

# Recording of the Intensity of the Electric and Magnetic Fields at 50 Hz and of the Electromagnetic Field in the Range 100 kHz - 3 GHz in the City and Province of Gjirocastër, Albania

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## Abstract

For the first time the intensity of the electric and magnetic field in the range of electrical power supply and power transmission lines (50 Hz) and in the range of radio-television broadcasting and telecommunications (100 kHz - 3 GHz) was measured in occupational sites and power plants of the city of Gjirocastër, Albania, and its surroundings. The interest is mainly due to the absence of laws limiting field intensity and to the uncontrolled proliferation of emission sources for mobile telephones in Albania.

## Keywords

Electrosmog, Electromagnetic Field

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## 1. Introduction

Rapid proliferation of mobile phone antennas (MPA) and mobile phone base stations (MPBS), well visible on the roof of palaces in the centre of the cities made worldwide people concerned about health effects of the emitted electromagnetic fields. The term “electrosmog” contributed attaching a negative label to electromagnetic wave emission. Despite the very controversial epidemiological studies on the possible enhancement of the rate

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of occurrence of leukaemia in children exposed to 50 - 60 Hz fields, some with positive evidences [1]-[3] others with negative ones [4] [5] and the number of negative results about the possible effects of high-frequency electromagnetic fields on people health (see e.g., [6]-[9]), every new power transmission station (PTS) or mobile telephone base station (MTBS) raises protests of concerned citizens. Everybody pretends very good signal for his mobile phone, but strongly opposes new antennas. Even in cities of Albania, where air pollution due to the rapidly increasing number of cars, most of them powered by very aged diesel engines, is very high and certainly very dangerous, people and public authorities are starting to put more and more attention to electromagnetic pollution.

In any case, even if in our opinion it is not at present the most urgent ecological problem for a country like Albania, the publication of directories of the European Commission on the limits of the intensities of electric and magnetic fields for citizens [10] and workers [11], the publication of the relative national laws on these item by neighbour countries like Italy [12] [13] with the most restrictive limits in Europe, and the necessity for Albania to adequate its regulations to the European Union (EU) models, roused the opportunity to perform a survey of the intensity of the electric and magnetic fields in the frequency range of interest. Due to a long-term collaboration between the universities of Lecce and Gjirocastër, the first survey was made in the city and province of Gjirocastër, south of Albania, at the border with Greece.

## 2. Experimental Details

First of all, a survey was made to detect the number and position of electric and magnetic field sources in Gjirocastër. More, information was got by local authorities about power plants and transformer stations in the surrounding territory. After, field measurements were made close to power lines, PTS, radio and TV broadcasting antennas, MPBS and in bar, restaurants and terraces in the nearby of electromagnetic radiation sources. Then, accurate measurements of the field intensities were made in Bistrice, about 40 km far from Gjirocastër, where a hydroelectric power plant with a power of 22.5 MW is operating. Measurements were performed both near power generators and voltage transformers and in the working positions (control panels, PC positions, rest rooms, etc.) and all around the border of the power plant. Last, electromagnetic field intensity was measured in the city of Delvine, about 50 km from Gjirocastër, where the major and population were concerned about the possible adverse effects on people health of a MPBS and asked for measurements.

For the above indicated measurements, the following diagnostic instruments were used:

- Holaday Instruments, model HI-3604 anisotropic sensor for extremely low frequency (ELF) electric and magnetic fields. It is appropriate for detection of electric fields in the frequency range 20 Hz - 5 kHz and magnetic fields in the frequency range 40 Hz - 1 kHz. The output linearity is close to 1 (0.96 - 1.04) for changes of the inductance B in the range 0.2  $\mu$ T - 1 mT.

- Holaday Instruments, model HI-4455 isotropic radiofrequency (RF) sensor, checked in the range 200 kHz - 40 GHz.

- Narda, model EHP-50C isotropic sensor of ELF/VLF magnetic fields, with various frequency ranges, from 0 - 500 Hz to 0 - 10 kHz. This sensor can store data for 24 hours at the rate of 1 record/minute. Data are then transferred to a PC and analyzed.

