UNIVERSITY OF TWENTE.

TOWARDS UAV-BASED LAND TENURE DATA ACQUISITION

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MOTIVATION

"75% of the world's population do not have access to formal systems to register and safeguard their land rights."

(Enemark et al. 2014)

"At current rates it would take decades, or even centuries, to deliver more complete levels of registration in many countries"

(Zevenbergen et al. 2013)

ITS4LAND

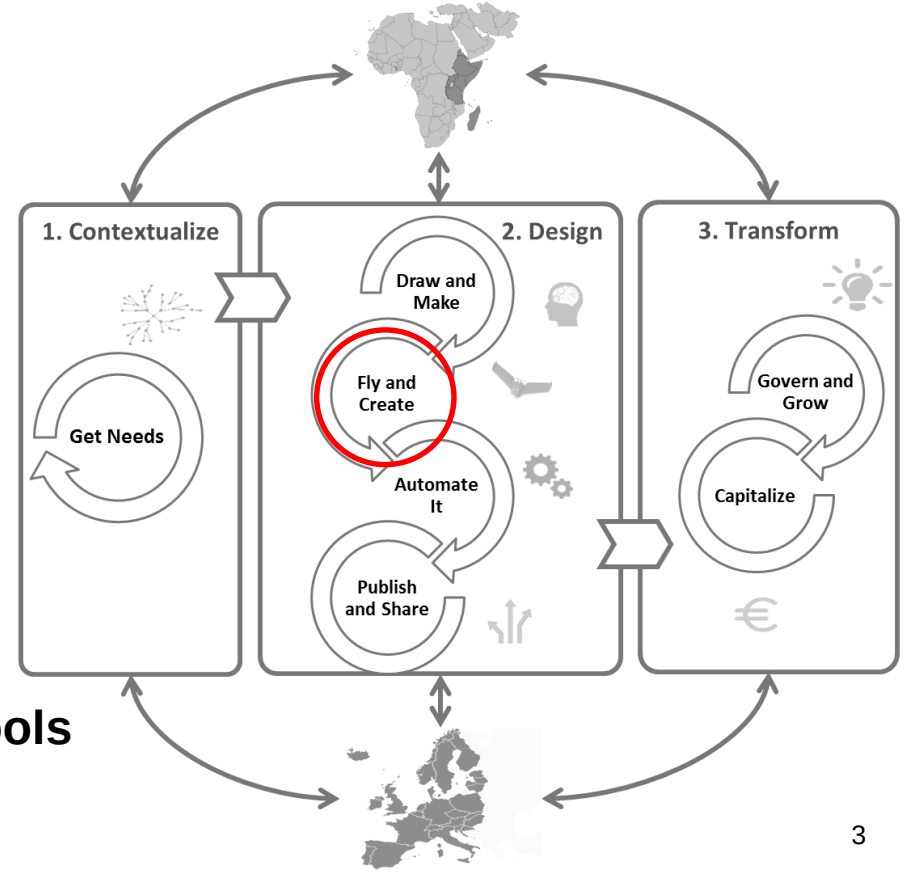
Program: EU granted H2020-ICT-2015

Start date: 2016-02-01

Duration: 48 months

Consortium: 8 partners

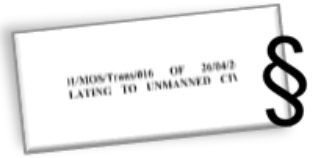
Objective: **Development of an innovative suite of land tenure recording tools**



