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Rebuilding the Cadastral Map of The Netherlands
Geodetic aspects

Frank van den HEUVEL, Gerbrand VESTJENS,
Gerbrand VERKUIJL, Mark van den BROEK

FIG
e-Working Week 2021

Some ‘Dutch’ numbers

Netherlands

- **Land mass: 41543 km^2**
- **17.5 million inhabitants (~ 420 inh. / km^2)**

Cadastral

- **Currently 1218 cadastral municipalities**
- **Divided in 7889 cadastral sections**
- **8 million historic and current parcels**
- **5.1 million fieldsketches**

Computational

- **Order of 500 million observations**
- **Order of 250 million unknowns**

Cadastral municipalities

Measurement types

Parallellism without distance
Tape distance
Perpendicularity
Distance point-line
Chainage offset
GPS
Collinearity
Parallellism with distance
Double distances
Total Station

Challenges / Ambitions

Quality

- **Current cadastral map has a ‘visual’ quality of around 20 cm to 1 meter (1σ)**
- **Expected cadastral map has computational quality of around 5 cm (1σ)**

Methodology

- **Least squares adjustment with (strict) statistical testing (‘Delft School’)**
- **‘Current’ dGPS-measurements as control points in adjustments**

Adjustment steps during vectorisation and coupling

Per individual fieldsketch

- **Quasi free network adjustment(*)**

*Per fieldsketch **with** neighbours*

- **Constrained adjustment, using any known (GPS-) points as control ($\sigma_{x,y}$ = 2 cm)(*)**

Per cluster of approximately 250 fieldsketches

- **Constrained adjustment, only using known (GPS-) points as constraints**

(*) Due to lack of sufficient redundancy, all (remaining) points are used as control with 20 meter a-priori standard deviation.

Large scale adjustment (LSA)

- **Proprietary development of fast adjustment using LM (Levenberg-Marquardt) solver**
- **Proprietary development of fast inversion routines to calculate statistics (w-test, F-test, MDB, Redundancy numbers)**
- **Written in Python, using Numpy and PyPardiso**

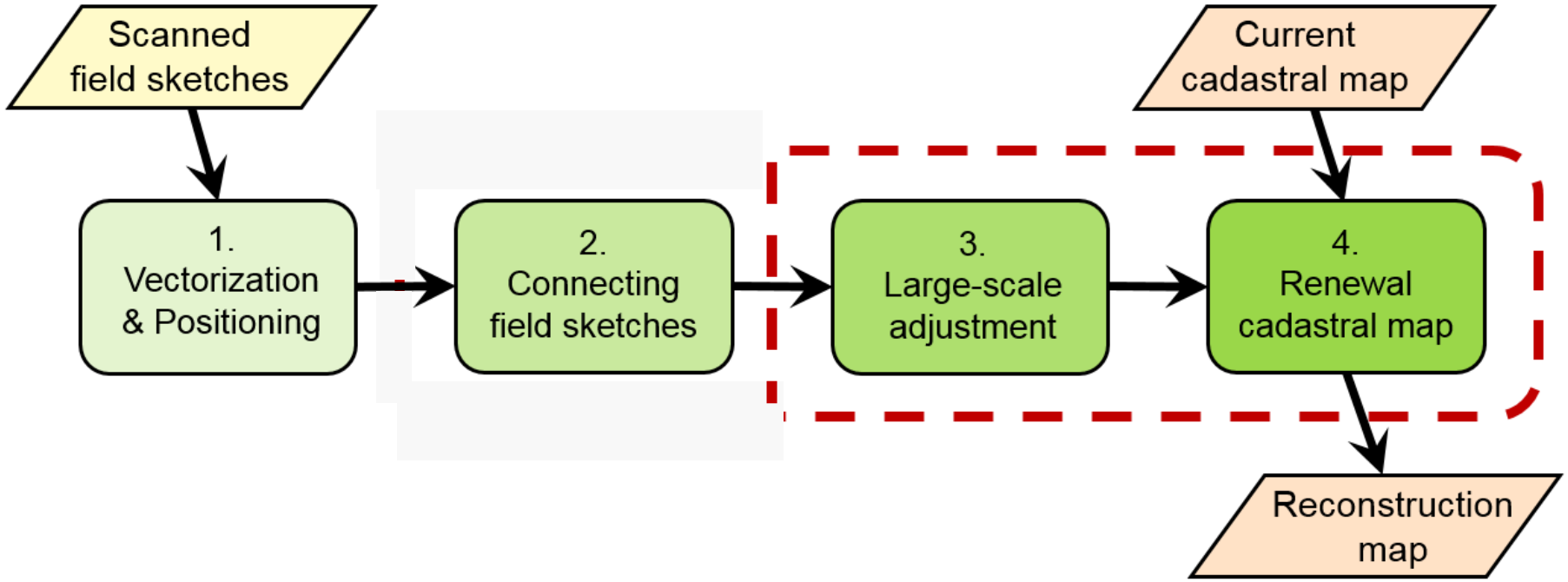
Number of variables	Equivalent number of field sketches	Number of iterations	Time (s)
10^3	5	11	0.16
10^4	50	15	0.89
10^5	500	13	7.47
10^6	5000	17	164.6
$2 * 10^6$	10000	19	453.6

