CRITICAL COMPARISON BETWEEN DIGITAL MAP AND LASER SCANNING

MAURO CAPRIOLI
POLITECNICO DI BARI ITALY
DIPARTIMENTO DI VIE E TRASPORTI
Caprioli@dvt005.poliba.it

KEY WORDS: AIRBORNE LASER DATA, DTM GENERATION, ACCURACY.

ABSTRACT
The regular GRID of Airborne LASER data and the existing maps have been imported into MODELER software (by Intergraph) in order to create a DTM. With this software it has been possible to analyse the data. Both the Laser data and the existing cartography representation has been compared from metric point of view in order to carry out the possible differences and individuate the weak point, if any. Two test areas has been selected, taking in account the different characteristics of the territory.
In the future, as software and hardware are going to improve, the use of LASER SCANNING DATA will be more frequent in order to obtain much accuracy and a possible friendly use of this new methodology.

1. INTRODUCTION

The territory representation with cartographic methodology has been deeply changed in the last years by the introduction of new technologies.
The ancient maps on different scale have been replaced, step by step, with different media type which contain digital files related to the point localization (such as buildings corners, roads, spots heights, etc.), with the 3 spatial co-ordinates and a (feature) code that permits the localization of the objects.
In this way the plotting is just one of the many type of the territory representation, with the limits coming out from the map plane reduction. The 3D representation and visualization, eventually from different point of view, of the territory and of the human objects (roads, buildings, etc.) is possible, on the contrary, using various software that now are in common use on the market.
With this respect the metric characteristics and information of the Absolute Orientation of the air-photography or of other data source (such as remote sensing, radar, laser, etc.) are given by alternative technologies instead of topographic survey which are more and more expensive because realized by specialists. Also for the GPS methodology, so helpful for the survey of a topographic net, many specialists are required.
The Airborne Laser Scanning could be a new methodology to determine the metric information of the air-photography, which continue to be the most important data source, because of the not-replaceable photography quality image interpretation.
On this future perspective, with this article we have analysed the accuracy of the Airborne Laser Scanning methodology on a building area in the City of Pavia (Italy), with the comparison of the laser data on an existing cartography of the same area.
We have described all elaboration performed in order to make the data homogeneous, and consequently to make the two methodologies compared and to point out the differences.

2. EXISTING CARTOGRAPHY

A) - 1:2000 Map scale
The available cartography on 1:2.000 scale of Pavia town, developed in 1991, has been converted in digital files (digitizing) and updated in 1998. We can consider that the planimetric accuracy is around +/- 50 cm, and the altimetric one is around +/- 25 cm.
B) - 1:500 Map Scale
Also this cartography is coming out from existing maps converted on digital files with digitizing methodology; the spot height feature has been obtained with direct survey (levelling, etc.) on the ground and the building height has been drawn up with Photogrammetric methodology. So we can consider that the planimetric accuracy is around +/- 30 cm and the altimetric one is around +/- 15 cm.
In order to make homogeneous the data coming out from the existing cartography (digital files) with the Laser data the following tasks have been performed:

- 1:2000 MAPS:

the digital files in DWG format containing the buildings shape with only the height on the ground, has been converted in DGN format compatible with MICROSTATION and MGE software by Intergraph.
After that the roof height (available on the existing maps) has been added at each building, in the test area, in order to extrude the original shapes into a 3D objects and the existing ground spot height has been used too.
In this way a 3D buildings representation has been elaborated unfortunately without the information about the roof geometry (terrace, roofs shapes, etc.). The resulting file, related to the test area, was ready to be used for geometry analysis such as Sections, Assonometry, 3 D vision, from different point of view, etc. in comparison with the Laser data on the same test area (see Fig. No.1).

