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New requirements for the relief in the topographic databases of the Institut Cartographic of Catalonia

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  - Spot heights generalization
  - New data model for the Cartography at 1:1000
- ICC challenges related with elevation data:
  - Classification of the break lines
  - The use of LIDAR data to refine the existing elevation data

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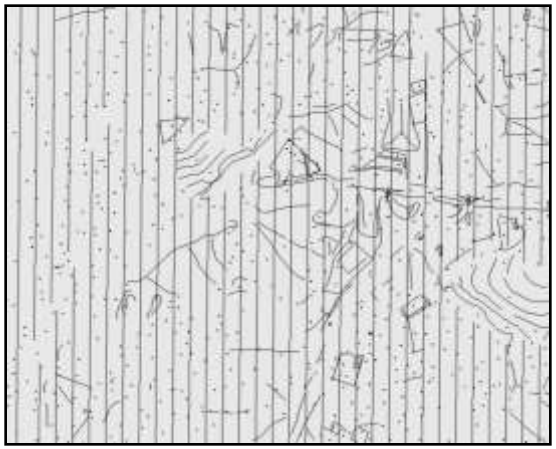
The Topographic Database at 1:5000 scale

- The most detailed database that covers Catalonia
- Compiled using photogrammetric systems according to a 2.5D data model
- The accuracy is: 1 meter RMS for X and Y
  1.5 meters RMS for Z
- The updating cycle is 5 years over all the country and more frequently over the most dynamic areas
- During the stereoplotting process all the features required to generate a DTM and a DSM are compiled together with the topographic objects

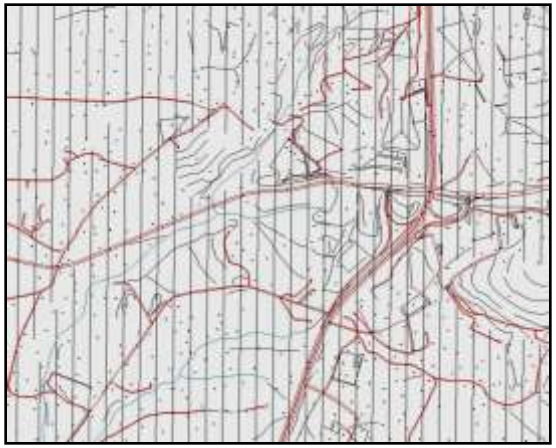
The Topographic Database at 1:5000 scale

Features collected on purpose for the DTM generation are:

- **Scan lines, break lines, spot heights, contour lines used to infer break lines, and flat areas**

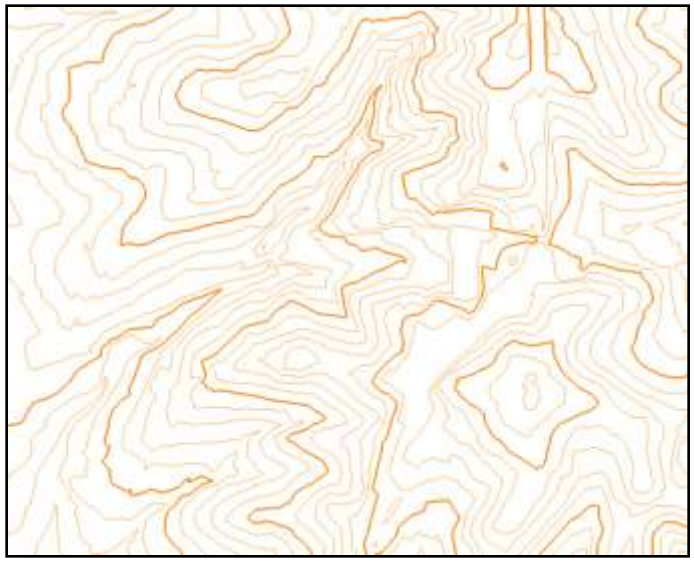


- **Moreover all the planimetric features captured on the ground are used as break lines**

