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Securing communal land-rights using Unmanned Aerial Vehicle imagery and Artificial Intelligence

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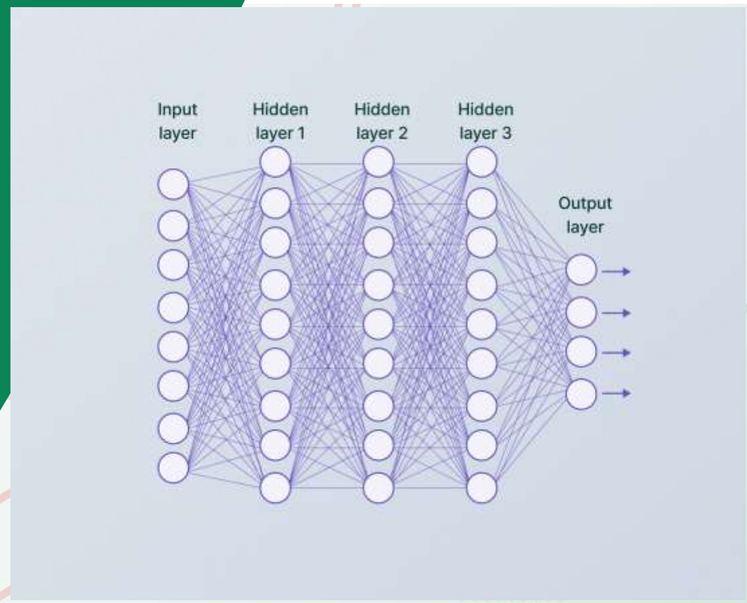
ORGANIZATION FOR WOMEN IN SCIENCE FOR THE DEVELOPING WORLD

