RF ELECTRIC FIELD REPEATED MEASUREMENTS IN URBAN ENVIRONMENT

BOTTURA VALERIA
CAPPIO BORLINO MARCO
CERISE LEO
IMPERIAL ERIK
MATHIOU MARZIA

AOSTA VALLEY REGIONAL ENVIRONMENT PROTECTION AGENCY (ARPA VDA)
44, LOC. GRANDE CHARRIERE, 11020 SAINT CHRISTOPHE, AOSTA, ITALY
m.cappioborlino@arpa.vda.it , v.bottura@arpa.vda.it

Abstract

In 2003 and 2004 the Environment Protection Agency (ARPA) of Aosta Valley (an Italian alpine region) performed a study on radio frequency electric field levels generated on the territory of Aosta town. The field sources are telephone mobile base stations and point to point radio links: radio and TV broadcast antenna are located on mountains surrounding the town far from the inhabited areas.
The study was planned in three tasks:

– broadband measures over a dense grid of points at ground level throughout the town
– long time acquisitions in some areas near the electromagnetic sources
– narrowband measures at several floor in buildings close to telephone antennas

Broadband measures were carried out in 606 spots, at ground level, on a non regular grid that followed the urban conformation. To assess the electric field values temporal evolution in the most exposed areas, measures in several points have been repeated yearly since 2003. Measured values vary according to sources evolution (new antennas were settled up, radiating power of existing one was modified etc.) and to changes in the town skyline. Spatial interpolations were made on the measures of each year: they show good agreement with the numerical simulations developed from radiation technical data.

Introduction

The city of Aosta is placed in a valley surrounded by high mountains: this particular location makes it possible to install all the antennas for radio - television broadcasting signal outside the municipal area, in locations at high altitudes from which the signal can be spread easily on the town and also on all neighbouring municipalities: in the town area there aren't radio-TV broadcast antennas.
The most common family of radiofrequency systems in Aosta, then, is constituted by base stations for mobile telephones (BTS). The configuration of BTS is in continuously evolving, due to the introduction of new services, i.e. UMTS, and to the increase in the use of those already existing, GSM 900 and 1800 MHz.
ARPA Valle d'Aosta has carried out an activity, since the year 2003, aimed at relieving of radiofrequency electromagnetic background in Aosta.

Background electromagnetic relief on Aosta

The activity was discerned in three stages run in parallel:
- broadband measures over a dense grid of points at ground level throughout the town
- long time acquisitions in some areas near the electromagnetic sources
- narrowband measures at several floors in buildings close to telephone antennas

Broadband measures on the road grid and continuous monitoring provide information on instantaneous exposure of people walking in the street or long time exposure of those living near the measuring point (the latter is a cautelative datum as the measurements were carried on in open areas, terraces or balconies, and not inside the houses).

With narrow-band measurements, the maximum exposure conditions can be evaluated: it is assumed that all channels of all BTS are transmitting with the maximum radiating power. This is the method in which the respect of exposure limits is assessed according to the Italian laws. It represent a quite unlikely condition, in which there is network congestion, but it is certainly a precaution condition.

For a better comprehension, it is important to say that ARPA know all technical details and evolution of radio transmitting plant, because a regional law requires that all TLC operator submit the plan of their apparatus: all this information is recorded in a regional register.

Broadband measures

In order to have a detailed picture of the intensity of the electric field present at street level throughout the town both in areas closer to sources and in remote areas, although scarcely inhabited, measurements of the electric field were performed with broadband methodology in a large number of points.
The criterion for the identification of measurement points was to perform a more dense sampling in pedestrian areas and in the historic centre and less dense in other areas of the city.
Overall measurements were carried out in 606 points distributed on a grid matching with the town planning: test points were mainly chosen at the crossroads.
Another important parameter to compare the values obtained is the time of sampling: in fact, since the major sources, especially in more densely populated area, are the stations for cellular telephony, the amount of telephone traffic significantly influences the reading. Hence all measurements were performed between 10:00 and 12:30.
The measurements were carried out by placing the detector on a tripod 150 cm from the ground.
The value of the electric field was not recorded until the indication of the average value was stable: if the value provided was abnormal compared to that of adjacent points then the measure was repeated to exclude values higher or lower due to occasional causes.
Moreover, to avoid surveying at a time when the nearest source was turned off, during the broadband measures in a defined area an instrument for continuous monitoring was placed near the main source of that area: the exam of the continuous recording time history assured of the broadband measurements were reliable.
After the survey carried out in 606 points, others two sessions were performed in a year in 78 sampling points chosen from the previous ones. The aim was to evaluate the time evolution of the electric field distribution over a long period and at the changing seasons. The measurement procedure performed was the same adopted in the first step: peculiar attention was given to verification of the values when they differed significantly from those previously recorded in the same place.
Points were chosen in greater numbers in the city centre, where there are most of the radio base stations and buildings, and fewer in more remote areas.