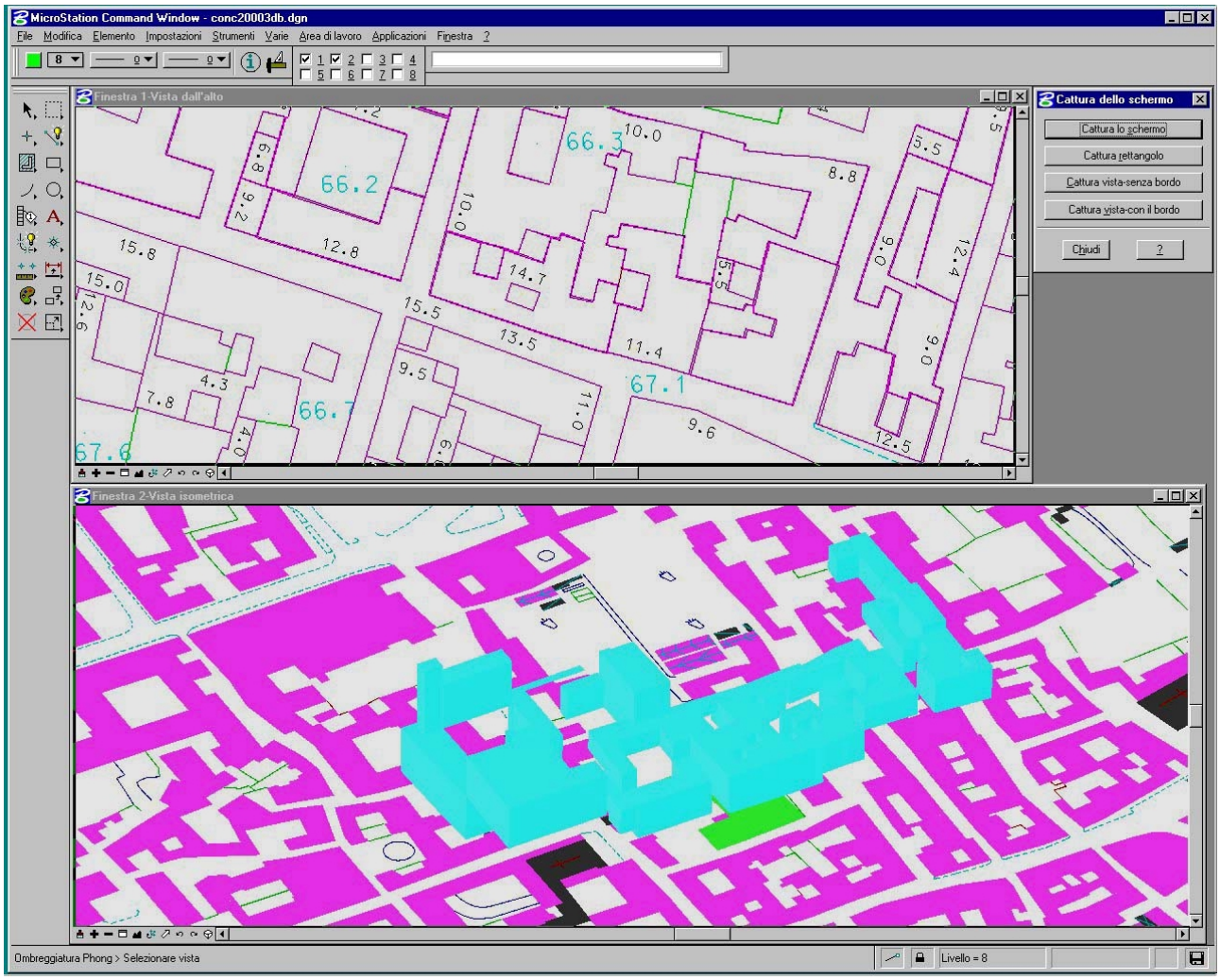

Figure 1. 3D representation of 1:2.000 map of Pavia town

- 1:500 Maps:

For this scale maps DWG files containing 2D objects and 3D spot height were available, furthermore a roofs maps containing the roof shape and the roof height on TIF (raster) format were available too. Also in this case the same procedure as before has been performed in order to have DGN files with 3D buildings and where possible, the roofs shape (see Fig. No.2).