- Chauvin-Arnoux, model CA43 isotropic RF sensor, operative in the range 100 kHz - 2.5 GHz. This sensor can detect electric field (E) values in the range 0.1 - 200 V/m. Data can be stored and processed with a PC.

- Chauvin-Arnoux, model CA40 anisotropic sensor for ELF magnetic fields. It can operate in the range 30 - 300 Hz. Magnetic fields B in the intensity range 0.01  $\mu$ T - 2 T can be measured.

- EMfields anisotropic sensor for ELF electric and magnetic (e.m.) fields (10 Hz - 2 kHz) operating for B intensities in the range 0.01 - 20  $\mu$ T and E intensities in the range 0.1 V/m - 2 kV/m.

Most of the instrumentation has already been used for monitoring e.m. fields in Otranto [14], with working methodologies in conformity with Italian regulations, coherent with the Electronic Communications Committee (ECC) and CEENELEC recommendations [15] [16].

The choice of the time of day in which to take the measurements was made, as far as possible, in such a way that the fields being measured were expected to be at the highest possible levels. The measuring process in general lasted for a period of about 1 hour for those points with the most significant electro-magnetic field (EMF) values. The sensors were also positioned in accessible points where the fields were expected to have the highest values. The places thus selected were sites where the workers or the public could be assumed to spend at least 4

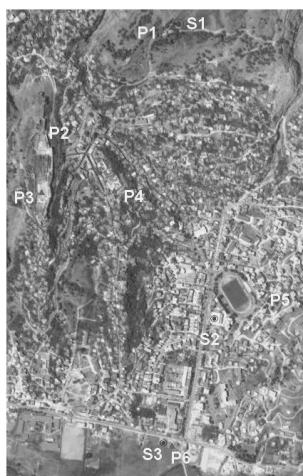
hours a day. In the case of use of the monoaxial sensors, account was taken of the correct alignment with respect to the sources in order to measure significant values.

### 3. Results

The first measurements were performed in Gjirokaštër. Source locations are evidenced in **Figure 1**, together with the sites where measurements were undertaken. Here, on the top of Keculla, a hill overhanging the city, are placed four very high antennas for radio-television broadcasting and mobile telephone communications (S1), huge and visible from every corner of the city. At the basis of the four ugly antennas, a very romantic restaurant (P1), with a wonderful view on the castle, the old city and the surrounding mountains, is an attractive point for summer dinners. In Gjirokaštër, other found out electromagnetic radiation sources are a MPBS (S2), placed on a roof in the downtown district and a PTS (S3), at the Southern limit of the city, where electrical power at 20 kV is reduced to 220 - 380 V and conveyed to the local users.

The frequencies of the electromagnetic radiation emitted by the above mentioned radiation sources is reported in **Table 1**.

Field intensity measurements started at the basis of the four antennas on the hill of Keculla (P1 in **Figure 1**). Measurements were performed for a period of about 1 hour, late in the morning. Peak values are given in **Table 2**. Electric and magnetic fields were independently measured, since in the proximity of the antennas measurements were not taken in the far-field region.



**Figure 1.** Satellite map of the city of Gjirokaštër. Emission sources (S1: MPBS on Keculla Hill, S2: MPBS on Bar First, S3: PTS of the city of Gjirokaštër) and measurement points (P1: Restaurant Keculla, P2: Medreseja School, P3: Castle Square, P4: Restaurant Fantazia, P5: University, P6: Border of the PTS) are evidenced.

**Table 1.** Electromagnetic radiation sources in the city of Gjirokaštër and their emission frequency.

Radiation source	Frequency
Power transforming station (PTS)	50 Hz
AM radio	500 - 1600 kHz
VHF-I/II TV	50 - 80 MHz
FM radio	88 - 108 MHz
VHF-III TV	170 - 220 MHz
UHF-IV/V TV	470 - 850 MHz
TACS mobile phone	870 - 950 MHz
GSM mobile phone	880 - 960 MHz
DCS mobile phone	1710 - 1880 MHz
UMTS mobile phone	1900 - 2170 MHz

**Table 2.** Peak intensities of the electric field E, of the magnetic inductance B and of the specific surface power S, as measured in diverse positions on the Keculla hill in Gjirokastër.

