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RESEARCH ARTICLE / ARAŞTIRMA MAKALESİ

Analysis and Evaluation of The Electromagnetic Field Pollution in Marmara University Başıbüyük Campus Using Gas Discharge Visualization Tehnique According to Different Weather Conditions

Marmara Üniversitesi Başıbüyük Kampüsü'ndeki Elektromanyetik Alan Kirliliğinin Farklı Hava Koşullarına Göre Gaz Boşalım Görselleştirmesi Tekniği Kullanılarak Analizi ve Değerlendirilmesi

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Abstract
The continuous development of technology and, accordingly, people's interest in technological devices is increasing. Electric powered devices generate electricity and magnetic fields. The intensity of electric and magnetic fields is restricted by international organizations and limit values by Turkey's Information Technologies and Communication Authority (BTK). The values of the electromagnetic field generated by the base stations are monitored by the BTK. The limit values determined by the BTK are more stringent than those set by international organizations. The intensity of the electromagnetic field varies according to the distance and power to the system. In this study, electromagnetic field pollution in Marmara University Başıbüyük Campus was analyzed periodically and according to different weather conditions. Measurements were performed at 19 different points and the results were mapped. SRM 3006 model selective radiation meter was used in the measurement. Measurement results were compared with international limit values and evaluated. The limit value determined by international organizations for the environment is 61 V/m and the limit value determined by BTK is 42 V/m. 12-day average electric field is 1.53 V/m for periodical measurements. The average electric field in sunny weather is 1.9 V/m, 1.28V/m in rainy weather and 1.39V/m in cloudy weather. Gas Discharge Visualization technique was used to observe the possible changes in the energy and stress situation of the different electromagnetic field points within the campus. Energy and stress measurement with this technique was performed with Bio-well device. According to the measurement results, no change in stress and energy status was observed.
Keywords: Electromagnetic field measurement, different weather conditions, gas discharge visualization technique, stress and energy

Öz
Teknolojinin sürekli gelişimine bağlı olarak insanların teknolojik cihazlara olan ilgileri artmaktadır. Elektrik ile çalışan cihazlar elektrik ve manyetik alan üretirler. Elektrik ve manyetik alan yoğunlukları uluslararası kuruluşlar ve Türkiye Bilgi Teknolojileri ve İletişim Kurumu (BTK) tarafından sınırlandırılmaktadır. Baz istasyonları tarafından üretilen elektromanyetik alan değerleri BTK tarafından takip edilmektedir. Ayrıca BTK tarafından belirlenen sınır değerler uluslararası kuruluşlara göre daha katıdır. Elektromanyetik alanın yoğunluğu, sisteme olan mesafe ve gücüne göre değişmektedir. Bu çalışmada, Marmara Üniversitesi Başıbüyük Kampüsü'ndeki elektromanyetik alan kirliliği periyodik olarak ve farklı hava koşullarına göre analiz edilmiştir. Ölçümler 19 farklı noktada yapılmıştır ve haritalandırılmıştır. Ölçümde SRM 3006 model selektif radyasyon ölçer cihazı kullanılmıştır. Ölçüm sonuçları uluslararası limit değerlerle karşılaştırılmıştır ve değerlendirilmiştir. Uluslararası kuruluşlar tarafından ortam için belirlenen sınır değer 61 V/m, BTK tarafından belirlenen sınır değer ise 42 V/m'dir. 12 günlük periyodik ölçümlerin ortalama elektrik alan değeri 1,53 V/m'dir. Güneşli havalarda ortalama elektrik alan 1,9 V/m, yağışlı havalarda 1,28 V/m ve bulutlu havalarda 1,39 V/m'dir. Kampüs içindeki farklı elektromanyetik alan noktalarının enerji ve stres durumlarındaki olası değişikliklerini gözlemlemek için Gaz Boşalım Görselleştirmesi tekniği kullanılmıştır. Bio-well cihazı ile bu teknik kullanılarak stres ve enerji ölçümü yapılmıştır. Ölçüm sonuçlarına göre stres ve enerji durumlarında herhangi bir farklılık gözlenmemiştir.
Anahtar Kelimeler: Elektromanyetik alan ölçümü, farklı hava koşulları, gaz boşalım görselleştirmesi tekniği, stres ve enerji

I. INTRODUCTION

Nowadays, with the progress of technology, the demand for new technological devices has increased. Electrical high-voltage lines, radio / television broadcasts, base stations, wireless modems, electrical appliances etc. systems create an electromagnetic field and this field varies according to the systems. The intensity of the electromagnetic fields varies depending on the signal strength and distance of the electrical devices.

