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A STUDY OF MONITORING HIGH-FREQUENCY ELECTROMAGNETIC FIELD POLLUTION IN URBAN AREAS

A. Cannuli*, E. Calabrò, M.T. Caccamo, S. Magazù

Department of Mathematics and Computing, Physics and Earth Sciences, Messina University, Messina, Italy

Abstract. *In this paper, the results of a study of monitoring high-frequency electromagnetic field pollution in some residential areas of Spadafora (38°13'29"28 N Latitude, 15°22'48"36 E Longitude), a little town in the province of Messina with a large number of base stations, and a statistical analysis of values recorded for these stations, were reported. The measurement values were collected by means of a NARDA SRM-3000 radiation meter with an isotropic antenna that can be used for measurements in the frequency range 75 MHz - 3 GHz. The obtained measurement levels were compared with the exposure limits, warning values and quality objectives established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP) and the Council of Ministers Presidential Decree (D.P.C.M.) for electromagnetic fields generated in a frequency range between 100 kHz and 300 GHz. In particular, the amplitude fluctuations of the electromagnetic radiations radiated by the present five base stations were recorded for a long time and statistical analyses were performed for certain spectrum ranges under far-field conditions by using an isotropic field probe and selective spectrum analyzer. The measurement results for each station were compared and their contributions to the combined radiation were analyzed through a software packet to calculate the high-frequency electromagnetic field and for the interpolation points. The data were also processed using wavelet analysis. In almost all cases, the electromagnetic field values respected the established limits, but one case has proven more interesting, because of the strong vicinity of a base station near to inhabited houses and to an elementary school. In particular, in this urban area, values close to 5 V/m at the frequency of 900 and 2300 MHz were measured, very near to the limits indicated by the ICNIRP and the D.P.C.M. Further research is underway to assess the effects on health of people who live there.*

***Key words*:** *Electromagnetic field pollution, high frequencies, radiation meter, base stations*

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1. INTRODUCTION

The potential effects of the high frequencies electromagnetic field pollution are subject of study and public debate for many years. The monitoring of electromagnetic pollution on urban areas are very important for the people health [1-4]. The development of modern technology and telecommunications has led to an increase in electric and magnetic field sources used for different applications.

New technologies have facilitated the daily life of millions of people, but in recent times, they have also generated considerable concern about the possible health effects related to exposure to electromagnetic fields for long periods.

The protection policy and exposure limits have been recommended by International Commission on Non-Ionizing Radio Protection (ICNIRP) and the International Commission on Electromagnetic Safety (ICES), with specific guidelines to protect people from known health effects considering a large safety margin [5]. In 1999, the European Organization established a common recommendation on the limitation of the exposure of the people to electromagnetic fields and a RTTE directive, requiring that all telecommunications devices are compliant with the European Council recommendation. However, there is yet a considerable public misunderstanding regarding the ratio and magnitude of the electromagnetic fields within the different bands as well as the qualitative differences between various sources, for instance close-to-body devices and infrastructure installations, and their contribution to the total exposure. To respond to these concerns, a pollution monitoring policy can permit to collect the systematic data and establishment of a paradigm to monitor EMF exposure, to develop an appropriate equipment, to assess and monitor personal EMF exposures and data interpretation standards for near-field sources [6-7]. From the statistical analysis of the measurement results, Electromagnetic fields levels can be modeled through various calculations and formulas and examined by means of time series analysis [8-9]. Electromagnetic pollution measurements within the scope of this study were executed in a chosen pilot region, Spadafora, (38°13'29"28 N Latitude, 15°22'48"36 E Longitude), a little town in province of Messina (see Fig. 1), densely populated of base stations and a statistical analysis of values recorded for these stations, were reported [10].

* acannuli@unime.it

In particular, five base stations sites are present, one of this near a school and populated houses. The obtained measurement levels were compared with the exposure limits, warning values and quality objectives established by [11-13] for electromagnetic fields generated in a frequency range between 100 kHz and 300 GHz. In particular, the amplitude fluctuations of the electromagnetic radiations radiated by the present base stations were recorded for a long time and statistical analyses were performed for certain spectrum ranges under far-field conditions by using an isotropic field probe and selective spectrum analyzer. The measurement results of the five stations were compared, and their contributions to the combined radiation were analyzed through a software packet to calculate the high frequency electromagnetic field and for the interpolation points. The data were also processed using wavelet analysis.

