Palsa mires and monitoring in Enontekiö, Finland

Mires and wetlands in the North Calotte Area, Vadsø, 2.10.2019

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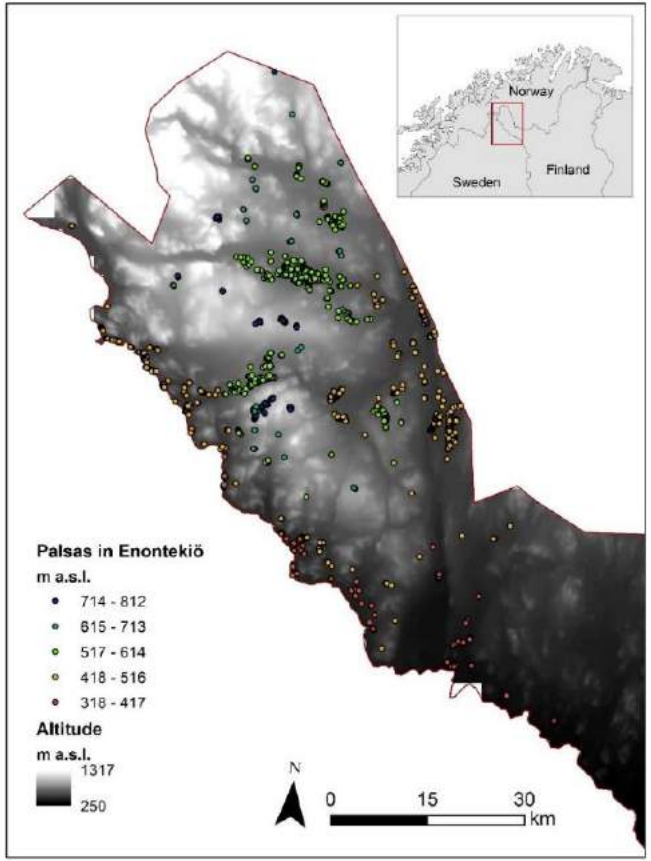
Outline

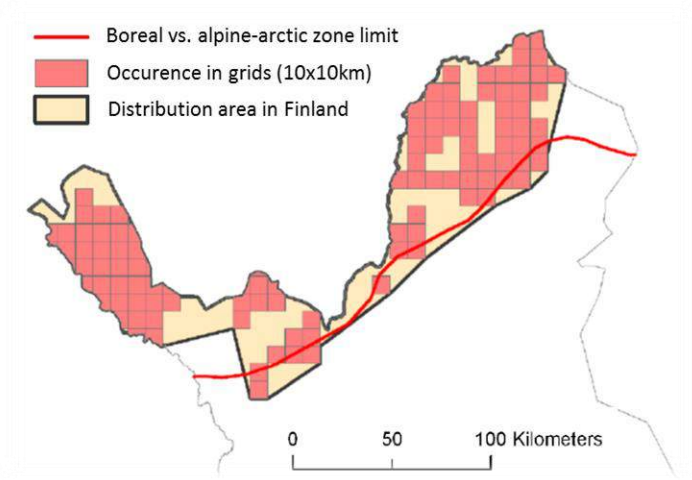
- General overview – Palsa mires in Finland
- Change detection from aerial image time series
- RTK GPS measurements
- Unmanned Aerial Systems in Palsa research
- Palsa mires as part of SHIFTMIRE project
- Active-layer thickness from remotely sensed data – preliminary results



General overview (Finland)

- Total habitat area 417 km2
- Current area trend: ”stable”
- Past 50 yr area trend: ”no significant decline”
- Future area trend: ”most likely to decline”
- Historic area trend: ”no significant decline”
- Extent of quality degradation: ” 10-20%”
- Severity of quality decline: ”moderate”
- Current trend of quality: ”decreasing”