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Todays, mobile telecommunication systems have global high-speed accessibility technologies (audio, video, video, internet, etc.). Base stations are larger in city centers than in rural areas due to the need for capacity and quality of coverage. This requires more frequency and may cause more electromagnetic field pollution.

One of the main topics of electrical engineering is electromagnetic fields. Field is the spatial distribution of a physical quantity over time. Vector and scalar fields are divided into two. The magnitude and direction is defined as the vector field which depends on space and time [1-4].

The penetration of electromagnetic energy into matter is defined as electromagnetic radiation. Electromagnetic radiation is divided into two as ionizing and non-ionizing. Each wave in the electromagnetic spectrum has its own characteristics.

The effects of electromagnetic fields on human health vary according to the frequency ranges of ionized and non-ionized. Ionizing radiations, which include x-rays and gamma rays. These electromagnetic fields can damage DNA or cells directly. Non-ionizing radiations, which include static fields, magnetic fields from electric power lines, radio waves, microwaves, infrared radiation and visible light. These electromagnetic fields aren't known to damage DNA or cells directly [5,6].

In the extremely low frequency electromagnetic field exposure and restraint stress induce changes on the brain lipid profile of Wistar rats research aimed to evaluate the effect of chronic extremely low frequency electromagnetic field (ELF-EMF) exposure, restraint stress or both on lipid profile and lipid peroxidation in Wistar rat brain. Furthermore, chronic exposure to ELF-EMF is similar to physiological stress, and induce changes on brain lipid profile [7].

In the research by Samuel, examines effects of EMF of major electrical technologies including power lines and undersea cables, communication systems, solar power satellite, radar, high-powered broadcast transmitters, cellular phones. To summarize this study, The effects of EMFs produced by electrical devices are documented but the established effects are apparently of local and minor significance [8].

According to research by Marko, EMF's hazard and benefit is discussed on human life. Finally, therapeutic devices are engineered without consideration of biological properties. Therefore much work remains to be done in designing magnetotherapeutic devices [9].

Studies by Kıvrak EG. et al evaluated the exposure to EMF results in oxidative stress of the body. The aim of this sdudy was to highlight the impact of oxidative stress on antioxidant systems [10].

According to research by Valberg, in the field of epidemiology has not been associated with health problems in people exposed to low-level electromagnetic field yet [11].

In the research by Keysan, electromagnetic pollution map of Balıkesir city center and Balıkesir University Çağış Campus was prepared and the results were evaluated. Measurement results were found to be below the limit values [12].

In the thesis study by Aktaş, the effect of the electromagnetic field on the employees of an electricity distribution company was analyzed and evaluated. According to the results of the survey, 60 migrants exposed to transformer-induced electromagnetic effects and 20 non-exposed persons differed only in terms of the incidence of migraine disease [13].

According to research by Callialp and Seker, electromagnetic field pollution of a low frequency home and office environment was compared with ICNIRP limit values of the measurement results. As a result, it was seen that the calculated and measured values are close to each other [14].

In the research by Callialp Kunter, Seker, Surmeli and Cerezci, attenuation characteristics of 2G, 3G and 4G frequency bands has been investigated in different environments. Measurements were made in the open area and on different floors and rooms of a 5-storey building [15].

In our study, isotropic electric field measurements were made for the environment at 19 different points in the campus. Firstly, 12-day periodic measurements were performed. Then, measurements were made according to different weather conditions (sunny, cloudy and rainy). The measurement results were compared with the limit values determined by the International Commission on Non-ionizing Radiation Protection (ICNIRP) and BTK. In order to see the effect of electromagnetic field pollution on energy and stress, 11 days periodical measurements were carried out on campus by Gas Discharge Visualization technique. In addition, it is aimed to see the possible effect of mobile phone on human by this technique. There has been a different study by analyzing the electromagnetic field pollution measurements with GDV technique.