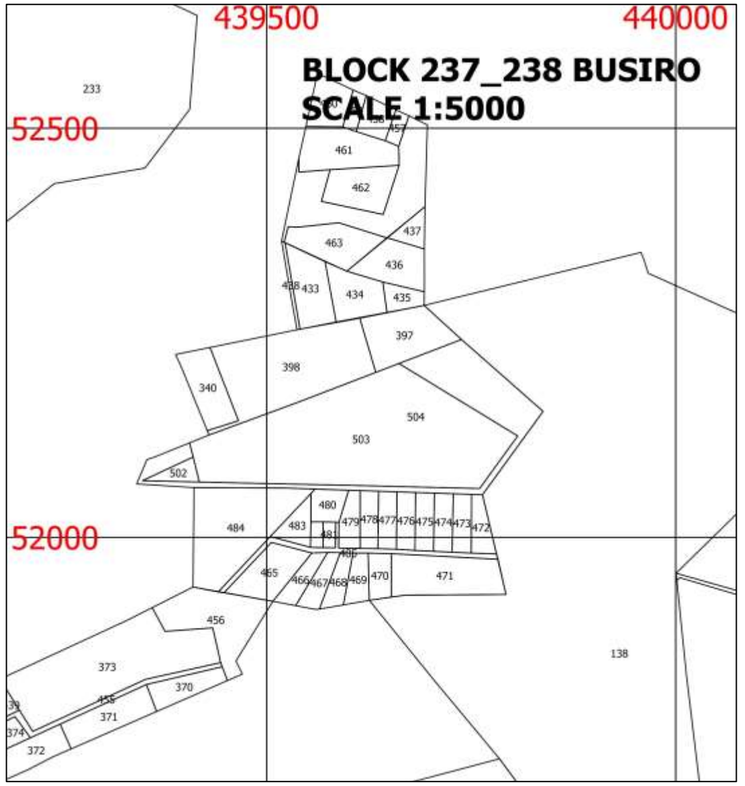
orthoimage

UAV

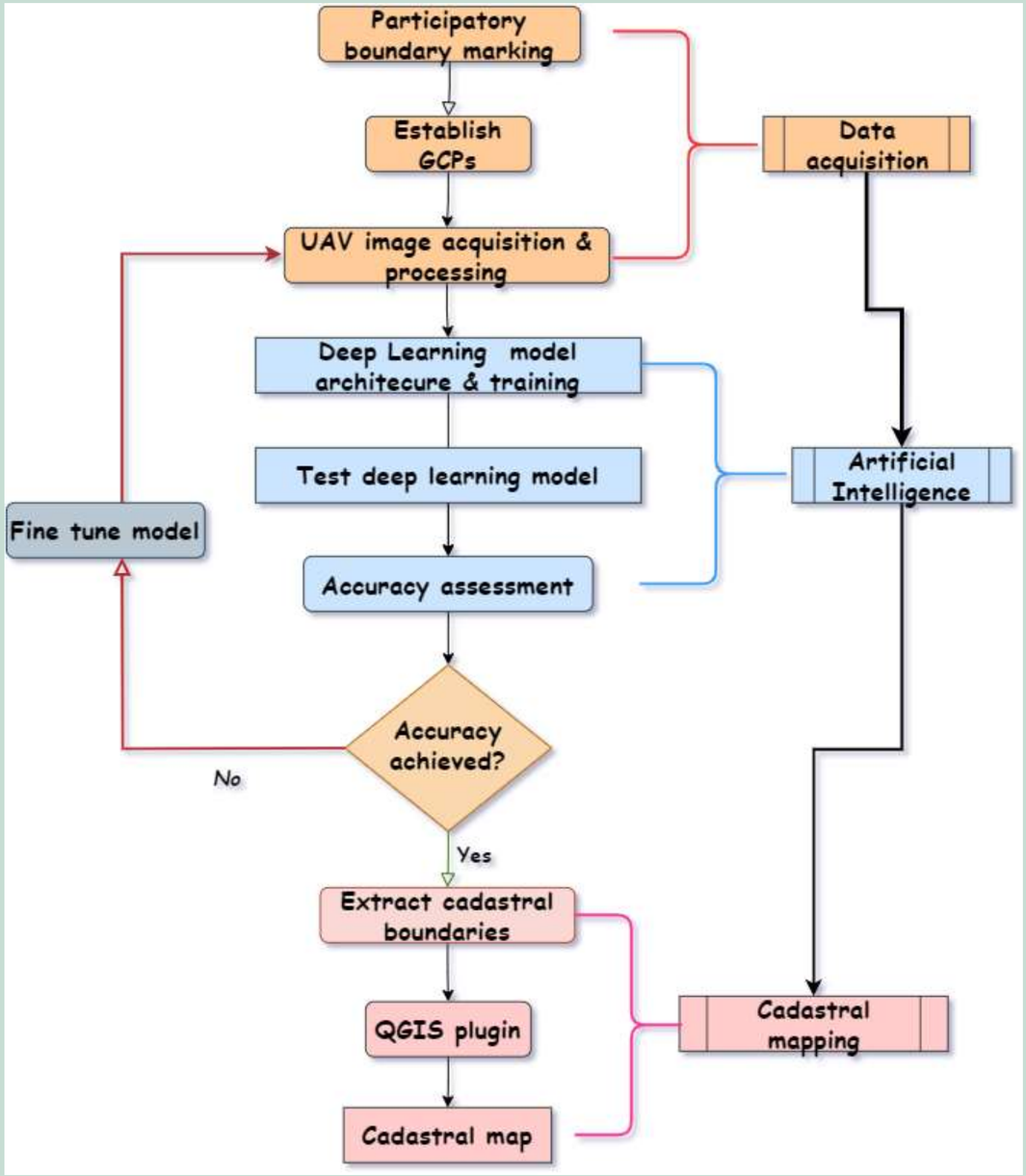
CNN



Cadastral map



Methodology



Data collection

community engagement

boundary marking

uav image acquisition

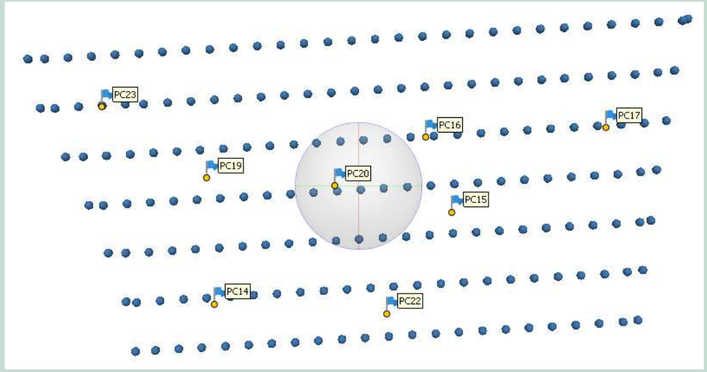
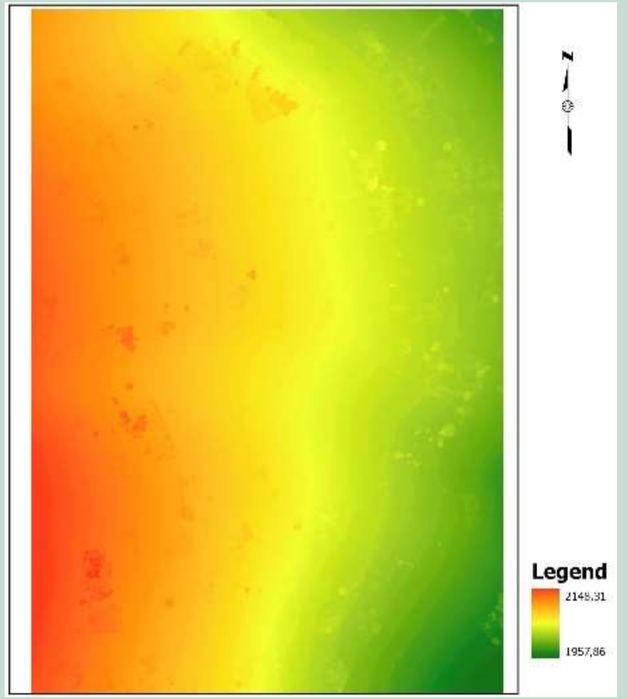


