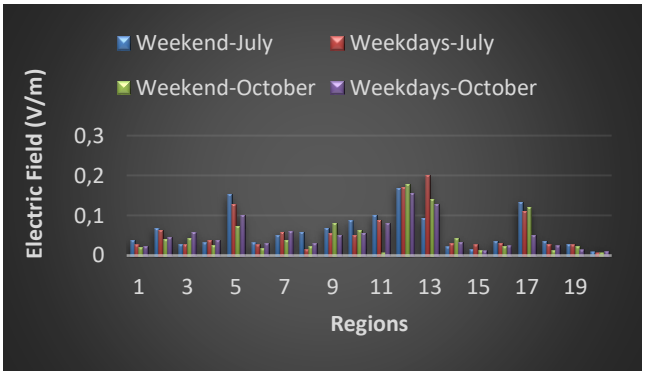

Figure 6. Average electric field values measured for UMTS in all regions during the weekdays and weekends in July-2020 and October-2021.

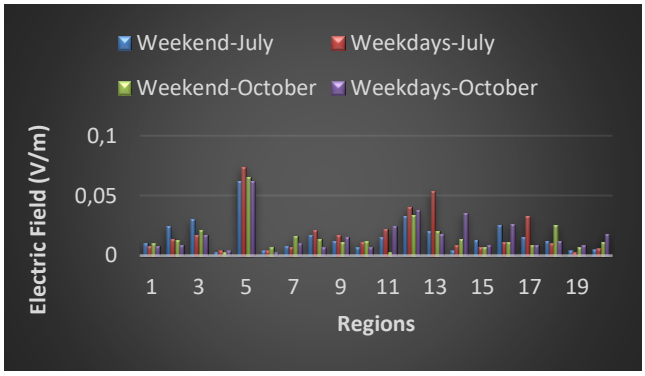

Figure 7. Average electric field values measured for Wlan in all regions during the weekdays and weekends in July-2020 and October-2021.

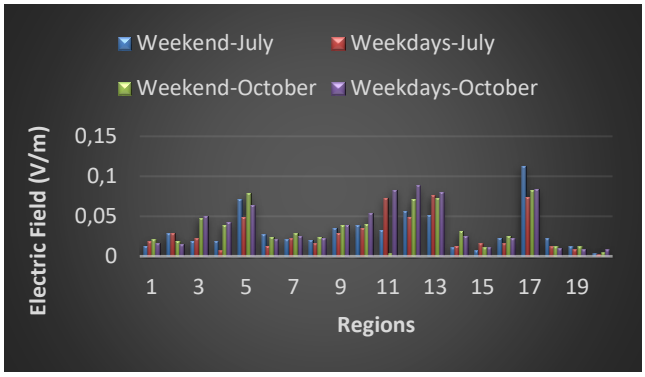

Figure 8. Average electric field values measured for LTE2.6 in all regions during the weekdays and weekends in July-2020 and October-2021.

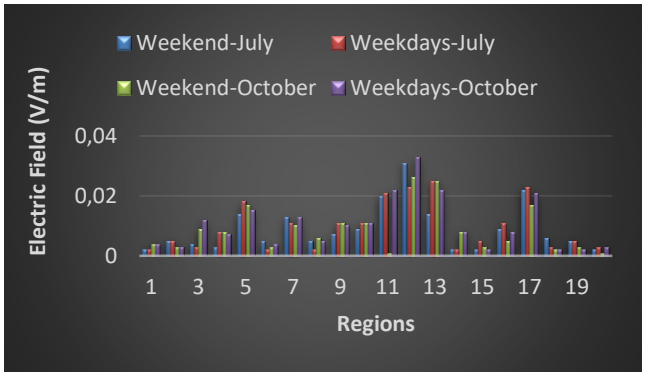

Figure 9. Average electric field values measured for Dect in all regions during the weekdays and weekends in July-2020 and October-2021.

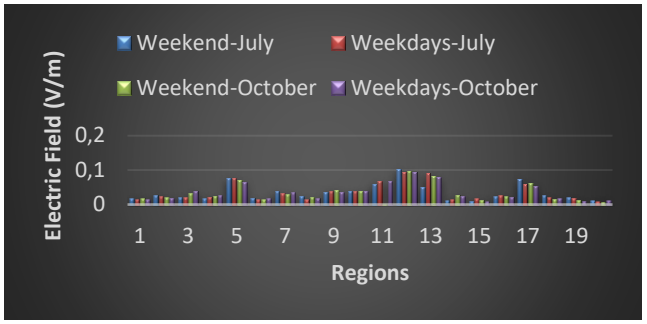

Figure 10. General average electric field values measured in all regions for all frequencies during the weekdays and weekends in July-2020 and October-2021.

