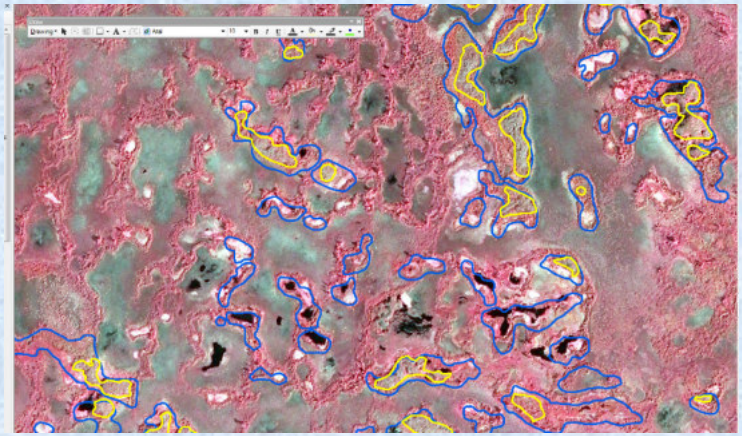
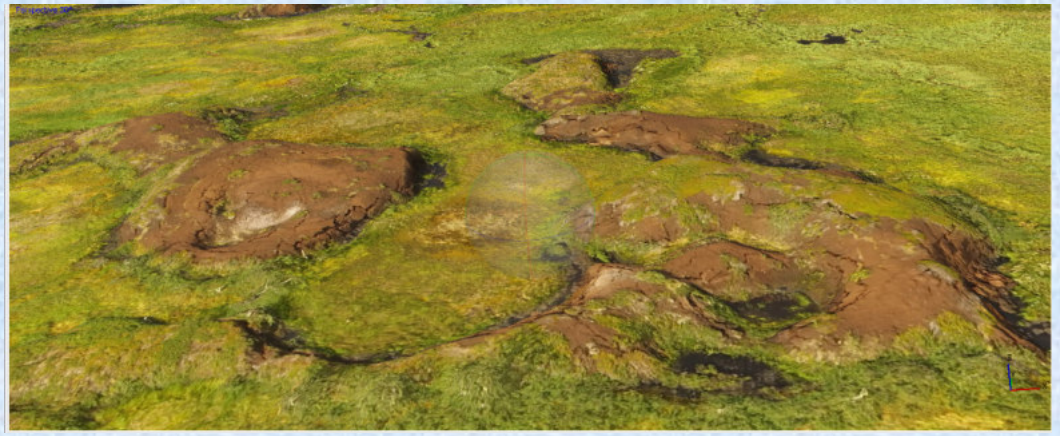
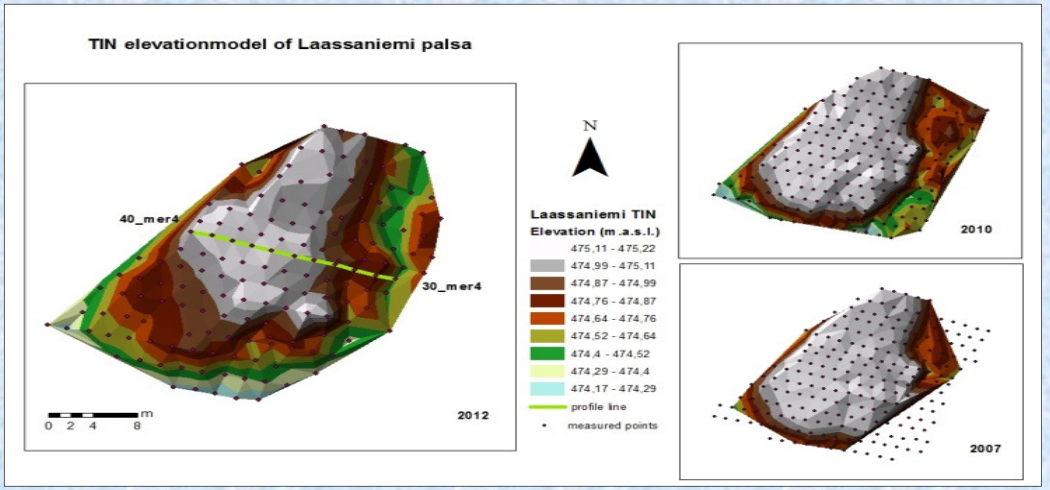
Rapid decay of palsas monitored using RTK GPS, UAS data and aerial photographs

