



DIGITAL TRANSFORMATION FOR RESPONSIBLE LAND ADMINISTRATION

FIG Commission 7 & 2 Annual Meeting 2023

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Cadastral surveying methods

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Overview

- The current standard for cadastral surveying in Norway
 - General concept
 - Demands
 - Equipment
 - Measurement procedures
 - Calculation
 - Data delivery
 - Critique

- Alternative methods



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General concept: Reasons for cadastral surveying

- There is a public need for a cadastral map, the society often needs to know who owns where
- New parcels will not be registered and receive a parcel identification number unless a cadastral surveying has been carried out



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General concept: The duties of the cadastral surveyor

- Notification of all the involved parties
- Impartiality
- Survey the boundary points that are approved by the landowners
- Register attributes
- Document sufficient position quality
 - Adjustment, blunder detection analysis, reliability analysis



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General concept: What the cadastral surveyor doesn't need to

- Find out where the correct boundary is
 - This is the responsibility of the landowners
- Be responsible for the quality of the result
 - Only responsible for that the procedures have been followed



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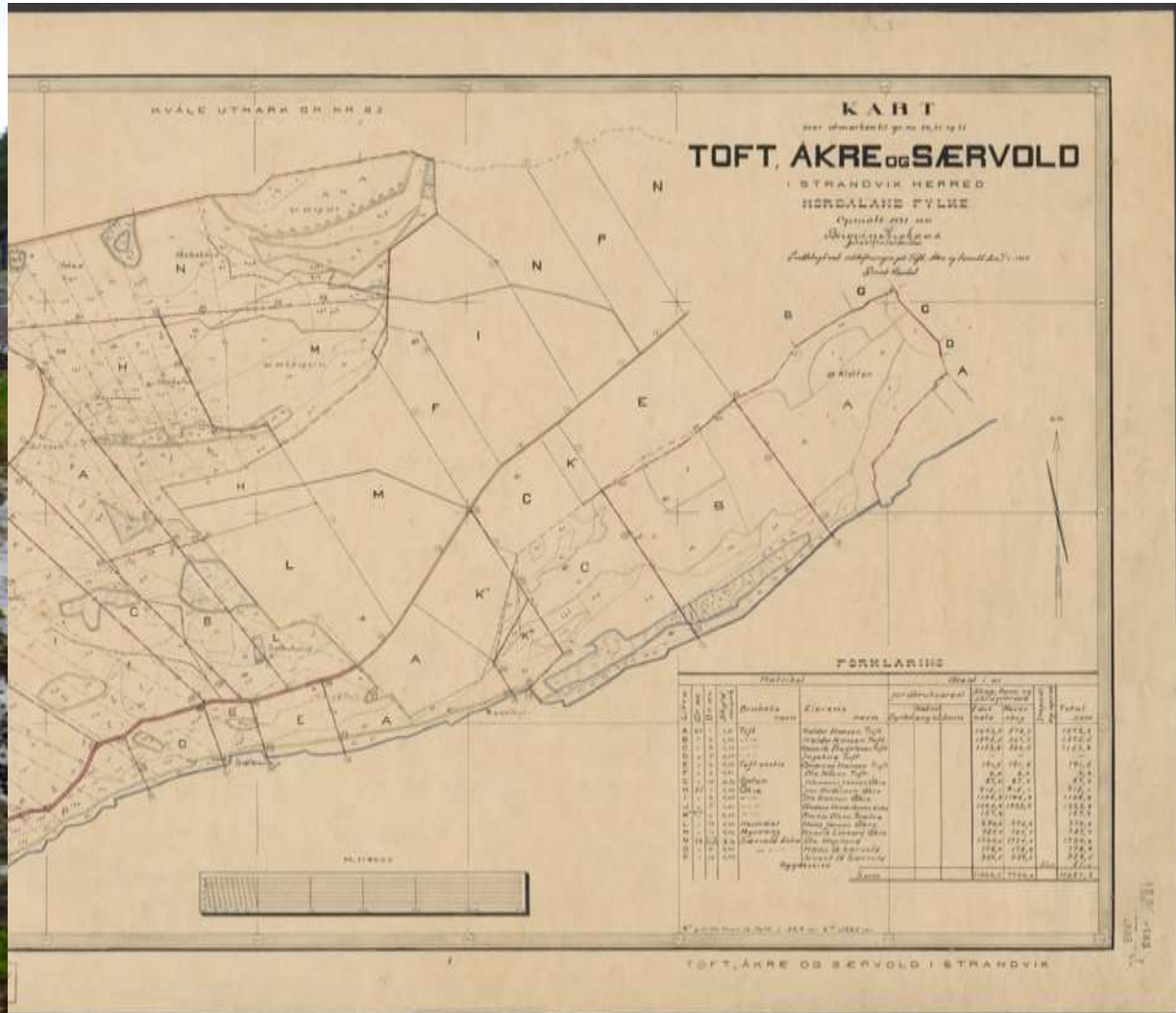


