Journal of Engineering Faculty

| cumfad.cumhuriyet.edu.tr | Founded: 2023 Available online, ISSN Publisher: Sivas Cumhuriyet Üniversitesi

The Electromagnetic Field Intensity Map of Sivas Cumhuriyet University Campus at Different Frequencies

Ayşe Demirkazık[1,a], Yavuz Türkay[2,b], Tarık Türk[3,c], Vekil Sarı[4,d]*, Anılcan Birdal[5,e], Gülistan Onocak[6,f], Furkan Yıldırım[7,g]

[1]*Department of Biophysics, School of Medicine, Sivas Cumhuriyet University, 58140, Sivas, Turkey*
[2]*Department of Electrical and Electronics Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey.*
[3]*Department of Geomatics Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey*
[4]*Department of Electrical and Electronics Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey.*
[5]*Department of Geomatics Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey*
[6]*Department of Electrical and Electronics Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey.*
[7]*Department of Electrical and Electronics Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey.*
**Corresponding author*

Research Article

History

Received: 15/10/2024
Accepted: 31/10/2024

ABSTRACT

The speedy progress of the global system for mobile communication services and the ensuing increased electromagnetic field (EMF) exposure to the human body have generated debate on the potential hazard with attentiveness to human health. The aim of this study is to provide a homogeneous distribution of electromagnetic field sources on our university campus and determine possible risk zones via the electromagnetic intensity maps drawn using the data to be obtained from the measurement results. It was determined how much electromagnetic intensity of the campus was under 4 different high frequencies (900, 1800, 2400, and 2600 MHz), which were determined using the geographic information system. Electromagnetic field measurements were performed at points where the topographic structure of the land allowed. These measurements were taken at intervals of about 50 meters in the parts with building density, while at intervals ranging between 100 and 120 meters in the open areas where there were no buildings. The geographic location information about the points where these measurements were made was specified with an accuracy of cm level. As a result, our measurement values are also below the limit values of the limit electromagnetic values determined by ICNIRP.

Keywords: Electromagnetic field intensity; Geostatistical interpolations; Radio frequency.

[a] *dmrkzk@yahoo.com* *0000-0001-7224-2832*
[b] *yturkay@cumhuriyet.edu.tr* *0000-0002-4263-8286*
[c] *tarikturk@gmail.com* *0000-0002-2671-7590*
[d] *vsari@cumhuriyet.edu.tr* *0000-0001-5963-0179*
[e] *anilcanbirdal@gmail.com* *0000-0002-2416-2296*
[f] *gulistanonocak856@gmail.co* *0000-0003-0202-296x*
furkanyildirimm58@gmail.com *0000-0003-2937-3196*

How to Cite: Demirkazık A, Türkay Y, Türk T, Sarı V, Birdal A, Onocak G, Yıldırım F (2024) The Electromagnetic Field Intensity Map of Sivas Cumhuriyet University Campus at Different Frequencies , Journal of Engineering Faculty, 2(2): 119-124

Main text

The widespread use of rapidly developing technological devices is unavoidable, and many institutions and researchers are working in this area to reveal whether this technological development is harmful to human health or to determine which limits will provide a sheltered area for human health. In many countries, there are electromagnetic field (EMF) intensity limits declared by the World Health Organization (WHO) [1].

The limit values valid in Turkey were designated with the "Regulation on Determination of Limit Values of Electromagnetic Field Intensity Arising from Fixed Telecommunication Devices Operating in the 10 kHz-60 GHz Frequency Band, Measurement Methods, and Inspection" published by the Telecommunications Authority in the Official Gazette on 07/12/2001 [2].

Moreover, the General Directorate of Primary Health Care of the Ministry of Health issued a circular dated 05/29/2000 and numbered 2000/56 under the name of Non-Ionizing Radiation-Electromagnetic Pollution. In this circular, it is emphasized that necessary measures should be taken in the selection, establishment, operation, and use of appropriate sites regarding the effects on and risks for human and environmental health, and the measures should be controlled.