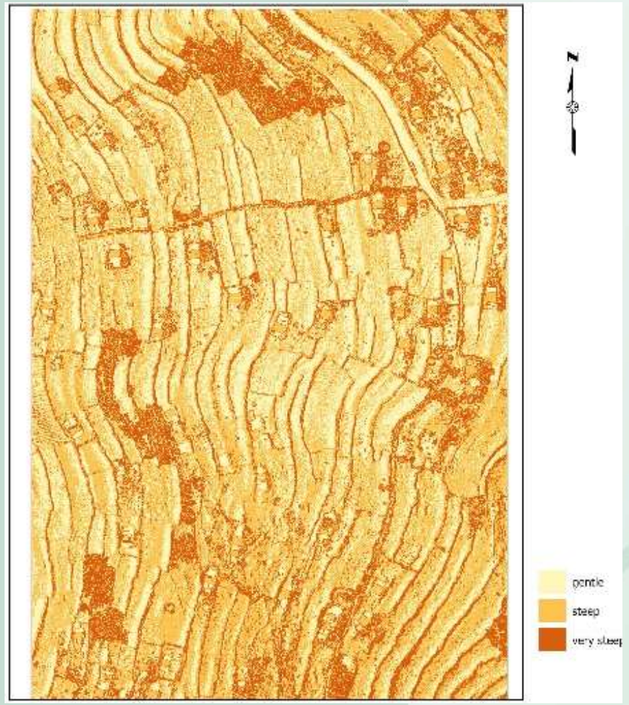
Image processing

image processing

*a) **orthoimage***

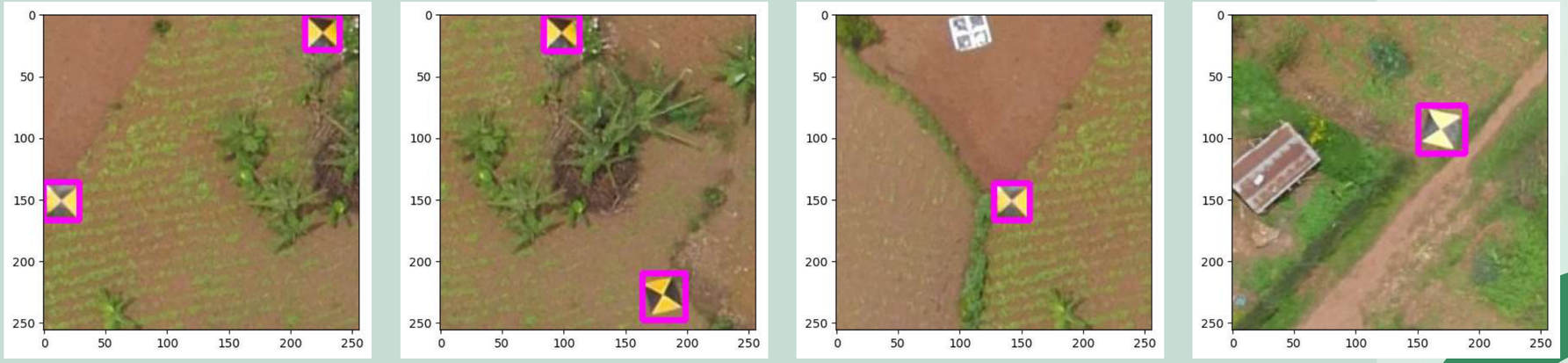


*b) **DEM***



c) Slope map

cnn model training



Training data

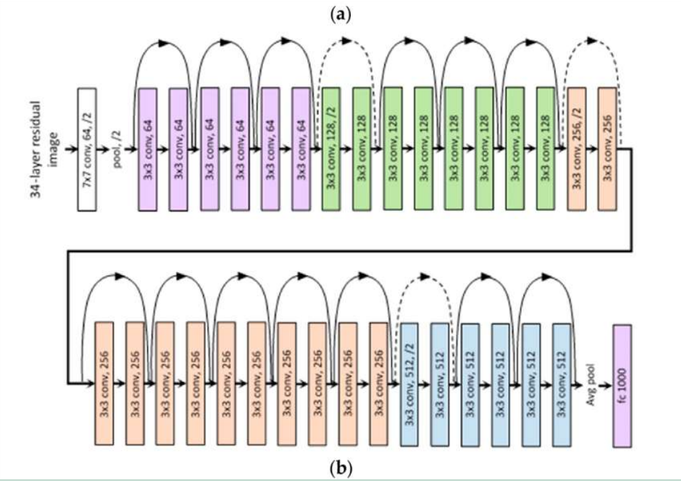
ML models

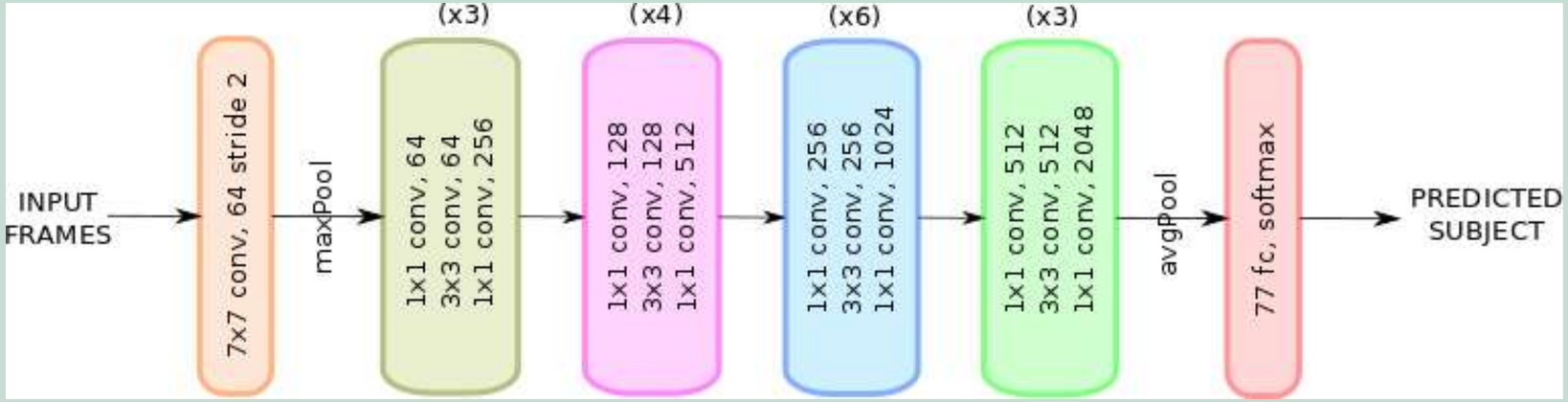
One stage CNNs

- SSD-ResNet34