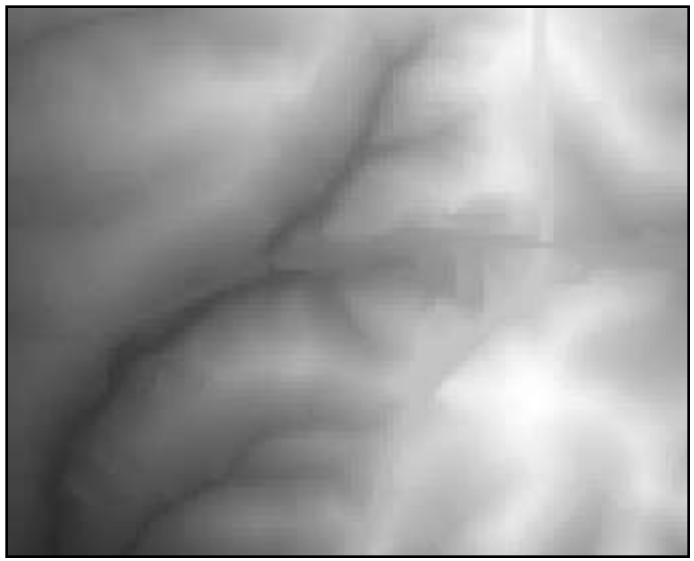


The Topographic Database at 1:5000 scale

Uses of DTM is to derive the contour lines and the shaded relief at smaller scales



Contour lines



Shaded relief

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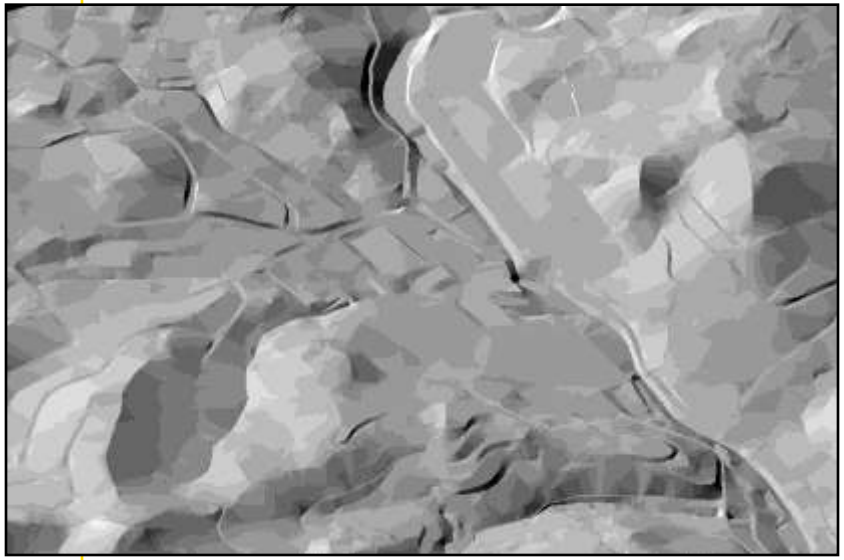
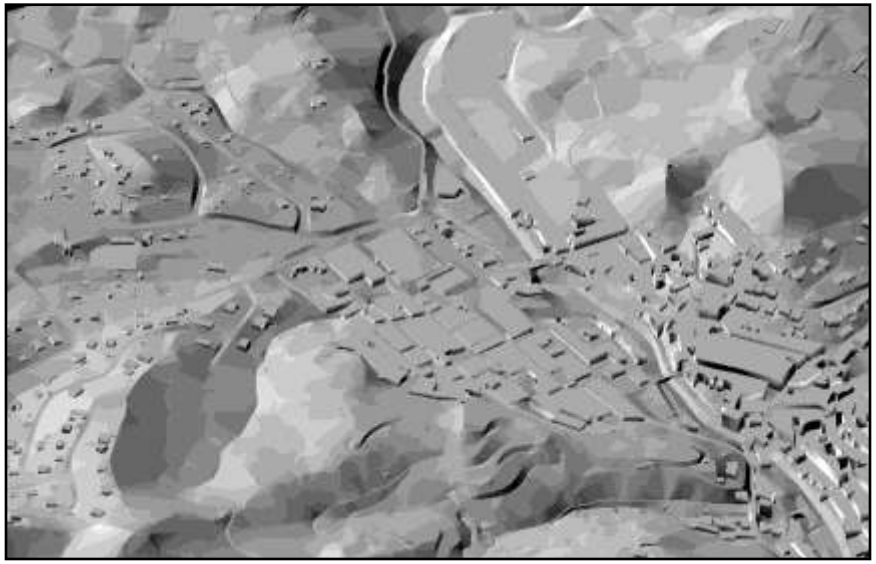
The Topographic Database at 1:5000 scale