II. MATERIALS and METHODS

2.1 Methods

2.1.1. Locations

EMF measurement is planned at 19 different locations in Başıbüyük campus of Marmara University. In the selection of 19 different places, the density of people in the campus was taken into consideration. Stress and energy status measurements were performed at two different points, high and low EMF levels.

2.1.2. Statistical analyses

EMF measurements are made with an isotropic antenna, it collects all the signals between 27 MHz and 3GHz. In measurements made with isotropic antenna; Total electric field strength E (V / m), each is the sum of the values taken from the direction. Environmental electricity in the measurements made to determine the field strength values; n. source Electric field strength (En) becomes. These equations are illustrated by the formulas (1) and (2) below [16].

$$|E| = \sqrt{E_x^2 + E_y^2 + E_z^2} \tag{1}$$

$$|E| = \sqrt{E_1^2 + E_2^2 + E_3^2} \tag{2}$$

In the above formula, x, y and z show the axes of the signal. E indicates the intensity of the electric field. Stress and energy analysis is performed according to the ranges determined in the biowell device.

2.1.3. Limit values

The electrical field measurements will be compared by International Commission on Non-Ionizing Radiation Protection (ICNIRP) and Turkey's Information Technologies and Communications Authority (BTK). The limit values determined by these institutions are shown in Table 1 and Table 2 below.

Table 1. ICNIRP reference levels for whole body exposure [17]

Frequency Range	E-field strength (V/m)
0,1-20 MHz	$560/f$
20-30 MHz	28
30-400 MHz	28
400-2000 MHz	$1{,}375f^{0,5}$
2-300 Ghz	—

Table 2. BTK reference levels for whole body exposure [18]

Frequency Range	E-field strength (V/m)
0,010-0,15 MHz	65,25
0,15-1 MHz	65,25
1-10 MHz	$65{,}25/f^{0,5}$
10-400 MHz	21
400-789 MHz	$1{,}03f^{0,5}$
789-2000 MHz	$0{,}96f^{0,5}$
2-94 Ghz	42,93

2.2. Materials

For electromagnetic field measurement, SRM-3006 model selective radiation meter was used. It shows the electromagnetic field intensity values at each frequency with the frequency selector feature of the device. SRM series devices have high resolution, stability, high dynamic, wide frequency spectrum and high measurement accuracy. The measurement results are stored on the memory card in the device and the data is transferred to the desired computer environment via the output port. The device can measure up to 6 GHz, but it also measures different frequency ranges from triaxial E-field antennas. The device is designed for light and practical use and is easy to use in harsh conditions. SRM-3006 can be fitted with single-axis and three-axis antennas and measurements can be made [19]. The SRM-3006 device is shown in Figure 1. The device is periodically calibrated.

SRM device is fixed with the neck collar to the person making the measurement. The device is fixed at a height of 1.5 meters from the ground. Measurements were made for 6 minutes for each location.

Figure 1. SRM-3006

In order to observe the stress and energy situation in human, measurements are made by GDV (Gas Discharge Visualization) technique. Gas Discharge Visualization device is designed for photoelectric event. Photoelectric is defined as electrons scattered from a surface where light falls. The name of the GDV device is Bio-well. Device produced by photoelectric imaging technique [20]. The Bio-well device is shown in Figure 2.