The International Commission on Non-Ionizing Radiation Protection (ICNIRP) examined the frequency band separately as low frequency (0-100 kHz) and high frequency (100 kHz-300 GHz) bands to review the biological and potential health effects of electric, magnetic, and electromagnetic fields and published it as different guides. These values are accepted by many countries in various parts of the world. The electromagnetic field is also considered non-ionizing radiation. Thus, it can influence all conductive systems depending on the exposure time and intensity. The main purpose of this study is to provide a homogeneous distribution of electric field intensity and electric field sources on our university campus and determine possible risk zones via the electromagnetic intensity maps drawn using the data to be obtained from the measurement results. In Table 1, the limit values determined by the ICNIRP are demonstrated in the table as electric field (V/m) values created at three different frequencies [3]. The values indicating the countries that determine these limits at different frequencies are given in Table 2 [4], and the reference levels for average occupational exposures of ≥6 minutes to electromagnetic fields from 100 kHz to 300 GHz are stated in Figure 1 [3].

There is a strong relationship between the use of wireless communication technologies and the magnitude of EMF [5], and this is more obvious in certain living areas [6]. Consequently, it does not seem possible to avoid the effects of EMF. While mobile phones and radiofrequency waves particularly affect the head area, waves emitted from base stations affect the whole body. This study will enable learning about how to determine the emissions of base stations and coordinates of the widespread use of mobile phones and electronic devices, to determine the geographical coordinates with the highest EMF intensity, and to refrain from establishing new base stations outside the regions with high EMF intensity or the construction of new buildings in a residential area. The distribution of electromagnetic waves emitted by base stations in an environment depends on many parameters. For example, communication traffic changes in different parts of the city at different times of the day, and temperature and humidity values of the environment that influence the propagation of the electromagnetic wave in the environment can be included in such parameters. Furthermore, depending on the physical characteristics and health status of some living beings, low-level, high-frequency electromagnetic waves may also lead to severe illnesses [7]. The use of Geographic Information Systems in solving environmental problems is one of the strongest and most successful application areas. As a result of the technological developments in the world, the tendency toward Geographic Information Technologies in Turkey is constantly increasing. Especially the need for the rapid analysis of spatial information with different contents in the same geography is now deemed important as an effective decision-support instrument for individuals as well as public institutions and organizations. Making location-based decisions on the data stored in the Geographical Information System is possible with the query, viewing, and analysis of geographical data. In spatial analysis procedures, new information sets are produced by making use of existing inputs.

To determine electromagnetic pollution, the Geographical Information System includes the functions of storing, processing, and presenting spatial and non-spatial information in the database and performing various inquiries and analyses. Thus, it becomes useful for the relevant institutions, which take measures and make decisions, in monitoring pollution.

- Electromagnetic pollution levels can be identified.
- A risk assessment can be made according to the results of the identification and measurement. Measures for decreasing the level of electromagnetic pollution can be implemented.
- The necessary measures can be taken in places exceeding the limit values by checking whether the results to be obtained exceed the limit values.
- It can be identified whether there are any issues about the installation of base stations in communal living and usage areas such as school gardens, kindergartens, hospitals, and parks, and risk maps can be created.
- The maps that will be created can be used as a base for future studies in the region.
- It can be ensured that different warning signs are placed in areas where base stations are installed, as per the electromagnetic field intensity they create, and arrangements such as limiting the environment of stations in open areas with warning signs can be provided.

As a result, it is assumed that electromagnetic pollution maps can be created with GIS. Hence, this will provide great convenience to us in risk assessment [7].

Table 1. Limit values determined by the ICNIRP.

	Mobile phone base station frequency		
	900 MHz	1800 MHz	2100 MHz
Electric field	41.25 V/m	58.34 V/m	56 V/m

Table 2. Electric field intensity limits.

