

## **TA-10: NON IONIZING RADIATION**

### **MONITORING ELECTRO-MAGNETIC FIELD IN URBAN AREAS: NEW SET-UPS AND RESULTS**

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#### **INTRODUCTION**

***Electromagnetic fields (EMF) actually represent one of the most common and the fastest growing environmental factors influencing human life. Besides natural sources, the electromagnetic fields are generated by man-made sources and the environmental exposure has been steadily increasing as growing changes in social behaviour have created more and more artificial sources. Common sources of man-made EMF include power lines, household electrical wiring, appliance and motor driven instruments, computer screens, telecommunications and broadcast facilities, mobile telephones and their base stations (1).***

***The growing attention of the scientific and civil community to the pollution from electromagnetic fields due to possible health effects gives an important role to the environmental monitoring, specifically in urban areas (for an introduction and for links to research papers, see the site of the World Health Organization (2)).***

***In order to implement an efficient policy against the electromagnetic pollution, it is important a complete, continuous, ongoing monitoring of the electromagnetic field generated by ELF and RF sources, with particular attention paid to the sensitive sites, i.e. schools, hospitals, residential areas.***

***In order to achieve an efficient and correct action of monitoring and information/formation in this domain, a map of electromagnetic field measured in the surroundings of power lines and/or systems used for telecommunications are implemented in a GIS framework. The maps have been elaborated considering sources, sensitive sites, results of experimental measurements and predictive models to estimate the electromagnetic pollution radiated by emitters deployed in the environment. Usually measurements are performed in a given time and in few points: no information can be confidently drawn on what could happen to the electromagnetic emission as function of the time and in spatial points different from the ones considered.***

***In this paper two different set-ups for continuous monitoring of electromagnetic levels are presented: the first one (Continuous Time EMF Monitoring System) is based upon a network of fixed stations, allowing a detailed field monitoring as function of the time; the second one (Mobile Measurements Units) resorts to portable stations mounted on standard bicycles, allowing a positional screening in limited time***

*intervals. For both set-ups a particular attention has been paid to the data management, by means of tools like web geographic information systems (Web-Gis). Moreover the VICREM/ELF software has been used for a predictive analysis of the electromagnetic field levels along with the georeferenced data coming from the field measurements.*

*Starting from these results it has been realized that there is a need for an efficient and correct action of monitoring and information/formation in this domain, where disinformation or bad information is very often spread in the population, in particular in a field where the process of the appreciation and assessment of risk does not necessarily make use of a rationale, technically-informed procedure, but the judgement is rather based on a personal feeling, which may derive from a limited, unstructured set of information, using a set of qualitative attributes rather than a quantity (3-5).*

## **ELECTROMAGNETIC FIELD MONITORING SET-UPS**

### **Continuous Monitoring of EMF versus the space**

*The Mobile Measurement Unit complements the measurement done with the fixed units. Indeed, it can catch special informations about the EMF that the fixed units cannot give: for example fields can vary in a very small space range, depending on their frequency; it is then worthwhile to have a snapshot of the fields distribution in space. The representation of these information on a map can give a quick idea of the area of interest, finding unknown sources and ruling out the zones in which fields are low.*

*The system consists of three main building blocks:*

- a mobile unit with
  - a wide-band field meter with interchangeable probes (extremely low frequency magnetic induction probe for electric lines, radio frequency electric field probe with different band for radio, TV, cellular bands);*
  - a global positioning system (GPS) unit for the collection of the location data;*
  - a mobile computer used as a storage unit to acquire the data in real time;*
  - the mobile vehicle: a bicycle in order to have the right speed in the monitoring, more flexibility in driving and less EM interference. The computer and the GPS unit are fixed with an ad-hoc set-up, the probes are attached to a two meters wood stick to keep them far from the metallic part of the bicycle (and from the operator);**



Figure 1 : A picture of Mobile Measurements Unit.

- a server to collect the spatial data and show them in a suitable format;
- the Web-Gis software.

The last two blocks can be shared with the network of fixed stations in such a way to have a coherent one-step access point to the whole set of data.

A picture of the mobile system is shown in Fig.1: the mobile computer is placed in the front together with the GPS unit, the field meter and probe are on the back.

