HORA 2019
www.horacongress.com

International Congress on Human-Computer Interaction, Optimization and Robotic Applications
July 5-7, 2019, Urgup, Nevşehir, Turkey

SETSCI Conference Proceedings
www.set-science.com
8: 43 - 46, 2019

Electromagnetic Pollution and Electromagnetic Field Mapping in Hatay

Serkan BULUT[1*], Yakup HAMEŞ[2] and Gülnur YILMAZ[3]

[1, 2, 3] *Iskenderun Technical University, Electrical and Electronics Department, Turkey*
[*]*(bulutserkan@gmail.com)*

Abstract – With the rapid development of technology and the importance of electronic devices in our lives, electromagnetic waves produced by various sources and the related electromagnetic pollution concepts have become an important issue that directly affects the nature and all microorganisms, especially people. Energy transmission lines, radio and television antennas, base stations and mobile phones, radars, radios, medical devices, microwave ovens, etc. have increased electromagnetic fields as the utilization rates of electromagnetic propagation devices increase. In this area, depending on the work done throughout the world that is a member of Turkey to determining the international standard 'International Commission on Non-Ionizing Radiation Protection' (ICNIRP) established is the electric field and magnetic field exposure limit values prepared by the commission is considered essential. The instructions issued by the Commission are decisive and binding, and it is foreseen that these limit values are a preventive factor for electromagnetic pollution. In this paper, it is aimed to measure the electromagnetic pollution in Hatay province, to compare with the limit values determined by national and international organizations and to map the electromagnetic field. At the end of the study, the regional measures to be protected from electromagnetic pollution will be discussed in detail.

Keywords – Electromagnetic waves, electromagnetic pollution, electromagnetic field measurements, region-based mapping

I. Introduction

With the development of concepts such as Artificial Intelligence Applications and Internet of Things (IoT), technological developments that are expected to dominate every aspect of our lives in the future bring new needs and some difficulties [1]-[9]. In many areas, rapid developments, especially in the field of wireless communication, accelerates the implementation of new applications such as Industry 4.0, Remote Machine Control, Autonomous Cars and Smart Traffic Applications, Unmanned Aerial Vehicles and Military Defense Systems, e-Health Services and Remote Control Surgeries, Smart Cities / Houses, Smart Energy Systems etc.

According to the researches, the number of devices connected to the Internet is expected to increase to 50 billion by 2020. According to the same research; It is estimated that the number of interconnected devices per capita in the world will be 6.48 in 2020 and the information traffic generated by only 20 typical home devices will be higher than the total internet traffic generated in 2008 [10], [11].

The problem of electromagnetic pollution continues to be discussed with the 5G applications developing due to this increasing communication need [12]-[15]. 5G is the next generation of mobile communication technologies [16]. The basic promise of 5G is to meet the increasing needs of the services and applications created by mobile networks [17]. It also promises to extend communication technologies to every area of life and provide communication capability to every object.

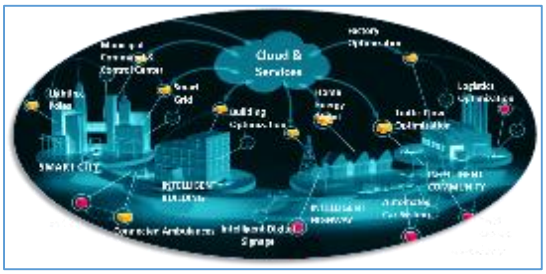

Fig. 1. 5G Applications

There are two types of sources of EM pollution in nature which are natural and unnatural sources. The sun, lightning and some stars are among the natural sources of EM. Microwave ovens, underground and above ground electric lines carrying electrical current, radio and TV transmitters, televisions and computers, electrical appliances, GSM base stations, and GSM telephone devices, radio communication systems are among the unnatural EM sources.