Long time acquisition

Monitoring on long period was performed by automatic stations for the acquisition of electric field values. The aim was twofold: the first was the assessment of the electric field evolution within 24 hours and during the week. The second was the monitoring of sources during the broadband mapping in the surrounding area to avoid surveying in abnormal conditions.
Points of installation of the monitoring units were chosen according the following criteria:
1) Maximum exposure: electric field isolevel curves were calculated with a numerical model and superimposed on the 3D area map: buildings were the exposure was higher were identified.

2) Sensitive sites: Italian people perceive as sensitive sites like schools and hospitals. So surveys were performed in these sites too.

Eleven monitoring were carried out.

Narrowband measures

Narrowband measurements points were chosen on the basis of numerical simulation (criterion number 1 in the previous paragraph). Building were the simulated electric field was higher were identified. In these buildings, when possible, a full characterization of the electric field, according to the Italian Electrotechnical Committee norm, CEI 211-7, was performed on the top floor, on intermediate floor and at street level, which made information available on the variation of field levels as a function of altitude above the ground.

A narrow-band measure was also performed at a point of the hill far from the BTS to compare data with those collected from the BTS in the town.

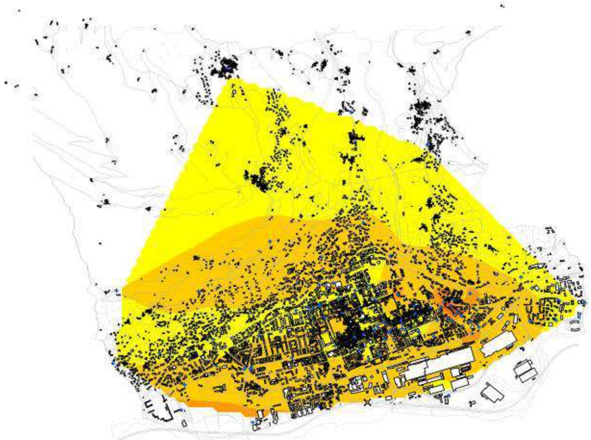
Eleven surveys were conducted.

Broadband repeated measures over time

When the electromagnetic background evaluation was accomplished the photography oh the field distribution in 2003 on the entire town area was clear. This result was an important but it wasn't enough. The radio stations are in continuous evolution due to the increase in service demand and to the technological evolution. In 2003 in Italy UMTS services were starting to develop. It was clear that the photography should be updated frequently: every year in the same season, June/July, broadband measurement in a subset of the original 606 points are repeated. Firstly, 78 points were identified as representative of the whole set, then, due to the installation of new BTS, in 2008 9 more points were added to the list.

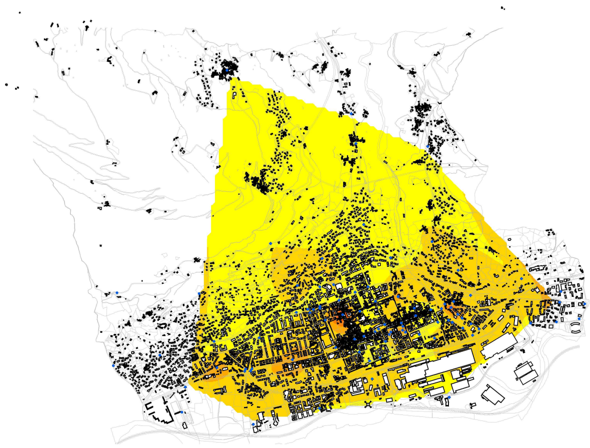
For each annual set of data, a geographical interpolation was performed on the 87 field values to obtain a map of the field distribution on the town. The interpolations were done as if buildings were transparent to electric field: absorption and reflection weren't taken into account. The results are shown, in sequence, in Figure 1: the following maps are very small and differences aren't so noticeable, maps of a specific area can be drawn so that differences appear clearly. In Figure 2 and 3 a detail relating the field distribution in 2003 and 2010 in the centre town is shown: the control points, as specified above, are thicker in the centre of the city and thinner on the outskirt, therefore the interpolations have a more precise significance in the central area;