### Continuous Monitoring of EMF versus the time

In order to give a contribution in decreasing the level of alert connected to potential risk for the health of persons and, at the same time, in supplying the local administration with an interesting and advanced way to face one of the hardest problems of actual life, a solution, proposed and well supported by sanitary and Italian National Environmental Authorities (APAT - ARPA regioni - ISS, Ministeri dell'Ambiente, Sanità e Telecomunicazioni, etc.) consists in monitoring the EMF in a continuous way in time (6).

The Continuous Time EMF Monitoring System here described, is already operating in many southern Italian sites and it works in very efficient way as mean of:

- Info to the citizens, thanks to diffusion of daily collected data on Internet WEB.

- **Control for local administrations and Authorities, due to capability of the system itself of alerting for danger situations against limits reported in the Italian laws, which is, furthermore, one of the most restrictive among the limits established in the rest of the European Community.**
- **Planning, for the implementation of :**
  - **new procedure agreed among Environmental Agency, local administrations and providers of mobile communications to plan the network and the management of alarm situations;**
  - **new local guidelines document concerning the installation and operation of telecommunication apparatuses.**

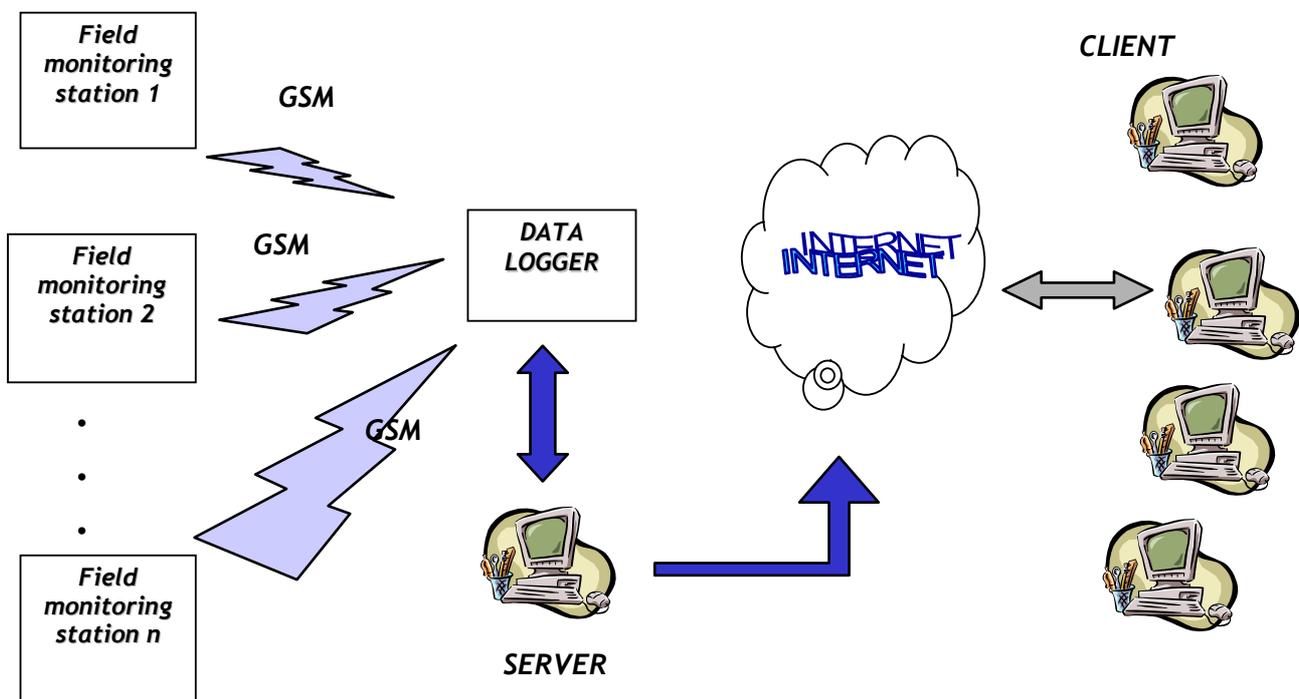


Figure 2: Continuous Time EMF Monitoring System - schematic draw

**The system is composed by:**

- **Field monitoring stations.**
- **Data Logger.**
- **Data management software.**
- **Georeferenced maps and digital orthophotos.**
- **Web site.**