Due to all these technological developments defined above, the number and diversity of unnatural (artificial) resources increase. With the increase of natural and artificial sources, the intensity of the electromagnetic field exposed increases. The change of the loads in the source (operation of the equipment, etc.) causes the electric and magnetic fields

DOI : 10.36287/setsci.4.5.010

generated by these loads to emit wave energy. More wave energy is generated when the dimensions of the source and the movement of the loads reach the same level as the wavelength. In this way, the spread of electrical energy is called EM wave propagation. The energy of the EM field is directly proportional to the frequency and inversely proportional to the wavelength (1)–(3).

$$V = \lambda . f \quad (1)$$

$$E = h . f \quad (2)$$

$$E(eV) = h . c . \left(\frac{1}{\lambda}\right) \quad (3)$$

f: frequency, λ: wave length, h: Planck constant, c: speed of light

The electromagnetic field can also be classified according to the nature of the presence of an ionizer. Ionizing EM Fields (Radiation) can affect living tissue in different ways depending on the size of the energy transferred [18]. It can disrupt the chemical structure by creating ionization in the atoms or molecules of living tissue. Ionizing radiation is exemplified by nuclear weapons and especially the Chernobyl accident. Non-ionizing (Nonionizing) EM Fields are radiation types that do not have enough energy and do not ionize the atoms in the environment [19]. Visible Light, very low frequencies (ELF), Microwave, Radio Frequencies (RF), can be classified as infrared. There is no similarity with ionizing radiation because non-ionizing radiation does not have the energy to break the chemical bonds in the body. Non-ionizing radiation has no energy to disrupt the genetic material [20].

Electromagnetic fields generate current induction in living or inanimate beings in the domain. The resulting energy is absorbed by those residing in the area of action, depending on the strength of the field, the frequency of the transition mechanism and the field. Electromagnetic power absorbed by living things can cause some effects such as heat exchange in metabolism.

The energy absorbed by the living body from the electromagnetic wave is given by the Specific Absorption Rate (SAR) [21]. Specific Absorption Rate represents the amount of energy per kg that an average human body absorbs [22]. The SAR value in the tissues is proportional to the square of the applied electric field strength [23]. Although the measurement of SAR is quite complex, its calculation is only possible with the following formula (4):

$$SAR = \frac{\sigma E^2}{\rho} \left[\frac{W}{kg}\right] \quad (4)$$

σ: Conductivity[S/m], E:Electric field[V/m], ρ:Density[kg/m]

In the studies, it was found that an exposure value of SAR = 4 W / kg is required to increase the body temperature of an average weight person by 1º C and this limit has been determined to determine the limit values over this increase in temperature.

In Turkey, EMO, TUBITAK and some universities make measurements according to the measurement methods in the regulation of BTK claims "Determination, Control and Governance of Exposure Limit Values of Electromagnetic Field Intensity Caused by Electronic Communication Devices According to International Standards". All measurements are based on the limit values determined by ICNIRP.

In this study, it is aimed to measure the electromagnetic pollution in Hatay province, compare with the limit values determined by national and international organizations and map the electromagnetic field.

II. Materials and Method

The measurements were carried out by hand - held HF - 60105 Aaronia Spectran Analyzer brand spectrum analyzer, which can be used for carrying out safety analysis and environmental measurements of high frequency EMAs in the frequency range of 1MHz to 9.4GHz.

Fig. 2. Hf- 60105 Aaronia Spectran Analyzer

The device can determine the total concentration of compound EA produced by the EMA waves in the medium. Also it can easily locate the surrounding EMA resources and perform exposure limit calculations automatically with the high-performance Digital Signal Processor (DSP) instead of performing complex calculations. In addition, this device can only determine the intensity of the EMA in the beam of interest by means of the directional antenna. With the use of directional antennas, the device provides the opportunity to determine the most accurate measurement by preventing the negative effects caused by reflection, refraction, diffraction and scattering losses.

In order to make the most accurate evaluation as a result of the measurements, the measurement was carried out at regular intervals and averages of all measurements were recorded. In some cases, the measurement was repeated and compared with the first result and its accuracy was checked.

As a result of the measurements, the findings were recorded in a chart and according to the findings, electromagnetic field maps of certain regions were prepared. The geographical information software system software used for mapping is ArcGIS.