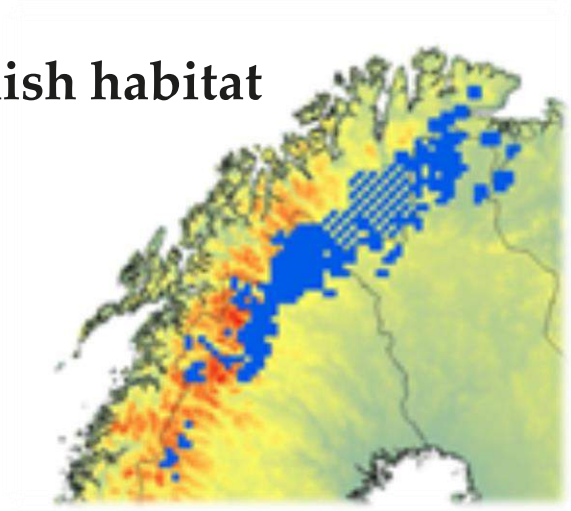
- Threats: main threat climate change, minor threats erosion due to off-road vehicles and reindeer overgrazing



Comparability issue: e.g. Finland and Sweden:

- Finnish classification: Palsa mire is a complex including the whole mire area with palsas → habitat complex classification -> **417 km²**
- In comaprison: Swedish area calculation: All 100x100 squares with at least 1% cover of palsa mounds → habitat classification -> **137 km²**

➢ **Estimated Finnish total Palsa mire area by Swedish habitat definition: 104 km²**



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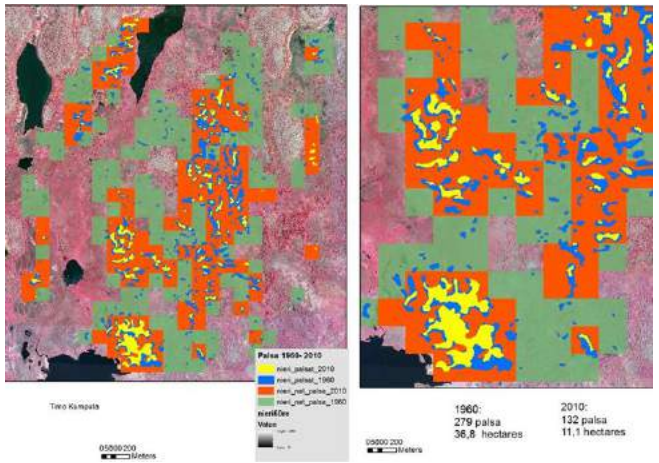
Aerial image time series 1959 - 2012

- Data from Topografikunta and the National Land Syrvey of Finland
- Change detection by digitising manually edges of palsas from aerial imagery
- Possible errors (+/-) due to misinterpretation (esp. b&w photographs).

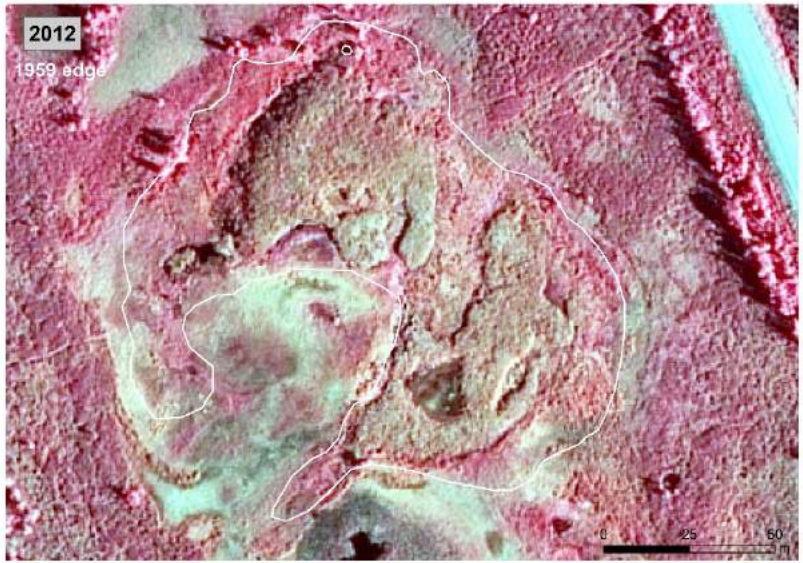
- Grid analysis – 100 m grids with / without palsas:

-> Palsa mound area decline 70%

-> Palsa mire habitat grid decline 48%



Peera:



Area (ha) of digitised Palsas within sample areas:

	Peera	Iitto	Nierivuoma
	1959: 22,4	1959: 9,2	1960: 28,4
	1985: 18,8	1979: 8,4	1979: 20,4
	1997: 16,2	1997: 6,9	1991: 16,3
	2000: 13,6	2000: 4,9	2000: 11,6
	2012: 12,1	2012: 4,8	2012: 8,2
change	-54 %	-48 %	-71 %