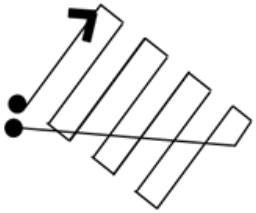
FLY AND CREATE

UAV

UAV pilots

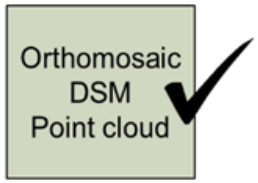


Flight permission



Flight planning

Data acquisition



Data processing

PLATFORM DT18 PPK

delair-tech
AIRBORNE SENSORING

- 2 kg
- 1.20m long, 1.80 wingspan
- 1h of flight autonomy

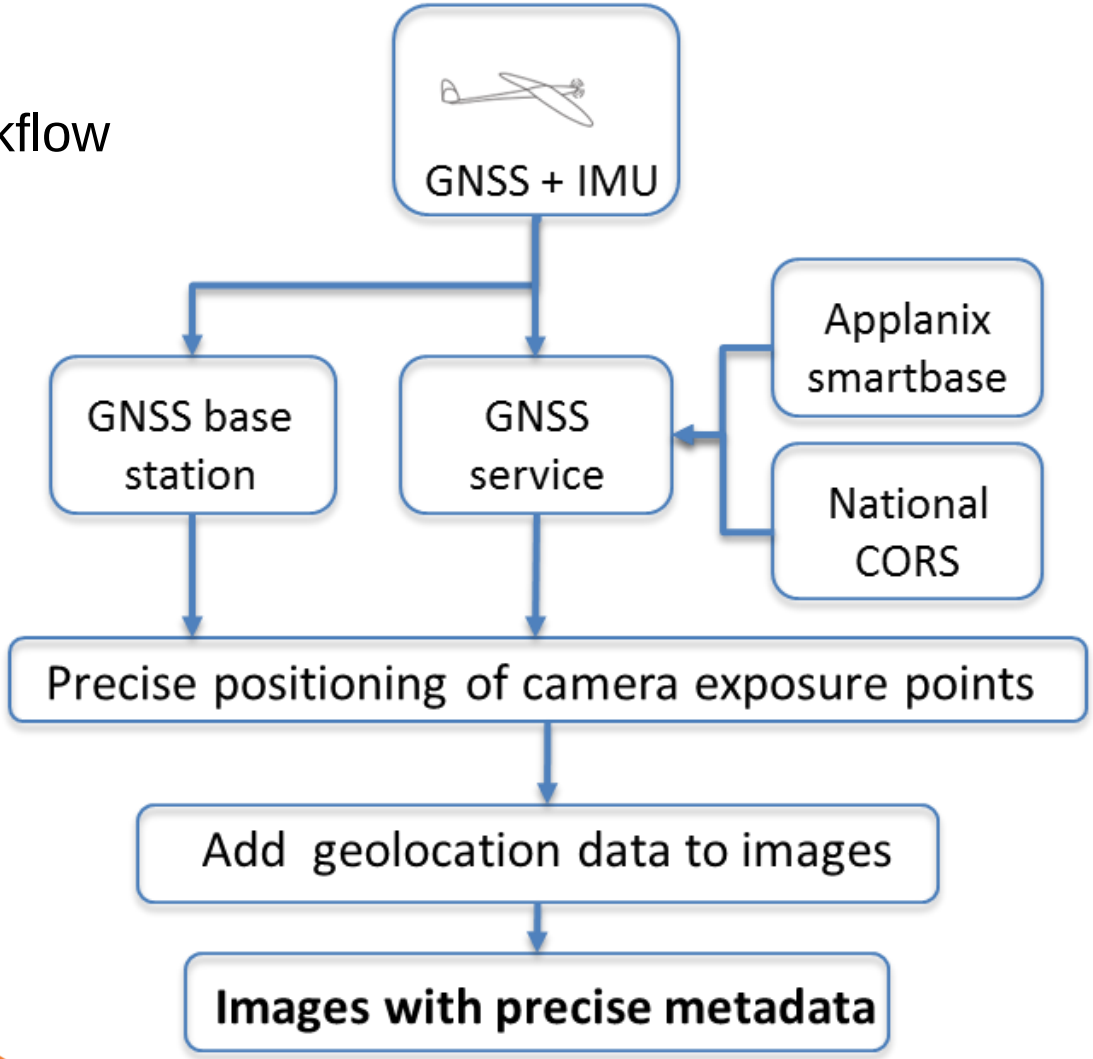
Payload:

- RGB sensor
- IMU/GNSS: Applanix APX-15

Trimble

PLATFORM DT18 PPK

Post-processing workflow

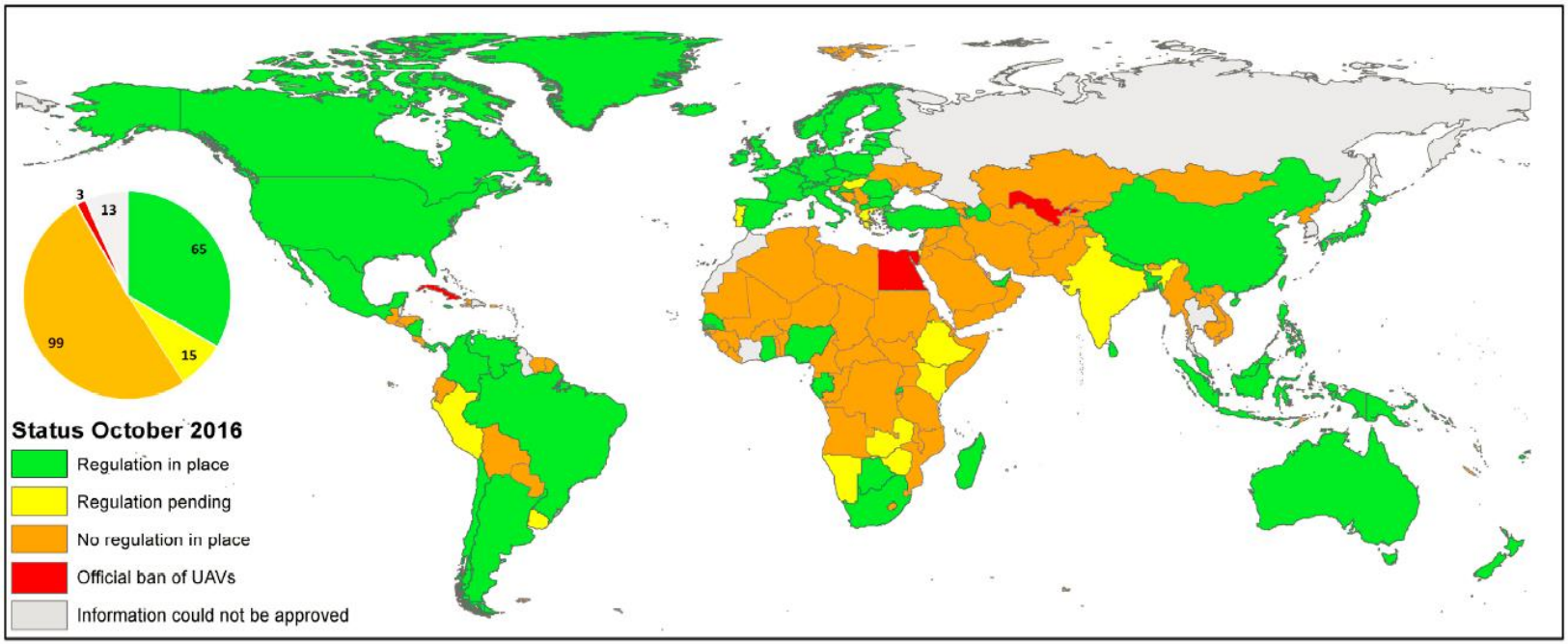


PILOTS

Two pilots for each UAV in all East African partners (5 day training)




LEGISLATION



- 1/3 of all countries have UAV regulations in place
- Distinct heterogeneity of national rules and different level of implementation

LEGISLATION

Key aspects they address in common are:

- Use of airspace by UAVs
- Operational limitations
- Administrative procedures of flight permissions, pilot licenses and data collection authorization

Significant impact on **how**, **where**, and **when** data can be captured

UAV MAPPING

What is important?