Figure 1: broadband measures interpolation from 2003 to 2010

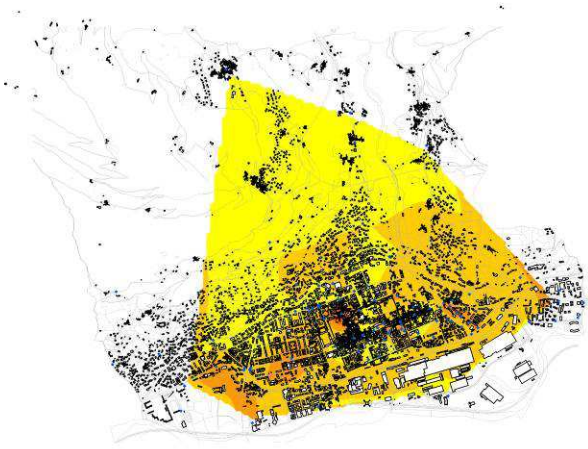


Year 2003
(interpolation on 87 points)

Year 2004
(interpolation on 78 points)

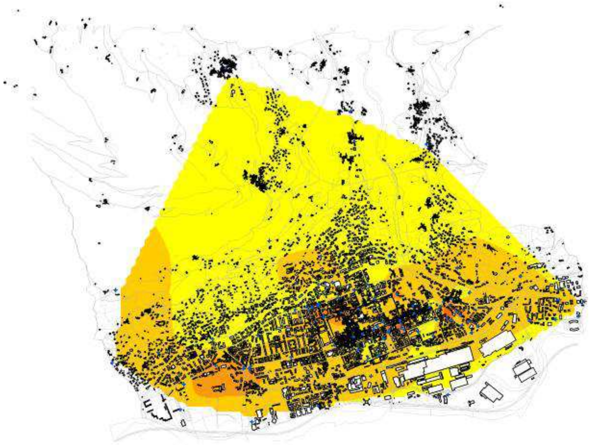


Year 2005

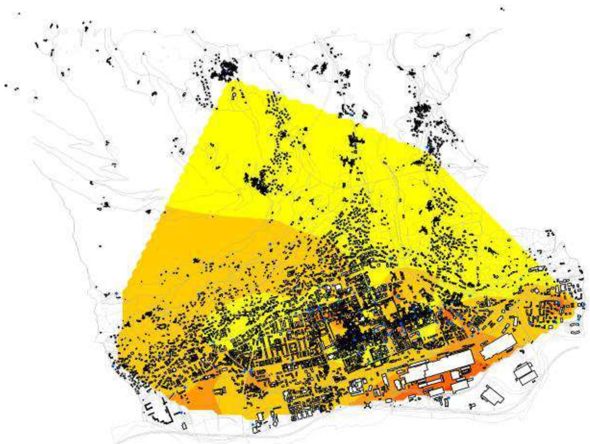


Year 2006

Year 2007



Year 2008
(interpolation on 87 points)



Year 2009
(interpolation on 87 points)

Year 2010
(interpolation on 87 points)

	E (V/m)		**E (V/m)**
	0 - 0.2		0.6 – 0.8
	0.2 – 0.4		0.8 – 1.0
	0.4 – 0.6		1.0 – 1.2