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Demands: Instruments and observations

- Instrument:
 - Realtime GNSS phase-observations combined with data from base-network
- Differences:
 - Antennas at different price-levels, high-end instruments most common until now
- Accuracy
 - Standard deviations computed by the instrument, based on
 - the calculated (adjusted) position solution (ETRS UTM)
 - Consecutive averaging of individual (but not independent) solutions
- Issues to consider
 - Centering accuracy may come in addition to the accuracy of the calculated antenna position
 - Handheld pole with or without supporting device, sometimes in strong wind
 - Base network provider estimates standard deviations that are most often larger than the values from the instrument.
 - Averaging may compensate for antenna movement, but not for other systematic or time-varying errors.

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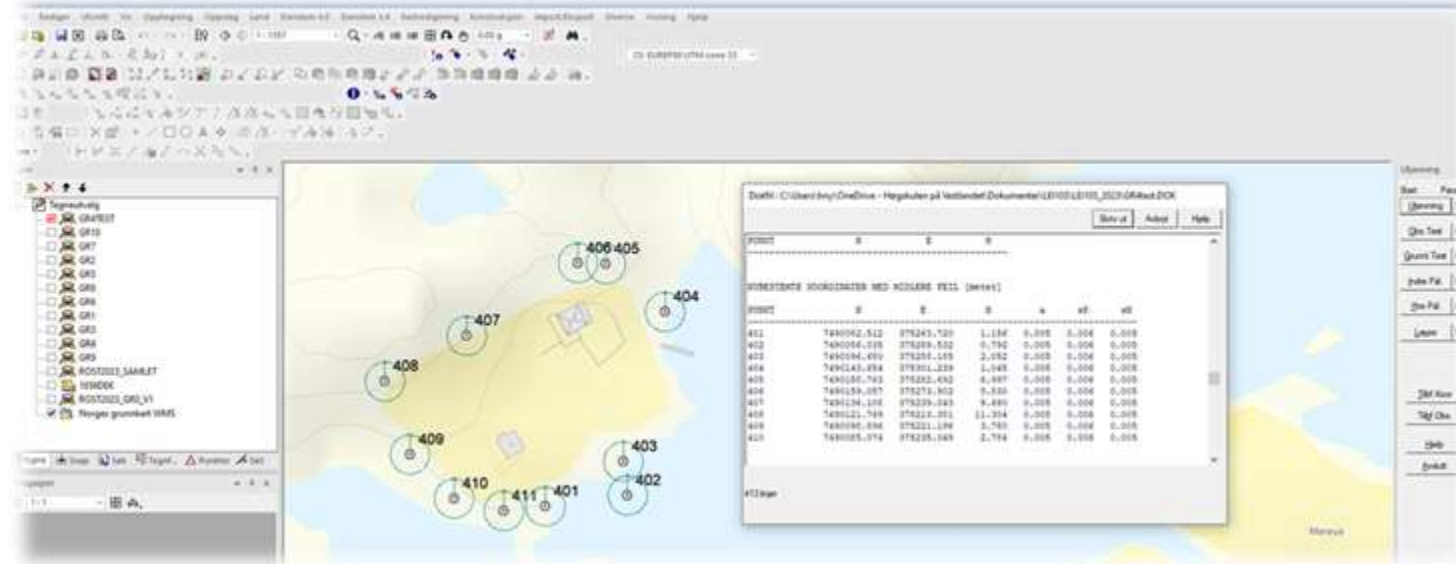
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Demands: Surveying and computation procedure

- Control measurement in known position
- Measure each point 3 times
 - At least 15 min between two measurements of the same point
- Import all measurements in surveying software package
- Test against blunders
- Adjustment with reliability analysis