The Arctic Biodiveristy Congress 9-12.2018 Rovaniemi







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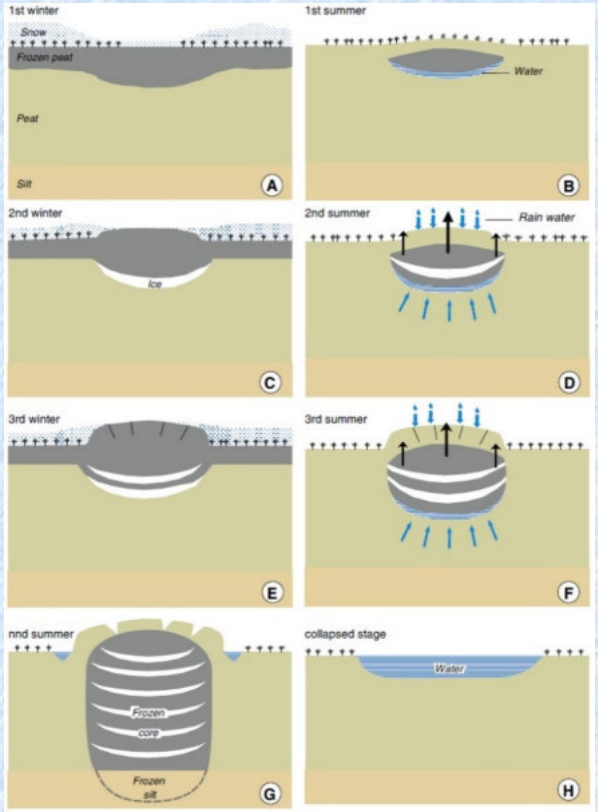
Palsa

- On mires in the zone of discontinuous permafrost in the circumpolar north
- Palsa is a peat mound with a core of permanently frozen peat, ice and mineral soil. The palsa can be from one to several meters high (1-7 meter).
- Optimum areas have low annual precipitation (<450mm) and mean annual temperature between -3°C and -5°C
- Peat's insulate property control the initiation and growth of a palsa.
- Locations where snow cover is thin → the frost penetrates deep enough that the summer warmth doesn't melt it completely. Frozen peat rises above the level of the surrounding mire, which leads to an increasingly thin snow cover.

Lifecycle of palsa



Seppälä (2011)

Focus of this research

- Palsa's occur in the southern border for permafrost existence and they are sensitive to small changes in climatic conditions
- There are several studies which indicate that palsa's are melting and decaying as a result of climatic warming. There are estimations and scenarios how fast and in which magnitude palsa's are decaying.
- We aim to demonstrate the exact rate of the palsa decay in peatland level.
- We used a time series of aerial photographs to detect the decay process of palsas (1959, 1970's,1980's, 1990's, 2000 & 2012)
- In detailed scale we have studied two palsa's since 2007 with Real Time Kinematic-GPS and have followed palsa decay rate and active layer depth.
- Establish UAS based palsa monitoring

Research area:

- NW Lapland
- 440 palsa mire's with several hundred palsa's
- 330-735 meters a.s.l.

Primary field data locations:

-Laassaniemi, Peera , Poussu (RTK GPS-data)