	Electric field intensity (V/m)	
Country	900 MHz	1800 MHz
Italy	6	
Lithuania	6.1	
Poland	7	
France (only in Paris)	5	7
Turkey	41.25	58.34

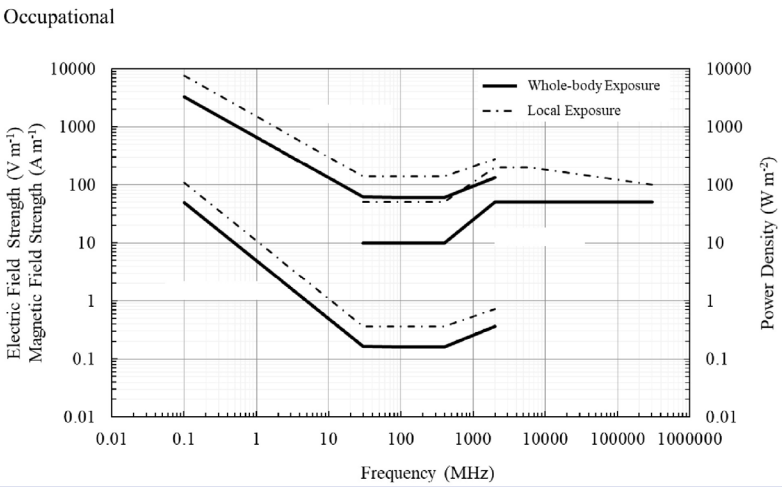

Figure 1. Reference levels for average occupational exposures of ≥6 minutes to electromagnetic fields from 100 kHz to 300 GHz.

Materials and Methods

Sivas Cumhuriyet University is a very crowded and 11000-acre campus with 50205 students, together with academic staff including 1973 members and administrative staff including 3,355 members. There are two base stations on the campus. In this study, electromagnetic field measurements were performed at points where the topographic structure of the land allowed, at intervals of about 50 meters in the parts with building density inside the campus, and at intervals ranging between 100 and 120 meters in the open areas where there were no buildings, and geographical location information about the points where these measurements were made was specified with an accuracy of cm level. Electromagnetic measurements were performed in four different frequency ranges, i.e., 900 MHz, 1800 MHz, 2400 MHz, and 2600 MHz, which had previously been planned inside the campus. At each point, values were read six times at an altitude of 120 cm (average human height) for each frequency, and these values were then averaged. In the study, a Spectran HF-6085 portable RF spectrum analyzer (Aaronia, Spectran, HF, Germany) was used for measurements. The geographical locations of the measurement points were obtained with the help of the Global Navigation Satellite System (GNSS) receiver with an accuracy of cm level through the Continuously Operating Reference Stations (CORS-TR) satellite-based positioning technology. It is extremely important to determine the position of the electromagnetic measurement point with high accuracy in such studies, as electromagnetic waves change inversely with the square of the distance between the points. Field measurements were consistently conducted between 10:00 and 15:00 daily at 473 points. Considering these criteria, the measurements took approximately four months. Afterward, the electromagnetic measurement obtained in the field and the geographical location data of these measurement points were integrated with ArcGIS 10.5 software in the Geographical Information System.

Results

The map of Sivas Cumhuriyet University campus and the direction of the measurement points are demonstrated in Figure 2. These data were interpolated with the Inverse Distance Weighting (IDW) method, and electromagnetic field intensity maps and energy density maps of each frequency were produced (Figures 3-5).