- RetinaNet-ResNet34

Two-stage CNNs

- Faster R-CNN-ResNet34
- Mask R-CNN-ResNet50

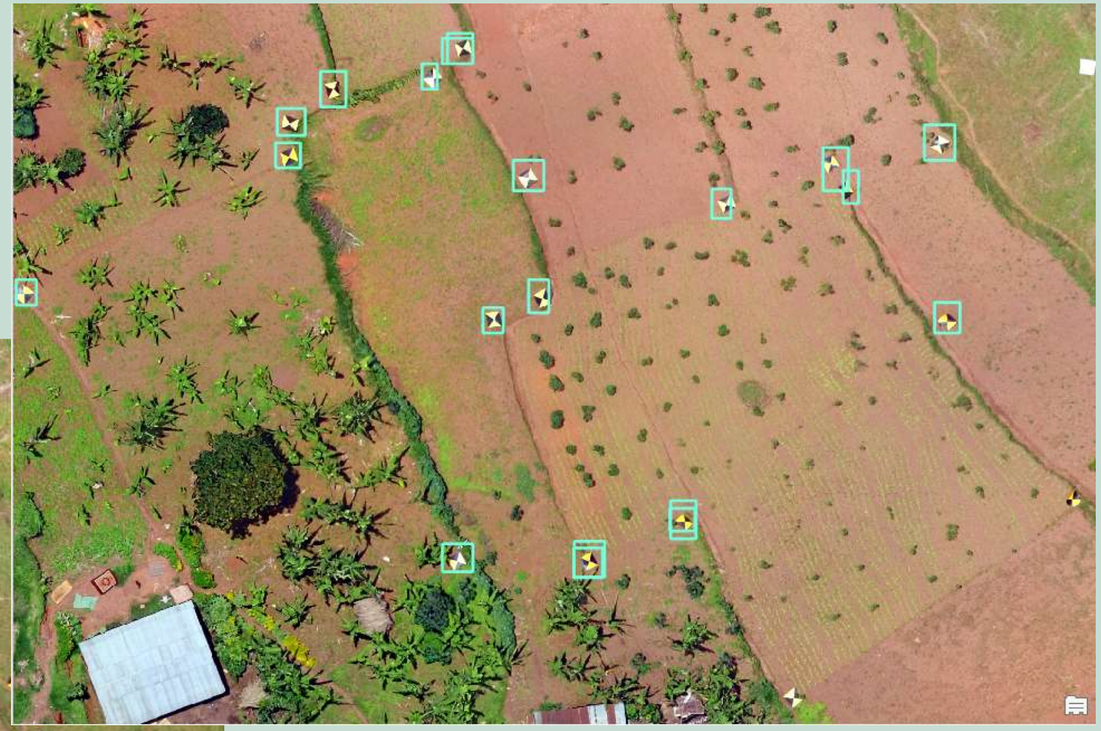




Boundary detection

Object detection

orthoimage

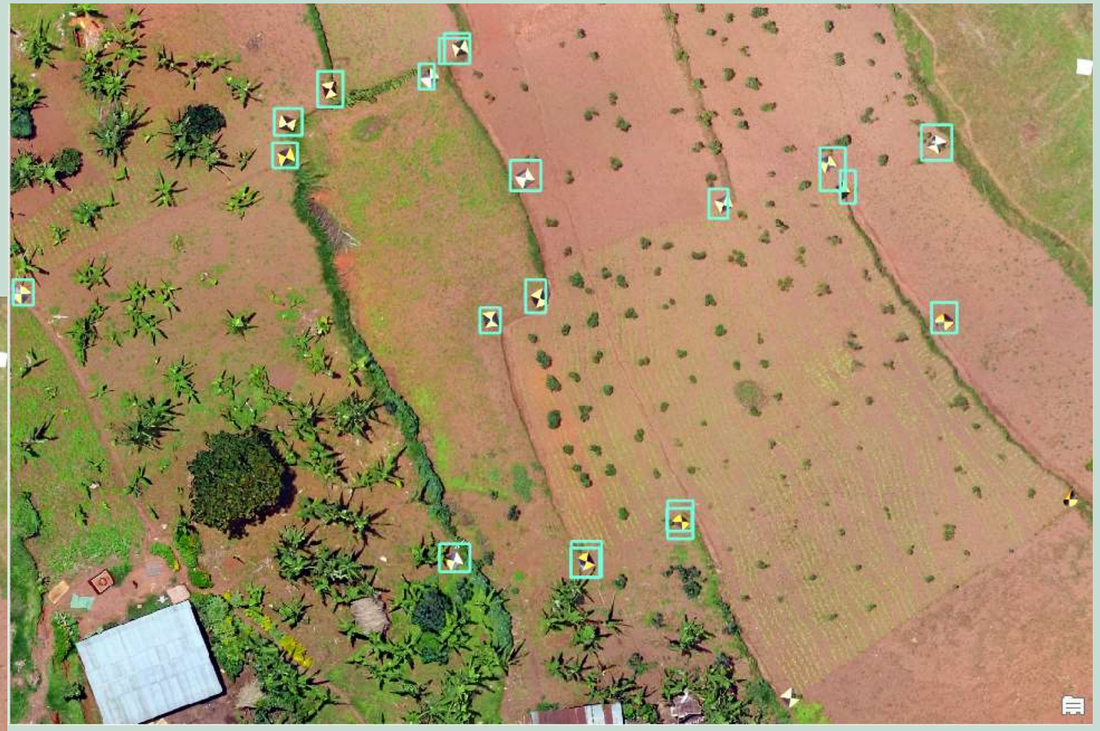


Object detection results

Boundary detection

Object detection

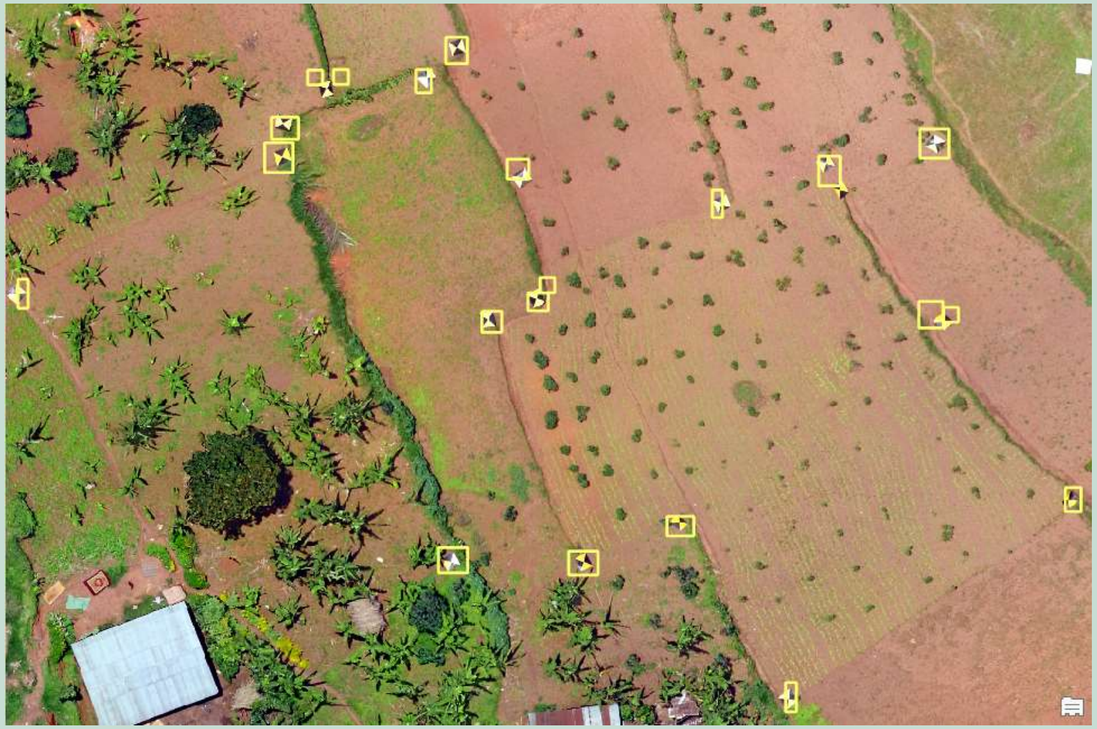