RTK GPS measurements – ALT monitoring

- Annual measurements with Real Time Kinematic (RTK) GPS, accuracy < 5 cm
- Laassaniemi and Peera, ca. 400 points 2007 ->
- Palsa surface & depth of active layer
- In addition, ground temperature data since 2016 and game camera recording snow cover conditions on Peera palsa

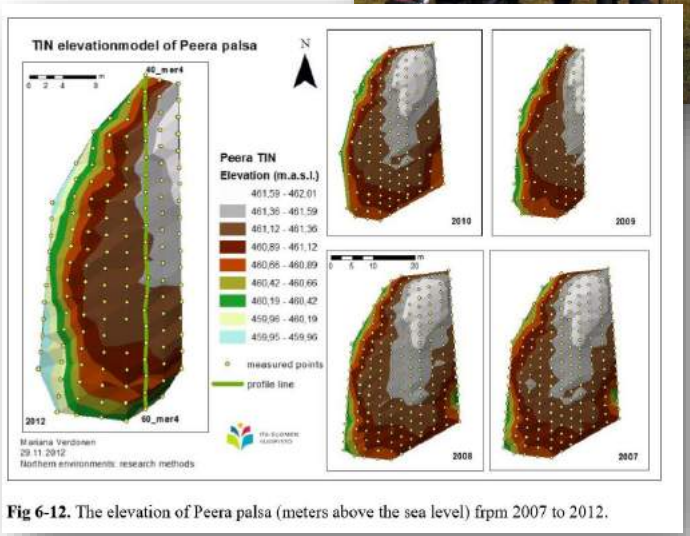
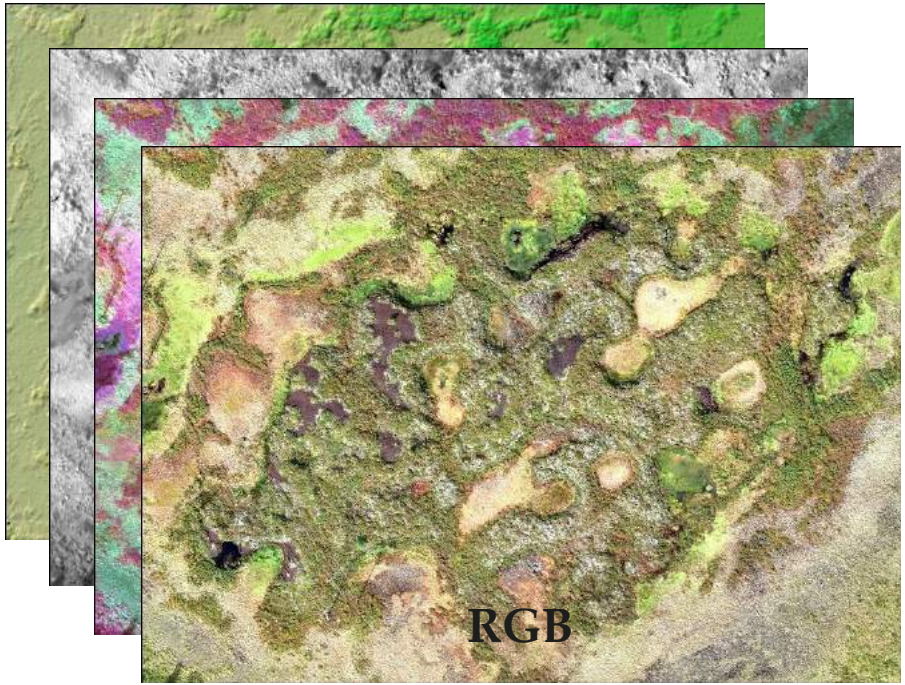


Fig 6-12. The elevation of Peera palsa (meters above the sea level) frpm 2007 to 2012.

Unmanned Aerial Systems (UAS)

Rasaniva, August 2019:



DJI Phantom 3 Pro

Parrot Sequoia

S.O.D.A.

