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Generalizing the altimetric information of the Topographic Database of Catalonia at 1:5,000: classification and selection of break lines

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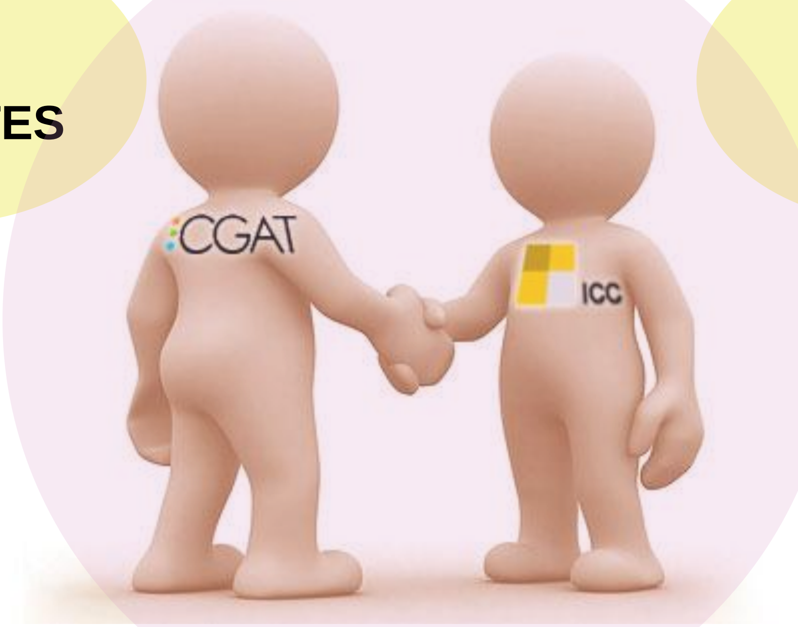
1.Collaboration framework

2007

GENCOTES

2010

GENBL



Baella, B., Pla, M., Parlomar-Vazquez, J., Pardo-Pascual, J.E., (2007). 'Spot heights generalization: deriving the relief of the Topographic Database of Catalonia at 1:25,000 from the master database'. *In 9th ICA Workshop Generalization and Multiple Representation*, Moscow.

Palomar-Vazquez, J. and Pardo-Pascual J.E., (2008). 'Automated spot heights generalisation'. *International Journal of Geographical Information Science*. Vol. 22 (1). Pp 91-110.

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2. Introduction

BT-5M
The most detailed topographic database covering Catalonia
DTM and DSM (1.5 m accuracy in triangle format) are compiled
DSM is used for rectifying orthophotos and 3D city models

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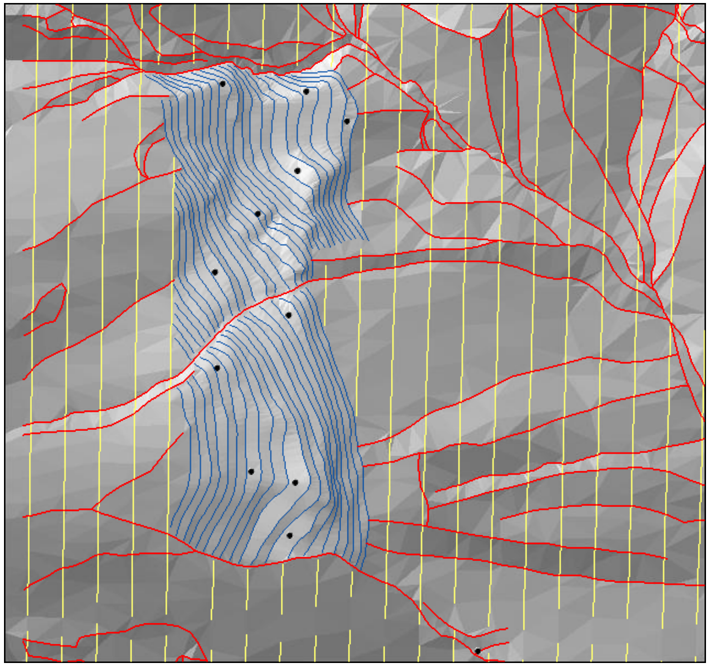
2. Introduction

DEM at BT-5M
Spot heights
Break lines
Scan lines
Contour lines (BL inferred)

Break lines
Man made objects (roads, urban parcels, paths, etc.)
Natural objects (rivers, creeks, talwegs, etc.)
Small terrain details (to ensure quality in contour line derivarion)