**By using the Continuous Time EMF Monitoring System one can make:**

- **Implementation and data population concerning Base Telecommunication Stations (BTS) for mobile telecommunication and EMF source database;**

- *Measurement data reports, by using data collector calendars and daily charts;*
- *Management of a data control centre;*
- *“Spot measurements” to localize the suitable locations for the positioning of stations;*
- *Reallocation of stations in function of results or of critical environmental needs.*

## THE VICREM/ELF SOFTWARE

*For predictive analysis the VICREM software has been used. It is a simulation and analysis software tool for evaluating electromagnetic fields in the Far and Near Regions. The fields may be generated by a system of transmitters, even non homogeneous (e.g. for mobile telephony and for radio/TV broadcasting). The transmitter main features are recorded in georeferenced files, easily upgradeable with the tool interface. So the resulting information can be easily represented on georeferenced maps.*

*The GIS simulation model may include several different data types: ground elevation (buildings elevation in urban areas), raster (land use, population density), vector data (roads, civic numbers, hydrography, etc.).*

*Vicrem provides a number of basic functions, like 2D and 3D representations, coordinate conversion among the most common reference systems (ED50, Rome40, WGS84, Gauss Boaga, UTM, etc.), representation of different information layers, points or area analysis, distance and azimuth calculations, in-sight analysis, vertical cross-section representation and circular horizon from any location.*