- **For orthophoto rectification at large scales, the DSM is used instead of the DTM**
- **Features collected on purpose for the DSM generation include all the features collected for DTM excluding the areas covered by buildings or bridges, where their elevation substitutes the terrain**





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The Cartography at 1:1000 scale

- Cartography at 1:1000 scale covers the urban areas and the areas planned for urbanization
- Data is compiled photogrammetrically and it is completed by data surveyed on the field
- The accuracy is: 20 centimeters RMS for X and Y
  25 centimeters RMS for Z
- The updating cycle is approximately 5 years
- Although the data model is 2.5D, it is not designed to generate neither a DTM nor a DSM
- The relief is represented by contour lines and spot heights as in the traditional cartography at this scale

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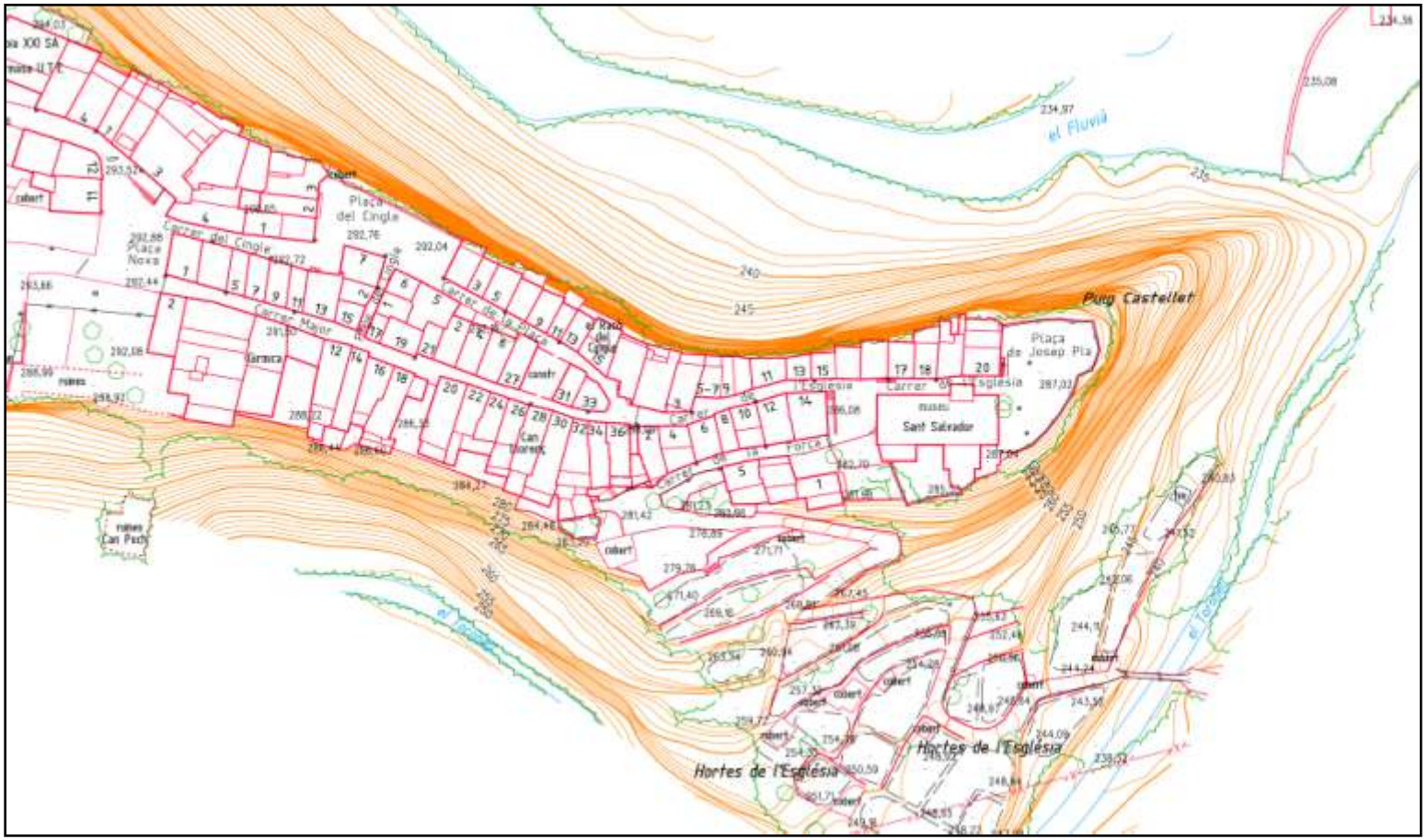
The Cartography at 1:1000 scale