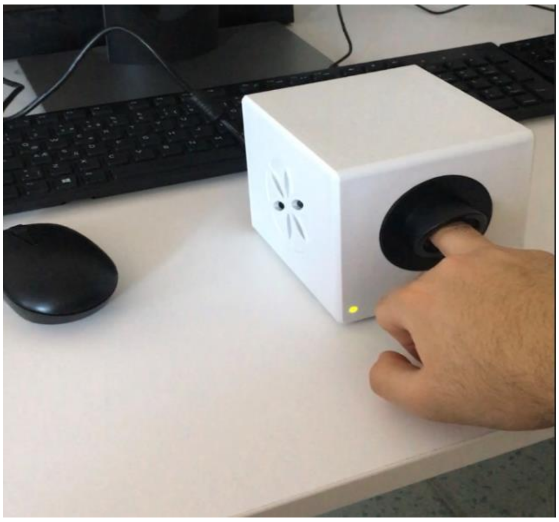

Figure 2. Bio-well device

III. RESULTS and DISCUSSION

Periodic EMF measurements were performed for the environment in order to determine the reliability and accuracy of the measurements within the campus. The measuring zone is shown in Figure 3. In total, measurements were carried out at 19 different points determined by SRM-3006 device for 12 days. The measurements were made at the same time intervals. All periodic measurements have taken care of sunny weather. The results of the measurements were mapped with Mapinfo map application.

The locations of the GDV and electric field measurements at the Başıbüyük Campus of Marmara University are shown in Figure 3 below. 19 different measuring points are indicated by yellow icons. The red area shows the active roads and areas within the campus.

Figure 3. Measured locations

Figure 4 shows the result of the first day of the periodic electric field measurements. Point result mapping was done with mapinfo application. The electric field measurement results are colored according to certain intervals.

Table 3 below shows the average values of the 12-day electric field measurements at 19 different points. At the same time the coordinates of 19 different points are indicated.