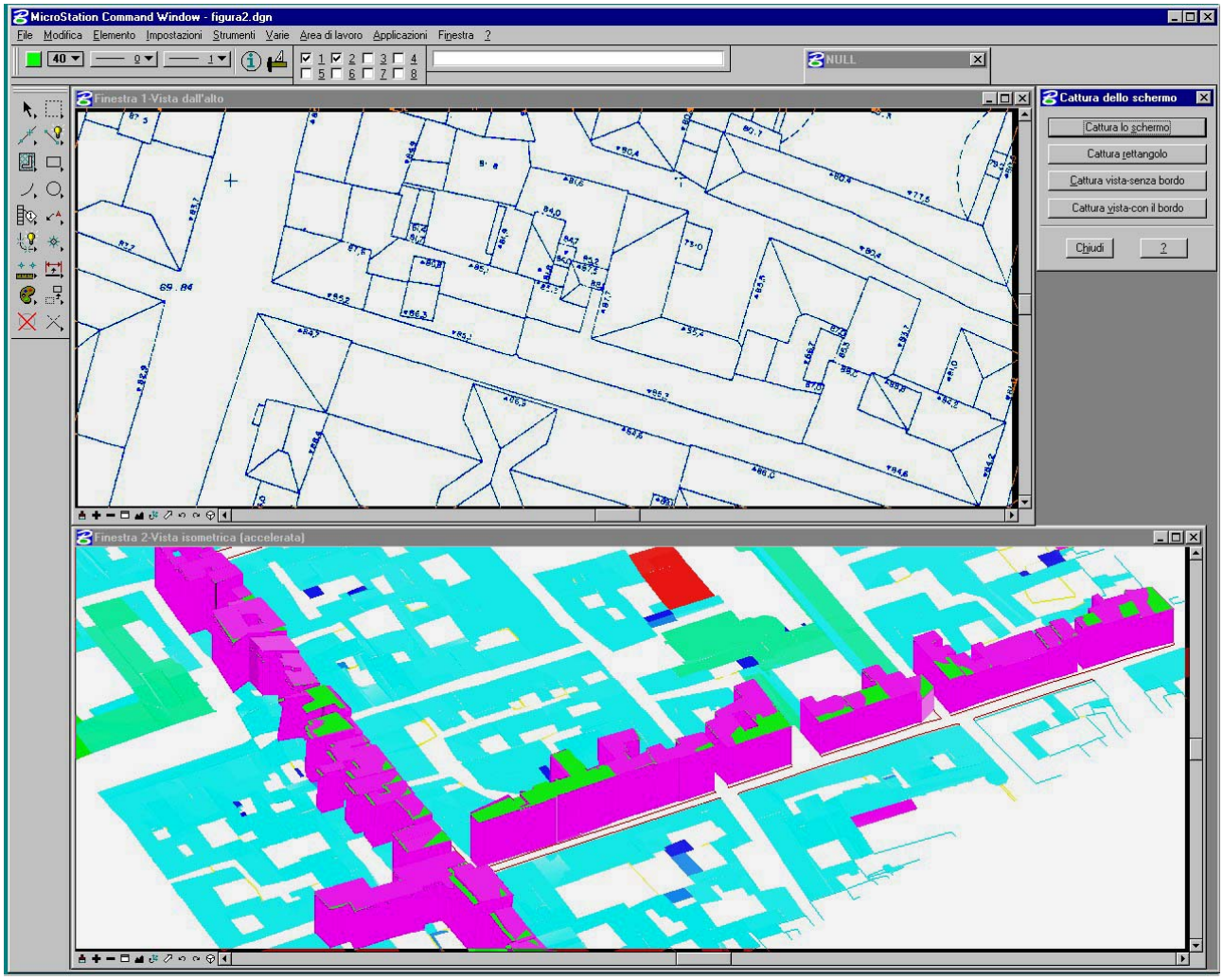

Figure 2. 3D representation of 1:500 map of Pavia town

3. LASER DATA PREPARATION

The Laser data has been acquired with a Toposys instrument on 18/11/1999, the flight height was about 850 mt In this way it was possible to have an planimetric accuracy of about +/-10 cm. and an altimetric accuracy of about +/-5 cm. Both the RAW-data (related to the DAT-last pulse, FAT-first pulse and QAT mode, cross-stripe) and 1 Mt Regular GRID data has been delivered. The second one (GRID data) is a sub-set transformation of the RAW data.
In this paper only the GRID data has been taken under examination postponing the use of RAW data into other future paper; those (RAW) data are certainly much more (as number of points) than the GRID one and perhaps more accurate: in fact in one square meter usually many distances are calculated from the aircraft to the ground.
The regular GRID data has been imported into MODELER software (by Intergraph) in order to create a DTM based on triangles. With this software it has been possible to analyse the data and to produce outputs such as: Sections, Assonometry, 3 D vision, etc. An example of GRID data representation is shown on Fig. No.3.

