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MEASUREMENT AND MAPPING OF ELECTRIC FIELD STRENGTH CAUSED BY THE GSM900 MOBILE COMMUNICATION BAND AT THE BALKAN CAMPUS OF TRAKYA UNIVERSITY

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Abstract
As mobile communication systems advance, electromagnetic field levels from these technologies are also increasing to some extent in densely populated areas. The GSM900 band, which offers wide coverage and operates in a dominant frequency range, is also part of these communication systems. In this study, electric field strength values originating from the GSM900 band were measured at the Trakya University Balkan Campus, which houses a hospital, student dormitories, educational buildings, and social facilities and an electric field distribution map was created. The measurements were performed at 197 separate points using an Aaronia Spectran HF 60100 spectrum analyser. At each point, signal data sequences were recorded for a specific period, and the time-averaged electric field strength values were calculated. Using the measurement points and the corresponding electric field strength values, an electric field distribution map of the site was created using open-source software (QGIS). The results show that electric field levels in areas close to cell towers, such as the hospital garden, dormitories, and shopping centres, where population density is high, are slightly higher than in other areas. It was determined that all electric field levels measured throughout the campus remained well below the limit values specified in national and international standards. These findings provide a baseline assessment for the campus and lay the groundwork for more comprehensive electric field measurement studies, including those involving different frequency bands and periodic measurements.

Keywords: Mobile communication, GSM900 Band, Electromagnetic field, Electromagnetic pollution map

INTRODUCTION

The development of mobile communication systems brings with it the consideration that the electromagnetic fields generated by these systems must also be taken into account. They may differ in the frequency ranges they occupy, their coverage areas, their wave-propagation characteristics, and the levels of electromagnetic fields they generate in the surrounding environment. One of these systems is GSM900 (Global System for Mobile Communications, 900 MHz), a mobile communication infrastructure. GSM 900 is a second-generation (2G) digital cellular network system based on European standards that operates in the 900 MHz frequency band and enables voice and data transmission between mobile devices [1]. The GSM900 band is one of the frequency ranges that significantly impacts environmental exposure from mobile communications [2, 3]. Electromagnetic pollution from GSM900 is also a significant issue in living spaces such as university campuses and hospitals [4, 5]. University campuses are sensitive areas where thousands of students, as well as academic and administrative staff, are present and spend significant time [6, 7]. Furthermore, the presence of departments such as medical Faculties on these campuses necessitates

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hospitals; this, in turn, increases visitor numbers. Although measurement studies in these areas indicate that electric field levels generally remain below International Commission on Non-Ionizing Radiation Protection (ICNIRP) standards and national legal limits, the potential risks of long-term exposure must be considered [8-10].

In this study, electric field strength values for the GSM900 band were measured at 197 locations within the Balkan Campus of Trakya University in Edirne. The Balkan Campus has high human density and traffic, housing student dormitories, a faculty of medicine hospital, a faculty of dentistry clinic, and various other faculties and units. Therefore, determining electromagnetic field levels from mobile communication systems across the campus is important for assessing the exposure individuals may encounter in their daily lives. In this context, electric field measurements for the GSM900 frequency band were conducted at various locations throughout the campus. Moreover, a campus map showing the spatial distribution of the electric field values measured at the various measurement points was produced, and the results were analysed.

EXPOSITION

Electric field measurements within the GSM900 band were conducted at 197 locations on the Balkan Campus in Edirne Centre, Trakya University's largest and central campus. This area has a high population density and includes educational buildings for various institutions, including student dormitories, the Faculty of Medicine and its hospital, and various institutes and faculties. A satellite image of the campus in question and the distribution of measurement points across the campus are presented in Figure 1.

Measurements were conducted during the autumn term (October-November) of 2022, between 08:00 and 19:00, corresponding to periods of high campus activity. The GSM900 band is a system still widely used in mobile communications that operates within the 900 MHz frequency range, specifically 890–915 MHz (uplink) and 935–960 MHz (downlink).