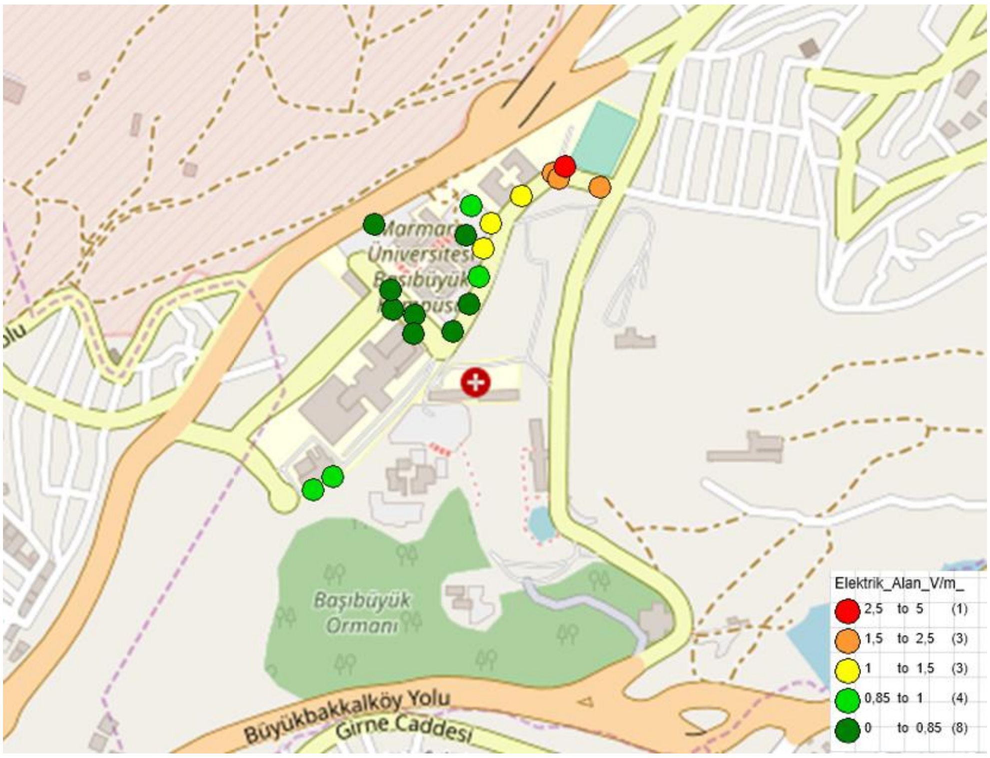

Figure 4. First day measurement result

Table 3. 12-day average electric field values

Locations	Average of Electric Field (V/m)	Latitude	Longitude
Base Station Side	4,11	40,953927	29,142369
Institute of Neurological Sciences	0,87	40,949014	29,137320
Institute of Neurological Sciences and Gastroenterology	0,88	40,949221	29,137698
Bus Station1	0,88	40,951668	29,139349
Bus Station2	0,85	40,951751	29,138922
Car Park	0,89	40,953041	29,138539
Health Sciences_Location1	0,96	40,952880	29,140373
Health Sciences_Location2	0,88	40,953330	29,140485
Health Sciences_Location3	2,01	40,953066	29,140888
Health Sciences_Location4	1,58	40,952672	29,140733
Faculty of Medicine_Location1	0,89	40,951829	29,140436
Faculty of Medicine_Location2	0,90	40,952251	29,140651
Faculty of Medicine_Location3	0,89	40,951420	29,140115
University Entrance	2,79	40,953603	29,143067
Walking Path1	2,70	40,953465	29,141490
Walking Path2	2,74	40,953813	29,142127
Walking Path3	2,52	40,953736	29,142236
Walking Path4	0,85	40,952055	29,138871
Walking Path5	0,85	40,951389	29,139335

Periodic electric field measurements were performed according to 3 different weather conditions. These are sunny, rainy and cloudy days. The results of measurements made according to different weather conditions are given in Table 4 below.

Table 4. Electric field (V/m) measurement results according to different weeather conditions

Locations	Sunny	Cloudy	Rainy
Base Station Side	5,163	4,386	3,509
Institute of Neurological Sciences	0,895	0,851	0,862
Institute of Neurological Sciences and Gastroenterology	0,923	0,848	0,851
Bus Station1	0,913	0,849	0,86
Bus Station2	0,922	0,862	0,883
Car Park	0,865	0,835	0,873
Health Sciences_Location1	2,111	1,259	0,923
Health Sciences_Location2	0,868	0,843	0,88
Health Sciences_Location3	2,88	0,903	1,285
Health Sciences_Location4	2,382	1,306	1,26
Faculty of Medicine_Location1	1,135	0,893	0,882
Faculty of Medicine_Location2	1,744	0,907	0,904
Faculty of Medicine_Location3	1,079	0,905	0,933
University Entrance	2,576	1,501	1,351
Walking Path1	3,952	2,317	2,148
Walking Path2	2,692	2,875	2,167
Walking Path3	3,339	2,553	1,987
Walking Path4	0,889	0,844	0,876
Walking Path5	0,948	0,857	0,877