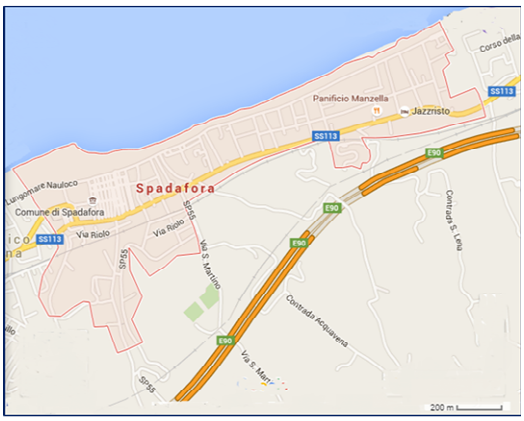

Figure 1. Site of electromagnetic pollution monitoring study

2. Data acquisition system and analysis methods

Data acquisition system consists of a NARDA SRM-3000, a specific model of NARDA Safety Test Solutions, connected to a PC for the saving of electric field values (see Fig. 2). The coordinates of each measurement sites were also recorded through a Global Position System (GPS) for mapping process. The SRM-3000 is an ideal instrument to use particularly under conditions that require high mobility and robustness. It incorporates a very wide, versatile range of functions in an extremely light weight, handy device, and is designed for measuring high frequency fields [100 KHz - 3GHz], determining the three spatial components of the electromagnetic field being measured at the GSM or UMTS transmission frequency bands, close to 900, 1800 and 2100 MHz, depending on the local mobile phone provider [14]. It was linked through a cable to a three-axis isotropic E-field antenna, that covering the frequency range from 75 MHz to 3 GHz, to determine the three spatial components of the electromagnetic field being measured. This antenna can be mounted directly on the measurement instrument or through a RF cable of 1.5 m. The three-axis measurements are simpler and much faster compared to single axis antennas. The three-axis antenna allows measurements with the dot matrix method. The specific space points are measured in according to a fixed scheme, so as to determine for each measured an automatically isotropic result. The “Spectrum Analysis” mode was chosen as preliminary analysis to detect and measure the exact frequencies values relative to the waves of the electromagnetic fields (see Fig. 3).



Figure 2. NARDA SRM-3000 data acquisition system

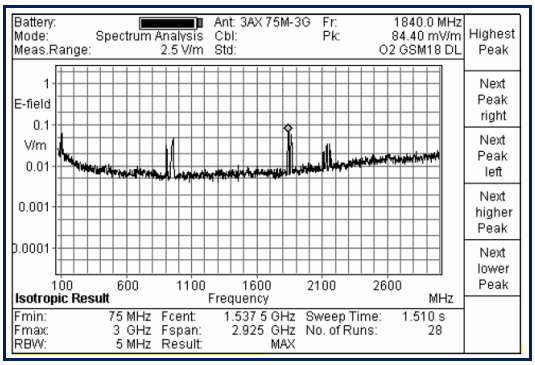

Figure 3. Electromagnetic fields due to GSM900, GSM1800 and UMTS frequencies band

The electromagnetic field measurements in broadband were performed in according to D.M. n. 381 of 10th September 1998, prescribing measures averaged over an equivalent area to the vertical section of the human body in an interval time of six minutes. The D.M. establishes the exposure limit values of the public to electromagnetic fields related to the functioning and operation of fixed systems operating in the range frequency of between 100 kHz and 300 GHz. In particular, three measures were carried out at each investigation point, corresponding to a height of 1.90, 1.50 and 1.10 m, using an isotropic detector (PMM 8053), equipped with probe EP- 330 with a frequency range of 100 kHz - 3 GHz. Each measuring station in relation of the characteristics of the site have been identified and described and the measurements of maximum, minimum and average electromagnetic field were performed. The frequency band used for the measurements by NARDA is been between 800 and 2300 MHz. The wavelet thresholding method was applied for the signal de-noising, the wavelet coefficients are thresholded in order to remove their noisy part. The results of broadband measurement are not reported because are used the represented 5 spots for narrowband measurements.

3. Results and discussion

The results of the measurement are shown in the figures below for the 5 sites monitored. In particular, the electromagnetic field values at the frequencies of

GSM-900, GSM-1800 and UMTS are reported, together with the base station distance from the measurement device.

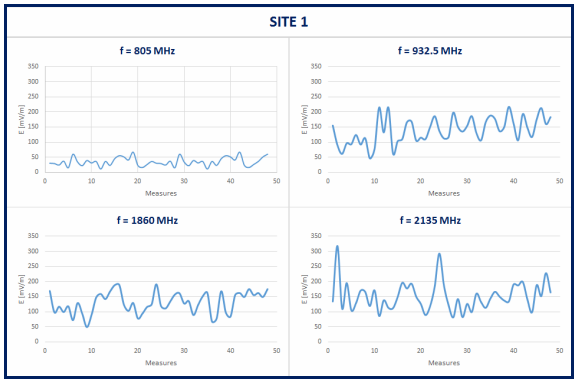

Figure 4. Electromagnetic field values at different frequencies (f = 805 MHz, 932.5 MHz, 1860 MHz and 2135 MHz) for Site 1. Base station distance of 7 meters



Figure 5. Electromagnetic field values at different frequencies (f = 937.5 MHz, 1847.5 MHz, 2115 MHz and 2145 MHz) for Site 2. Base station distance of 5 meters