- Reliable and geometrically correct representation of the surface (true orthophoto)

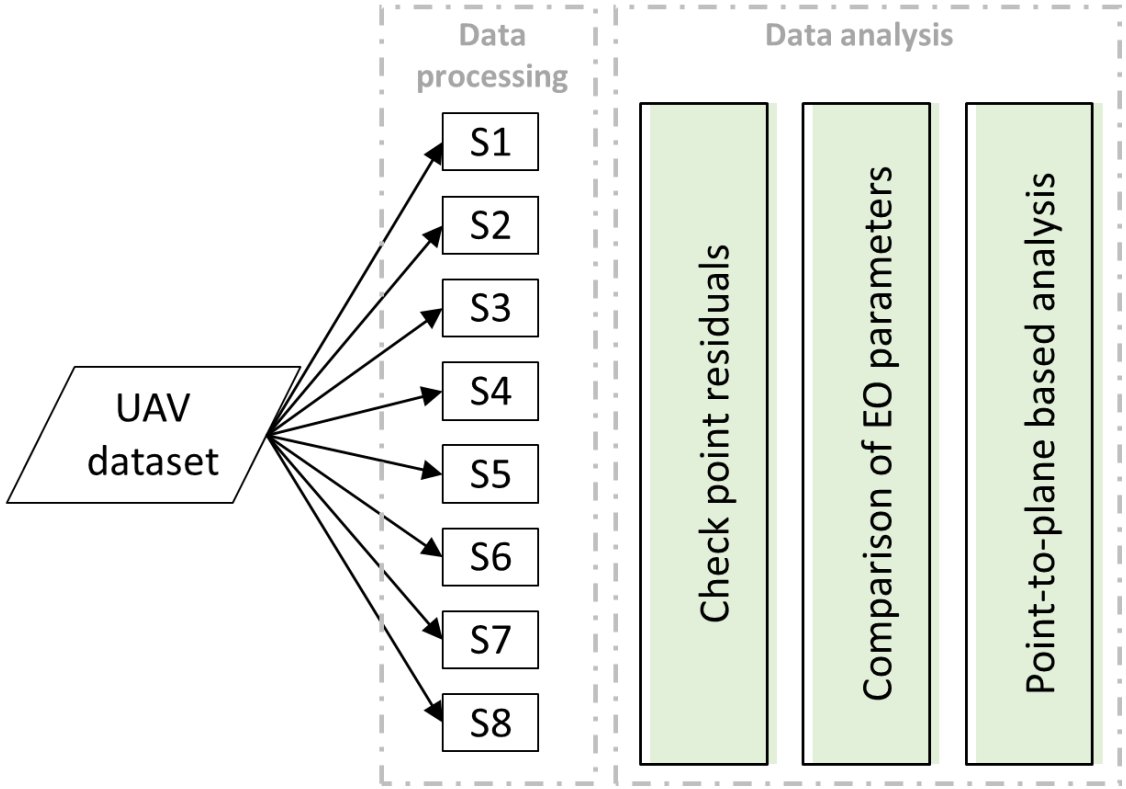
Challenge:

- How to minimize time consuming deployment and measurements of ground control points (GCPs)?

EXPERIMENTAL DATA PROCESSING

Evaluation of geometric accuracies to derive the potentials of direct georeferencing with post-processed IMU-GNSS data

One dataset processed with 8 different settings (GCPs,num. on/off PPK)