ArcGIS technology is a scalable integrated Geographic Information System software developed by ESRI. ArcGIS provides a scalable infrastructure for Geographic Information System applications in single- and multi-user environments on the desktop and server-side.

Geographic Information System is a large system that collects, processes, stores and analyzes high volumes of geographic data around the world and presents them to the users in a whole with software, hardware and other tools.

III. RESULTS

A measurement result based on the above data is given in the Table 1, 2, 3. The findings were compared with the data in the regulation published by BTK.

The Limit values in Turkey with regulations issued by the BTK values were determined. The limit values here are based on the limit values in the ICNIRP Guideline and each base station has a specific limitation. Accordingly, for a single device in the 400-2000 MHz frequency band, the limit values stated in the BTK regulation for general living areas are 0,341*f½ V/m (f =frequency (MHz)) for electric field strength, 0,0009*f½A/m for magnetic field strength and power density of f/800 W/m². The limit values given are for the average values obtained after a six-minute measurement.

Sample Measurement Results

Station Id: HT1906
Station Name: TT (AVEA) DERINCE KOYU
Coordinates: N 36° 18' 31,60" E 36° 11' 53,30"
Station Address: M.K.U. Vocational High School, Derince, Parcel No:427 Antakya / Hatay

The intensity of the electromagnetic field within 70 meters of 3 antennas on the base station in Derince Village, Antakya was measured at different times. The map of the measurements is shown in Figure 3. Measurements were made according to the sectors indicated by 1, 2 and 3 in the same figure.

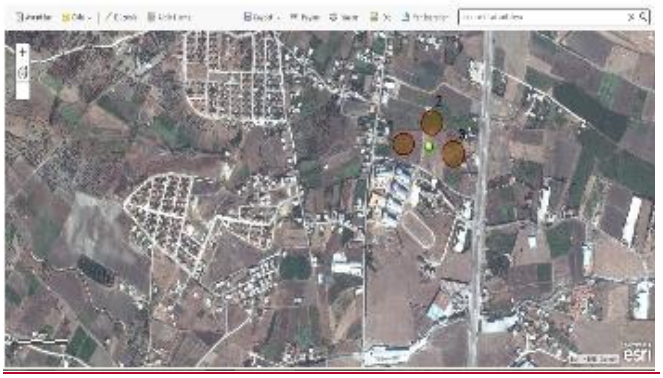

Fig. 3. ArcGIS Image

Table 1. Measurement results for Antenna 1

Antenna Sector	Distance to Antenna (m)	Measured Magnetic Field Strength (A/m)	Measured Electric Field Strength (V/m) Total Media	Measured Power Density (W/m²)	Measurement Time
1	70m (-20º)	0,0013	0,50	0,000670	10:09
	70m	0,0016	0,59	0,000933	10:16
	70m (+20º)	0,0014	0,52	0,000725	10:23

Table 2. Measurement results for Antenna 2

Antenna Sector	Distance to Antenna (m)	Measured Magnetic Field Strength (A/m)	Measured Electric Field Strength (V/m) Total Media	Measured Power Density (W/m²)	Measurement Time
2	70m (-20º)	0,0015	0,55	0,000811	10:37
	70m	0,0017	0,62	0,001031	10:44
	70m (+20º)	0,0016	0,60	0,000965	10:51

Table 3. Measurement results for Antenna 3

Antenna Sector	Distance to Antenna (m)	Measured Magnetic Field Strength (A/m)	Measured Electric Field Strength (V/m) Total Media	Measured Power Density (W/m²)	Measurement Time
3	70m (-20º)	0,0018	0,66	0,001168	11:08
	70m	0,0016	0,59	0,000933	11:15
	70m (+20º)	0,0017	0,63	0,001064	11:22

IV. CONCLUSION AND RECOMMENDATIONS

As can be seen from the measurement results in the tables, the data obtained are below the accepted legal standards. In all of the measurements carried out in 6 different densities where the population is dense in Hatay, no measurement results were taken above the values determined by ICNRP.