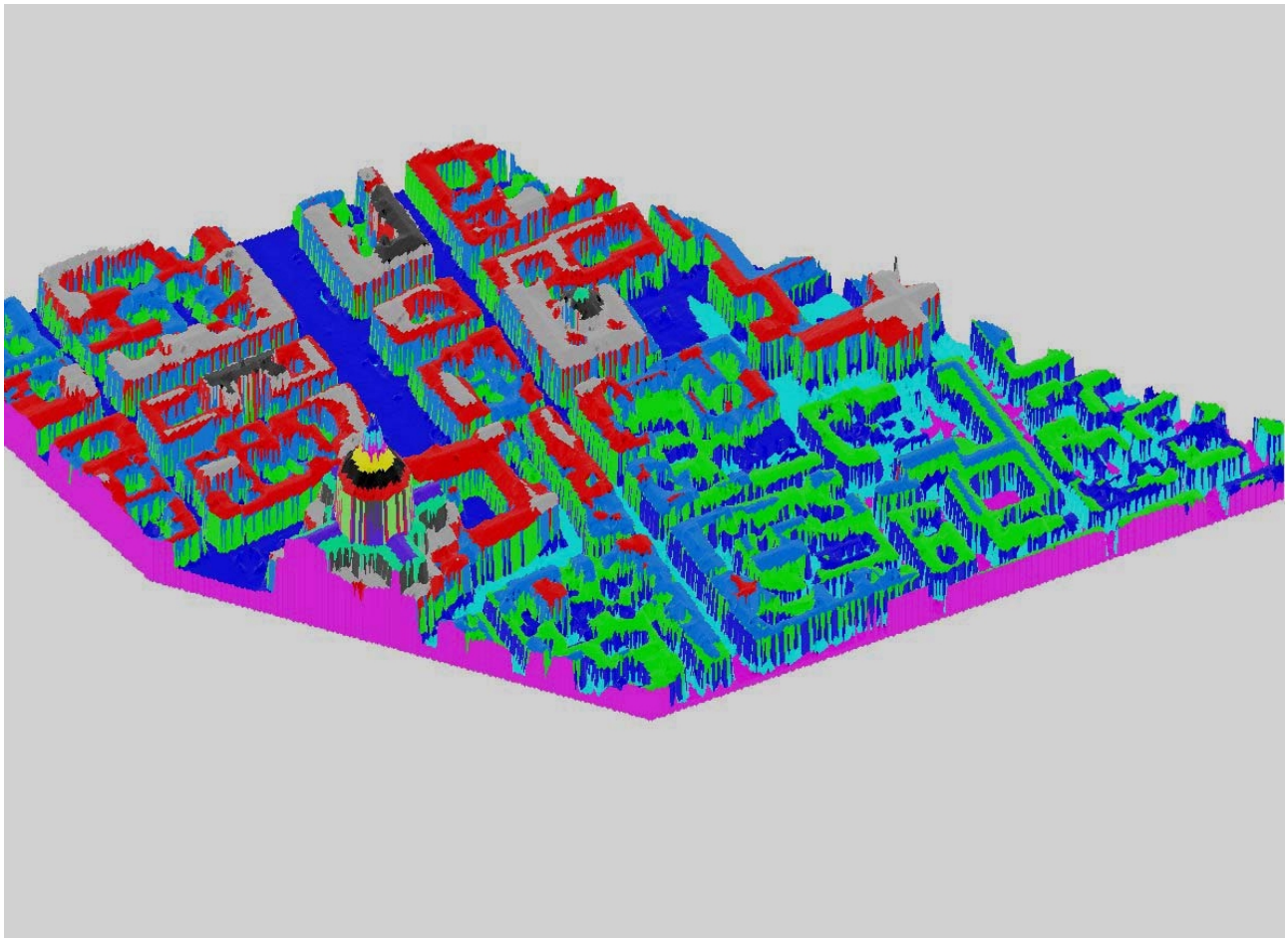

Figure 3. 3D representation of DTM based on Laser Data of Pavia town

4. COMPARISON EXECUTED

Both the Laser data and the existing cartography representation has been compared from metric point of view in order to carry out the possible differences and individuate the weak point, if any. Two test areas has been selected, taking in account the different characteristics of the territory, such as:

A) NOT BUILDED AREA

Within the two different maps scale two areas without buildings has been localized in order to make possible a comparison only on the ground surface.
In the two Sections at 1:2.000 scale and at 1:500 scale (see Fig. No.4 and No.5) the difference are shown up, at different scale for horizontal line and for the Vertical line.

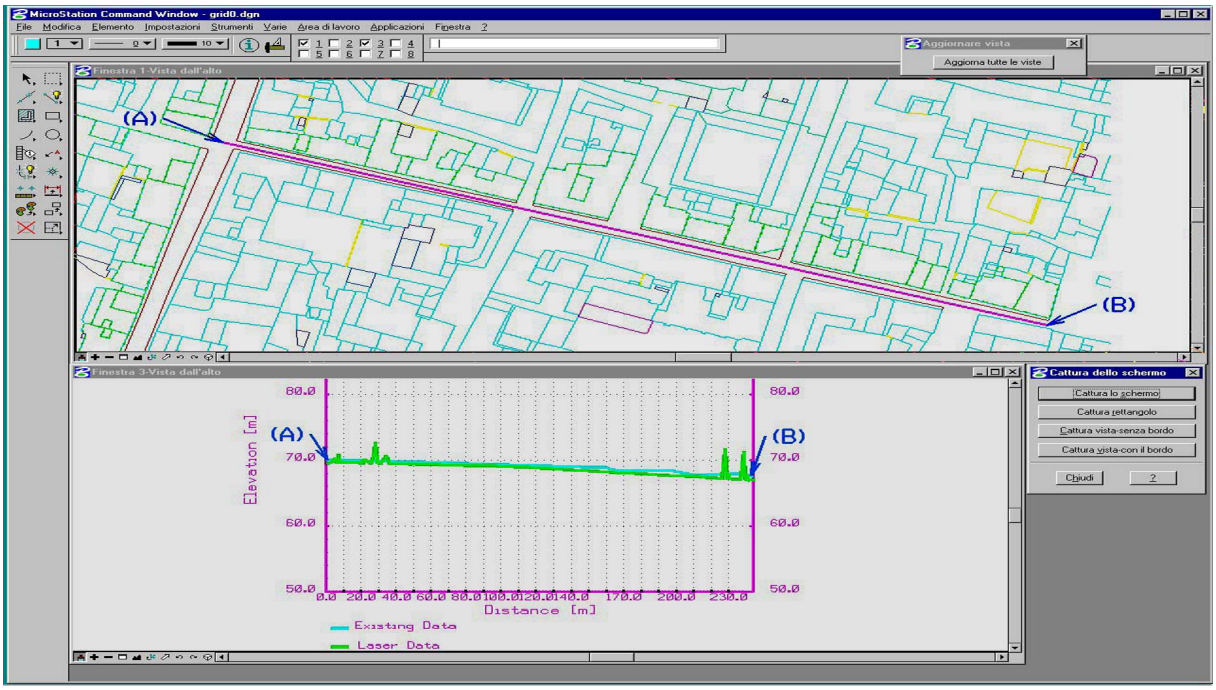

Figure 4. Section along a road on 1:2.000 map scale

About the 1:500 maps related to the centre of the city, the only possible comparison is along a road because there are not any no building areas (see Fig. No.5).