2. Introduction

Problem description
BT-5M → high level of detail and a huge volume of break lines (BL)
BL can produce problems and costly processes
Generalization processes could be applied to solve these problems
Main Gen-operators: classification and selection

Output quality must be acceptable

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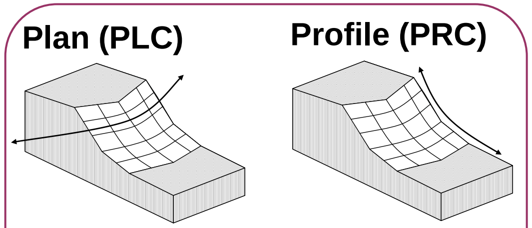
3. Main workflow

- Main idea: geomorphological approach
- Curvature as classification parameter
- Absolute mean curvature (AMC): classification of significant break lines (SBL)



AMC = Abs((PLC + PRC) / 2)

Input data → **DEM** → **Classification and selection** → **DEM’**

Input data	DEM	Classification and selection	DEM’
Spot heights SBL Scan lines Contour lines	GRID	SBL → Significant BL (AMC)	GRID’

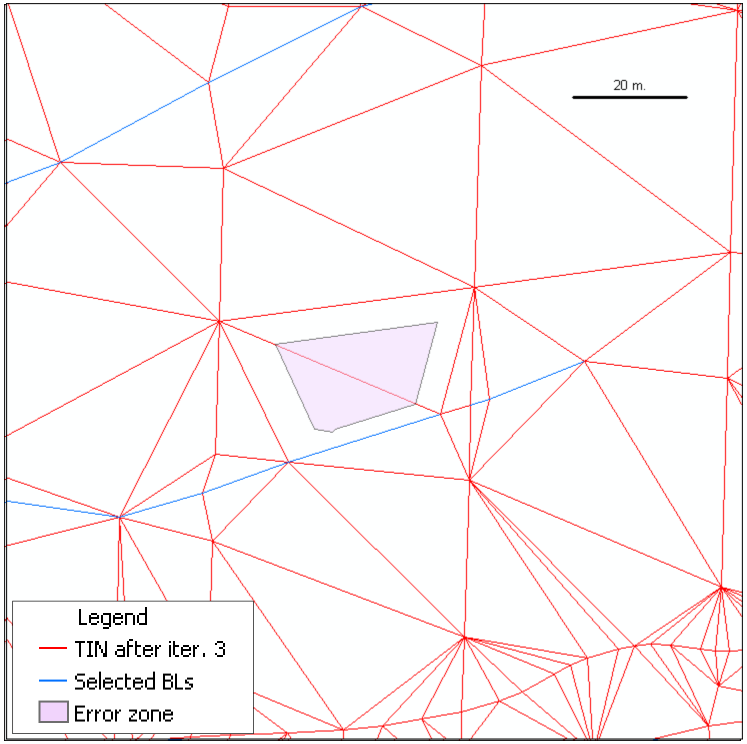
Error zones: DEM – DEM’ > threshold

BL recovering: Error zones ∩ Original BL + SBL

Input data’: Spot heights, Break lines’, Scan lines, Contour lines

3.1 Classification and selection

Detailed process description



Threshold parameters

AMC threshold: after several tests a value of 20 was decided.

- The most SBL are detected
- Less final line “fragmentation”

Error threshold: 1 m.

