

# Predicting topsoil organic carbon using UAV-based hyperspectral sensor

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# UAV system

Multicopter – sensor system:

CarbonCore Cortex X8 frame, Pixhawk 2 Cube FMU and Here+ RTK GPS  
Cubert UHD-185 (JPG + CUB) sensor

125 spectral bands covering 450-950 nm spectrum  
with 4 nm steps (stored in CUB files)

Raw resolution 50×50 px

1 panchromatic spectrum image (stored in JPG in  
greyscale)

Raw resolution 1000×1000 px

Pre-processing steps:

CUB -> TIFF

Pansharpening native hyperspectral bands with  
panchromatic band (optional)



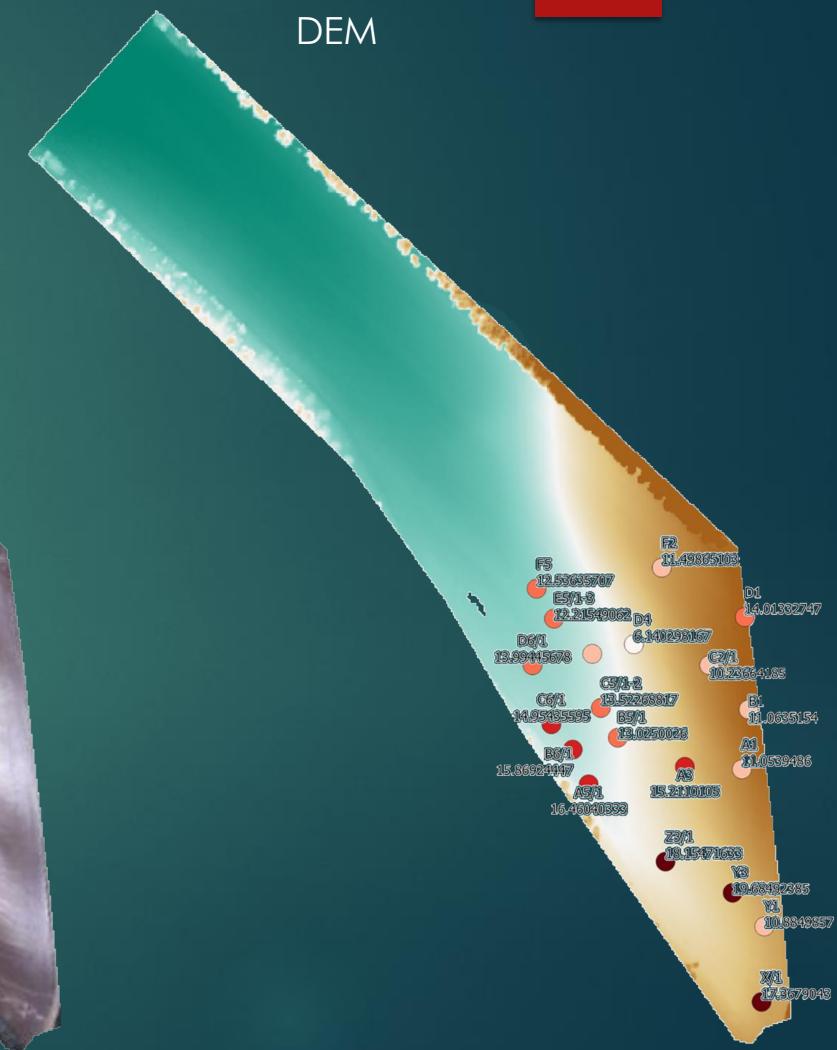
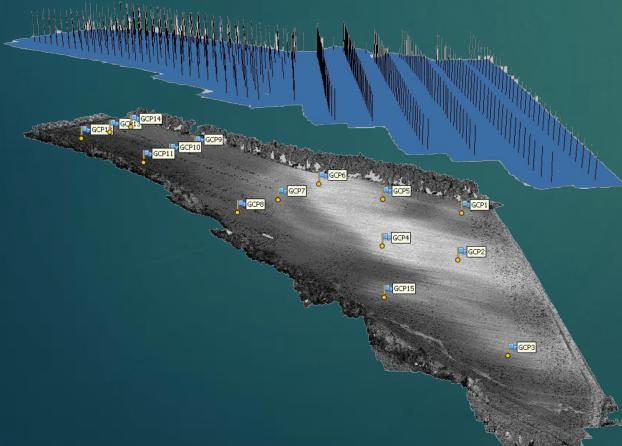