- **Relief databases**
  - 1:5000 scale
  - **1:1000 scale**
- LIDAR
- New applications
  - Spot heights generalization
  - New data model at 1:1000
- ICC challenges
  - Break lines classification
  - LIDAR data to refine DB



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The relief derived from the ICC LIDAR data

- **In 2001, ICC acquired its first LIDAR system, an Optech ALTM 3025E**
- **In 2007, it was substituted by an ALS 50-II LIDAR from LEICA GeoSystems**
- **The current state of the art of this technique allows centimeter level precision, although the GPS and INS errors reduce this precision to 15 centimeters in normal operating conditions**
- **Some examples of applications are flood risk analysis, mapping of power lines, management of forest areas, analysis of the changes in the shore line, change detection in urban areas, accurated elevation data, etc.**

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The relief derived from the ICC LIDAR data

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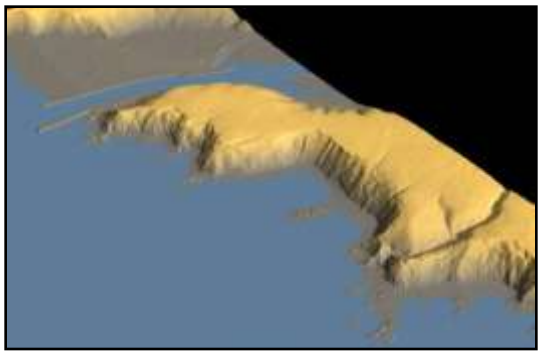
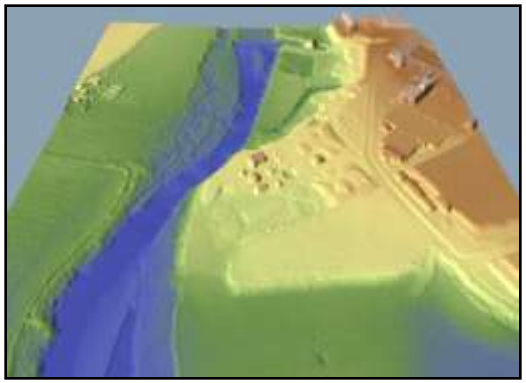
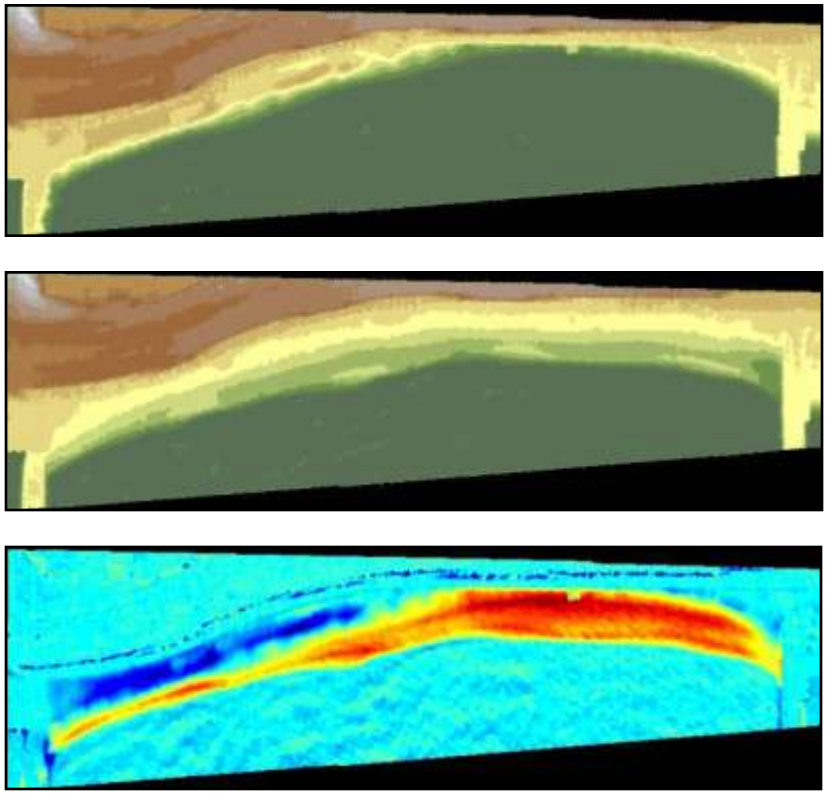