SenseFly eBee RTK

DJI Phantom 4 RTK

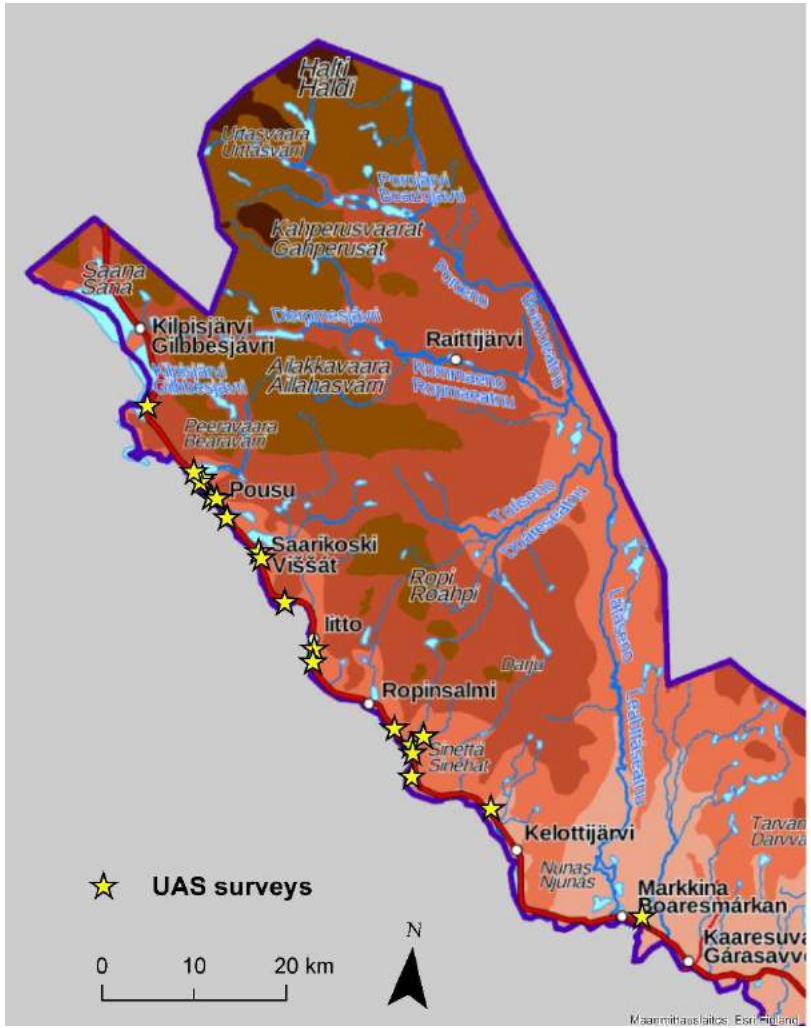
DJI Matrice 210 RTK

UAS datasets

Drone surveys of Palsa mires along Käsivarrentie since 2016/2017:

- End of August every year
- Beginnig of June every 2nd year

Laassaniemi
Peera East
Peera West
Laakiopalsa
Pousu
Pousuniva
Pousuniva South
Saarikoski (fence)
Saarikoski (ditch)
Lammasoaivi
Iitto
Kiljupalsa
Rasaniva
Idatjeaggi
Adjamohkki
Pättikkäsuvanto
Kouttavuopio
Sottuvuoma
Markkina



SHIFTMIRE

Ecosystem shift potential of northern mires in response to hydrological change
(Academy of Finland, PI Teemu Tahvanainen)

Field expedition 22.-31.7.2018 to three palsa mires in Enontekiö, at different altitudes:

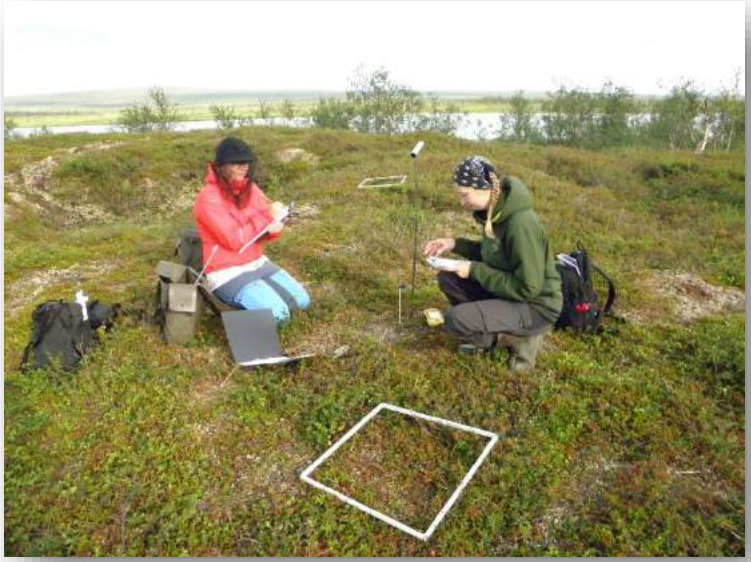
- Nierivuoma (68°48'N, 22°15'E; 440 m a.s.l.)
- Rommaeno (69°01'N, 21°34'E; 550 m a.s.l.)
- Balsaláhku (68°56'N, 21°35'E; 730 m a.s.l.)

Data

- UASs
  - Orthomosaics and Digital Elevation Models (DEM) produced in Agisoft

- Field measurements
  - Active-layer thickness with 1 m metal probe
  - GPS locations with various devises, accuracy 0.2 – 2 m
  - Vegetation plots
  - Gas samples (CO_2, CH_4 & N_2O)

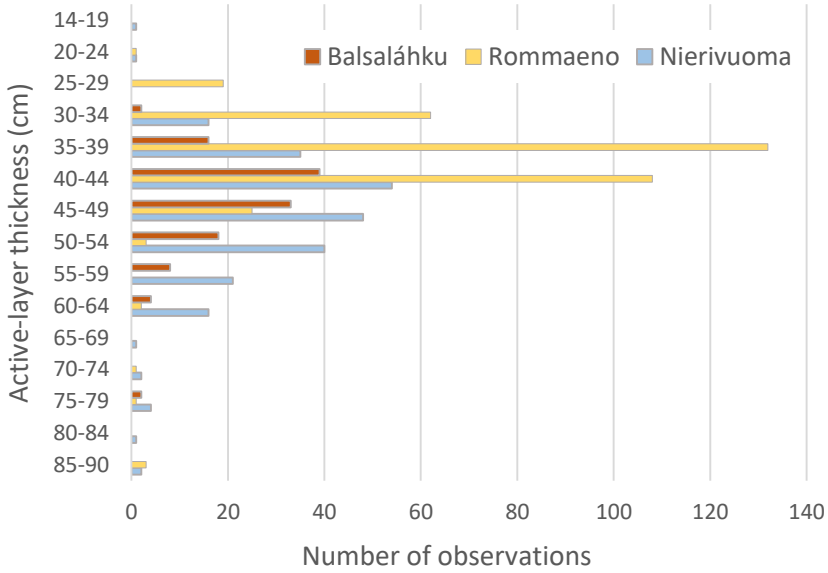
- From the National Land Survey of Finland (NLS):
  - LiDAR based 2 m DEM (2016)
  - Orthophotos (1959 - 2012)
  - Mires layer from the Topographic database (maastotietokanta)