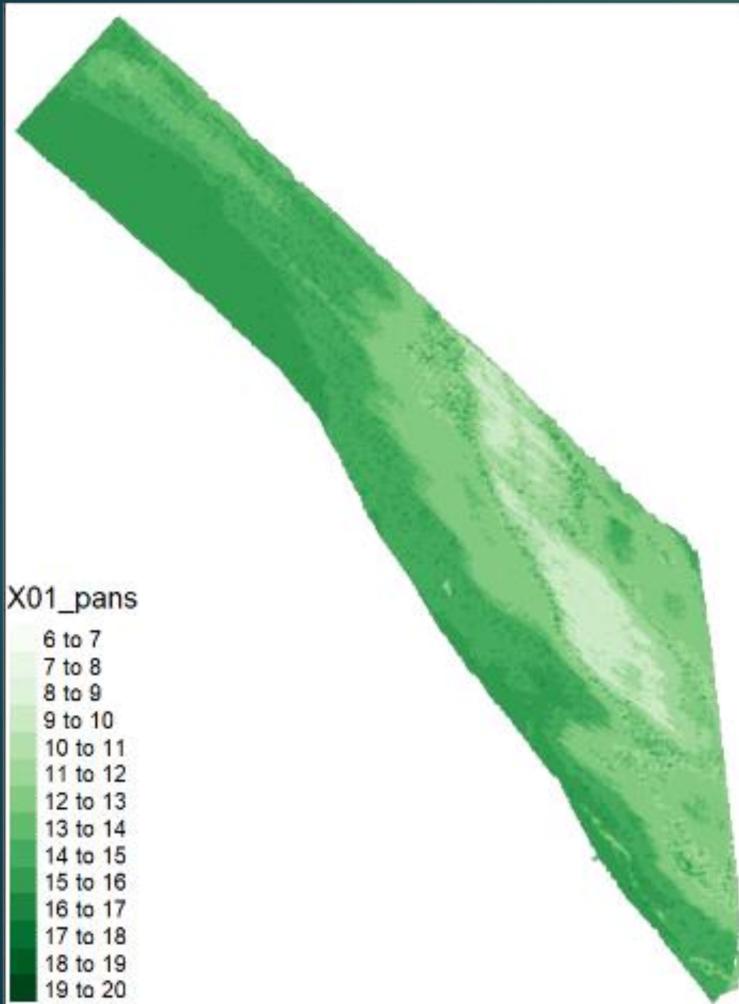
# Ceglédbercel – sample site



UAV survey carried out on cca. 10 ha area

Samples collected on the undulating slope part of the sample area





# Methods

**DSM:**

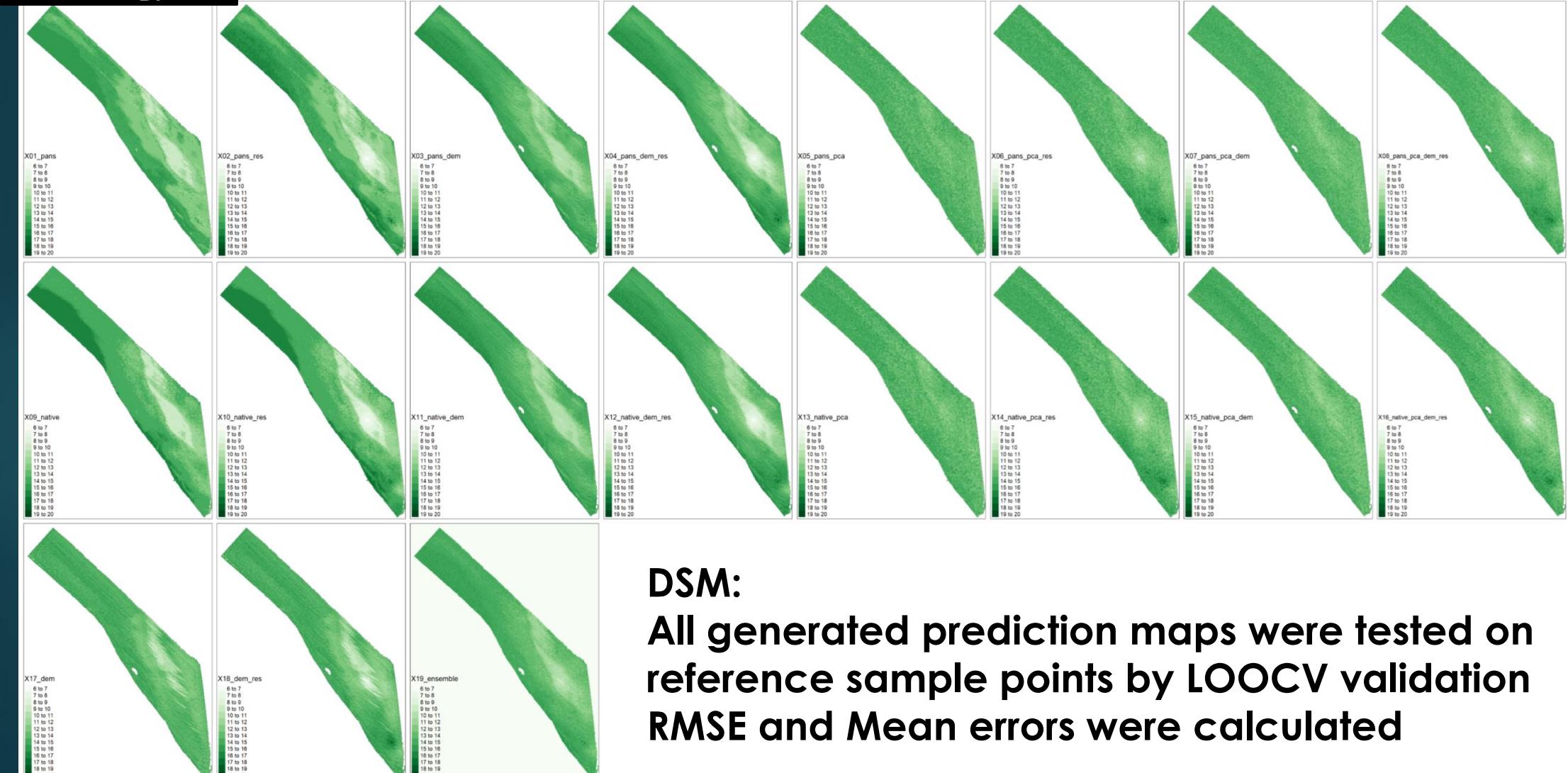
Based on spectral bands and DEM-derived bands in various combinations predicted TOC maps were generated in R by RandomForest and RandomForest-krigged methods

**Generated combinations:**

Native – Pansharpened hyperspectral data  
Only spectral bands – Spectral bands and DEM-derived bands  
Non-PCA-transformed – PCA-transformed spectral bands



BY



**DSM:**  
All generated prediction maps were tested on reference sample points by LOOCV validation  
RMSE and Mean errors were calculated