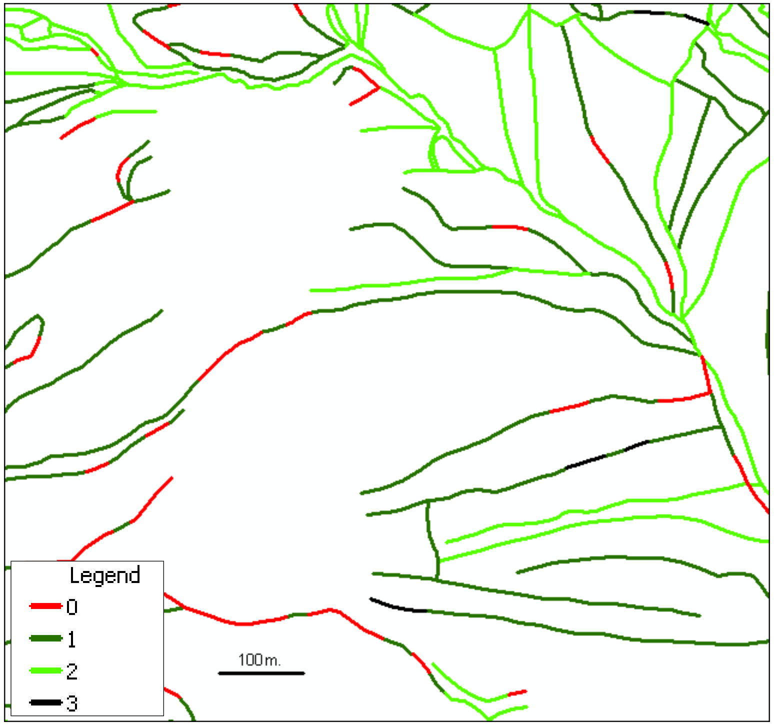
- Maximum error allowed

Performed tests show that three iterations are enough

Residual error zones does not recover BLs. They are caused by new triangle configuration in TIN model. The closest removed BL to error zones are marked as possible recovered BL.

3.1 Classification and selection

Final product (database enrichment)



BL integration

Every segment derived from the fragmentation process is classified according 4 categories:

Not selected BL

- BL to be eliminated (0)

- BL candidate to be recovered to solve residual errors (3)

Selected BL

- BL recovered after iterative process (1)

- BL selected after applying geomorphological criteria (2)

3.2 Additional ICC requirements

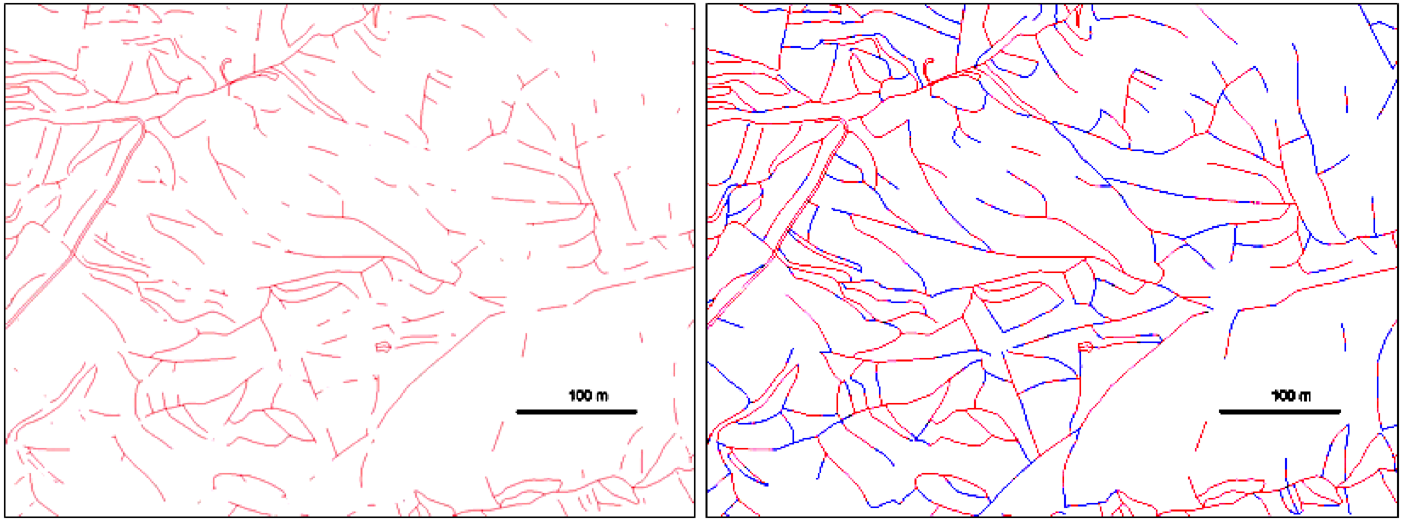
Requirements

All break lines representing paved roads must be preserved

Selection by attributes

The minimum length of break lines and gaps should be 25 meters

Extension of break line segments



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3.2 Additional ICC requirements