Figure 2: broadband measures interpolation in centre town in 2003

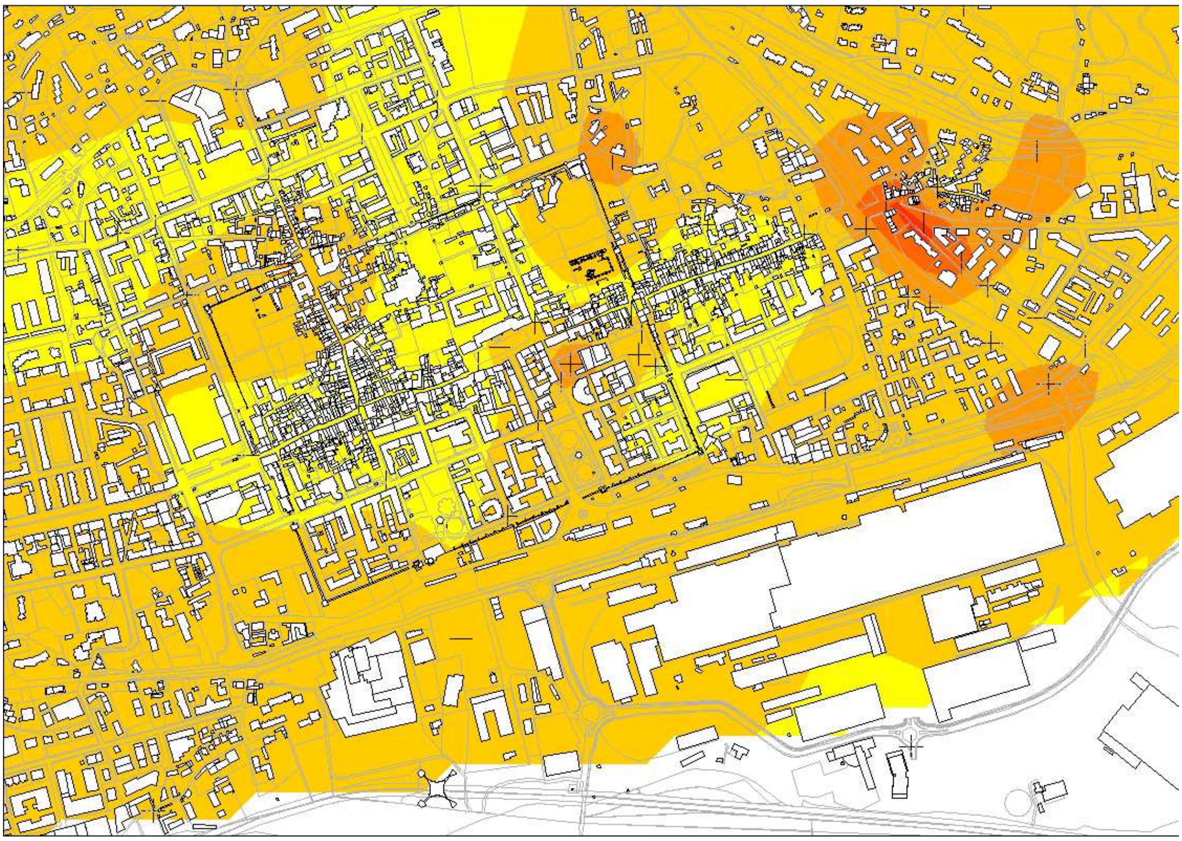
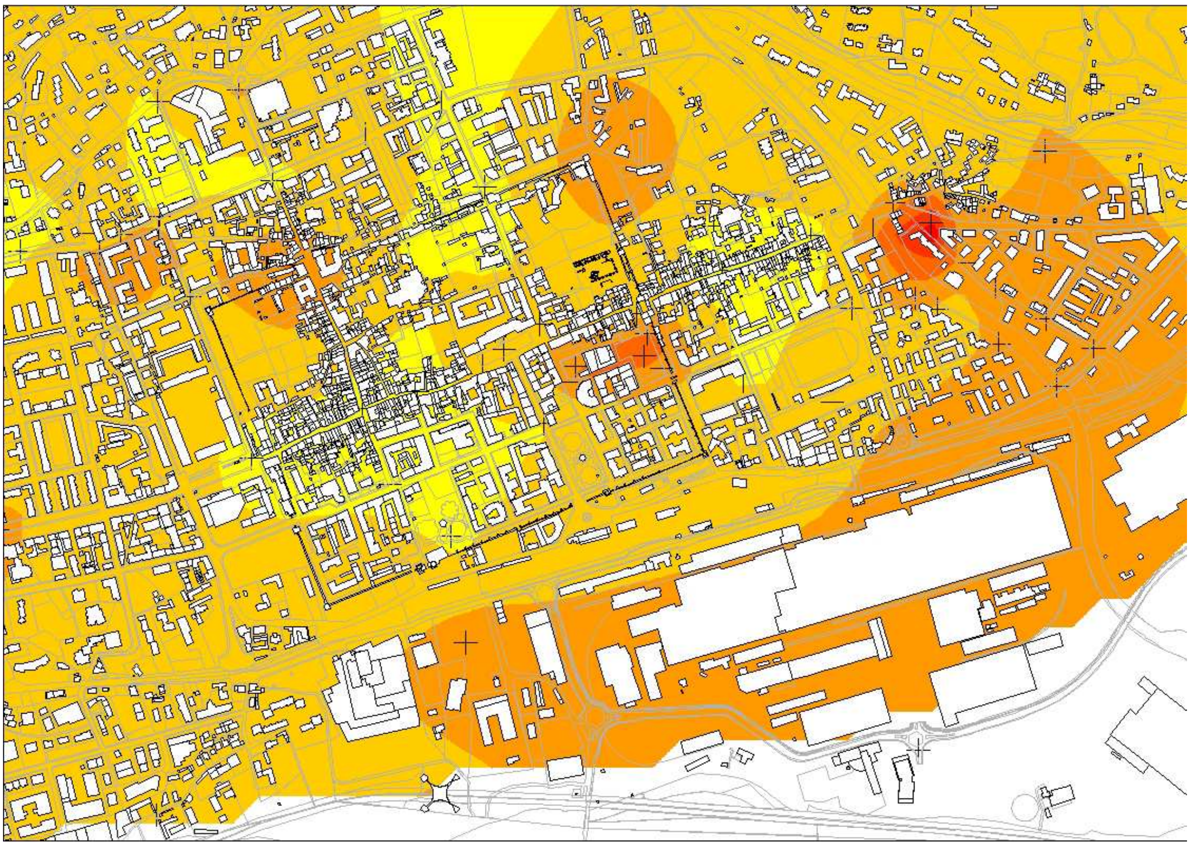