Shaded relief



Flooding area model



Changes in the shore line

New ICC applications based on elevation data

Spot heights generalization

- In the year 2002 the Universitat Politècnica de València (UPV) developed the GENCOTES application for generalizing spot heights (Vall de Núria, 2004)
- It is based on the analysis of the morphology of the terrain while taking into account cartographic aspects such as the significant points or the map names
- Since 2006, the ICC and the UPV have been working together for adapting GENCOTES to the ICC cartographic specifications
- At this moment, it is applied in the generalization workflow of the Topographic Database of Catalonia at 1:25.000 scale derived from the Topographic Database at 1:5.000

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Spot heights generalization

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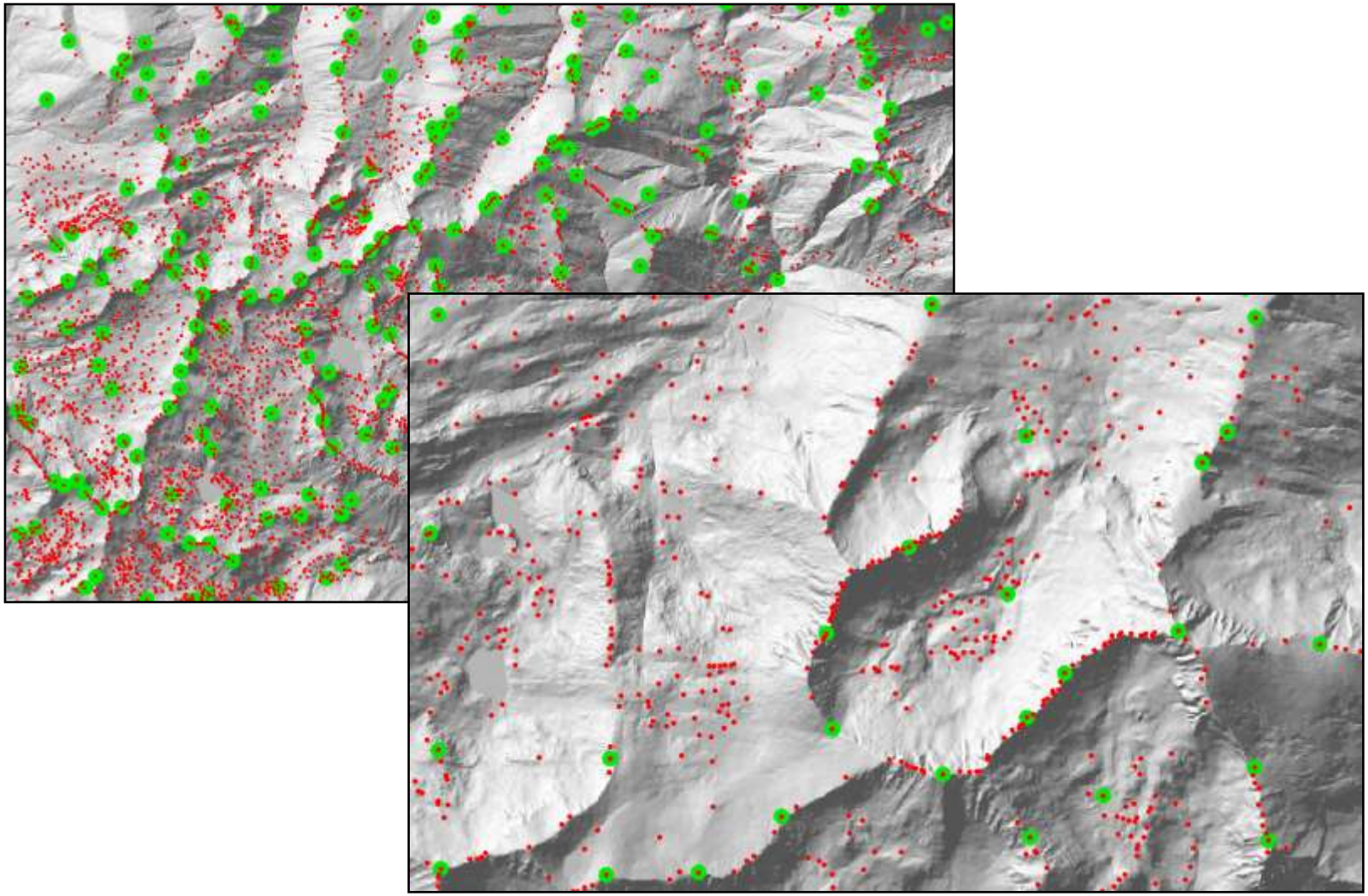