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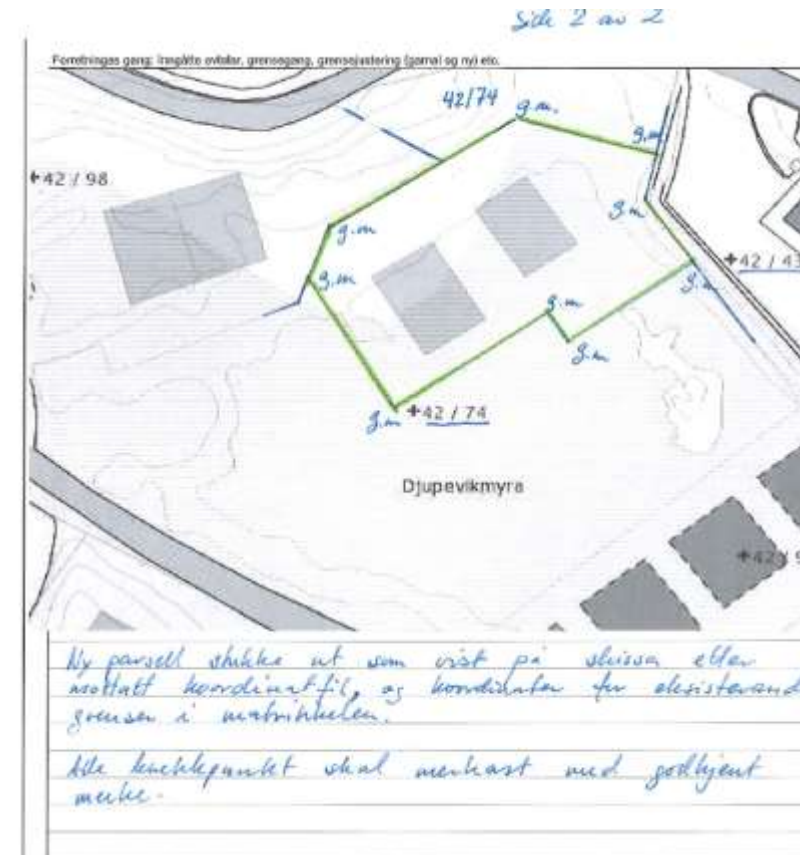
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Demands: Data delivery

- Official coordinate system: ETRS89-UTM
- Data format: SOSI
- Point objects with attributes
- Line object with attributes
- Polygon objects with attributes
- Protocol from the survey



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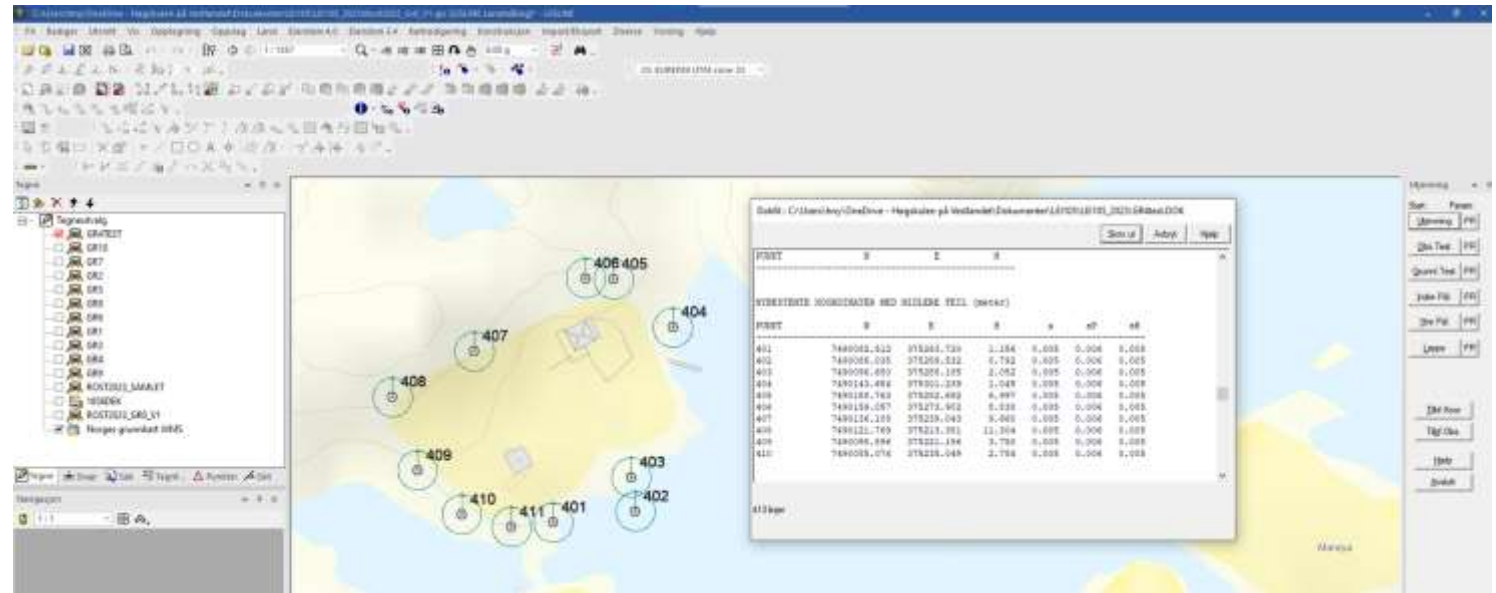
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Reasons for simplification