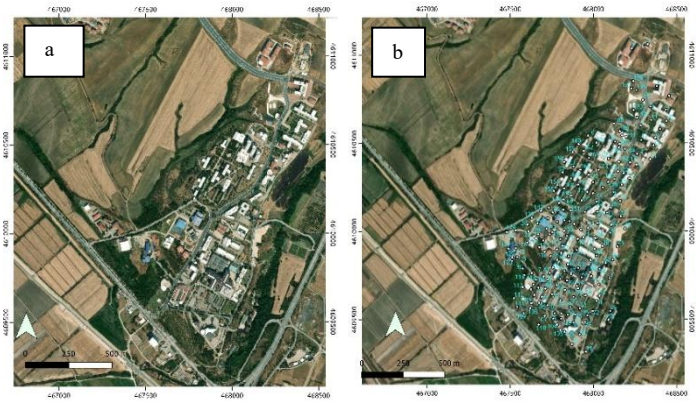


Fig. 1. *a) Satellite image of the Balkan Campus and b) the distribution of measurement points within the Balkan Campus (basemap: Esri World Imagery [11]).*

In this context, measurements were taken to determine the electric field levels in the GSM900 frequency band at various points on the campus and to examine their spatial distribution. For the measurements, we used an HF60100 spectrum analyser and a HyperLOG 601000 antenna, as shown in Figure 2. We took measurements at all locations continuously at a height of 1.5 meters above the ground, for durations ranging from 3 to 6 minutes, depending on site conditions.



Fig. 2. *HF-60100 Spectran Spectrum Analyser and HyperLOG antenna*

Using these values, the time-averaged electric field intensity for each location was calculated. During the measurements, we used the device manufacturer's MCS software to monitor and record data in real time.

CONCLUSION

In this study, the electric field values measured in the GSM900 band at various locations on the Balkan campus were mapped using the inverse distance weighting (IDW) interpolation method in QGIS. A colour-coded map showing the distribution of electric field strength across the campus is presented in Figure 3. On this map, blue areas represent regions with the lowest electric field, while red areas represent those with the highest. Green and yellow areas are transitional zones with intermediate values, while orange and red areas represent regions with comparatively higher values.

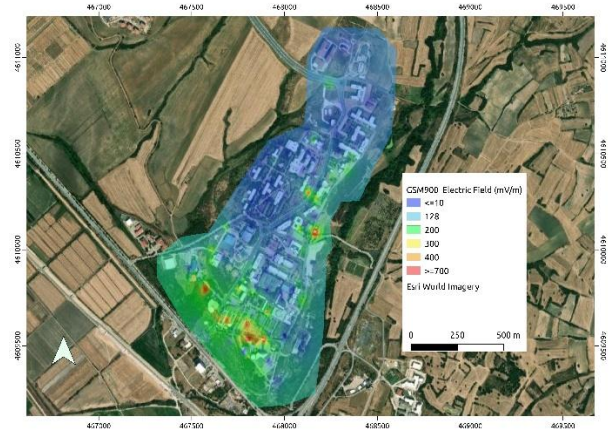


Fig. 3. *The spatial distribution (mV/m) of electric field strength measured at 197 points in the GSM900 band at the Balkan Campus (basemap: Esri World Imagery [11]).*

This view shows that electric field intensity is not distributed homogeneously across the site, with some areas higher than others. The colours indicate differences in values within the measurement area; they do not imply that any limits have been exceeded or that there is a direct health risk. Point number 169 has the lowest electric field value at 4.34 mV/m, while point number 100 has the highest electric field value at 798.7 mV/m. In addition, points 197, 130, and 27 stand out with values of 615.3, 580.7, and 555.7 mV/m, respectively. When the map is analysed on a regional basis, it can be observed that electric field levels are relatively high in areas containing facilities such as hospital grounds, car parks, conference centres, shopping centres, cultural centres and conservatoires. It is noteworthy that, in addition to these areas being densely populated, there are mobile phone mast towers situated in their immediate vicinity.

Furthermore, a relatively high electric field is observed at point number 27, and base station towers are present in its immediate vicinity. It has been observed that relatively high electric field values occur, in particular, in areas with high human activity. It is also noteworthy that base stations are located in the vicinity of these areas. However, the electric field distribution may be influenced not only by human density and the distance of measurement points from base stations, but also by transmitter characteristics, antenna orientation, data traffic, and environmental conditions. The maximum electric field strength measured across the entire campus is approximately 0.799 V/m; all measured values are well below the 41 V/m general public reference level established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) for 900 MHz [10], as well as the national environmental limit announced by the Information and Communication Technologies Authority of Turkey (BTK) [12]. The electric field map, generated using measurement data and an interpolation technique, has made it possible to determine how the electric field distribution originating from the GSM900 band varies according to location. These findings provide a snapshot of the situation during the measurement period and serve as a foundation for future studies that may be conducted at different times or within other mobile communication bands.

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