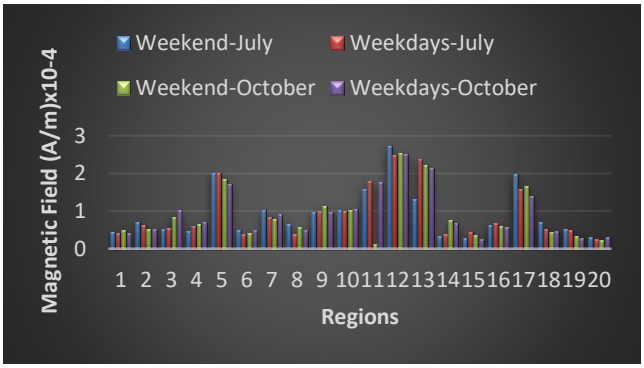

Figure 11. General average magnetic field values measured in all regions for all frequencies during the weekdays and weekends in July-2020 and October-2021.

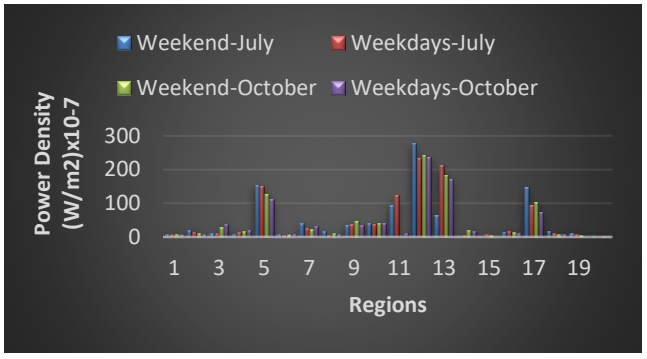

Figure 12. General average power density values measured in all regions for all frequencies during the weekdays and weekends in July-2020 and October-2021.

As seen from the figures, electric field values are generally higher for 5,11,12,13 and 17 regions (correspond to institute, student hostel, stadium, guesthouse and engineering faculty, respectively) than those for other regions. In weekend-July measurements, the highest E value was obtained in the 12th region for LTE800, GSM900, GSM1800 and UMTS. Location 5 had the highest E value for Wlan and location 17 had that for LTE2.6.

In weekdays-July measurements, the highest E value was obtained in the 12th region for LTE800, GSM900, GSM1800. Region 13 had the highest E value for UMTS, LTE2.6 and DECT, while region 5 had that for Wlan.

In weekend-October measurements, the highest E value was determined in the 12th region for LTE800, GSM900 (also region 13), GSM1800, UMTS and DECT. Region 17 had the highest E value for LTE2.6, while region 5 had that for Wlan.

In weekdays-October measurements, the highest E value was determined in the 12th region for LTE800, GSM1800, UMTS, LTE2.6 and DECT. Region 13 had the highest E value for GSM900, while region 5 had that for Wlan.

The highest E value for LTE800 measurements was determined in the 12th region on weekdays-July. For GSM900 measurements, the highest E value was determined on weekend-July in the 12th region. For GSM1800 measurements, the highest E value was determined on weekend-July in the 12th region. The highest E value for UMTS measurements was measured on weekdays-July in the 13th region. For Wlan measurements, the highest E value was determined on weekdays-July in the 5th region. The highest E value for LTE2.6 measurements was obtained on weekend-July in the 17th region. For DECT measurements, the highest E value was determined on weekdays-October in the 12th region.

An important point need to note is that higher values were obtained in 2020 measurements compared to the results in 2021 measurements. Since 2020 is a period when the pandemic is experienced intensely, making video calls, watching videos, transferring and sharing data, and using more electric devices on campus were intense during this period. It can be the reason obtaining this kind of result.

4. Conclusions

According to the results, it can be concluded that no region exceeded the limits set by both BTK and international organizations. Therefore, it can be said that the measurement results are safe in terms of limitations. It can be seen that the highest E value was measured as 0.201 V/m in the 13th region on weekdays-July for UMTS. Among the regions, the higher EMP values were observed mostly in the 12th region. The higher EMP values were determined mostly in July measurements. The measured E values are generally low in vocational school campus. Although the obtained EMP values are under the limit values, we can take simple precautions for our health in the long term. Electric devices must not be plugged in even if they are switched off. Electric devices should be kept as far away as possible, and we should keep short contact with devices we use constantly, such as mobile phones, computers, hair dryers, microwave ovens etc.

Acknowledgements

Authors acknowledge the financial support of Bitlis Eren University Scientific Research Projects Coordination Unit (BEBAP) with a project grant number 2020.005.

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