New ICC applications based on elevation data

The new data model for the Cartography at 1:1000 scale: improvements for the DTM and the DSM generation

- The main problem for producing high resolution orthophotos is the availability of a good and accurate DSM
- DSM can be obtained:
  - By stereoplotting of contour lines, scan lines, break lines and spot heights
  - By applying photogrammetric automatic image matching (correlation)
  - By using the measurements of a LIDAR system
- Correlation and LIDAR data require manual quality checking and editing to add break lines and control points to the model, specially in built up areas, bridges, walls, embankments, cliffs and plain water

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DSM generation

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Orthophoto rectified using a DSM derived from LIDAR data

Orthophoto rectified using a DSM refined by stereoplotting

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The new data model for the Cartography 1:1000

- The old model has been improved by adding the elements required for the computing of an adequate elevation model for large scale orthophotos

- Changes include:
  - Classification of the elevated sections of some linear elements (roads and railways over bridges)
  - Selection of the elements collected on the ground that must be considered as break lines
  - Compilation of auxiliary element to properly model bridges and tunnels
  - Generation of polygons for buildings and constructions

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Generation of polygons for buildings

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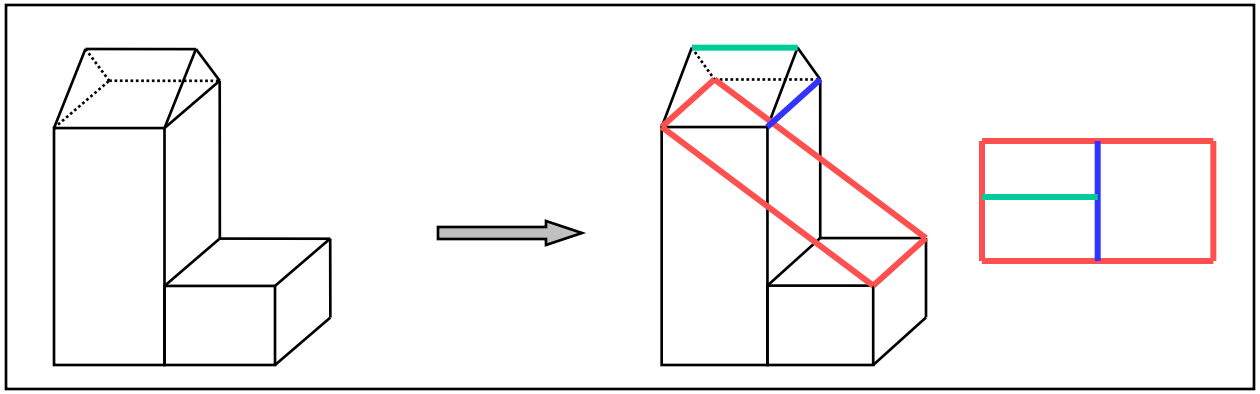