Figure 3: broadband measures interpolation in centre town in 2010



Comparisons between simulation and design data

In parallel with measurements and interpolations, simulation of electric field levels were performed on the basis of the plant technical data supplied by the operators. Data recorded in the regional register permits the comparison between field distribution simulation in 2003 and in 2010 in centre town. In this 7 years time period quite a big difference in the number and transmitted power of the BTS is noticeable: in Figures 4 and 5 BTS synthetic data are shown respectively for 2003 and 2010.

Figure 4: BTS position and radiated power in Aosta centre in 2003

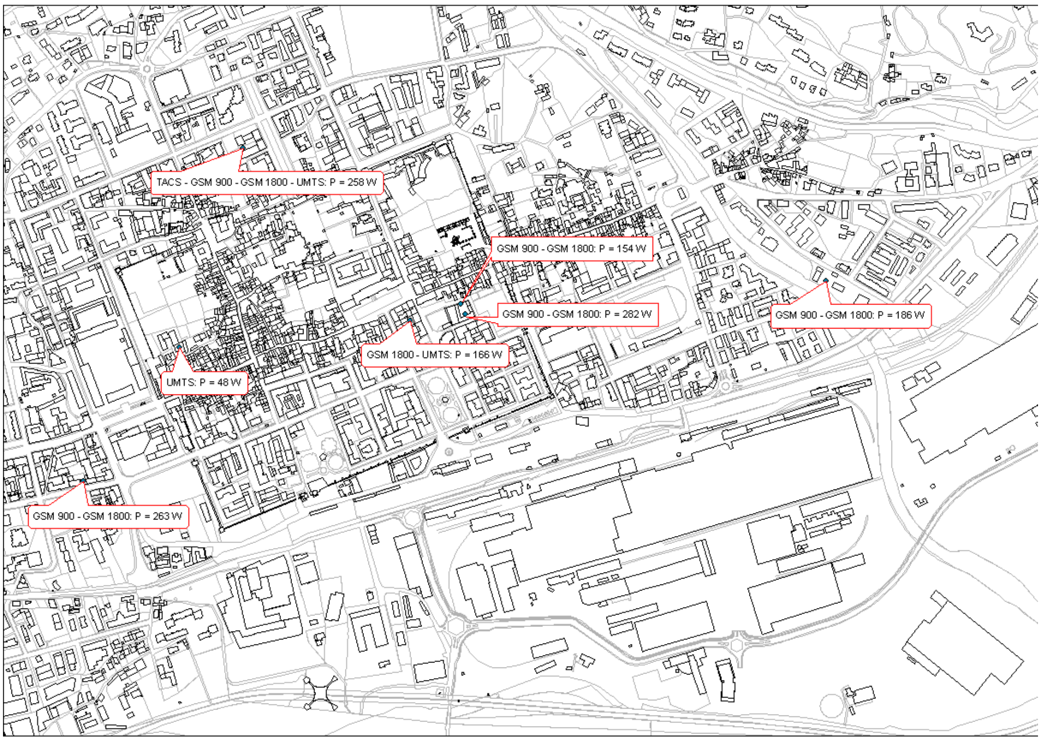
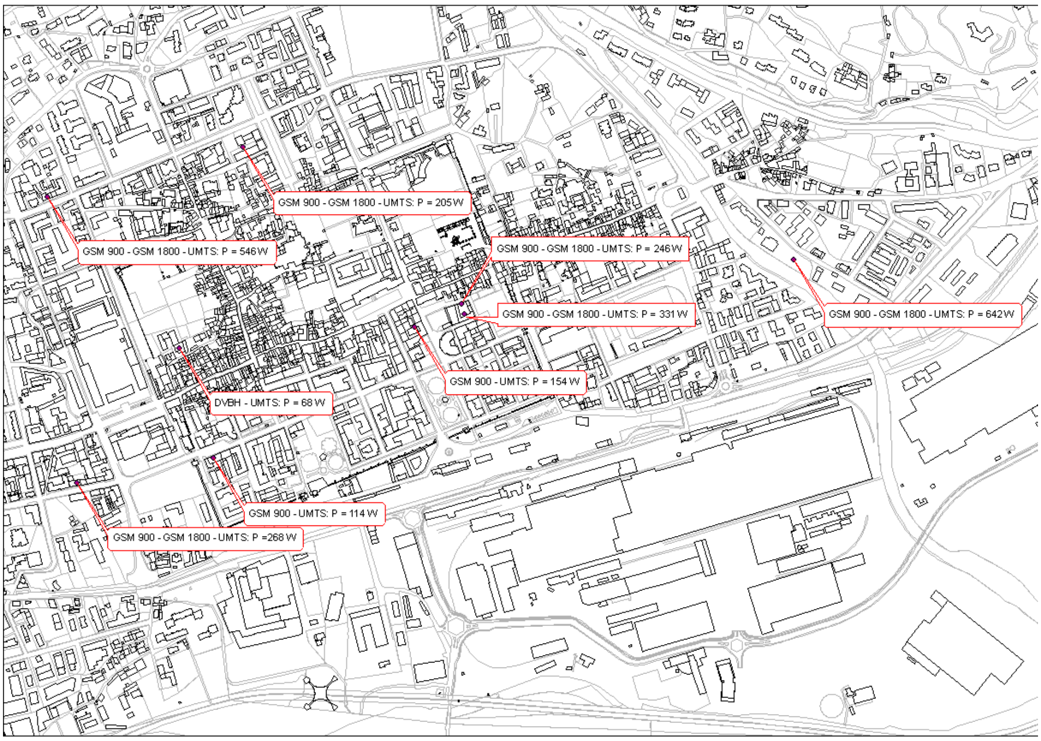