Requirements

Process must ensure continuity between adjacent areas

Buffer analysis

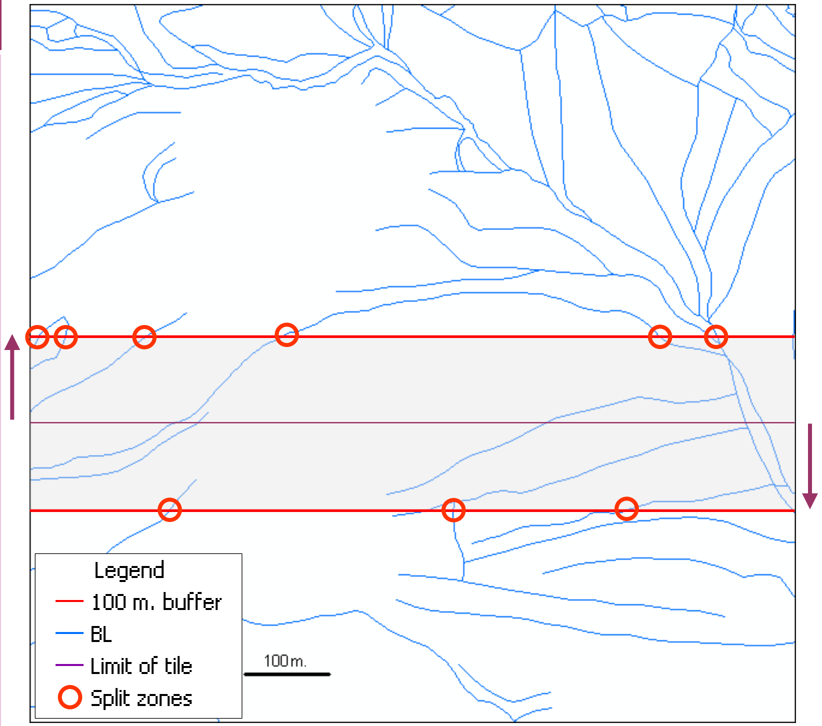
Tile processing

Every tile to be analyzed contains extra data, included into an expanded area.

200 m. to avoid border errors in DEM (and curvature) computation.

100 m. to ensure the same BL classification in overlapping zones.

BL are splited by 100 m. buffer before being analyzed.

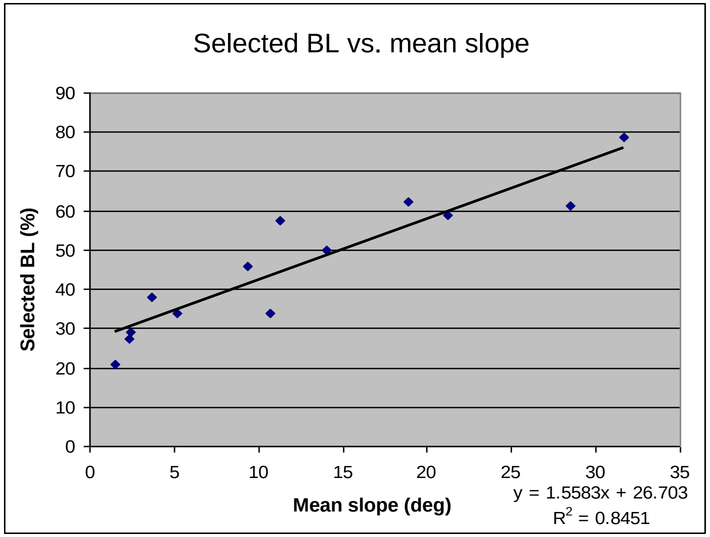


4. Results

Main results

The reduction proportion of break lines ranges from 20 to 80% depending on the topographic roughness of the analyzed area

Process area	Mean slope (Deg)	Length of Selected BL (%)
264_119	11.26	57.38
274_131	2.30	27.48
253_125	10.73	33.85
257_118	2.42	28.99
280_133	5.19	34.03
280_129	18.85	62.40
276_134	14.00	49.83
262_119	9.36	45.89
260_75	28.48	61.19
264_115	3.68	38.06
261_73	31.69	78.68
257_73	21.22	58.80



There is a clear relation between slope and selected BL. Areas with higher slope need higher number of break lines in order to define better the landforms

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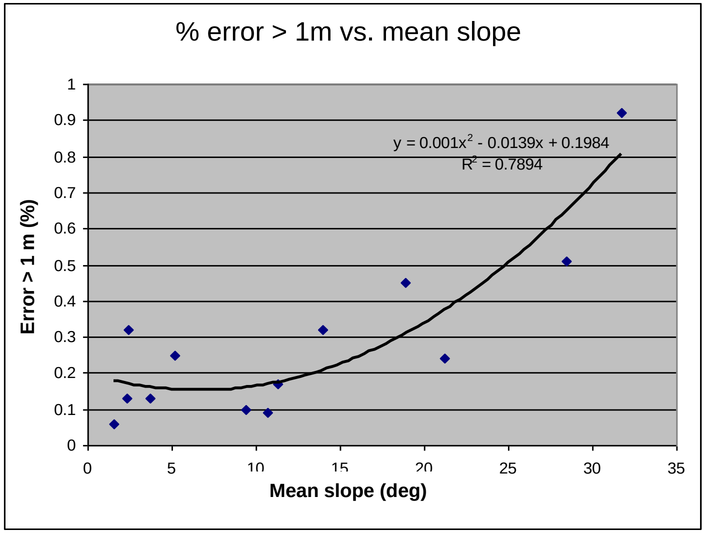
4. Results