Photos: T. Tahvanainen

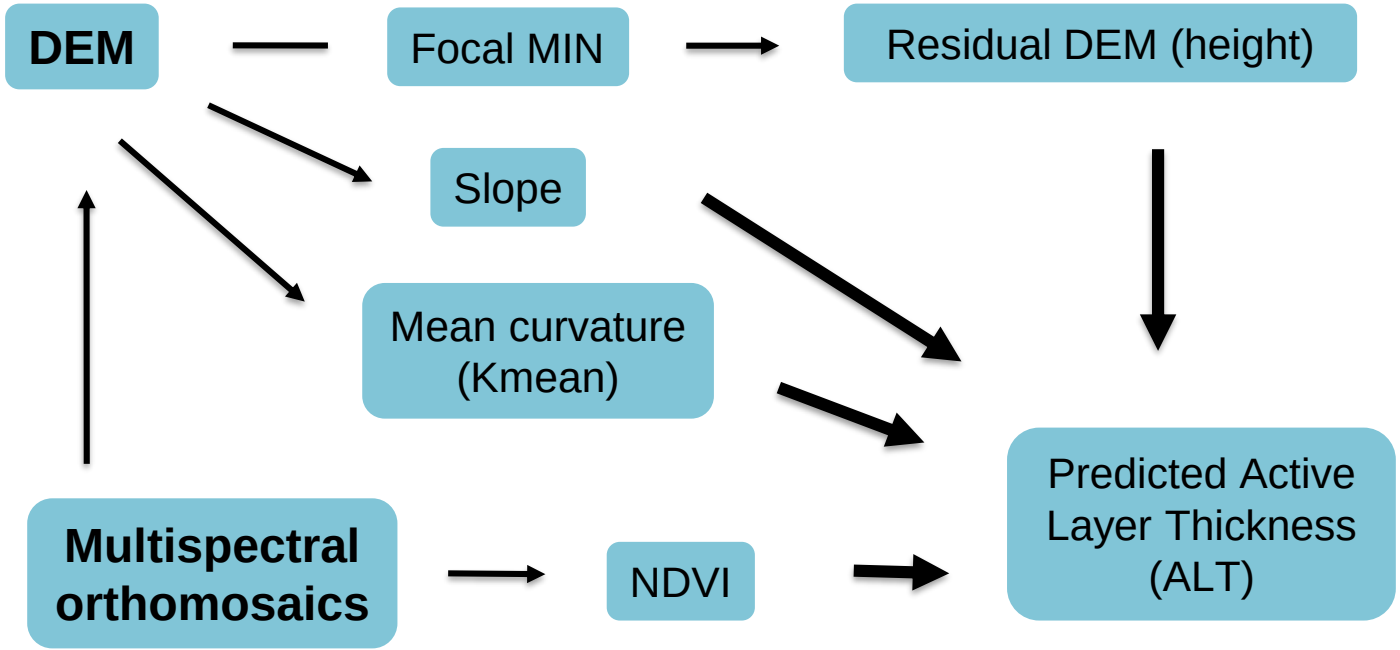
Results from UAS data and ALT measurements

- Significant difference of ALT between Rommaeno and Nierivuoma, and Rommaeno and Balsaláhku ($p < 0.001$). No sig. difference between Nierivuoma and Balsaláhku.
- Significant difference between plateau and dome-shaped palsas ($p < 0.001$)
- ALT and elevation of the measured point have significant positive correlation at all three sites.
- However, elevation alone explains only ca. 7-17 % of the variation in the ALT
- NDVI has some negative correlation with ALT at all three sites, but is significant only in Rommaeno.



	Nierivuoma	Rommaeno	Balsaláhku	Total
Altitude (m a.s.l.)	440	550	735	
Number of measurements	242	375	122	721
Mean ALT (cm)	46,8	38,4	45,8	42,5
StdDev (cm)	10,4	7,4	7,3	9,4
Min (cm)	14	23	31	14
Median (cm)	46	38	45	40
Max (cm)	90	90	77	90