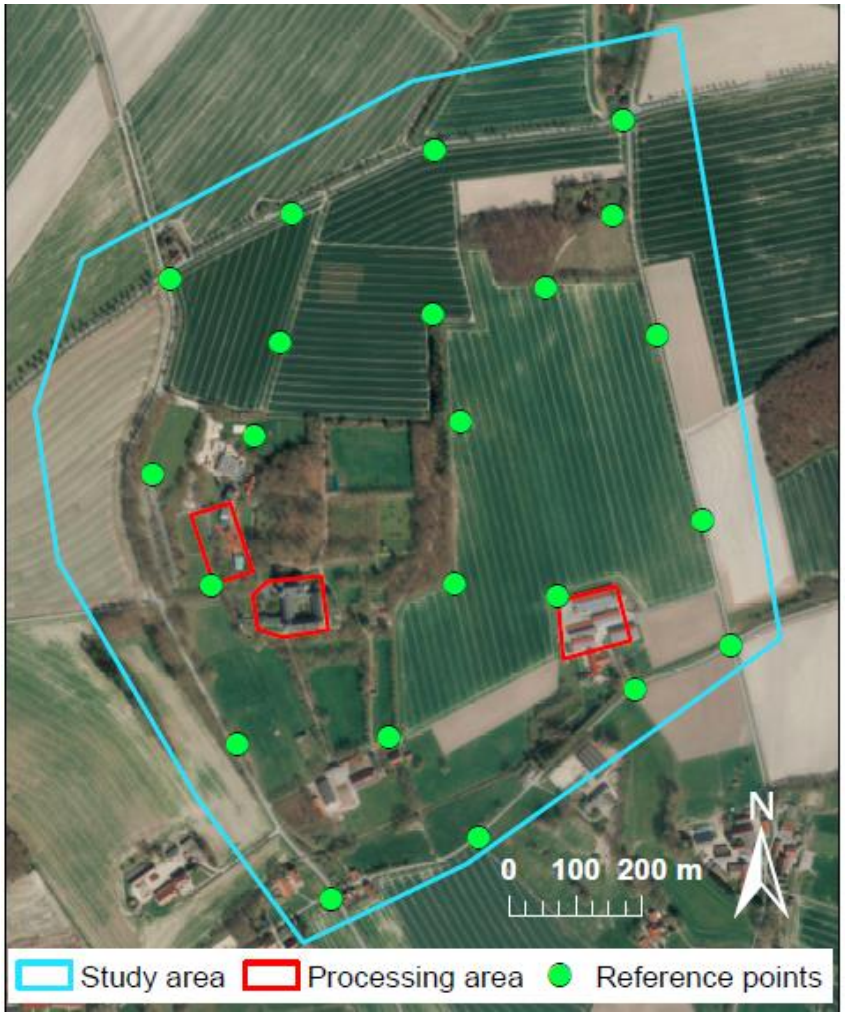


EXPERIMENTAL DATA PROCESSING

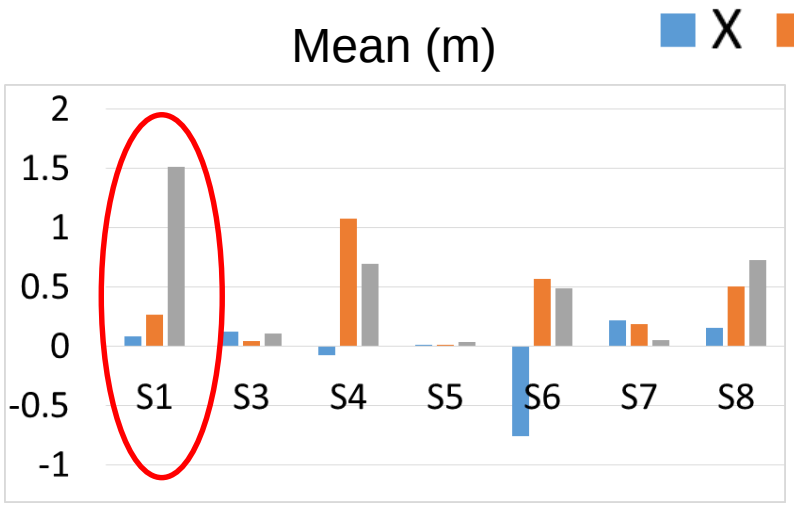
Scenario	EO data	EO parameters: assigned weight for image orientation		GCPs	CPs
		X,Y,Z	Ω,Φ,K		
S 1	none	-	-	18	4
S 2	none	-	-	4	18
S 3	raw	high	low	4	18
S 4	raw	high	high	4	18
S 5	PPK	high	low	4	18
S 6	PPK	high	high	4	18
S 7	PPK	high	low	0	22
S 8	PPK	high	high	0	22