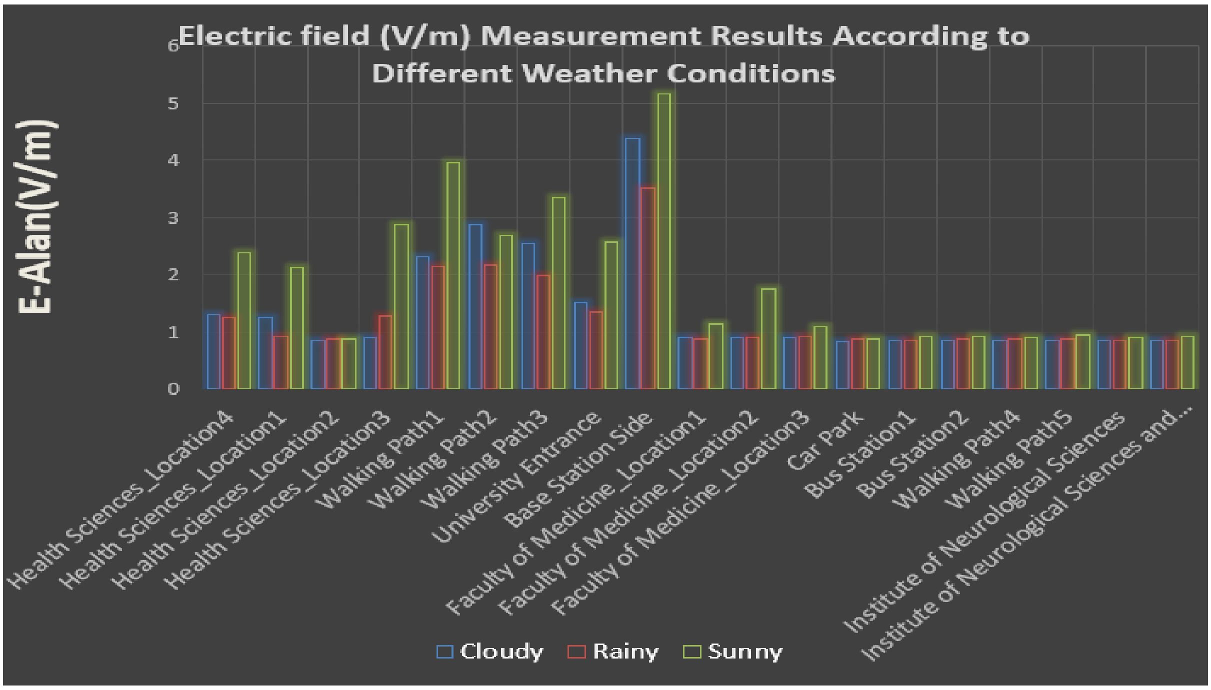

Figure 5. Electric field measurement results according to different weather conditions

Figure 5 shows a comparative graphical representation of the electric field measurements according to different weather conditions. Electrical field measurements at sunny, cloudy and rainy weather at 19 different locations are shown.

Measurements were made with Bio-well device in order to observe human energy and stress status at different electric field values in Başıbüyük Campus. 11-day periodic measurements were made at the highest point in the campus and at points with an electric field value less than 1 V / m. I applied all of the bio-well measurements on myself. Figure 6 shows numerical ranges and meanings for energy and stress states.

Figure 6. First day energy and stress measurement results at low electric field location

Table 5. 11-day energy and stress measurement results

Day	Low electric field location(Stress)	High electric field location (Stress)	High electric field location (Energy)	Low electric field location(Energy)
1	3,86	2,98	43,9	45,08
2	3,78	3,18	46,61	42,27
3	3,37	3,14	42,88	43,48
4	3,06	2,91	43,92	45,19
5	3,22	3,26	44,13	46,8
6	4,23	3,98	48,53	39,91
7	2,94	2,92	43,13	44,85
8	3,55	3,32	45,72	42,53
9	3,66	3,61	40,83	41,2
10	3,35	3,63	46,44	49,93
11	3,53	3,39	39,7	40,03

Table 5 shows the 11-day energy and stress measurement results. Energy and stress measurements were carried out in the location where the electric field was low and in the location where the electric field was high.

The study was conducted to observe the stress and body organ energies of the cell phone interview with the bio-well device. In this study, biowell measurements were made according to two different situations: no phone calls and 30 minutes after the phone call. According to the measurement results, no difference was observed in stress and energy states.

IV. CONCLUSION

In this article, electromagnetic field pollution map of Marmara University Başıbüyük Campus has been prepared. When the electric field value of the highest measured point in the campus is compared with the limit values determined by ICNIRP and BTK, it is seen that the limit values are below the limit values. The second measurement was carried out in different weather conditions. A total of 3 different electric field measurements were performed in sunny, cloudy and rainy weather conditions. In sunny, cloudy and rainy weather conditions, generally in sunny weather, electric field values were high. In general, the lowest electric field measurement was in rainy weather. For the point with the highest electric field, the electric field measurement in sunny weather was 47% higher than in rainy weather. In the third study, measurements were made to observe the changes in the stress and energy status of the human in relation to the electric field by using GDV technique with bio-well device. Two different points were selected in the campus. The selected places were determined according to the points where the electric field was high and low. When the results of the 11-day periodic measurements were examined, the stress and energy levels were close to each other at both points. The average of the stress values measured at the base station side point is 3.5, while the average of the measured values at the parking point is 3.3. There was a difference of 0.2 between two points and no significant difference was observed. In energy measurements, the average of the measurements at the base station side point is 44.16, while the average of the measurements at the parking point is 43.75. The difference between the two environments is 0.41. When the measured stress and energy values are examined, it is considered that the electric field environment between 0-5 V / m has no effect on stress and energy in human. Before the mobile phone call at the parking point and after 30 minutes mobile phone call, energy and stress status measurements were made with bio-well device. According to the measurement results, 30-minute mobile phone call has no negative effect on energy and stress level.

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