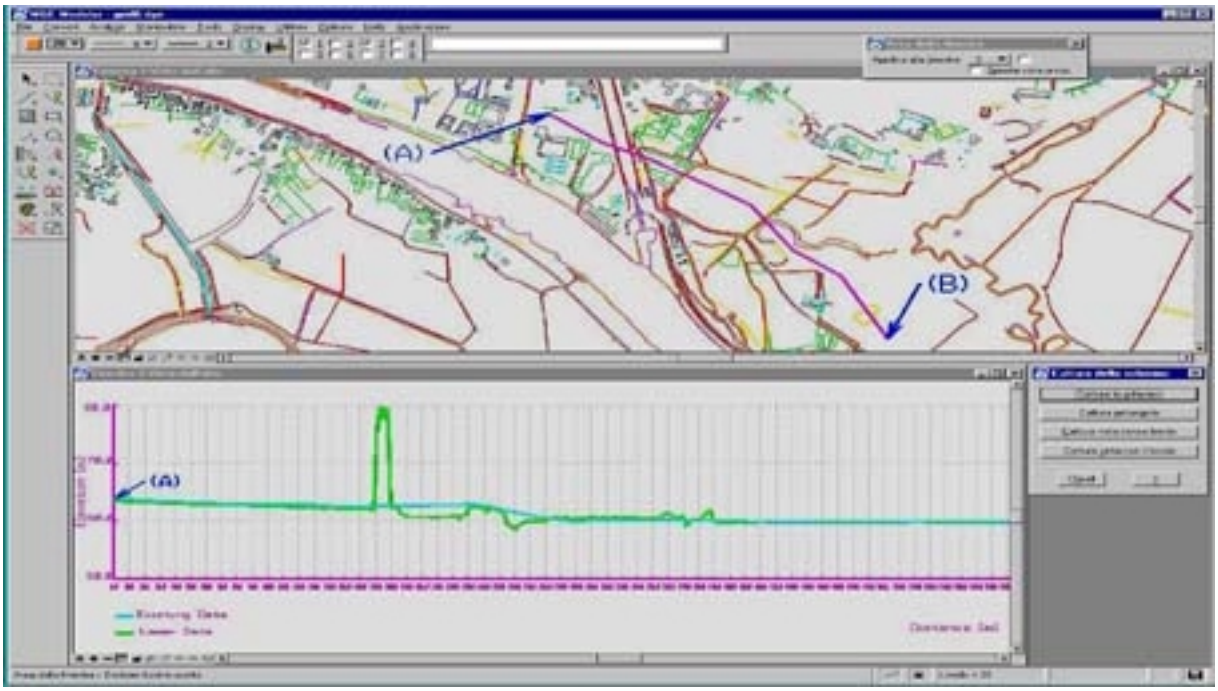

Figure 5. Section along a road on 1:500 map scale

B) BUILDED AREA

Also in this case two test areas has been chosen, the first one on 1:500 map and the second one on 1:2.000 map (see Fig. No.6 and No.7). It is possible to point out that the Vertical (height) differences are no more than 30-50 cm. while the Horizontal (planimetric) differences are less than the accuracy related to the different scale maps.