- A huge amount of unmapped and poorly mapped properties
- Time consuming survey
- Expensive and complicated software
- Black box computation which is also sub-optimal



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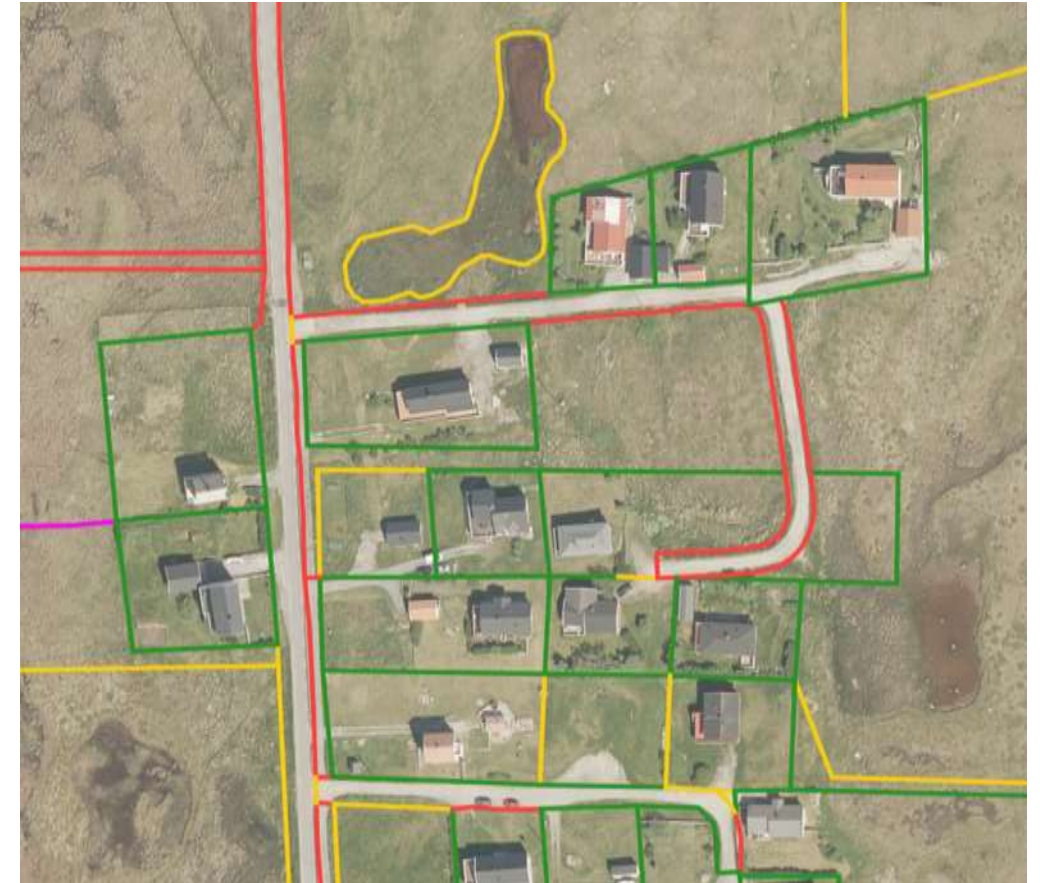
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Simplified surveying

- Each point only measured once with RTK-GNSS
- Visual control, comparing with aerial image
- Saving time



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Registration of accuracy

- Why
 - How big circle around the staked-out coordinates is needed to be sure it contains the surveyed boundary point?
 - Re-installing boundary marks that have disappeared
 - How accurate is the parcel area?