# Errors of generated maps

Reference sample point	TOC	Pansharpened orthomosaic								Native hyperspectral orthomosaic								No orthomosaic	
				DEM		PCA		PCA + DEM				DEM		PCA		PCA + DEM		DEM	
		RF	RFK	RF	RFK	RF	RFK	RF	RFK	RF	RFK	RF	RFK	RF	RFK	RF	RFK	RF	RFK
A1	11,05	-0,94	-2,78	-1,05	-2,20	-2,38	-3,26	-2,26	-3,16	-1,42	-1,92	-0,87	-2,00	-0,51	-0,79	-1,27	-2,26	-1,99	-3,24
A3	15,21	3,58	3,17	3,74	3,29	2,65	1,20	2,71	1,75	3,44	3,12	3,39	3,02	1,45	1,20	2,94	2,69	2,68	2,11
A5/1	16,46	0,68	1,13	1,58	2,18	2,17	2,72	2,20	3,38	0,52	1,05	1,23	1,98	0,54	1,79	1,59	2,18	1,82	2,87
B1	11,06	-1,23	0,06	-1,78	-1,23	-2,48	-2,00	-2,20	-2,25	-1,79	-0,68	-2,16	-2,02	-2,12	-1,24	-2,81	-2,31	-2,57	-2,51
B5/1	13,03	-2,24	-2,39	-2,17	-2,02	-0,55	-0,84	-0,52	-0,72	-1,63	-1,55	-1,24	-0,94	-2,20	-2,30	-0,45	-0,75	0,12	0,45
B6/1	15,87	0,15	1,13	0,19	1,60	0,97	2,12	0,71	1,91	-0,31	0,82	-0,19	1,59	0,44	2,04	0,28	1,77	0,57	2,32
C2/1	10,24	-2,90	-1,76	-3,21	-2,70	-3,18	-3,13	-3,35	-3,11	-2,35	-1,48	-3,32	-2,16	-3,88	-3,65	-4,17	-3,65	-5,07	-4,52
C5/1-2	13,52	-2,23	-1,54	-1,71	-1,52	0,05	0,00	0,22	-0,06	-2,26	-1,73	-2,14	-2,39	-0,98	-1,42	-0,86	-1,48	-1,09	-1,50
C6/1	14,95	-1,11	-1,64	-0,06	-0,22	0,15	-0,33	0,63	0,53	-0,50	-0,78	0,46	0,42	1,46	1,02	1,75	1,25	1,68	0,82
D1	14,01	0,78	3,78	0,40	4,18	0,92	3,86	1,12	4,09	-0,17	3,41	0,18	3,73	0,40	3,90	1,46	5,33	2,25	5,43
D4	6,14	-7,08	-6,34	-7,70	-6,94	-7,52	-6,66	-7,66	-6,62	-7,08	-6,47	-7,75	-6,94	-8,61	-8,60	-8,58	-7,95	-8,42	-7,42
D5	11,91	-0,70	-0,19	-1,54	-1,36	-1,86	-2,05	-2,12	-2,27	-1,55	-1,61	-2,26	-1,97	-0,25	0,08	-1,46	-1,33	-1,86	-1,55
D6/1	13,99	-1,19	-0,90	-0,39	-0,15	-0,15	1,08	-0,04	0,80	-0,41	0,37	-0,46	0,10	-0,81	-0,15	-0,74	0,34	0,09	0,71
E5/1-3	12,22	-0,72	0,76	-1,00	0,23	-2,27	-1,03	-2,47	-0,97	-1,91	-0,58	-1,36	-0,08	-1,59	-0,46	-1,50	-0,90	-1,49	-0,96
F2	11,50	-3,19	-2,89	-2,99	-2,57	-2,55	-2,11	-2,29	-1,86	-3,17	-2,25	-3,11	-2,49	-2,02	-1,37	-1,72	-1,58	-1,40	-1,34
F5	12,54	-0,34	-1,94	-0,36	-1,26	-0,33	-1,52	-0,39	-1,49	-1,43	-3,10	-0,55	-1,36	-0,63	-1,83	-0,43	-1,34	-0,08	-1,10
X/1	17,37	4,18	4,84	3,47	4,22	3,84	4,57	3,17	4,47	4,30	5,30	3,18	4,26	3,22	4,14	2,43	3,63	2,71	4,00
Y1	10,88	-2,17	-4,97	-3,02	-6,09	-2,65	-5,29	-2,55	-5,54	-2,92	-6,61	-3,63	-6,60	-2,54	-6,01	-2,98	-6,00	-3,52	-6,79
Y3	19,68	8,16	6,12	8,17	6,44	6,00	3,64	6,74	4,74	8,26	6,41	8,38	6,76	7,68	5,78	8,07	6,72	8,12	6,50
Z3/1	18,15	3,81	0,32	2,99	-1,01	5,15	1,12	4,60	0,59	4,12	0,56	2,97	-0,77	4,09	0,04	3,55	-0,79	2,91	-1,08
RMSE		3,18	3,07	3,22	3,25	3,10	2,95	3,11	3,08	3,25	3,23	3,28	3,29	3,20	3,27	3,31	3,44	3,38	3,57
mean		-0,23	-0,30	-0,32	-0,36	-0,20	-0,40	-0,19	-0,29	-0,41	-0,39	-0,46	-0,39	-0,34	-0,39	-0,25	-0,32	-0,23	-0,34



# Conclusion

First sample design did not support the compilation of reliable DSM products

A consecutive sampling is planned based on DSM-based sample design optimization to complete the former samples

Further investigation is needed in the use of UAV-based hyperspectral sensors for DSM