Current model

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Generation of polygons for buildings

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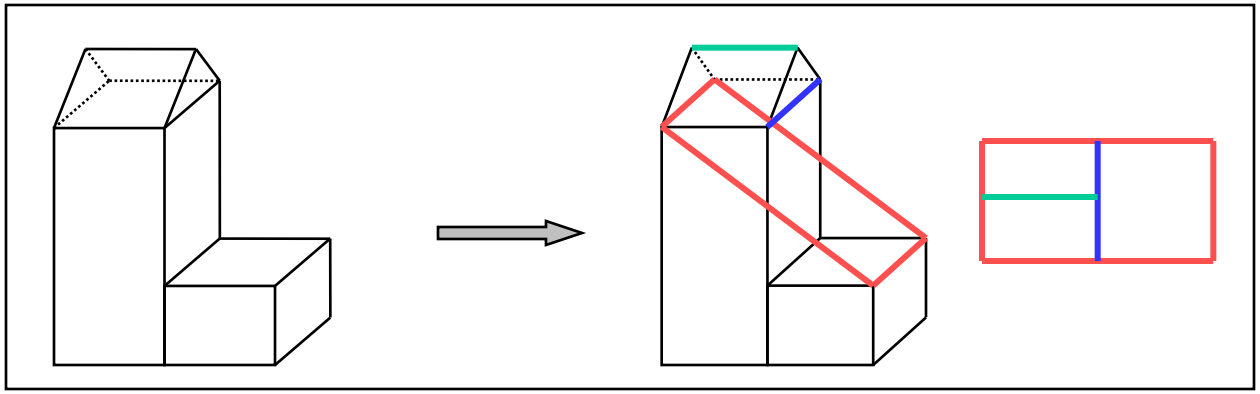

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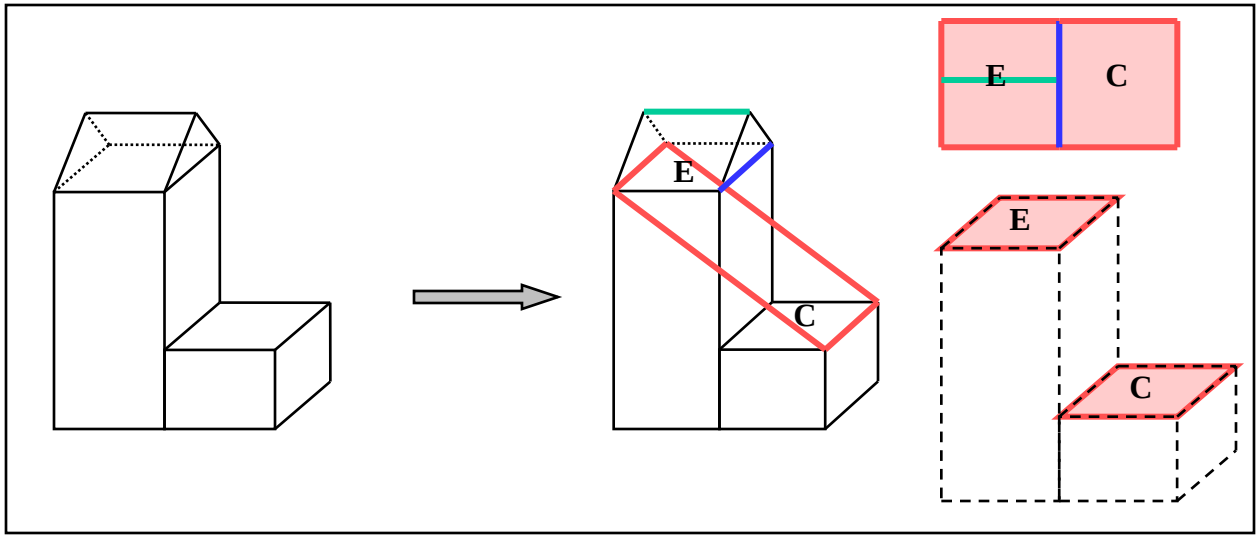
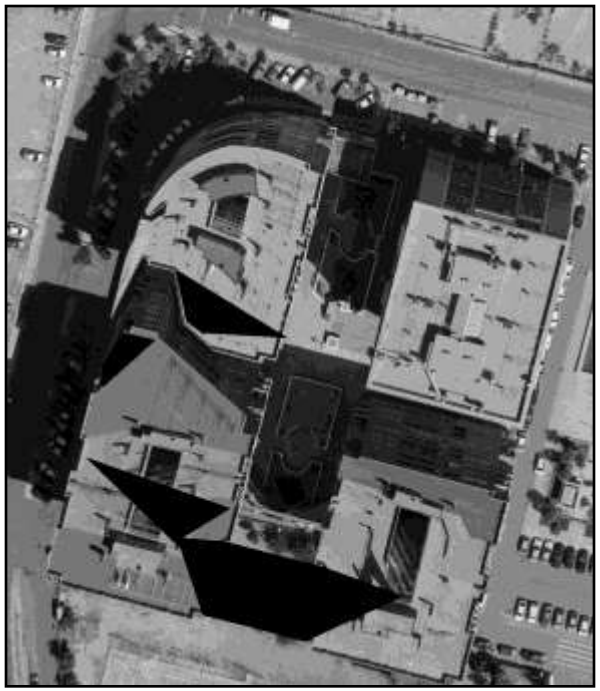