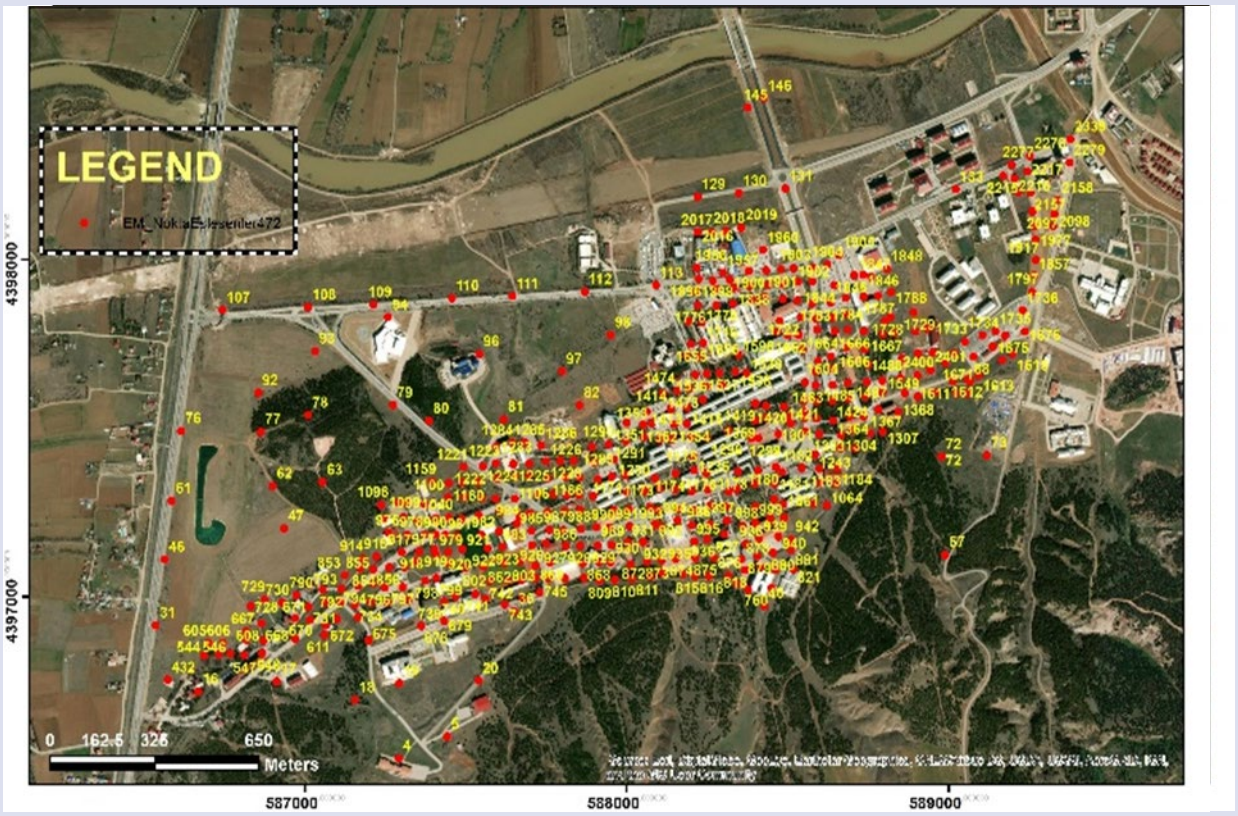

Figure 2. Map of Sivas Cumhuriyet University campus and measurement points.