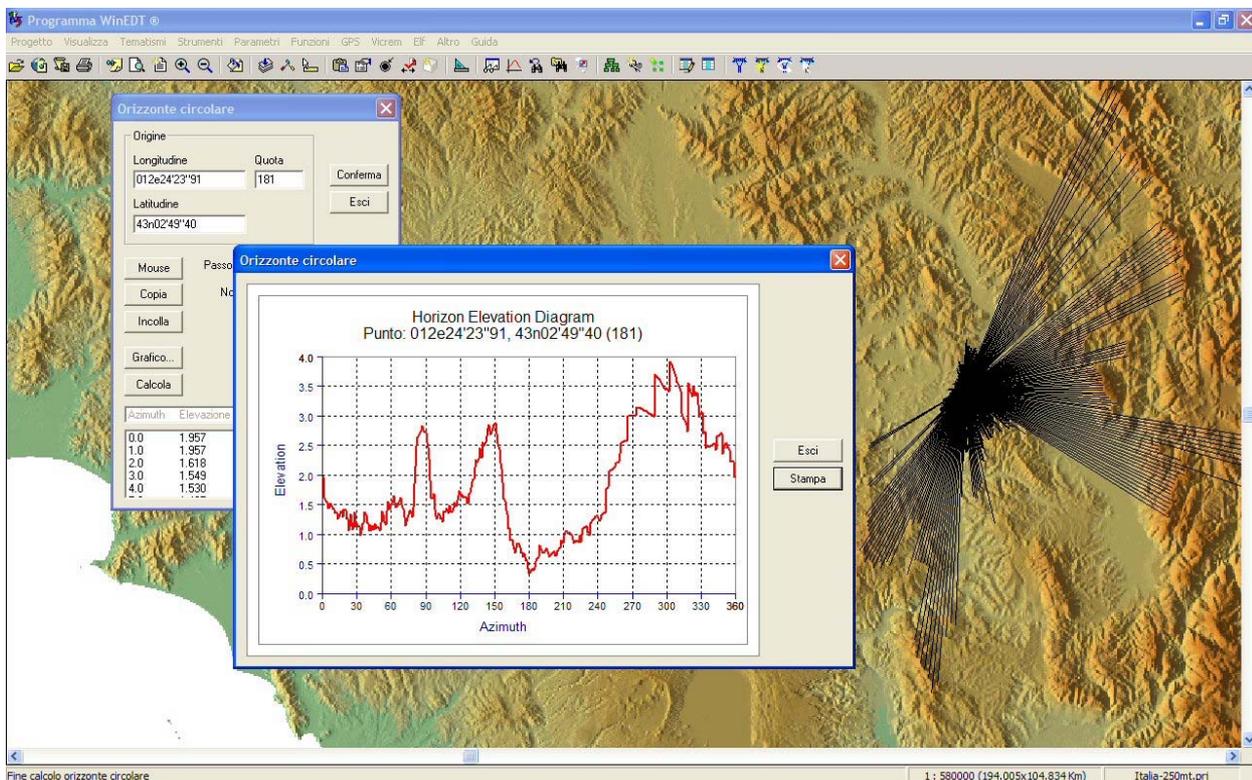


Fig.3: Representation of the circular horizon starting from an assigned location

Vicrem allows analyzing electromagnetic fields and representing them with several display criteria, according to the features to be highlighted: along horizontal or vertical planes, with constant value lines and/or surfaces, with boundary representation.

It is possible to choose among different propagation models (both statistical and deterministic) and computational methods: SL, optical or radio electrical in-sight (Deygout), Okumura-Hata, Cost 231, Point-to-Point, CCIR, indoor field level evaluation including crossing attenuation.

For radio electrical calculations, the Antenna diagrams can take into account their complete solid angle or be simplified according to the CEI 211-10.Recommendation (7)

With the "Point Analysis" Panel it is possible to calculate the EM field in locations interactively selected by the Operator or listed in a text file. Each location may also be associated to the measured field, which is then compared with the simulated value. Moreover, the Compliance Analysis may be carried out, according to the Italian Government Legislation (7).