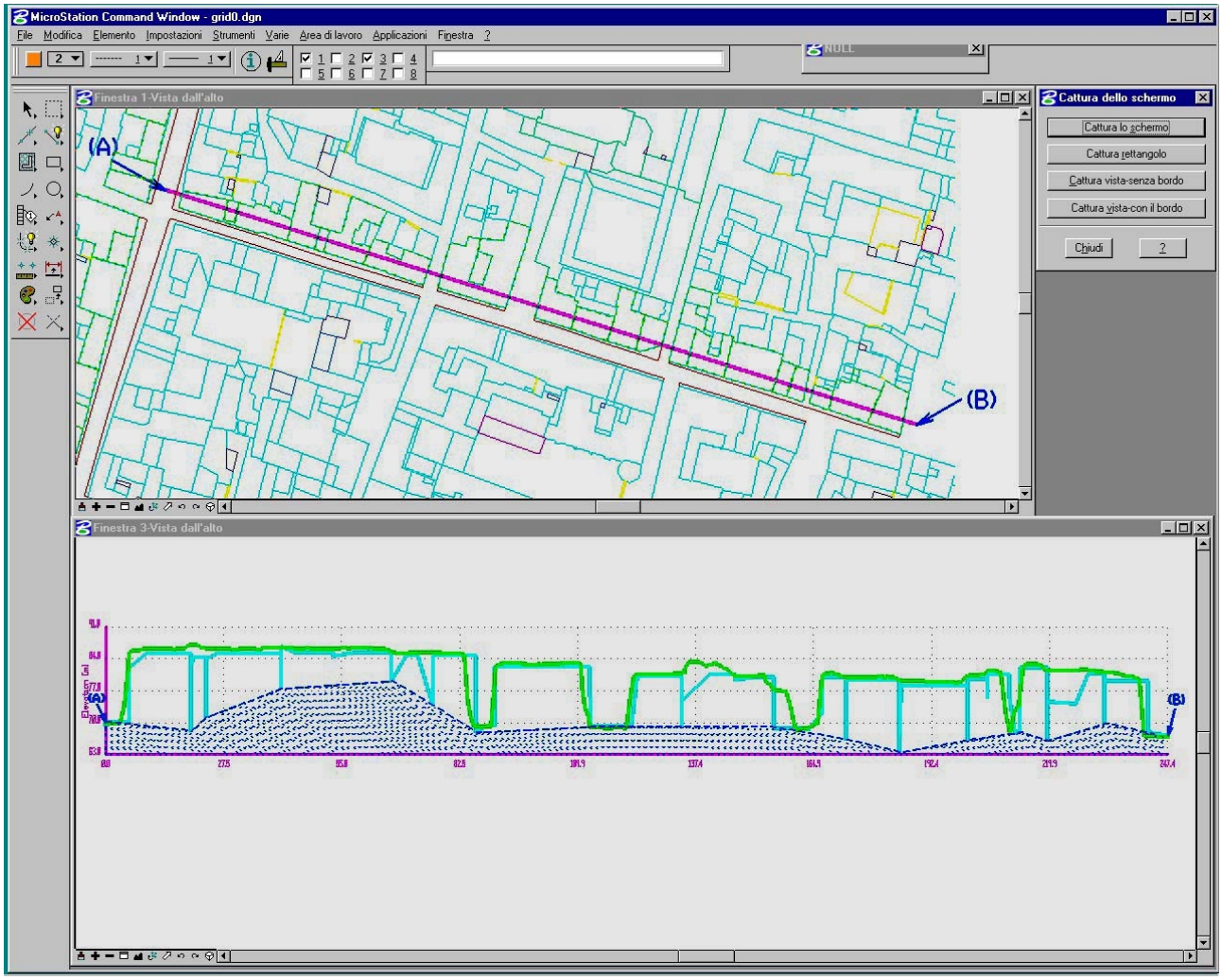

Figure 6. Section on a builded area on 1:2.000 map scale

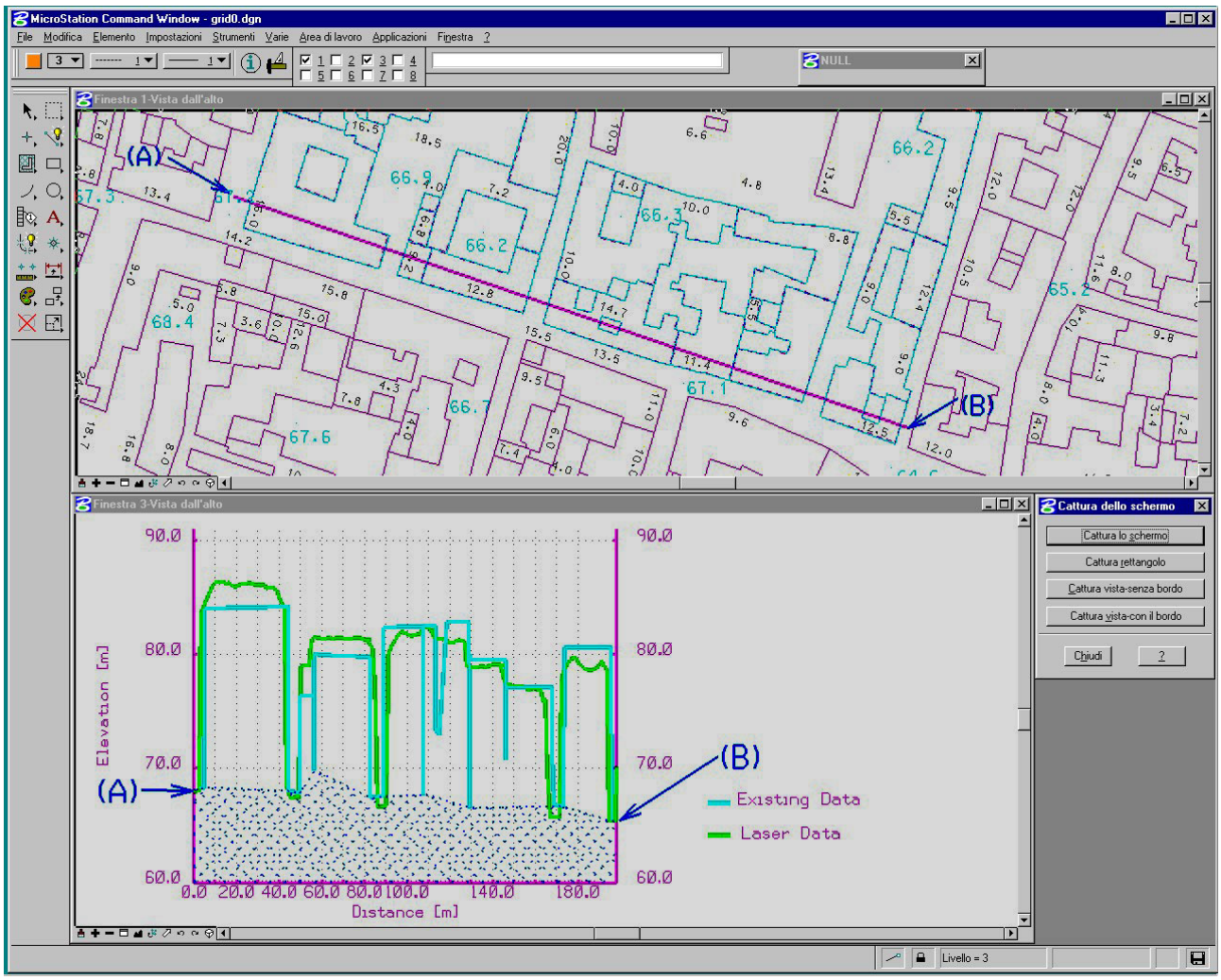

Figure 7. Section on a builded area on 1:500 map scale

5. CONCLUSION

The critical examination of the performed comparison consent to point out some basic considerations on the new laser methodology, thinking of photogrammetry methodology as the truth on the ground, with all the limits of this hipotheses.
The utilization of the LASER DATA results:

- In the not builded areas a lot of metric information (points) are available so that a very good surface terrain representation it is possible, with an accuracy certainly higher than the photogrammetric one, even if some strange value (poles, trees, etc) it is present because of the higher detail level reachable.
- In the builded areas the LASER data permit to obtain a high detail level of the roof while some problems appear when the laser move from the road to the roof because of points with intermediate values in between, related to the front-side of the buildings. These points should be removed to obtain a better representation of the whole area.