Modelling the spatial distribution of ALT in Palsa mounds



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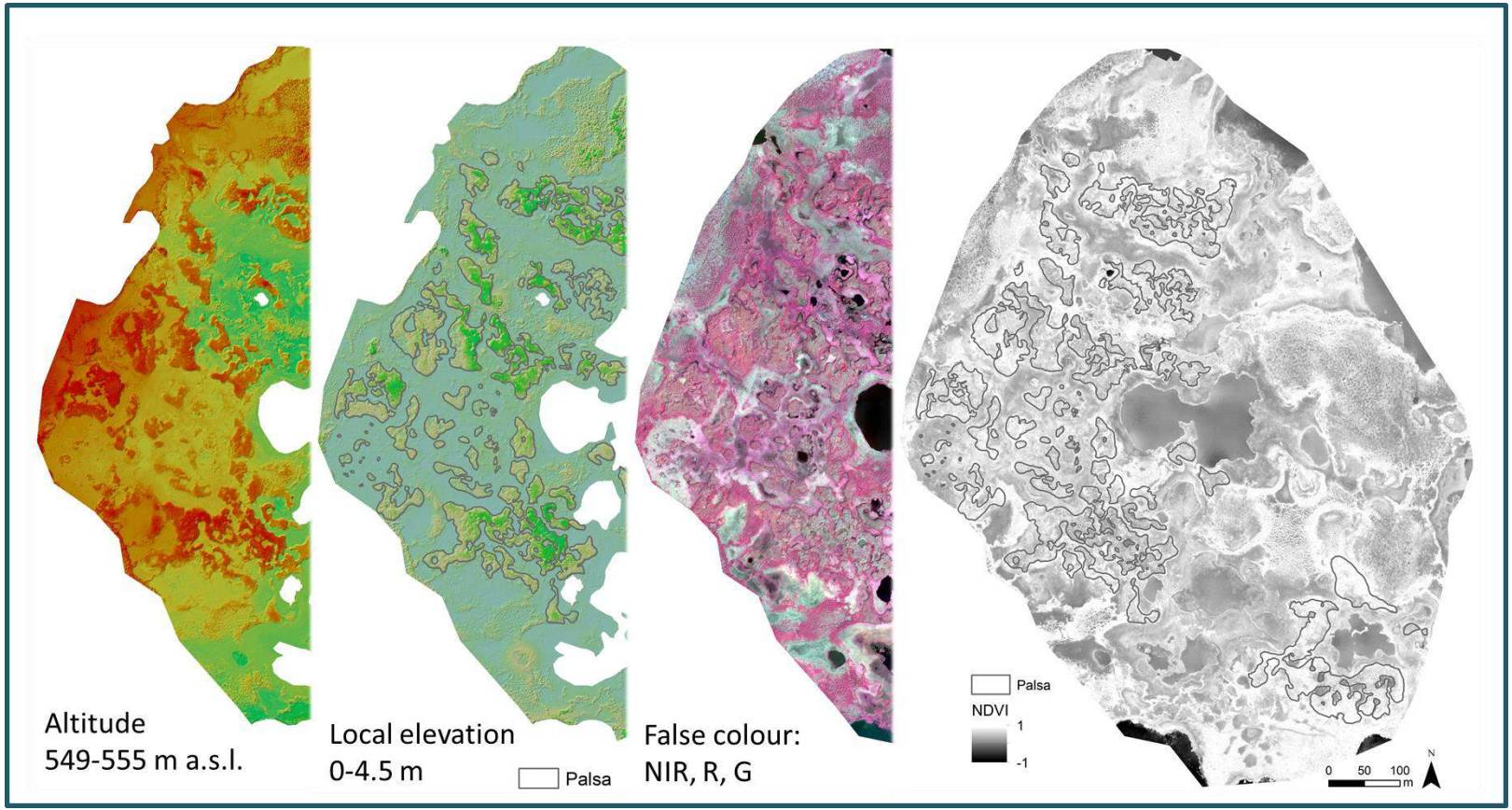