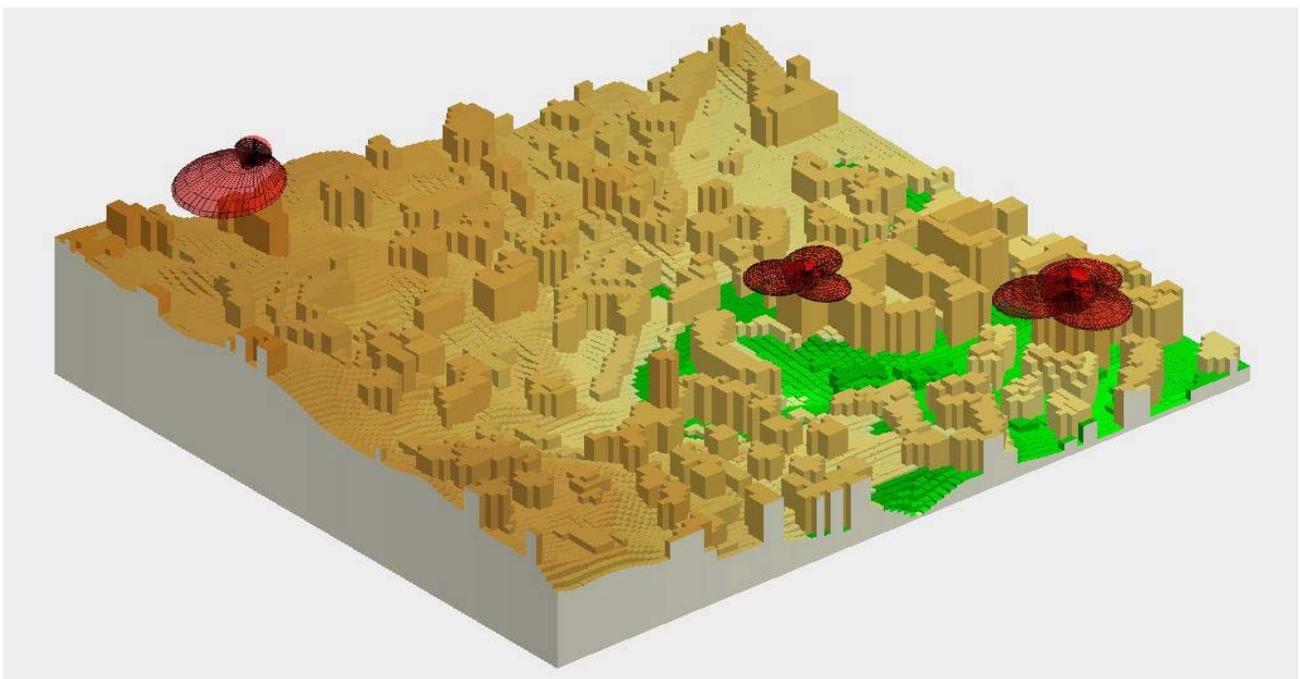


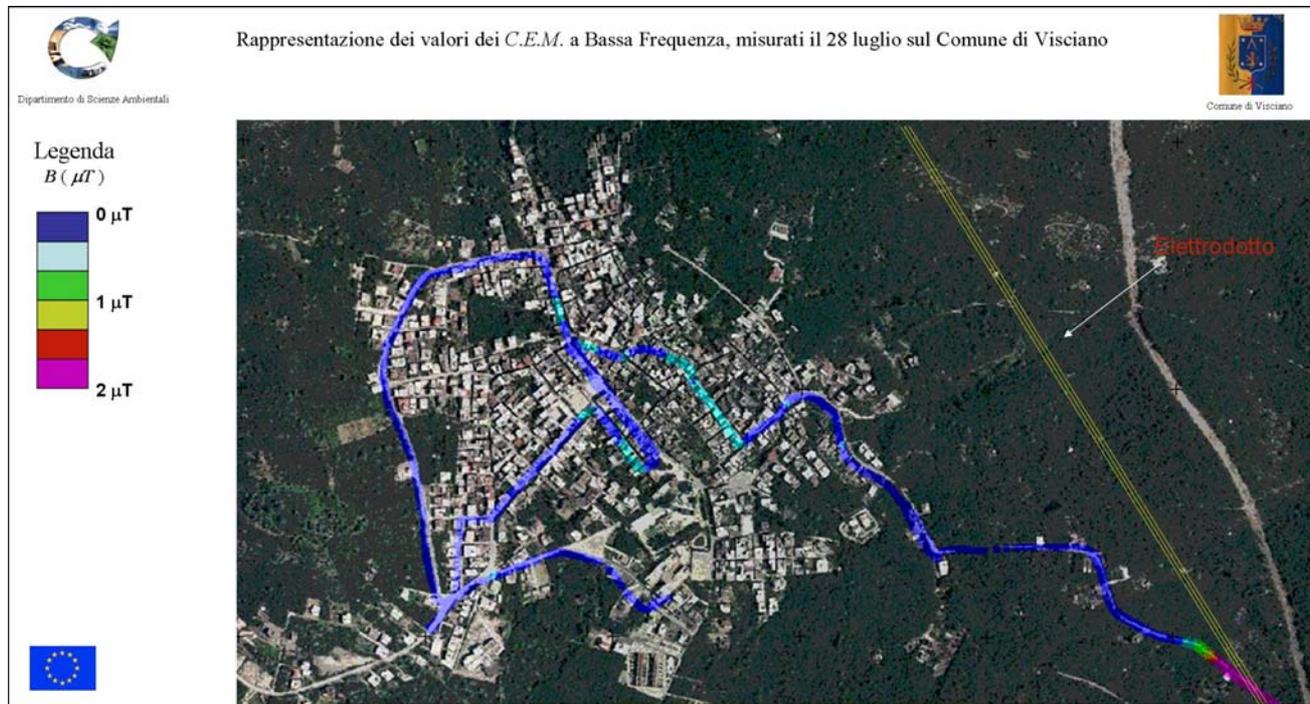
Fig. 4: Surface representation of e.m.f. levels

## RESULTS

Monitoring actions in specific urban areas of southern Italy have been carried out. By using the two above mentioned systems (with different probes), both the electric field (for radio frequency sources) and the induction magnetic field (for low frequency sources) have been measured.

In the following figures 5,6 are shown the GIS map reporting results of the magnetic field measurements performed at the city of Visciano (Naples) by using the Mobile

**Measurements Units and a typical daily report obtained with the Continuous Time EMF Monitoring System such as shown in the public access Web-Gis interface**



**Fig. 5 Measurements performed at Visciano (Naples) with Mobile Measurements Units**