When the results of other researches on this subject are examined, it is seen that there are no failures in this issue, the necessary arrangements are taken by the responsible institutions and organizations and the necessary measures are taken for the situations that may cause EM pollution through

regular audits. However, due to the increasing number of developing technologies and resources, EM Pollution continues to be a current threat as a potential threat to public health. It may be useful to follow the recommendations below:

- Power tools should be operated as far away from us as possible, and Electrical devices should be unplugged when not in use.
- Television and radio should not be available in the room where we sleep. Wireless modems and routers in the home should be turned off while sleeping. It is better for your health not to use a mobile phone unless necessary. Users should be careful about short talking times, usage of headphones if possible, keeping the phone away during the connection, and not to make calls on the ground with poor coverage.
- Cell phone use also affects brain activities. Children under 16 years of age are at higher risk because the nervous system continues to develop in the head. Therefore, children under the age of 16 should only use mobile phones in case of emergency.
- The SAR of the purchased mobile phone should be considered. When buying mobile phones, SAR rates should be considered rather than functions.
- Warning signs containing EMC measurement values and usage certificates shall be placed on the walls of the substations, radio and TV transmitting stations in a publicly visible manner.
- Educational programs on EM pollution should be broadcasted on television channels and relevant information should be added to the subject scope by focusing on the subject in schools.
- When urbans are planned by municipalities, especially in developing areas with high development potential, base stations and energy transmission lines should be planned in detail.
- There should be a protection zone around the base stations.
- Restrictions should be introduced to prevent the installation of base stations near schools, kindergartens, hospitals and playgrounds.

ACKNOWLEDGMENT

This study is a part of thesis titled “Electromagnetic Pollution and Electromagnetic Field Mapping in Hatay” conducted by Serkan Bulut.

REFERENCES

[1] J. Wan, J. Yang, Z. Wang, and Q. Hua, "Artificial Intelligence for Cloud-Assisted Smart Factory," *IEEE Access*, vol. 6, pp. 55419-55430, 2018.

[2] Y. Lin, Y. Lin, and C. Liu, "AItalk: a tutorial to implement AI as IoT devices," *IET Networks*, vol. 8, no. 3, pp. 195-202, 5 2019.

[3] A. El-Mougy, I. Al-Shiab, and M. Ibnkahla, "Scalable Personalized IoT Networks," *Proceedings of the IEEE*, vol. 107, no. 4, pp. 695-710, April 2019.

[4] A. Rego, A. Canovas, J. M. Jiménez, and J. Lloret, "An Intelligent System for Video Surveillance in IoT Environments," *IEEE Access*, vol. 6, pp. 31580-31598, 2018.

[5] A. H. Sodhro, S. Pirbhulal, and V. H. C. de Albuquerque, "Artificial Intelligence-Driven Mechanism for Edge Computing-Based Industrial Applications," *IEEE Transactions on Industrial Informatics*, vol. 15, no. 7, pp. 4235-4243, July 2019.

[6] J. Li, Z. Zhao, R. Li, and H. Zhang, "AI-Based Two-Stage Intrusion Detection for Software Defined IoT Networks," *IEEE Internet of Things Journal*, vol. 6, no. 2, pp. 2093-2102, April 2019.

[7] M. Shen, B. Ma, L. Zhu, X. Du, and K. Xu, "Secure Phrase Search for Intelligent Processing of Encrypted Data in Cloud-Based IoT," *IEEE Internet of Things Journal*, vol. 6, no. 2, pp. 1998-2008, April 2019.

[8] M. Mohammadi, A. Al-Fuqaha, S. Sorour, and M. Guizani, "Deep Learning for IoT Big Data and Streaming Analytics: A Survey," *IEEE Communications Surveys & Tutorials*, vol. 20, no. 4, pp. 2923-2960, Fourthquarter 2018.