Table 1: Timing of large-scale adjustment experiments.

Number of variables	Equivalent number of field sketches	Time (s)
$4 * 10^3$	20	2.5
10^4	50	11
$2 * 10^4$	100	30
$4 * 10^4$	200	200

Table 2: Timings of full inverse calculation with PyPardiso.

Production process: adjustment & mapping



More information on automating the vectorization step in FIG-paper:
Broek, M. van den, Heuvel, F. van den, Verkuijl, G., Vestjens, G.
”Rebuilding the cadastral map of The Netherlands, the geodetic concept”

Renewal of the cadastral map

Updating for each Large scale adjustment (LSA)

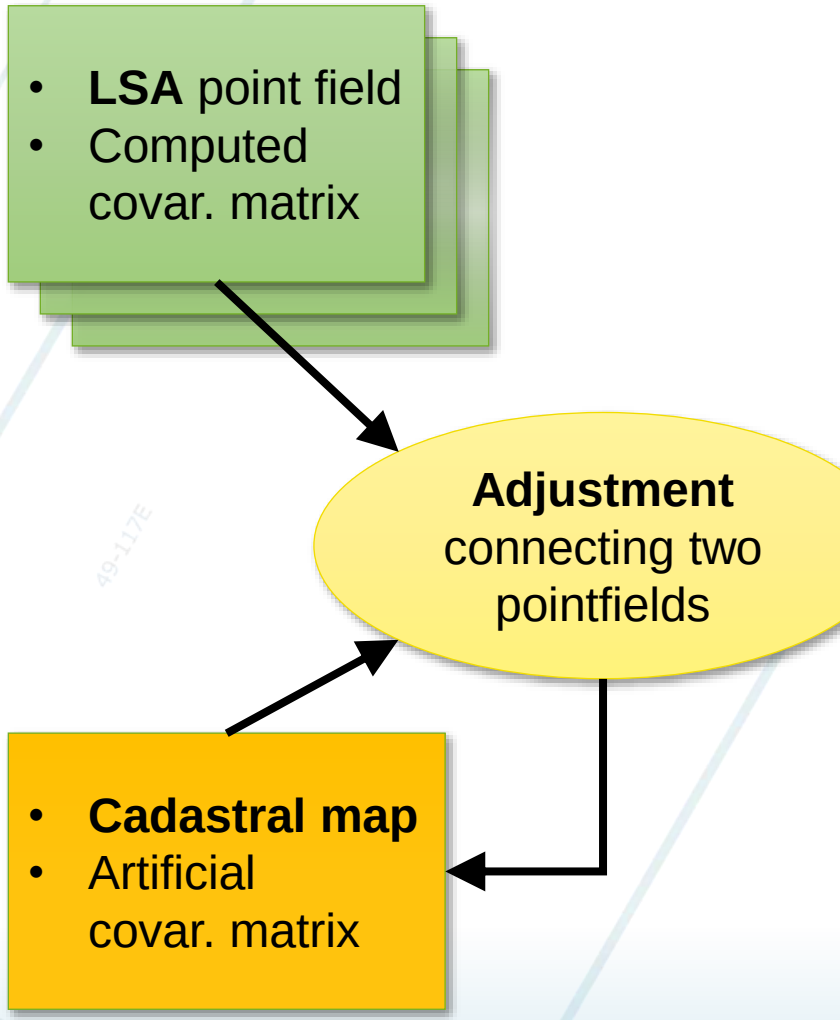
Compute point field and full covariance matrix