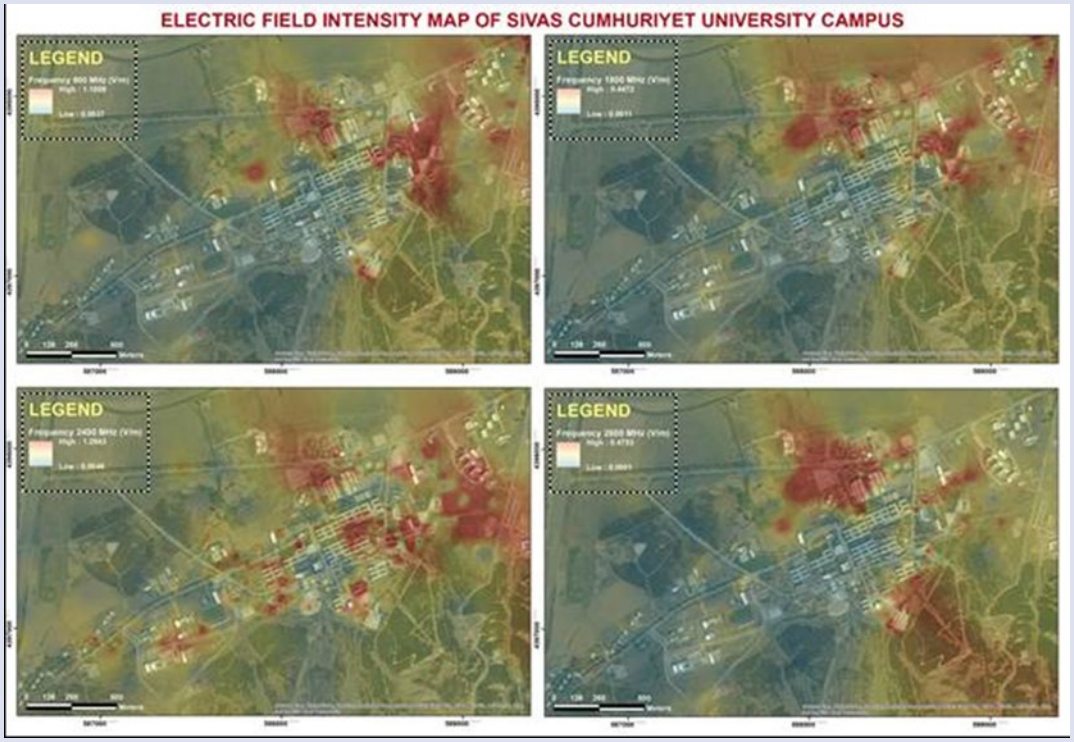

Figure 3. Electromagnetic field intensity map of Sivas Cumhuriyet University campus.