a) Object detection results - SSD

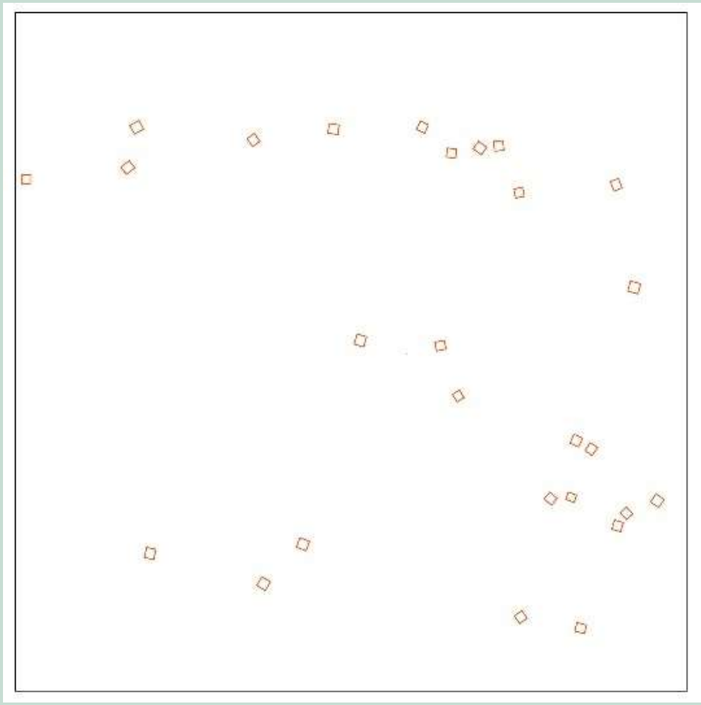


b) Object detection results – Faster R-CNN

Boundary detection

accuracy assessment





b) Ground truth data

Table 1 Accuracy assessment - SSD

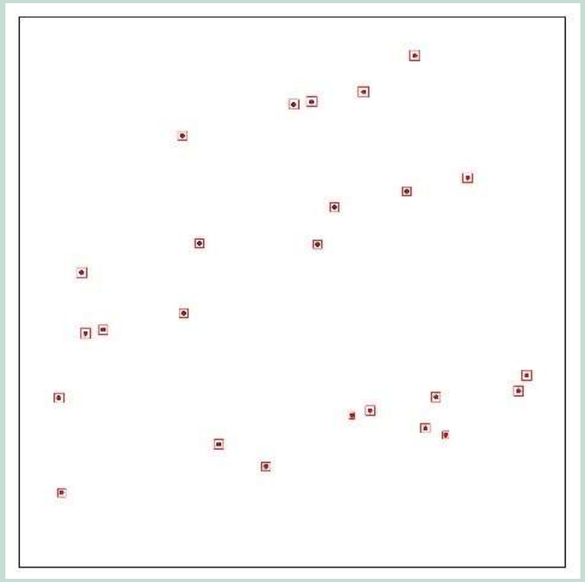
Backbone model	Precision	Recall	F1 score
Resnet34	0,88	0,93	0,91