Update the cadastral map using geometric relations

Focus on relations between lines of LSA and cadastral map

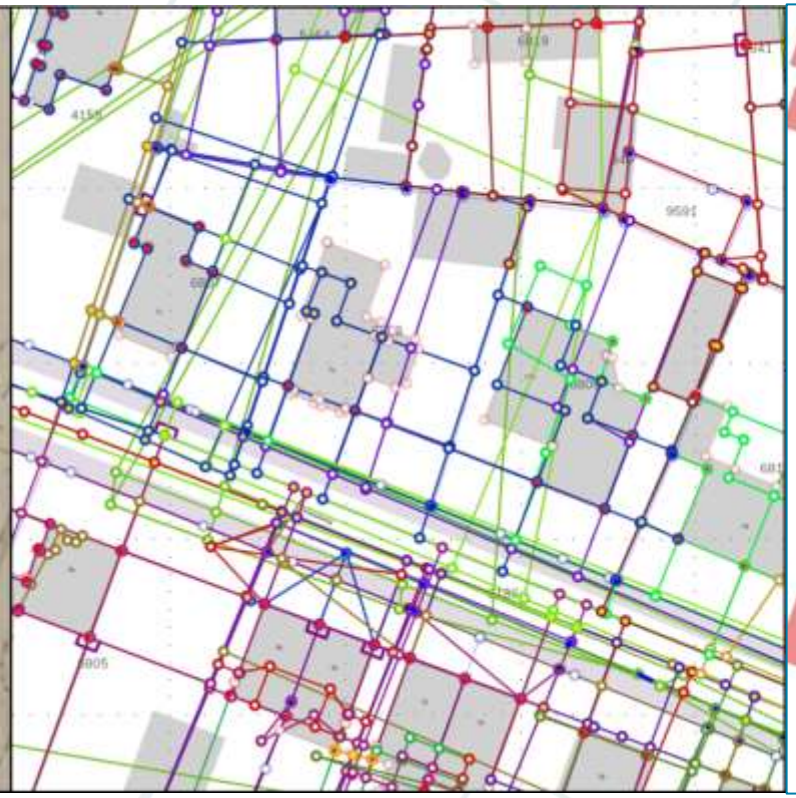
Initialize with current cadastral map and artificial covariance matrix