[9] J. Wan, J. Yang, Z. Wang, and Q. Hua, "Artificial Intelligence for Cloud-Assisted Smart Factory," *IEEE Access*, vol. 6, pp. 55419-55430, 2018.

[10] M. R. Palattella *et al*., "Internet of Things in the 5G Era: Enablers, Architecture, and Business Models," *IEEE Journal on Selected Areas in Communications*, vol. 34, no. 3, pp. 510-527, March 2016.

[11] A. Siddiqa *et al*., "Social Internet of Vehicles: Complexity, Adaptivity, Issues and Beyond," *IEEE Access*, vol. 6, pp. 62089-62106, 2018.

[12] C. Mao, M. Khalily, P. Xiao, T. W. C. Brown, and S. Gao, "Planar Sub-Millimeter-Wave Array Antenna With Enhanced Gain and Reduced Sidelobes for 5G Broadcast Applications," *IEEE Transactions on Antennas and Propagation*, vol. 67, no. 1, pp. 160-168, Jan. 2019.

[13] Y. Zhang, J. Deng, M. Li, D. Sun, and L. Guo, "A MIMO Dielectric Resonator Antenna With Improved Isolation for 5G mm-Wave Applications," *IEEE Antennas and Wireless Propagation Letters*, vol. 18, no. 4, pp. 747-751, April 2019.

[14] Y. Ban, C. Li, C. Sim, G. Wu, and K. Wong, "4G/5G Multiple Antennas for Future Multi-Mode Smartphone Applications," *IEEE Access*, vol. 4, pp. 2981-2988, 2016.

[15] J. Zeng, and K. Luk, "Single-Layered Broadband Magnetoelectric Dipole Antenna for New 5G Application," *IEEE Antennas and Wireless Propagation Letters*, vol. 18, no. 5, pp. 911-915, May 2019.

[16] M. Ali *et al*., "First Demonstration of Compact, Ultra-Thin Low-Pass and Bandpass Filters for 5G Small-Cell Applications," *IEEE Microwave and Wireless Components Letters*, vol. 28, no. 12, pp. 1110-1112, Dec. 2018.

[17] K. Lee, S. Choi, and C. Kim, "A 25–30-GHz Asymmetric SPDT Switch for 5G Applications in 65-nm Triple-Well CMOS," *IEEE Microwave and Wireless Components Letters*, vol. 29, no. 6, pp. 391-393, June 2019.

[18] S. Kim, J. Moon, I. Cho, J. Yoon, W. Byun, and H. Choi, "Advanced Power Control Scheme in Wireless Power Transmission for Human Protection From EM Field," *IEEE Transactions on Microwave Theory and Techniques*, vol. 63, no. 3, pp. 847-856, March 2015.

[19] A. Sannino *et al*., "Adaptive response in human blood lymphocytes exposed to non-ionizing radiofrequency fields: resistance to ionizing radiation-induced damage," *Journal of Radiation Research*, vol. 55, no. 2, pp. 210-217, March 2014.

[20] S. Lee *et al*., "Non-Ionized, High-Resolution Measurement of Internal and Marginal Discrepancies of Dental Prosthesis Using Optical Coherence Tomography," *IEEE Access*, vol. 7, pp. 6209-6218, 2019.

[21] R. D. Morris, L. L. Morgan, and D. Davis, "Children Absorb Higher Doses of Radio Frequency Electromagnetic Radiation From Mobile Phones Than Adults," *IEEE Access*, vol. 3, pp. 2379-2387, 2015.

[22] D. Senic, A. Sarolic, C. L. Holloway, and J. M. Ladbury, "Whole-Body Specific Absorption Rate Assessment of Lossy Objects Exposed to a Diffuse Field Inside a Reverberant Environment," *IEEE Transactions on Electromagnetic Compatibility*, vol. 59, no. 3, pp. 813-822, June 2017.

[23] T. Alam, M. R. I. Faruque, and M. T. Islam, "Specific absorption rate reduction of multi-standard mobile antenna with double-negative metamaterial," *Electronics Letters*, vol. 51, no. 13, pp. 970-971, 25 6 2015.