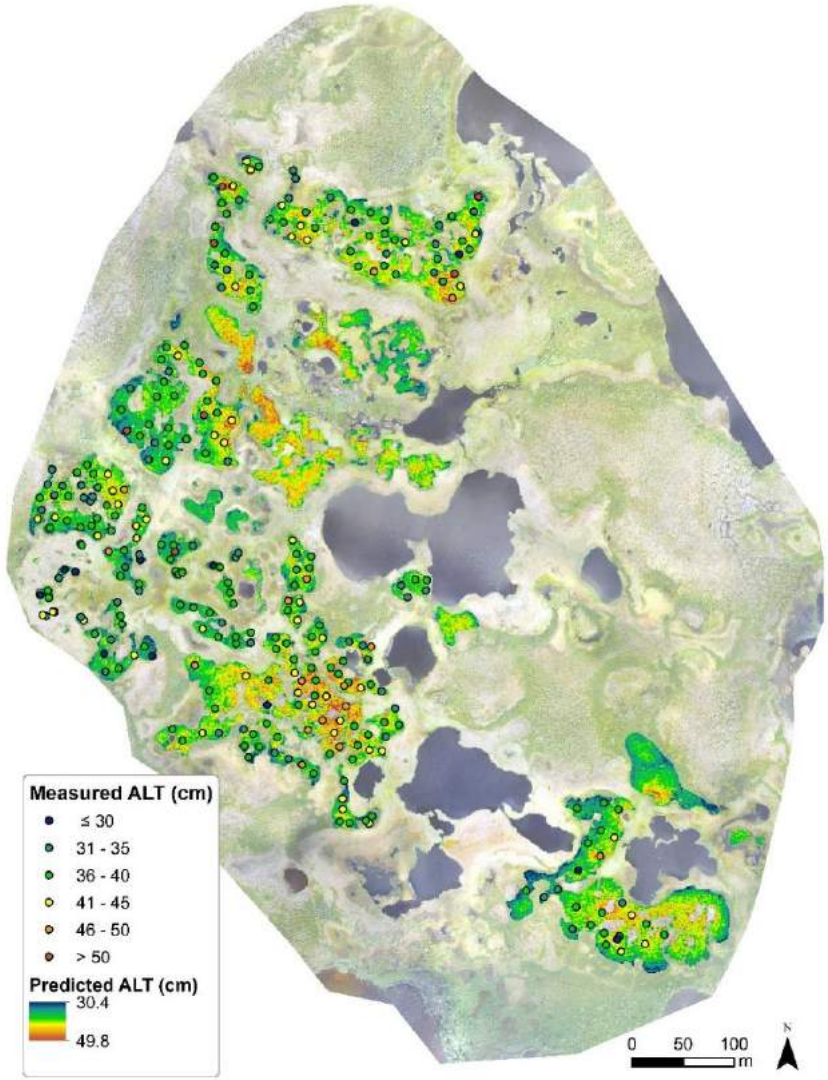
Preliminary results

Active-layer thickness in Rommaeno, July 2018:

Coefficients used in the models and respective RMS errors. Slope value is added to account for horizontal ALT at the edges of palsas.

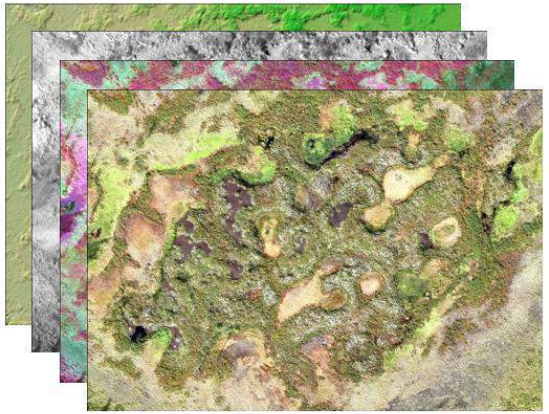
	Nieddavaoma	Rommaeno	Bahalahka
Constant	44.301	44.253	42.470
Height	3.610**	5.222**	3.469**
NDVI	-5.138	-15.663**	-2.178
Kmean	-3.327	-7.511*	-3.569
Slope	0.2	0.2	0.2
RMSE	10.08	4.61	4.50

** Significant at the 0.01 level. * Significant at the 0.05 level.

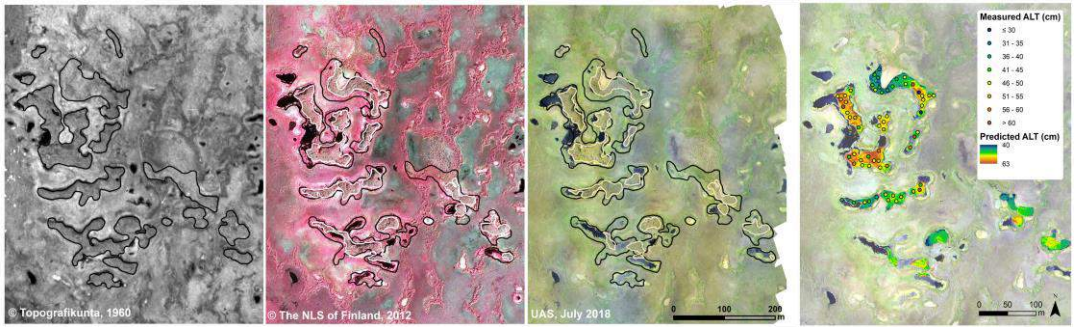


To sum-up

- In Finnish classification, the Palsa mire is a complex that includes the whole mire area with palsas. The area trend of Palsa mires as habitat is considered ”stable”, while the trend of habitat quality is ”declining”, as palsa mounds and peat plateaus are degrading.



- Differences in assessments of Palsa mires make comparison between countires challenging.
- Various research methods on different scales are applied to detect and monitor changes (RTK GPS, UAS, Aerial imagery time series)
- On-going work to predict the ALT based on available Remote Sensing data



- Extraction of Palsa mounds from DEMs semi-automatically?
- Vegetation succession, GHG-fluxes?

Thank you!

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