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Low-cost equipment

- ~ 2000 euros + subscription
- Emlid Reach RS2
- Trimble Catalyst DA2
- Smartphone



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Low-cost software:

- [QGIS](#) is the main software
- Free QGIS-based smartphone-apps for surveying
 - [MerginMaps](#)
 - [Qfield](#)
- [GnssCad](#) is a self-developed open-source QGIS plugin for cadastral computations, data-handling and cadastral mapping
- [Anaconda](#) is the opensource environment that provides the tools to develop GnssCad with Python



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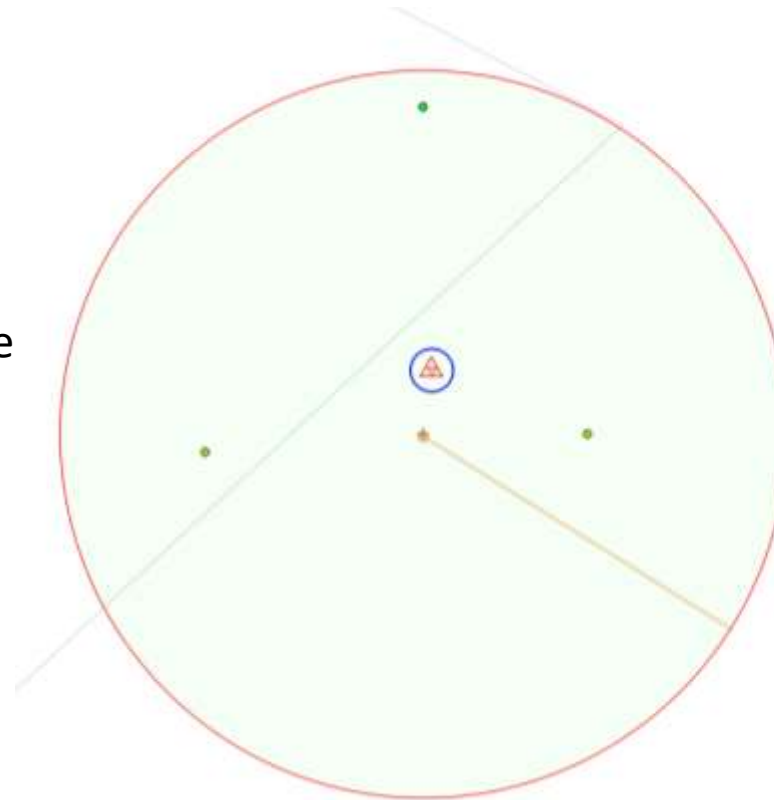




Adjustment

- How to detect blunders?
 - Set limit for distance to median
 - 3 observations is a very small sample, a statistical test may be undertaken, but the strength of the test will be very low

- Gain
 - Less sophisticated software
 - More understandable method
 - More understandable reports
 - Result shows factual accuracy