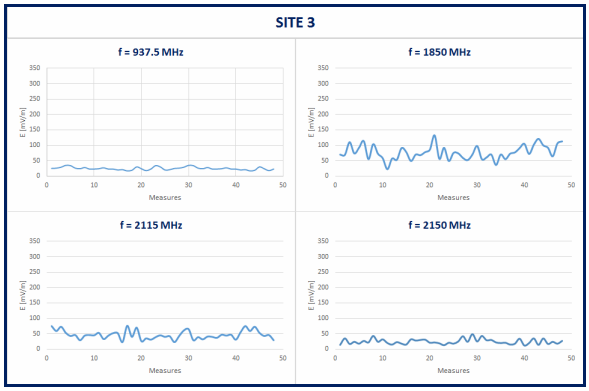

Figure 6. Electromagnetic field values at different frequencies (f = 937.5 MHz, 1850 MHz, 2115 MHz and 2150 MHz) for Site 3. Base station distance of 5 meters

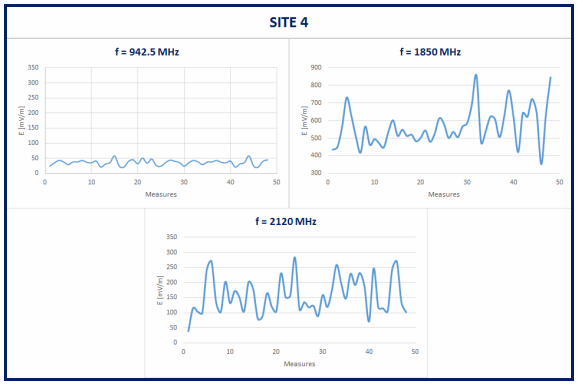

Figure 7. Electromagnetic field values at different frequencies (f = 942.5 MHz, 1850 MHz and 2120 MHz) for Site 4. Base station distance of 10 meters

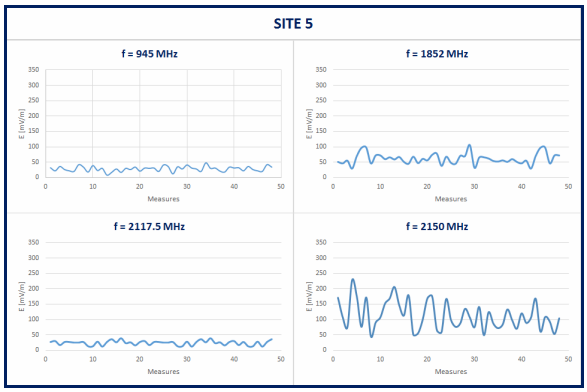

Figure 8. Electromagnetic field values at different frequencies (f = 945 MHz, 1852 MHz 2117.5 MHz and 2150 MHz) for Site 5. Base station distance of 30 meters

The electromagnetic field measurements show high values in the site 4. In the Fig. 7 the scale of values is in fact different than the other figures. The table below reports all average, maximum and minimum values for the 5 sites.

Table 1. Average, maximum and minimum values for the 5 sites

	SITE 1				SITE 2			
	GSM900	GSM900	GSM1800	UMTS	GSM900	GSM1800	UMTS	UMTS
	805 MHz	*932.5MHz*	*1860 MHz*	*2135 MHz*	*937.5 MHz*	*1847.5MHz*	*2115 MHz*	*2145 MHz*
Average value	35.104167	139.60417	129.79167	151.25	25.492292	76.925625	55.375	41.415833
Max value	67	217	191	293	44.59	132.5	149.5	71
min value	11	46	49	81	17	36	20	11

	SITE 3				SITE 4			
	GSM900	GSM1800	UMTS	UMTS	GSM900	GSM1800	UMTS	
	937.5 MHz	*1850MHz*	*2115 MHz*	*2150 MHz*	*942.5 MHz*	*1850MHz*	*2120 MHz*	
Average value	24.770833	76.925625	46.375	24.604167	35.9375	563.27083	56.45833	
Max value	35	132.5	76	49	58	857	76	
min value	17	36	23	12	21	352	23	

	SITE 5			
	GSM900	GSM1800	UMTS	UMTS
	945 MHz	*1852MHz*	*2117.5 MHz*	*2150 MHz*
Average value	28.25	61.4166667	24.125	112.416667
Max value	48	132.5	76	228
min value	8	36	23	45

4. Conclusions

In conclusion, the measurement made in Spadafora, have shown that in almost all cases the electromagnetic field values respected the established limits, but a case (site 4) has proved more interesting, because of the strong vicinity of a base station near to inhabited houses and to an elementary school. In particular, in this urban area values close to 5 V/m at the frequency of 900 and 2300 MHz were measured, very near to the limits indicated in [1-3]. Further research is underway to assess the effects on health of people who live there.

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