Table 2 Accuracy assessment - RetinaNet

Backbone model	Precision	Recall	F1 score
Resnet34	0,99	0,99	0,99

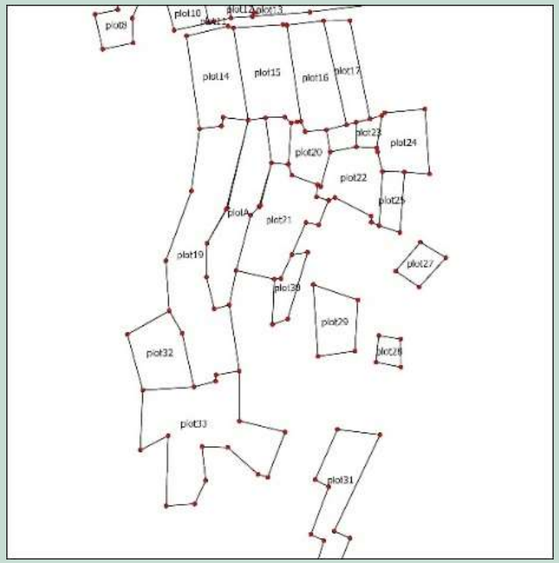
Cadastral mapping

a) Object detection results



b) Centroid of detected objects

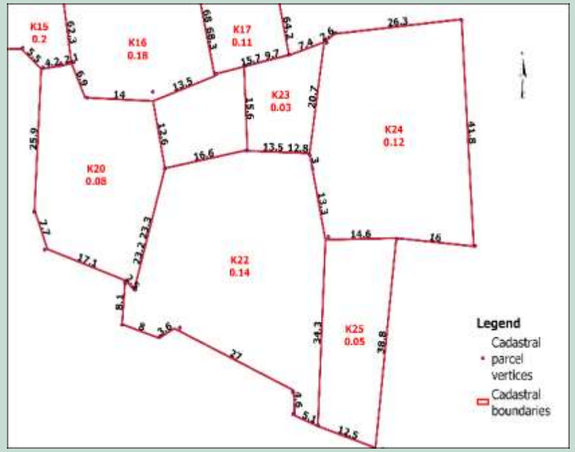
cadastral mapping



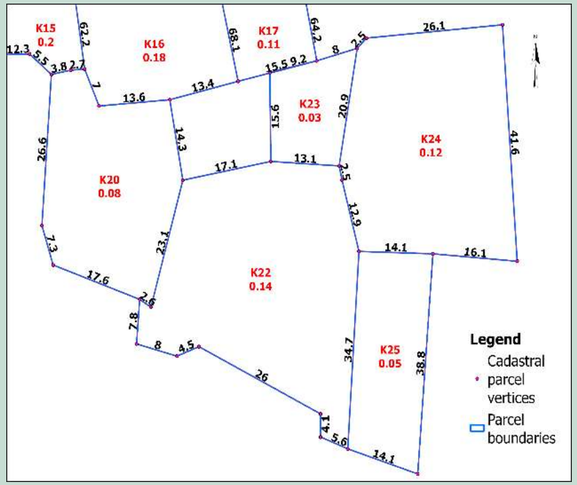
Cadastral mapping

Cadastral map validation

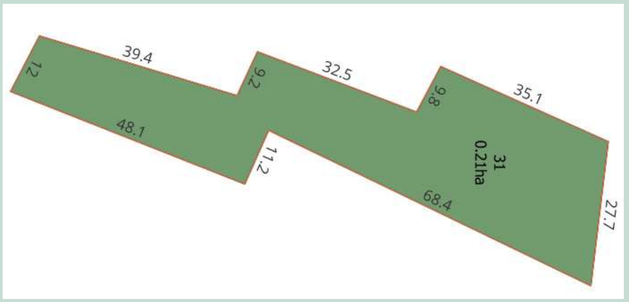
Cadastral map validation



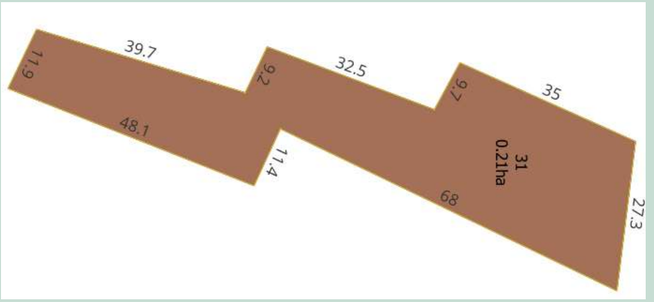
a) GNSS RTK



b) DL



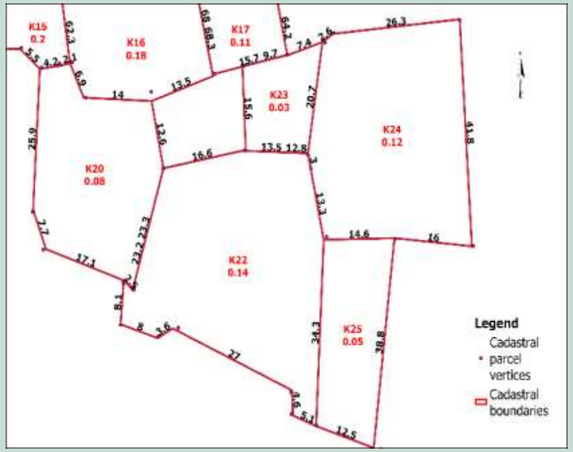
c) DL – cadastral map



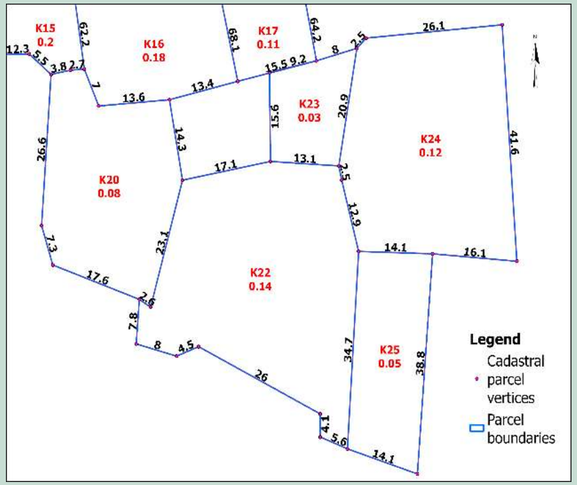
d) GNSS RTK – cadastral map

	DL coordinates			RTK coordinates					
Parcel ID	**Easting**	**Northing**	**Area (ha)**	**Easting**	**Northing**	**Area (ha)**	**ΔE**	**ΔN**	**linear error**
plot31	947.369	39.752		947.079	39.594		0.290	0.158	
plot31	917.690	-21.823		917.651	-21.654		0.039	-0.169	
plot31	927.955	-26.378		927.992	-26.451		-0.037	0.073	
plot31	910.270	-71.156		910.348	-71.17		-0.078	0.014	
plot31	899.650	-65.633		899.661	-66.01		-0.011	0.377	
plot31	911.044	-27.867		911.158	-28.022		-0.114	0.155	
plot31	902.672	-23.971		902.839	-24.014		-0.167	0.043	
plot31	914.181	6.437		914.239	6.41		-0.058	0.027	
plot31	905.488	11.061		905.730	11.049		-0.242	0.012	
plot31	919.835	43.088		920.001	42.989		-0.166	0.099	
plot31	947.369	39.752	**0.21**	947.079	39.594	**0.21**	0.290	0.158	
							-0.023	0.086	**0.089**
plot25	963.215	207.580		963.060	207.72		0.155	-0.140	
plot25	960.309	168.925		958.780	169.165		1.529	-0.240	
plot25	946.945	173.331		946.921	173.161		0.024	0.170	
plot25	949.086	208.001		948.477	207.415		0.609	0.586	
plot25	963.215	207.580	**0.05**	963.060	207.72	**0.05**	0.155	-0.140	
							0.494	0.047	0.496