In the future, as software and hardware are going to improve, the use of LASER SCANNING DATA will be more frequent in order to obtain much accuracy and a possible friendly use of this new methodology.

ACKNOWLEDGMENTS

This paper is part of a national research MURST COFIN-98, on Airborne Laser Scanning for digital models , Project Leader: Prof. R. GALETTO.
We are grateful to Mr. Roberto BRATTELLI, Intergraph Registered Consultant for his help.

REFERENCES

Lohr U. (1996) Surveying single objects with a laser scanner GIM, Geomatics Info Magazine, Col.10 N.9, September 1996, page 6-7.

Ackermann F. (1996) Airborne laser scanning for elevation models GIM, Geomatics Info Magazine, Vol.10 n.10, October 1996 page 24-25.

Kraus K., Pfeifer N. (1998) Determination of terrain models in wooded areas with airborne laser scanner data ISPRS Journal of photogrammetry & remote sensing, Vol.53 n.4 August 1998, page 193-203.

Casella V., Galetto R. (1998) Tecniche innovative per il rilevamento terrestre, aereo e da satellite documents of the second conference ASITA, Bolzano 24-27 November 1998, pages 33-53.

Casella V. (1999) Le potenzialità del laser scanning per la conoscenza del territorio Bollettino SIFET N.1-2 1999, page 87-96.