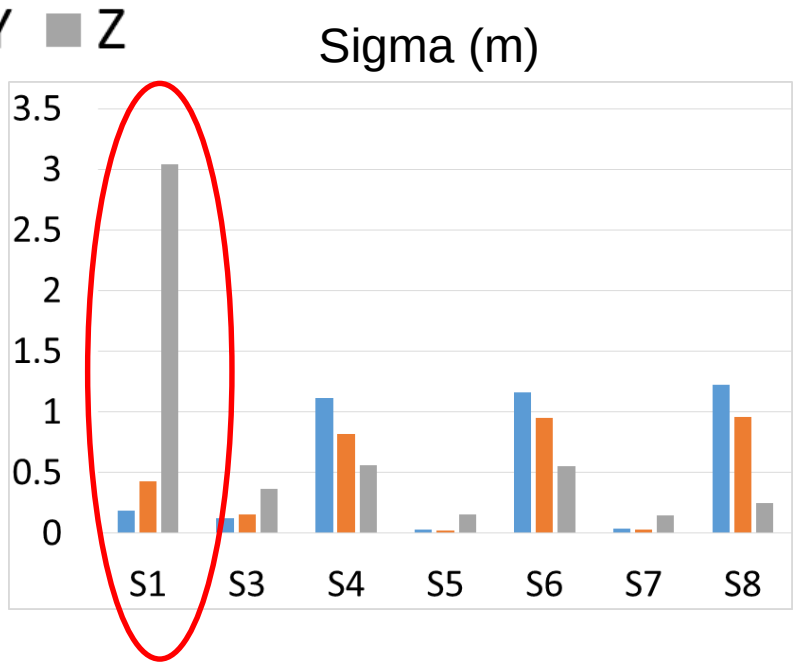
EXPERIMENTAL DATA PROCESSING

Test area in Germany



EXPERIMENTAL DATA PROCESSING

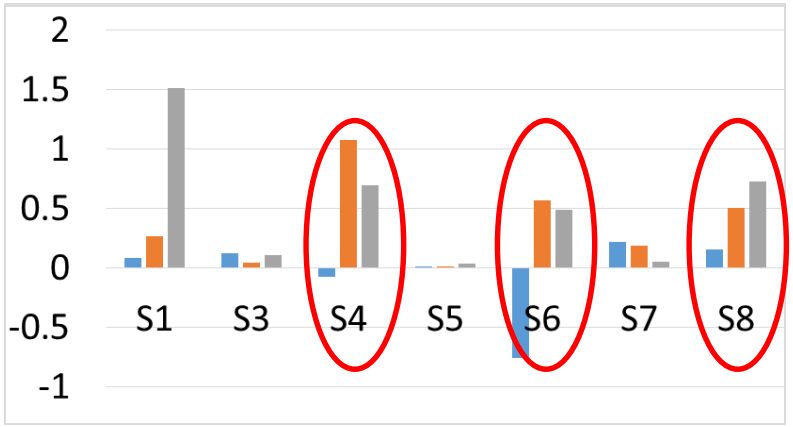




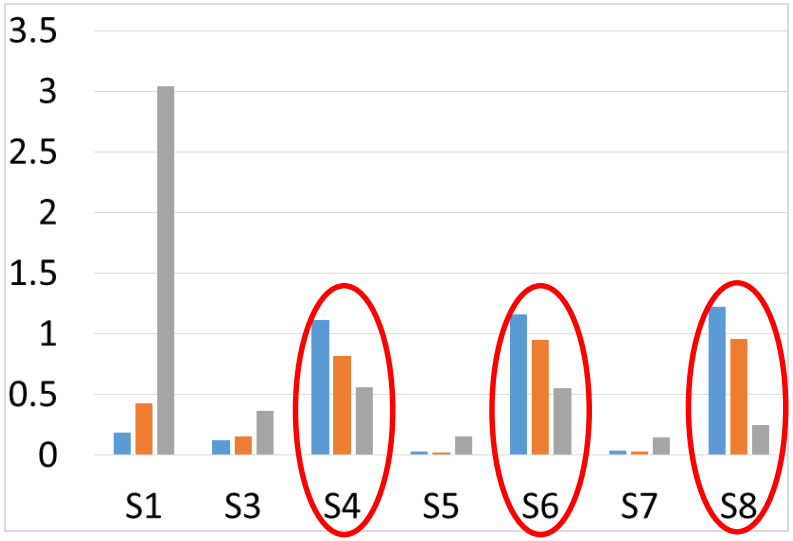
- S2 showed a height offset of more than 9 m and is not considered for graphical representation
- S1 and S2 → significant difference of z-values