Cadastral map& validation



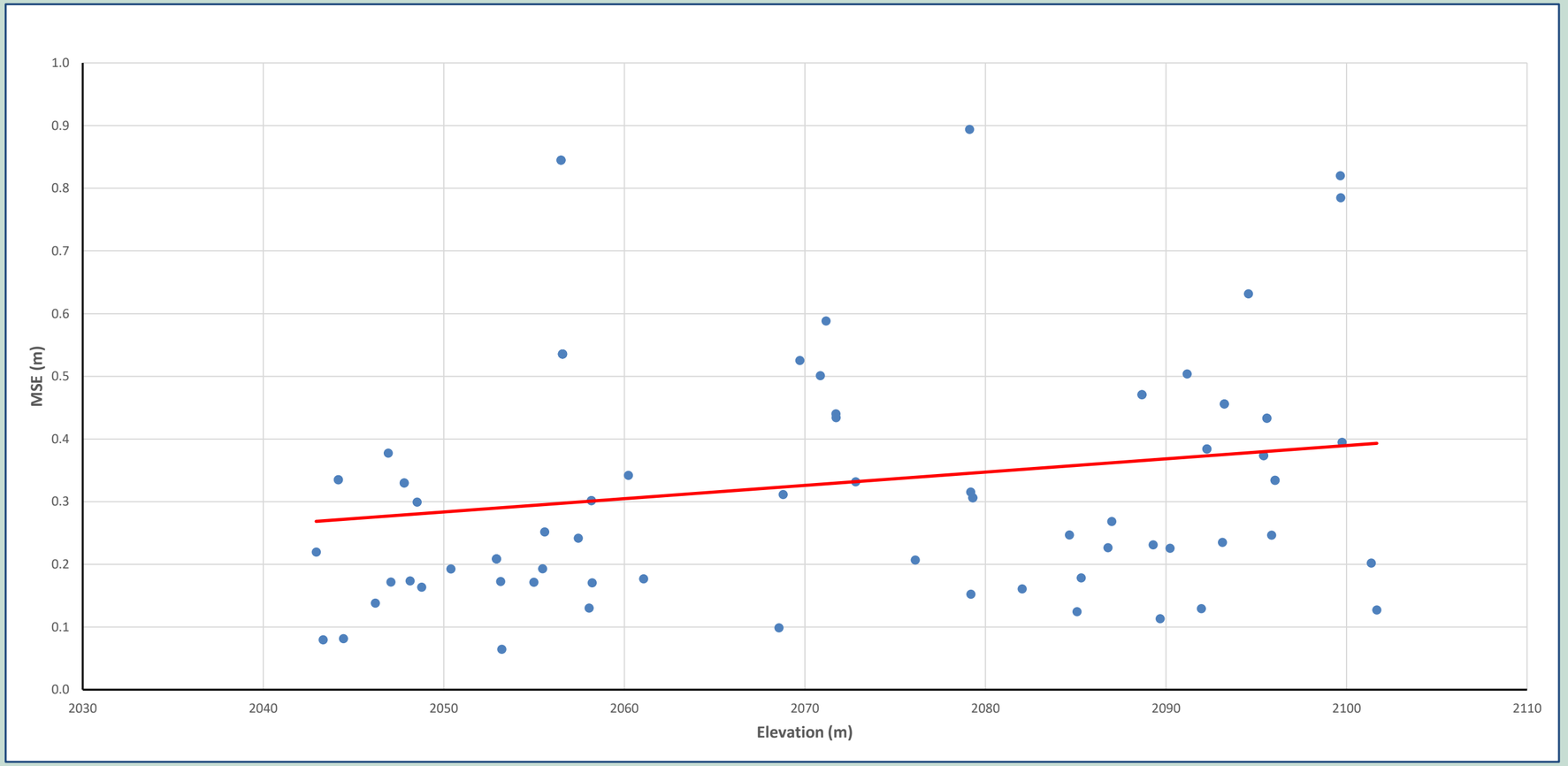
a) GNSS RTK



b) DL

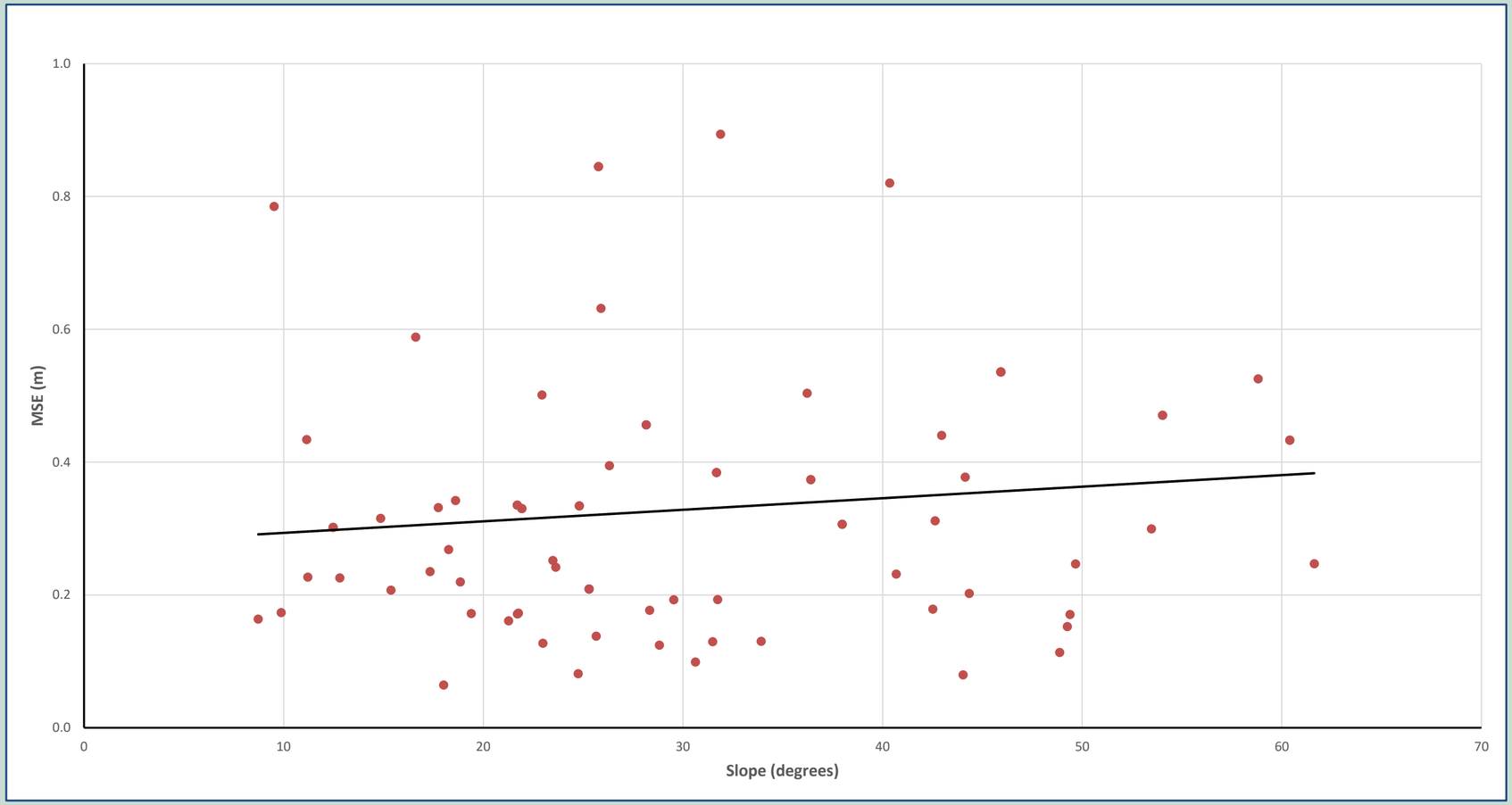
Parcel ID	Area (ha)	Horizontal error
plot4	0.02	0.302
plotB	0.02	0.348
plot5	0.02	0.435
plot23	0.03	0.194
plot28	0.03	0.226
plot27	0.05	0.185
plot12	0.05	0.343
plot25	**0.05**	**0.496**
plot30	0.05	0.210
plot2	0.06	0.347
plot11	0.07	0.264
plot10	0.07	0.319
plot20	0.08	0.160
plot3	0.10	0.450
plot17	0.11	0.182
plot24	0.12	0.267
plot1	0.14	0.309
plot22	0.14	0.156
plot32	0.15	0.119
plot16	0.18	0.399
plot14	0.19	0.361
plot15	0.20	0.262
plot31	**0.21**	**0.089**
plot33	0.41	0.176
	std	0.120

Cadastral data - analysis



Horizontal accuracy versus elevation of parcel boundary points

Cadastral data - analysis



Horizontal accuracy versus slope of parcel boundary points

THE END