Main goal: interpolation of points not linked to LSA



First results

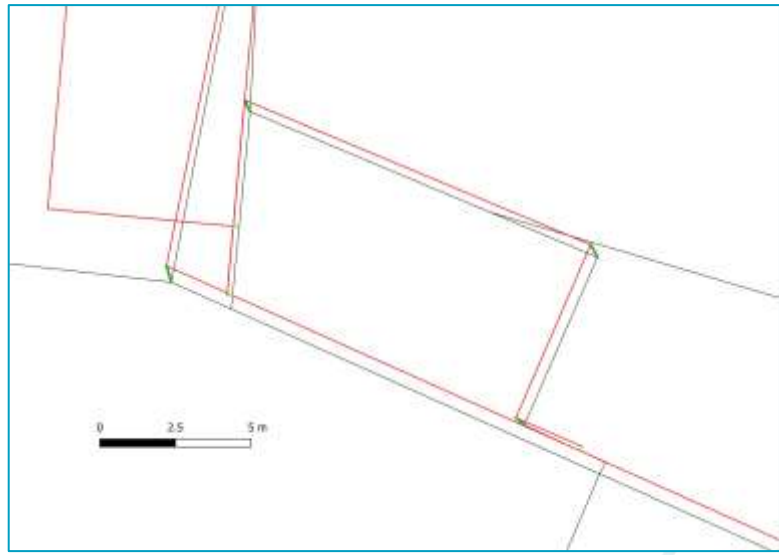
Field sketch



Vectorization

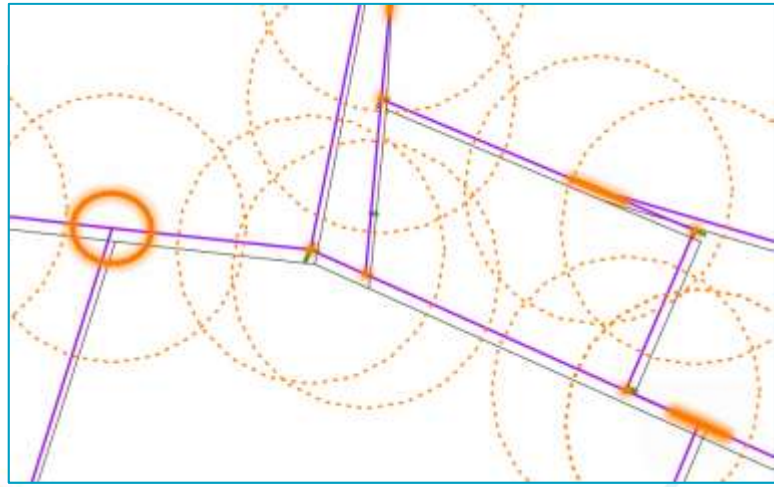
Reconstructed boundaries

Connecting the point fields



Standard ellipses - before and after

Zoom on central part



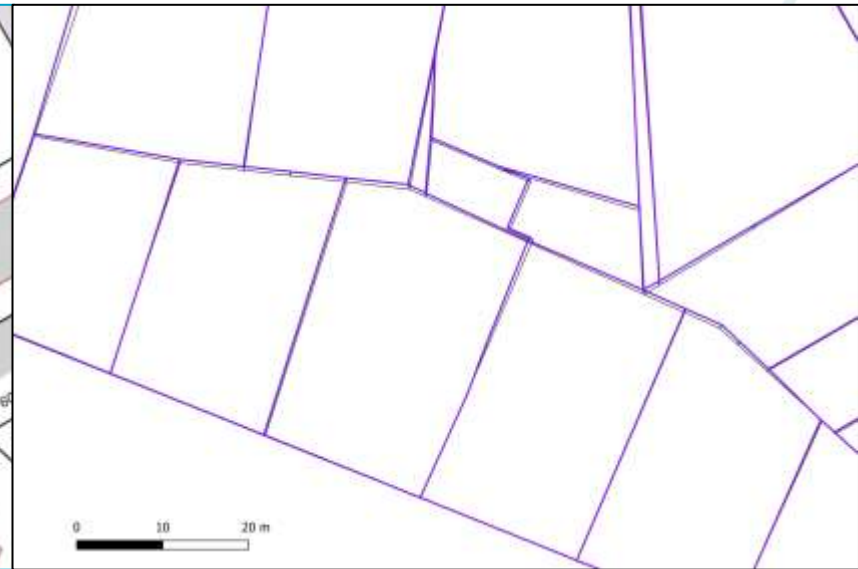
Conclusions

- **Statistical testing of observations in all steps of the renewal process**
- **Rigorous and scalable solution for cadastral map renewal and updating**

Field sketch

Cadastral map

Updated cadastral map



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