Position	Peak values		
	E (V/m)	B ( $\mu$ T)	S ( $W/m^2$ )
Entrance gate to the Keculla site	$9.0 \pm 0.8$	$11 \pm 1$	$0.20 \pm 0.02$
At the base of the first antenna	$15 \pm 1$	$19 \pm 2$	$0.60 \pm 0.05$
At the base of the second antenna	$7.0 \pm 0.6$	$8.8 \pm 0.8$	$0.16 \pm 0.01$
At the base of the third antenna	$4.2 \pm 0.4$	$5.3 \pm 0.5$	$0.050 \pm 0.005$
At the base of the fourth antenna	$4.9 \pm 0.4$	$6.2 \pm 0.6$	$0.16 \pm 0.01$
Parking place near the restaurant	$7.3 \pm 0.7$	$9.2 \pm 0.8$	$0.14 \pm 0.01$
Service door to the restaurant	$8.5 \pm 0.8$	$11 \pm 1$	$0.18 \pm 0.02$
Pedestrian path to the restaurant	$8.2 \pm 0.7$	$10.3 \pm 0.9$	$0.18 \pm 0.02$
Main entrance to the restaurant	$2.9 \pm 0.3$	$3.6 \pm 0.3$	$0.020 \pm 0.002$
Interior of the restaurant	$<0.1$	$<0.1$	$<0.001$

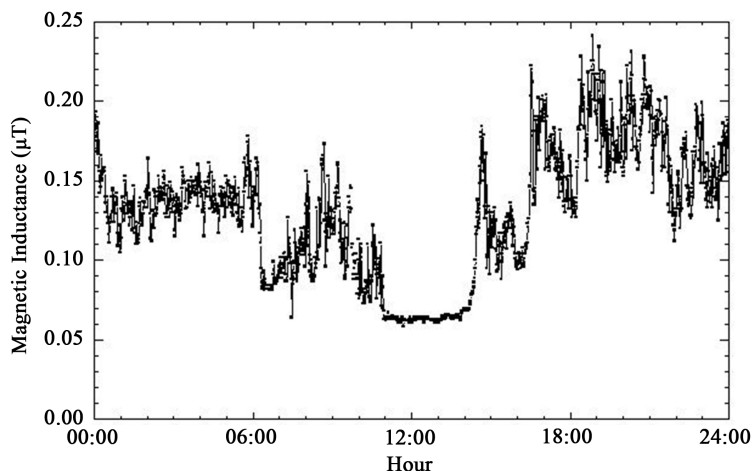
Even if the number of radiation sources was high and they were close to the measurement points, significantly high fields were not detected. The measured values are within the limits established by the EU regulations and also by the more restrictive Italian laws for places not permanently (less than 4 h/day) occupied by the population. Of course, except the restaurant, where chefs and waiters spend more than 4 h/day, the remaining area of the hill of Keculla is only occasionally occupied by people. But, in the restaurant the field intensities are very low. It means that, at the moment, there are no reasons to limit the access to the hill and its lovely restaurant.

Going down from the hill to downtown, measurements of the intensity of the electric field E (100 kHz - 30 GHz range) and of surface specific energy S have been made in very busy positions (P2: Medreseja School, P3: Castle Square, P4: Restaurant Fantazia—on a little hill) and near the MPBS (P5: Terrace of the University). Results are reported in **Table 3**. The intensity values of the magnetic field B can be found by the simple relation  $B = E/c$  in this frequency range, where c is the velocity of light in vacuum, since measurements were made in the far-field region. The values of S were always lower than the sensitivity of the used instruments ( $0.001 W/m^2$ ). Also these values, measured in very busy hours for mobile telephones (12 - 14), when the e.m. field should get their highest values, are generally very low. The electric field E has a discrete intensity only on the roof (terrace) of Bar First (S2). In any case, it must be noticed that it represents a peak value and would be considered in the limits of what allowed by the EU directory and the Italian law, even if it would be a mean, not a peak, value.

After this set of measurements, related to the e.m. emission at high frequency, we moved to the transformer power station, located at the border of the city. Results of measurements of ELF electric and magnetic field intensity are reported in **Table 4**. Since measurements were made in the near field region, electric and magnetic fields were separately measured.