x	y	Segments (meters)
375015,213	7491602,591	
375813,230	7491602,580	0,020

Total: 0,020 m meters

Cartesian Ellipsoid

Info

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Layers

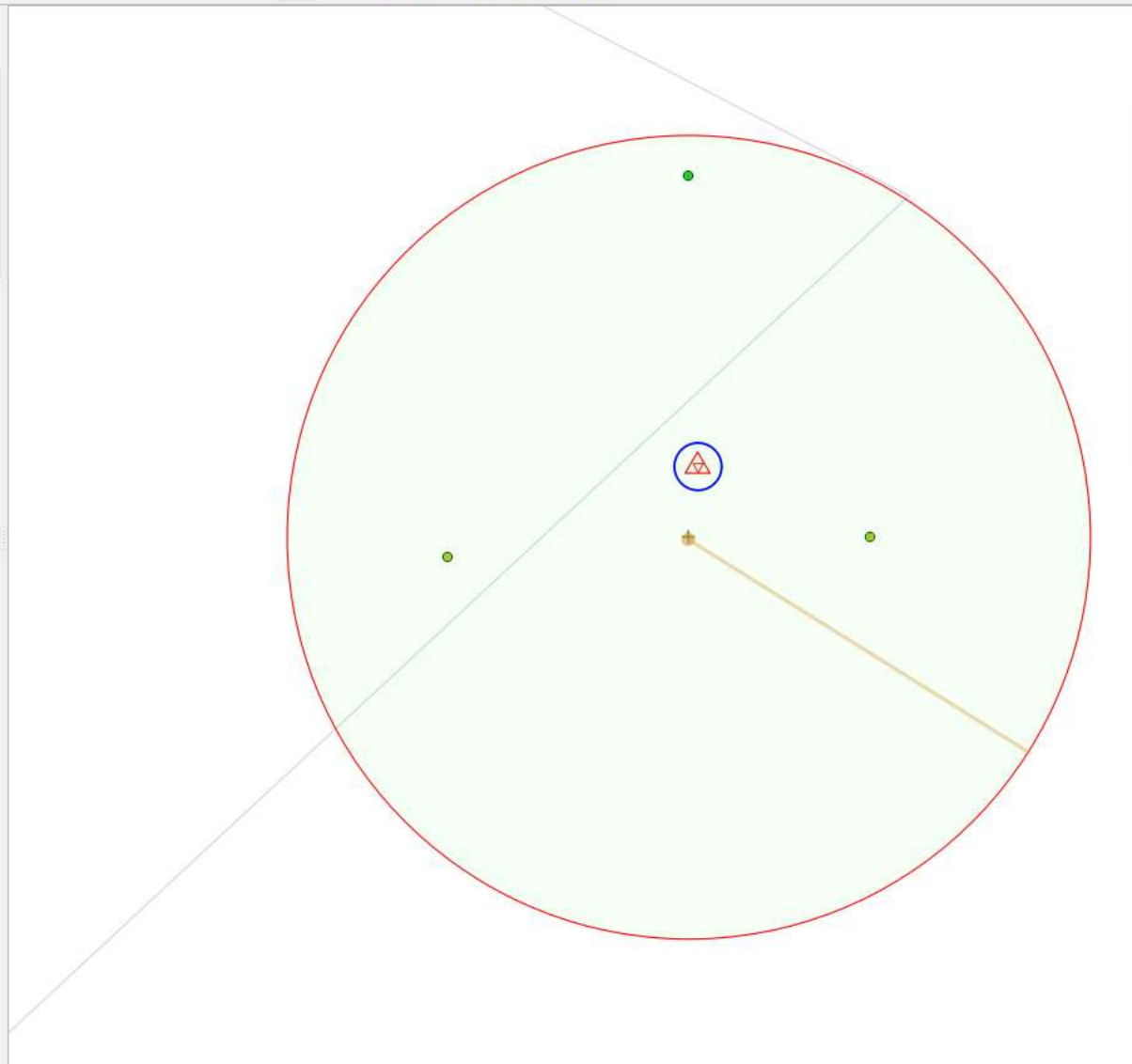
- ImportedKOF
 - 0 - 1,36
 - 1,36 - 1,52
 - 1,52 - 2
 - 2 - 3
 - 3 - 4,5
 - MedianPoints
 - AdjustedPoints

QGIS Cloud

Maps Upload Data Account About

Server:

Databases



Measure

x	y	Segments [meters]
375815,213	7491602,591	
375815,230	7491602,580	0,020

Total: meters

Cartesian Ellipsoidal

Info



Reliability analysis

- To quantify the reliability of the result, we calculate the possible effect of eventual remaining blunders
- No need for this when only point observations are present
- Provides no further insight

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Problems and disadvantages

- Synchronization with Qfield Cloud
- Differences in smartphone behaviour
- Estimated accuracy not passed on to iphone
- Project settings management not possible on smartphone
- Making new layers and projects on the phone

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Limitations of this research

- Untrained and to some extent unprepared students as surveyors
- Open landscape only
 - High-end antennas may perform better in difficult environments, especially with tilt-sensor
 - But the Emlid receiver has shown quite impressive performance between tall buildings in Bergen



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Conclusions

- The proposed methods have given good results
- The standard for cadastral surveying in Norway will probably remain focused on following procedures
- These procedures must, when needed, be updated to fit the possibilities and limitations of the current technology
- For cadastral surveying to be fit-for-purpose in Norway, the purpose and legal state of the cadastral map must be clearly defined.

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