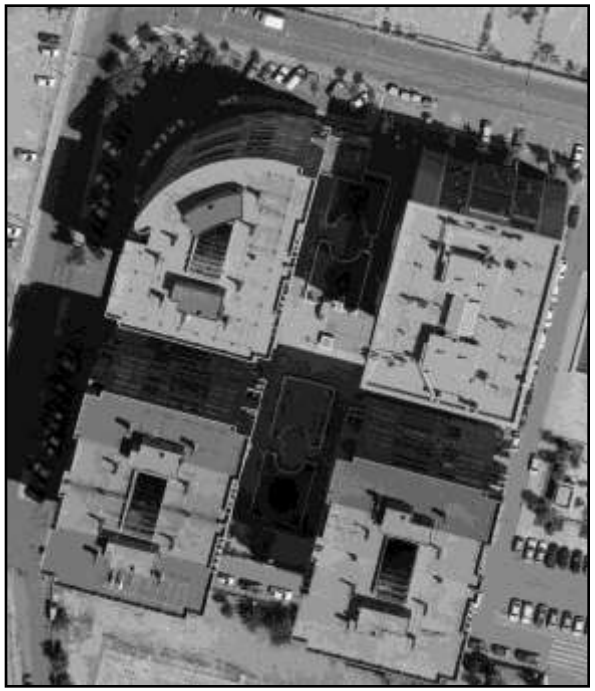
New model

DSM generation

The improved model allows a better orthorectification



The result using the old model



The result after the improved model

The improved model allows city model generation (LOD 1)

ICC challenges related with elevation data

Classification of the break lines

- **The poor classification of the BT-5M break lines limits further exploitations such as generalization for smaller scales (1:25.000 or 1:50.000) or the selection of specific break lines to enrich the LIDAR data**

- **The results of GENCOTES have encouraged the ICC and the UPV to continue their collaboration to apply a similar methodology, based on the analysis of the morphology of the terrain, for automating the classification of break lines**

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ICC challenges related with elevation data

The use of LIDAR data to refine the existing elevation data

- The comparison between LIDAR DTM and photogrammetric BT-5M DTM shows that the BT-5M achieves the nominal accuracy in elevation, except in the dense forest areas where the stereoplotting operator can not see the ground
- The ICC has decided to use the LIDAR data to refine the master DTM in the dense forest areas
- The ICC is covering Catalonia with LIDAR data and preparing a workflow for integrating both datasets