From the recorded data, it results that the electric and magnetic field intensities are well within the limits of EU directories, except close to the massive open-air external transformer. Of course, the presence of workers in the nearness of these transformers is a rare event. Measurements were performed in the evening, where peak current values are absorbed by the city, mainly for public and private lighting. In any case, to get average field values, a Narda, model EHP-50C, which allows storing data for 24 h, was placed in the working hall, obviously the critical point of the plant from the safety point of view. The peak values of the magnetic field B intensity, that is the most interesting parameter for possible biological and health effects of 50 Hz radiation, remained below  $0.25 \mu$ T, even in the moments of the highest power request by the citizens (**Figure 2**). Values below  $0.25 \mu$ T are universally considered safe even in the case of permanent living residence. During measurements there was a general blackout from 11:00 to 14:30. This is an event which arises frequently-almost daily-in Gjirokastër.

Once finished electric and magnetic field intensity measurements over the whole range of used frequencies, an accurate measurement was performed in the hydroelectric power plant (22.5 MW) of Bistrice. The points where field intensity was measured are:



**Figure 2.** Plot of the magnetic field B intensity at 50 Hz in the working room of the power transformer station of the city of Gjirokastër, as recorded for a 24 h period. From 11:00 to 14:30 there was a general blackout, which justifies the plateau in this time interval.

**Table 3.** Peak values ( $E_{max}$ ) of the electric field E (100 kHz - 30 GHz) measured in different points of the city of Gjirokastër.

Place	$E_{max}$ (V/m)
P2: Medreseja School	$0.5 \pm 0.1$
P3: Castle Gate	$0.3 \pm 0.1$
P3: Castle Museum	$0.2 \pm 0.1$
P3: Castle Square	$<0.1$
P4: Restaurant Fantazia	$0.2 \pm 0.1$
P5: Terrace of the University	$0.7 \pm 0.1$
S2: Terrace of Bar First	$5.0 \pm 0.5$

**Table 4.** Peak values of the electric field E and magnetic field B (50 Hz), respectively, measured in different points of the transformer electrical power station at the border of the city of Gjirokastër.

Position	Peak values
Working room	$E = 1.4$ V/m, $B = 0.064$ $\mu$ T
Close to control panels	$E = 40$ V/m, $B = 0.63$ $\mu$ T
Close to transformer cabinet	$B = 9.45$ $\mu$ T
Close to an external transformer	$E = 15$ kV/m, $B = 126$ $\mu$ T
External control cabinet	$E = 0.45$ V/m, $B = 0.315$ $\mu$ T
Along the street bordering the station	$B = 0.70$ $\mu$ T

- a) working hall, which contains desks and personal computers (PC);
- b) room, close to the working hall, which is filled with a number of control panels;
- c) transformer hall, crossed by nets of large-diameter cooper cables for high-intensity electrical current transmission;
- d) all around the open-air voltage transformers;
- e) inside the workers’ dining room.

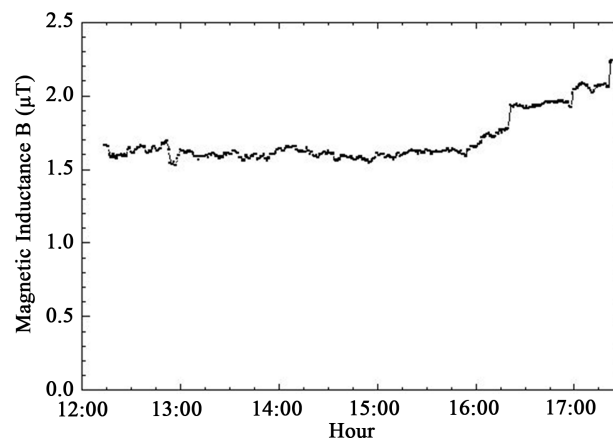
In the working hall (a) the intensity of the magnetic field  $B$  was recorded for about 5 h (12:15-17:20) by using the Narda, model EHP-50C, sensor. The record (**Figure 3**) shows  $B$  values between 1.5 and 2.5  $\mu\text{T}$ , well within the EU recommendation and Italian law limits. Note the increase of  $B$  intensity when the electric power demand increases for lighting.