EXPERIMENTAL DATA PROCESSING

Mean (m)



Sigma (m)

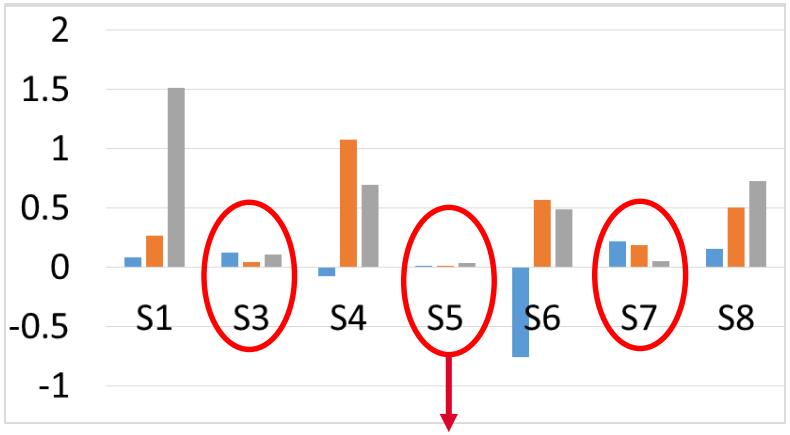


The effect of the assigned weight of the angular observations:

- High weight → similar pattern in sigma results

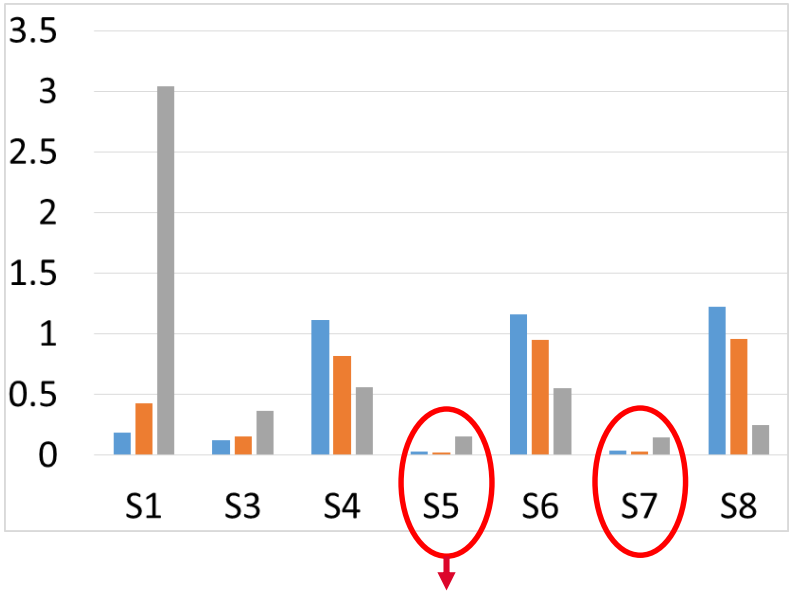
EXPERIMENTAL DATA PROCESSING

Mean (m)



X: 0.003 cm
Y: 0.081 cm
Z: 3.266 cm

Sigma (m)