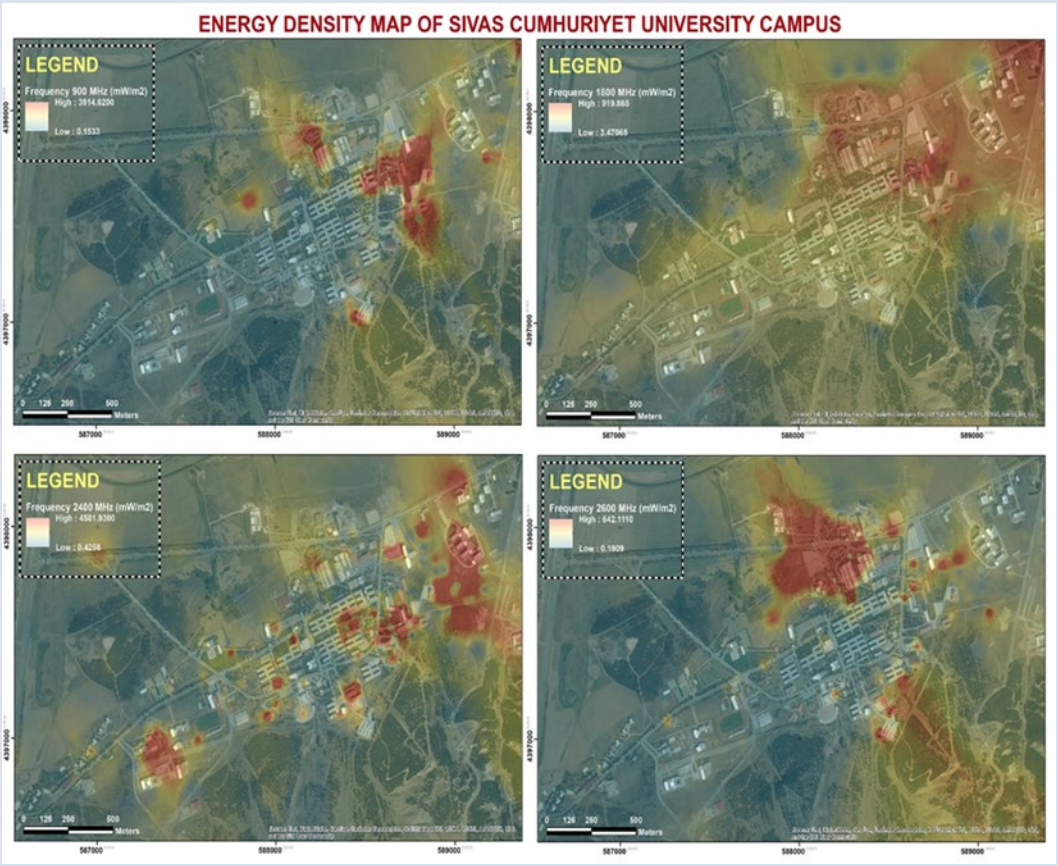

Figure 4. Energy density map of Sivas Cumhuriyet University campus.

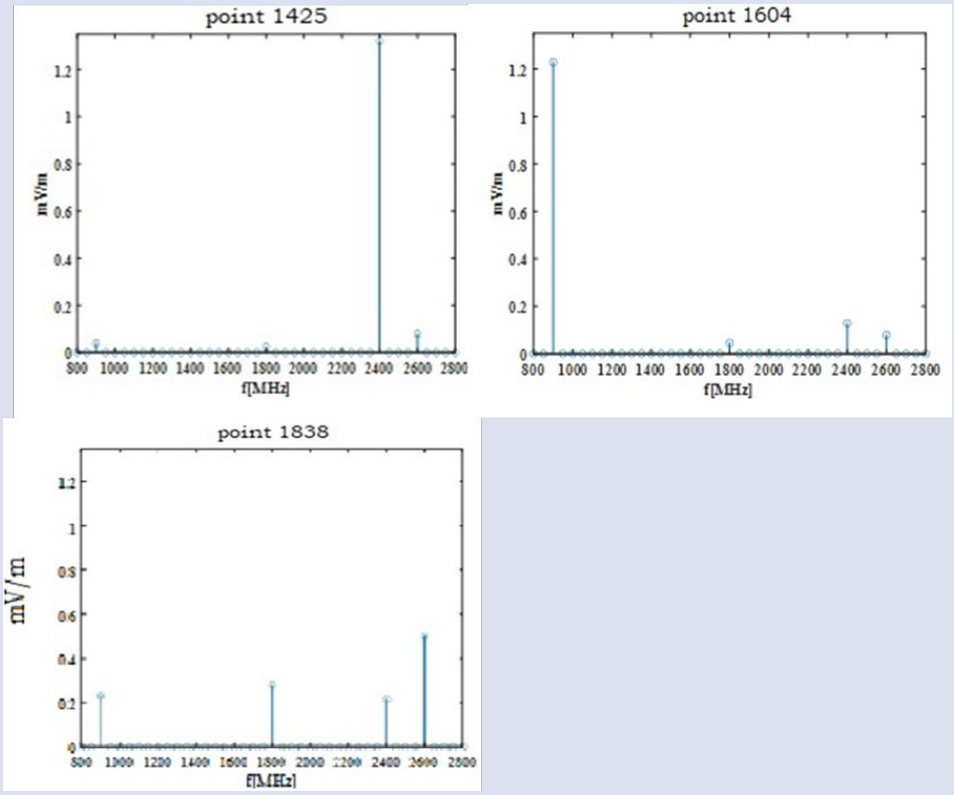

Figure 5. Graphs of the Electric field (mV/m) values in the 800-2800 MHz frequency band were obtained from 1425, 1604, and 1838 grid areas.

Discussion and Conclusion

Upon examining the maps showing the distribution of EMF intensity, we revealed that all values were ≤ 5,5 V/m (maximum 1,4 mV/m) in Sivas Cumhuriyet University campus area. In other words, they were below the limits set by the ICNIRP and accepted by Turkey. In some countries, the limit values of universities are accepted as higher than the limit values in the residential areas of people since there can be electromagnetic induction devices used in various studies. For example, this value is 6 V/m in Italy.