In the control panel room (b), the intensity of the  $B$  field was found to vary from a minimum of 0.3  $\mu\text{T}$  to a maximum of 3.15  $\mu\text{T}$ , except close to the wall of separation from the transformer hall (c), where a  $B_{\text{max}}$  value of 20.5  $\mu\text{T}$  was measured. It is clear that this relatively high value is not related to the control panels, but to the proximity of the high current cables in room (c). In fact, in room (c), where a transformer and a large number of cooper cables are present,  $B$  field intensities as high as 215  $\mu\text{T}$  were measured. Workers were advised not to stay in this room without a specific task, and to leave immediately after the task accomplishment.

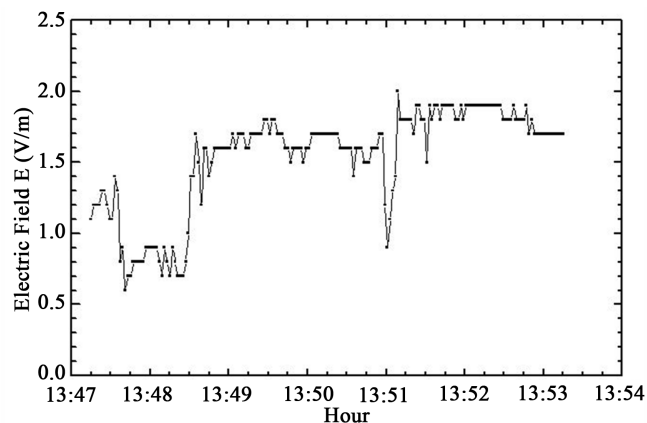
Very close ( $\sim 50$  cm) to the large voltage transformers (d) placed outside in the back yard,  $B$  field intensities up to 630  $\mu\text{T}$  were measured. Even in this case, workers seldom operate near power transformers. In any case, it was recommended to avoid standing in the nearby of transformers.

Into the workers' dining room (e), the  $B$  field intensity does not exceed 0.04  $\mu\text{T}$ , while the  $E$  field intensity does not exceed 2 V/m. Very low  $E$  and  $B$  intensity values were measured along the borders of the power plant and below the electric power line, too.

Finally, high-frequency (microwave) electric field  $E$  intensity was measured in the downtown of Devine. Here, on the roof of the Culture Palace, a mobile telephone base station was recently placed. Field measurements were made in a usually busy hour (13:47-13:53). During this 6 minute period,  $E$  intensity did not exceed 2 V/m (**Figure 4**), well below the EU and Italian limits.



**Figure 3.** Plot of the magnetic field  $B$  intensity at 50 Hz in the working room of the hydroelectric power plant of Bistrice, as recorded for a period of about 5 h.



**Figure 4.** Electric field  $E$  intensity (microwave) from a MPA in Delvine as recorded for 6 minutes. Minimum value: 0.6 V/m; maximum value 2.0 V/m.

## 4. Conclusions

For the first time measurements of the electromagnetic pollution were made in the city of Gjirocastër, Albania. The number and typology of e.m. sources in the city of Gjirocastër and its province was assessed. Field measurements were performed both in the ELF and in the radio- and micro-wave range of frequency.

Generally, the e.m. field intensities are well within the limits fixed by EU recommendations and Italian laws for long-term exposition. Of course, close to large facilities (power transformers, high current cables in the hydroelectric power plant of Bistrice) sometimes the B field intensity exceeds the EU regulation limit of 500  $\mu\text{T}$ . In any case, these are not permanent working places and the inactive stay is prohibited.

This survey should help concerned Albanian people to take a realistic approach to “electrosmog” problems.