Main results

The reduction proportion of break lines ranges from 20 to 80% depending on the topographic roughness of the analyzed area

Process area	Mean slope (Deg)	Error > 1 m (%)
264_119	11.26	0.17
274_131	2.30	0.13
253_125	10.73	0.09
257_118	2.42	0.32
280_133	5.19	0.25
280_129	18.85	0.45
276_134	14.00	0.32
262_119	9.36	0.10
260_75	28.48	0.51
264_115	3.68	0.13
261_73	31.69	0.92
257_73	21.22	0.24



Only in areas with higher values of slope the error caused by the elimination of several break lines will be significant

4. Results

Main results

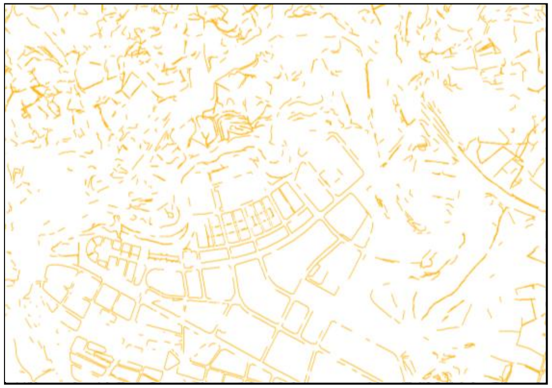
Method significantly reduces number and length of BL specially in flat and urban areas

	Number of original BL	BL selected by geomorphological criteria		BL selected by error analysis criteria		BL eliminated	
Flat	3229	386	12 %	1410	44 %	1433	44 %
Urban	3934	479	12 %	1932	49 %	1523	39 %
Mountainous	5798	3483	60 %	1626	28 %	689	12 %

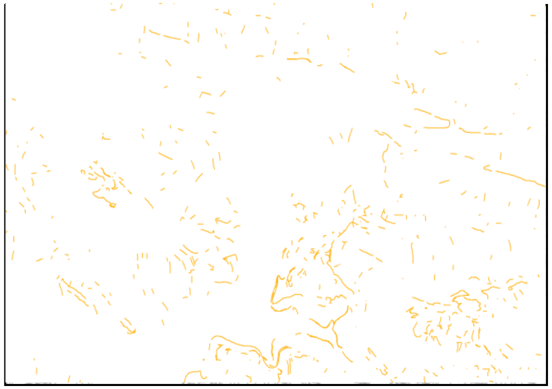
	Length of original BL (Km)	Length of BL selected by geomorphological criteria		Length of BL selected by error analysis criteria		Length of BL eliminated	
Flat	436.4	83.6	19 %	115.0	26 %	237.8	55 %
Urban	400.8	95.8	24 %	161.6	40 %	144.4	36 %
Mountainous	357.3	218.1	61 %	110.9	31 %	28.3	8 %

Flat area (removed BL)

Urban area (removed BL)



Mountainous area (removed BL)



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5. ICC tests

DEM derived from generalized BL has been used in the rectification of 100 orthophotoimages

Accuracy

The generalization has no influence on the accuracy of the product

Accuracy is measured comparing the coordinates of points measured on the field and the coordinates of the same points identified on the orthophotoimages

Performance

The save on the timing performance is around 12 seconds per rectification process (3%)

This small reduction becomes significant due the high number of frames rectified each year, around 80,000 (33 workdays)

6. Conclusions

Main conclusions

The terrain generalization must be focussed more in the **geomorphologic classification** than in the pure geometric simplification.

The proposed **methodology** selects the most significant break lines applying **geomorphological** analysis followed by an **iterative** process based on **error analysis**.

The **reduction** ratio is high dependent of the terrain **roughness**: in flat areas is about 55% of break lines length but the percentage decreases until 8% in mountainous areas.

The methodology applied for the break lines generalization provides also an efficient tool to **enrich the original data**, adding a classification based on the geomorphological characteristics of the terrain.

The application of **generalization techniques** to the topographic data, including altimetric information, can go further away of topographic data derivation and benefit the generation of **other type of products**, as orthophoimages.

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Thank you for your attention !!

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