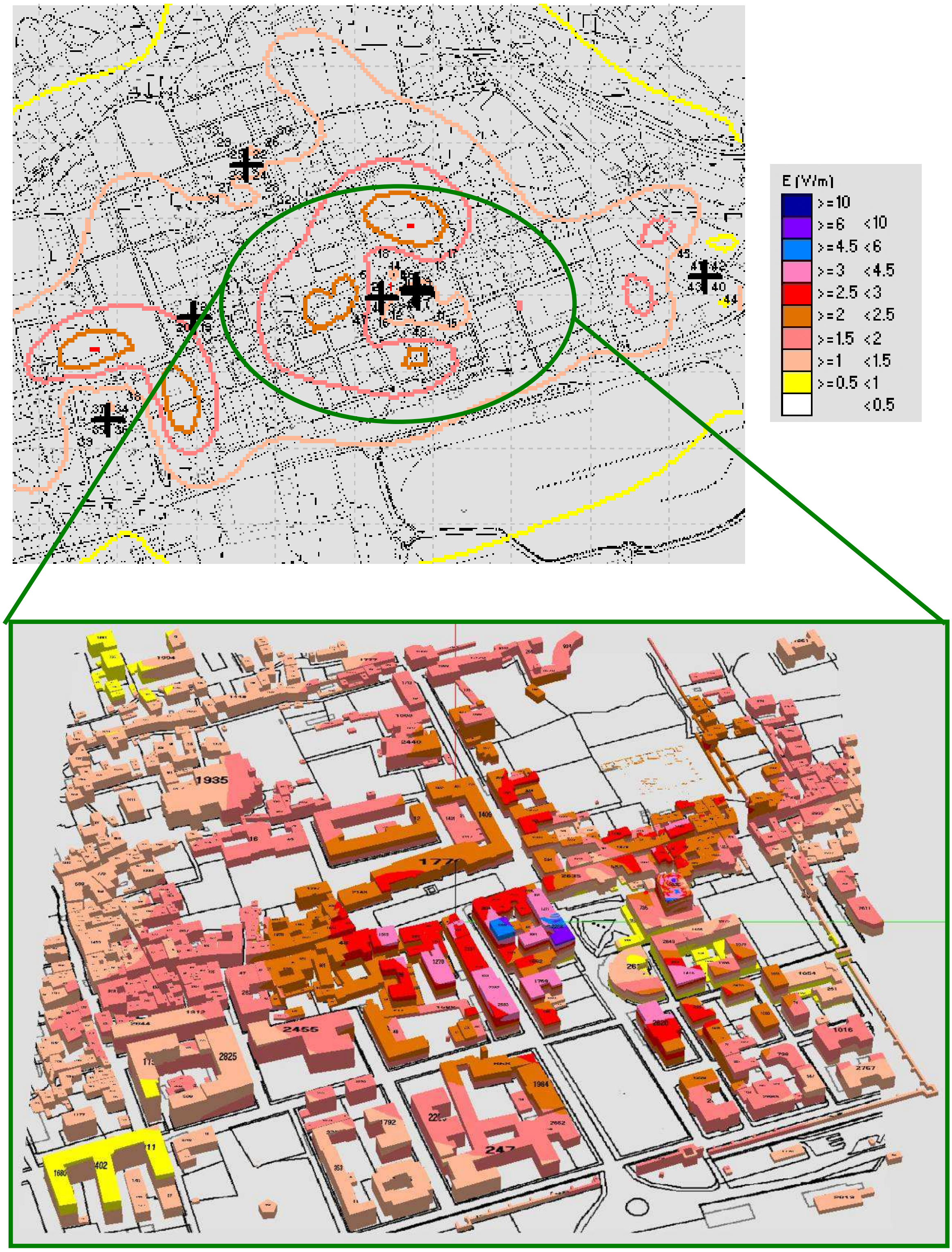
Figure 5: BTS position and radiated power in Aosta centre in 2010



Figures 6 and 7 show the simulation results for 2003 and 2010. In each image two different graphic information are reported:

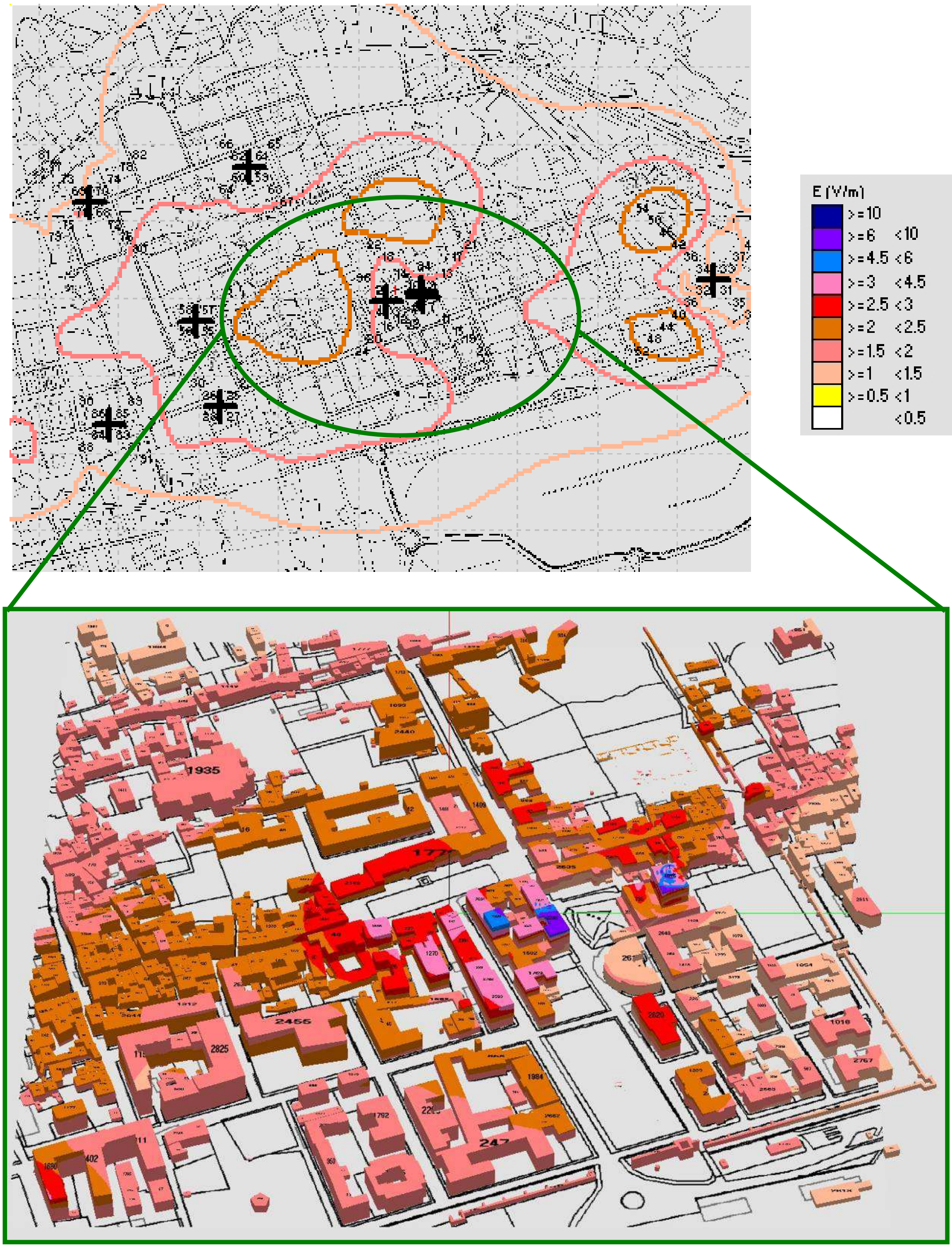
1) The first is the isolevel curves distribution of the electric field at ground level on a 2D map
2) The second is the 3D simulation taking into account the elevation of the building

Fig.6 Field distribution numerical simulation in 2003



Black crosses indicate BTS.

Fig.7 Field distribution numerical simulation in 2010



Agreement between measured data, shown in figures 2 and 3, and simulated values, in figures 6 and 7, is clear. However attention shall be paid on the fact that simulations are elaborated in worst case assuming all BTS emitting the maximum power.

The two field evaluation method are complementary: a variation in measured values is the effect of some change in the actual BTS configuration. If a telephone operator implement a major alteration in his plants without submitting the project to the local authority, annual measurements can relieve it. On the other hand, the possibility to evaluate the effect of a new plant on the overall field distribution (due to all existing BTS in an area) is a powerful tool in the analysis of projects for a new BTS.