X: 3.187 cm
Y: 2.431 cm
Z: 1.525 cm

- PPK option (S5 and S7) shows large improvements of the block stability
- S5-best performance – lowest sigma value

We proved that with PPK we can minimize the number of measured GCP – to 4 in the corners

TEST FLIGHT IN RWANDA

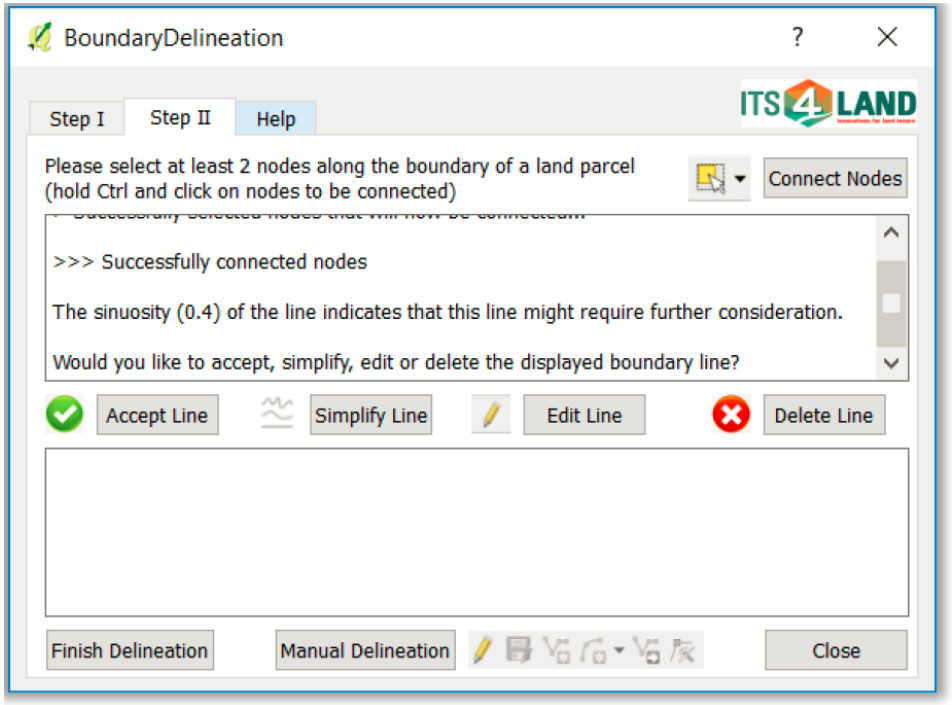
High
(GSD

BOUNDARY DELINEATION

- Community mapping

BOUNDARY DELINEATION

- Semi-Automatic Feature Extraction



Crommelinck, 2017

CONCLUSION

- Collection of reliable data for cadastral applications
- Minimized need for ground measurements
- Pending flight permissions

Looking ahead: Proof-of-concept in Rwanda, Kenya and Ethiopia

REFERENCES

Enemark, S., 2014. Fit-for-purpose land administration.

Crommelinck, S., 2017. QGIS Python Plugins Repository: BoundaryDelineation.http://plugins.qgis.org/plugins/BoundaryDelineation/ (13 June 2017).

Stöcker, E.C., Bennett, R.M., Nex, F.C., Gerke, M. and Zevenbergen, J.A., 2017. Review of the Current State of UAV Regulations. In: Remote Sensing: 9 (2017) 5, article no. 459, p.26

Stöcker, E.C., Nex, F.C., Koeva, M.N. and Gerke, M. (2017) Quality assessment of combined IMU/GNSS data for direct georeferencing in the context of UAV-based mapping. In: Proceedings of International Conference on Unmanned Aerial Vehicles in Geomatics, 4-7 September 2017, Bonn, Germany

Zevenbergen, J., Augustinus, C., Antonio, D., Bennett, R., 2013. Pro-poor land administration: Principles for recording the land rights of the underrepresented. Land use policy 31, 595–604.

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THANK YOU FOR YOUR ATTENTION

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