In Sivas Cumhuriyet University campus, power densities with some frequencies were measured higher at some points. For example, it has been detected that electromagnetic waves with a frequency of 2600 MHz at 1838 points, 900 MHz at 1604 points, and 2400 MHz at 1425 points create a higher field (mV/m). These results are parallel with the distribution of results obtained by [4]. While our findings were based on a more detailed analysis at four different frequencies, at 900, 1800, 2400, and 2600 MHz, in [4], EMF measurements were carried out only at 900 MHz and 1800 MHz on ITU campus. Compared to the nine base stations in this campus, there are two base stations in the campus addressed in our study and a Wi-Fi center to enable staff and students to connect online inside the campus. In the study in [8], only the electromagnetic pollution at 1800 MHz was mapped. In this study, electromagnetic pollution maps were obtained by measuring electromagnetic radiation at 185 points in Konya. As a result of the measurements, it was determined that there were no base stations exceeding the specified limits. However, it was determined that some base stations had relatively higher radiation values than others. In the measurement performed by Nilüfer As et al. on RTE University campus, the electric field was measured higher in certain frequency bands at crowded spots, and they reported that they found the results below the limit values [9]. Our measurement values are also below the limit values. In this study, by obtaining these base values, it will be identified how much these measurement values can increase with new base stations or other Wi-Fi centers to be added to the campus in the future.

In conclusion, we have established the first stage of our original data bank with this electromagnetic field scan made on Sivas Cumhuriyet University campus. Since our subject area was not the analysis of the effects of electromagnetic fields on human health, the details of where they can affect human health were not discussed. It is aimed at conducting research in this area in future studies. We believe that electromagnetic signal intensities should be determined in every field where people work collectively. Because humans have a conductive structure and electromagnetic field intensities affect this conductive structure for a long time.

Acknowledgements

This study was funded by Sivas Cumhuriyet University Scientific Research Project (T-796, CUBAP, Turkey).

References

[1] World Health Organization, Radiofrequency fields, Public Consultation Document, Geneva, 2014.

[2] Bilgi Teknolojileri ve İletişim Kurumu, Elektronik Haberleşme Cihazlarına Güvenlik Sertifikası Düzenlenmesine İlişkin Yönetmelik. Available at: https://www.resmigazete.gov.tr/eskiler/2009/05/20090516-19.htm

[3] International Commission on Non-Ionizing Radiation Protection, Guidelines For Limiting Exposure to Electromagnetic Fields (100 kHz to 300 GHz), *Health Physics*, 2020;118:5 483- 524.

[4] Boz K, Denli HH, Spatial Electromagnetic Field Intensity Modelling of Global System for Mobile Communication Base Stations in the Istanbul Technical University Ayazaga Campus Area, Geospatial Health, 2018;13:527 28-34.

[5] Kurnaz Ç, Mutlu M, Comprehensive Radiofrequency Electromagnetic Field Measurements and Assessments: A City Center Example, Environmental Monitoring Assessment, 2020;192:334.

[6] Hyland GJ, Physics and Biology of Mobile Telephony, *The Lancet*, 2000;356:9244 1833–1836.

[7] Kositsky NN, Nizhelska AI, Ponezha GV, Influence of High-Frequency Electromagnetic Radiation at Non-Thermal Intensities on the Human Body, Newsletter of the Cellular Phone Taskforce Inc., 2001;3:1 1–31.

[8] Durduran SS, Uygunol O, Seyfi L, Mapping of Electromagnetic Pollution at 1800 MHz GSM (Global System for Mobile Communication) Frequency in Konya, *Scientific Research and Essays*, 2010;5:18 2664-2672.

[9] As N, Dilek B, Şahin ME, Karan Y, Electromagnetic Pollution Measurement in the RTE University Campus Area, *Global Journal on Advances in Pure & Applied Sciences*, 2014;3:65-72.