## Acknowledgements

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## References

- [1] Wertheimer, N. and Leeper, E. (1979) Electrical Wiring Configurations and Childhood Cancer. *American Journal of Epidemiology*, **109**, 273-284.
- [2] National Academy of Sciences/National Research Council (1996) Possible Health Effects of Exposure to Electric and Magnetic Fields. National Academy Press, Washington DC.
- [3] Reitan, J.B., Tynes, T., Kvamshagen, K.A. and Vistnes, A.I. (1996) High-Voltage Overhead Power Lines in Epidemiology: Patterns of Time Variations in Current Load and Magnetic Fields. *Bioelectromagnetics*, **17**, 209-217. [http://dx.doi.org/10.1002/\(SICI\)1521-186X\(1996\)17:3<209::AID-BEM6>3.0.CO;2-7](http://dx.doi.org/10.1002/(SICI)1521-186X(1996)17:3<209::AID-BEM6>3.0.CO;2-7)
- [4] Linet, M.S., Hatch, E.E., Kleinerman, R.A., Robison, L.L., Kaune, W.T., Friedman, D.R., Severson, R.K., Haines, C.M., Hartsock, C.T., Niwa, S., Wacholder, S. and Tarone, R.E. (1997) Residential Exposure to Magnetic Fields and Acute Lymphoblastic Leukemia in Children. *New England Journal of Medicine*, **337**, 1-7. <http://dx.doi.org/10.1056/NEJM199707033370101>
- [5] McBride, M.L., Gallagher, R.P., Thériault, G., Armstrong, B.G., Tamaro, S., Spinelli, J.J., Deadman, J.E., Fincham, B., Robson, D. and Chaoi, W. (1999) Power-Frequency Electric and Magnetic Fields and Risk of Childhood Leukemia in Canada. *American Journal of Epidemiology*, **149**, 831-842. <http://dx.doi.org/10.1093/oxfordjournals.aje.a009899>
- [6] NRPB National Radiation Protection Board (1992) Electromagnetic Fields and the Risk of Cancer: Report of an Advisory Group on Non-Ionising Radiation. Oxon.
- [7] Kallen, B., Malmquist, G. and Moritz, U. (1982) Delivery Outcome among Physiotherapists in Sweden: Is Non-Ionizing Radiation a Fetal Hazard? *Archives of Environmental Health*, **37**, 81-85. <http://dx.doi.org/10.1080/00039896.1982.10667540>
- [8] UNEP (United Nations Environment Programme)/WHO (World Health Organization)/IRPA (International Radiation Protection Association) (1993) Electromagnetic Fields (300 Hz - 300 GHz). Environmental Health Criteria 137, Geneva.
- [9] Cridland, N.A. (1993) Electromagnetic Fields and Cancer: A Review of Relevant Cellular Studies. London.
- [10] European Union Parliament and Council (2000) Directive 1999/519/CE of the European Parliament and Council of the 12 July 1999. *Official Journal of the European Communities*, L199.
- [11] European Union Parliament and Council (2004) Directive 2004/40/CE of the European Parliament and Council of the 29 April 2004. *Official Journal of the European Communities*, L184/1.
- [12] Decreto del Presidente del Consiglio dei Ministri (2003) Fissazione dei limiti di esposizione, dei valori di attenzione e degli obiettivi di qualità per la protezione della popolazione dalle esposizioni a campi elettrici, magnetici ed elettromagnetici generati a frequenze comprese tra 100 kHz e 300 GHz. *Gazzetta Ufficiale*, **199**, 25-29.
- [13] Decreto Legislativo 257 (2008) Attuazione della direttiva 2004/40/CE sulle prescrizioni minime di sicurezza e di salute relative all'esposizione dei lavoratori ai rischi derivanti dagli agenti fisici (campi elettromagnetici). *Gazzetta Ufficiale*, **9**, 4-11.
- [14] De Donno, A., Guido, M., Fernández, M. and Signorile, G. (2005) Measurement of Low and High Frequency Electromagnetic Fields in a Southern Salento Town (Italy). *Journal of Preventive Medicine and Hygiene*, **46**, 58-65.

- [15] ECC Recommendation (2007) Specification for the Measurement of Disturbance Fields from Telecommunications Systems and Networks in the Frequency Range 9 kHz to 3 GHz. Helsinki.
- [16] CENELEC prEN 50492 (2007) Basic Standard for the *In-Situ* Measurement of Electromagnetic Field Strength Related to Human Exposure in the Vicinity of Base Stations. CENELEC.