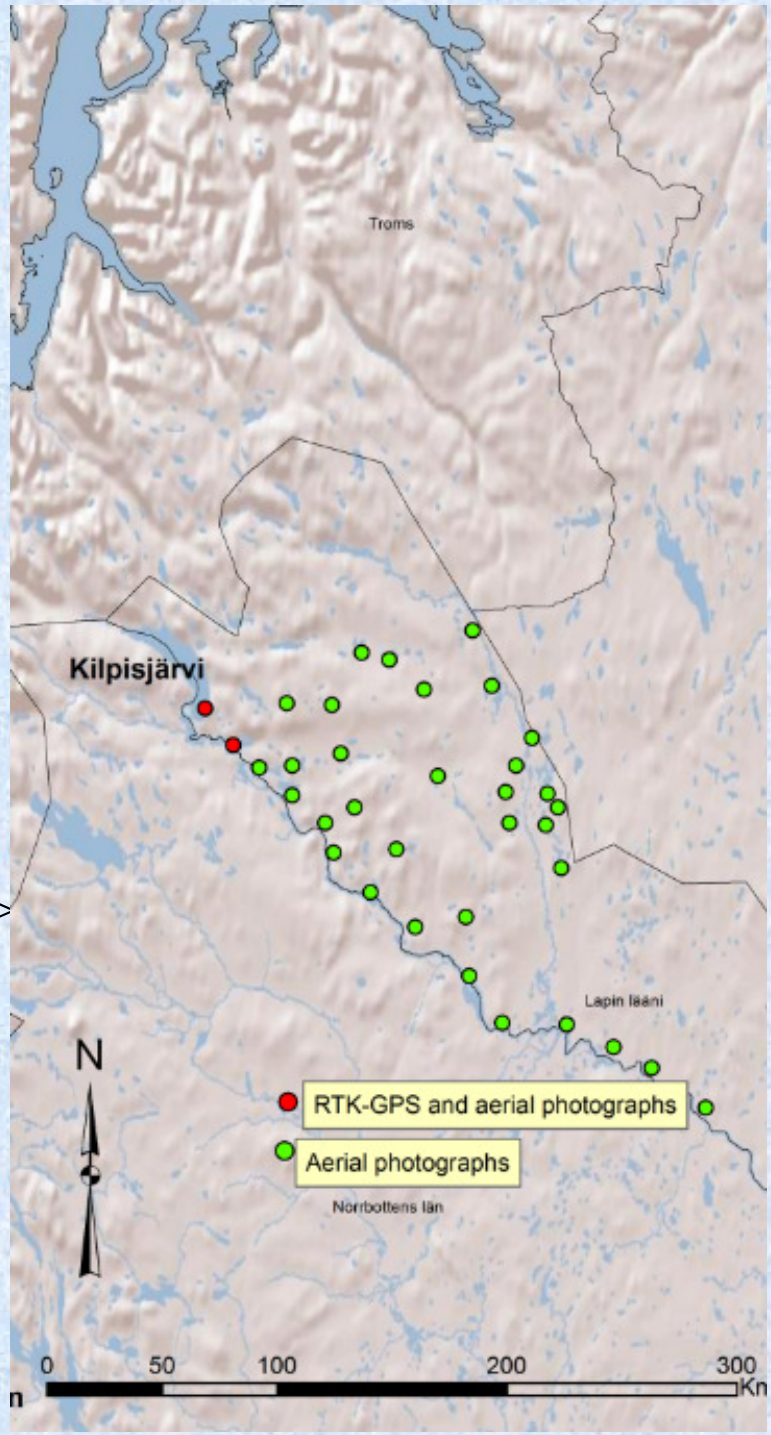
- Nierivuoma, Rommaeno (2018)

Field data

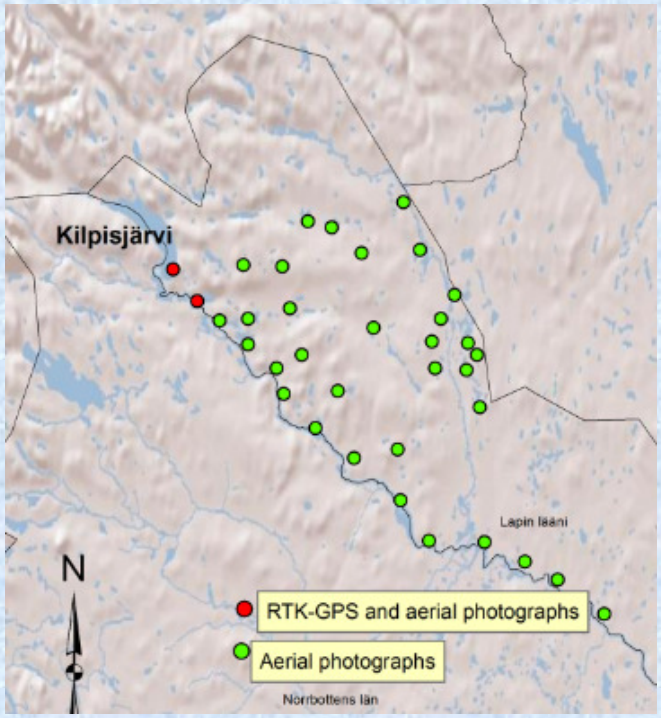
- Leveling 1990's to early 2000's (1 transect)
- RTK-GPS measurements 2007→
- Active layer sampling annually aug/sept 2007->
- Temp & soil moisture loggers 2012→

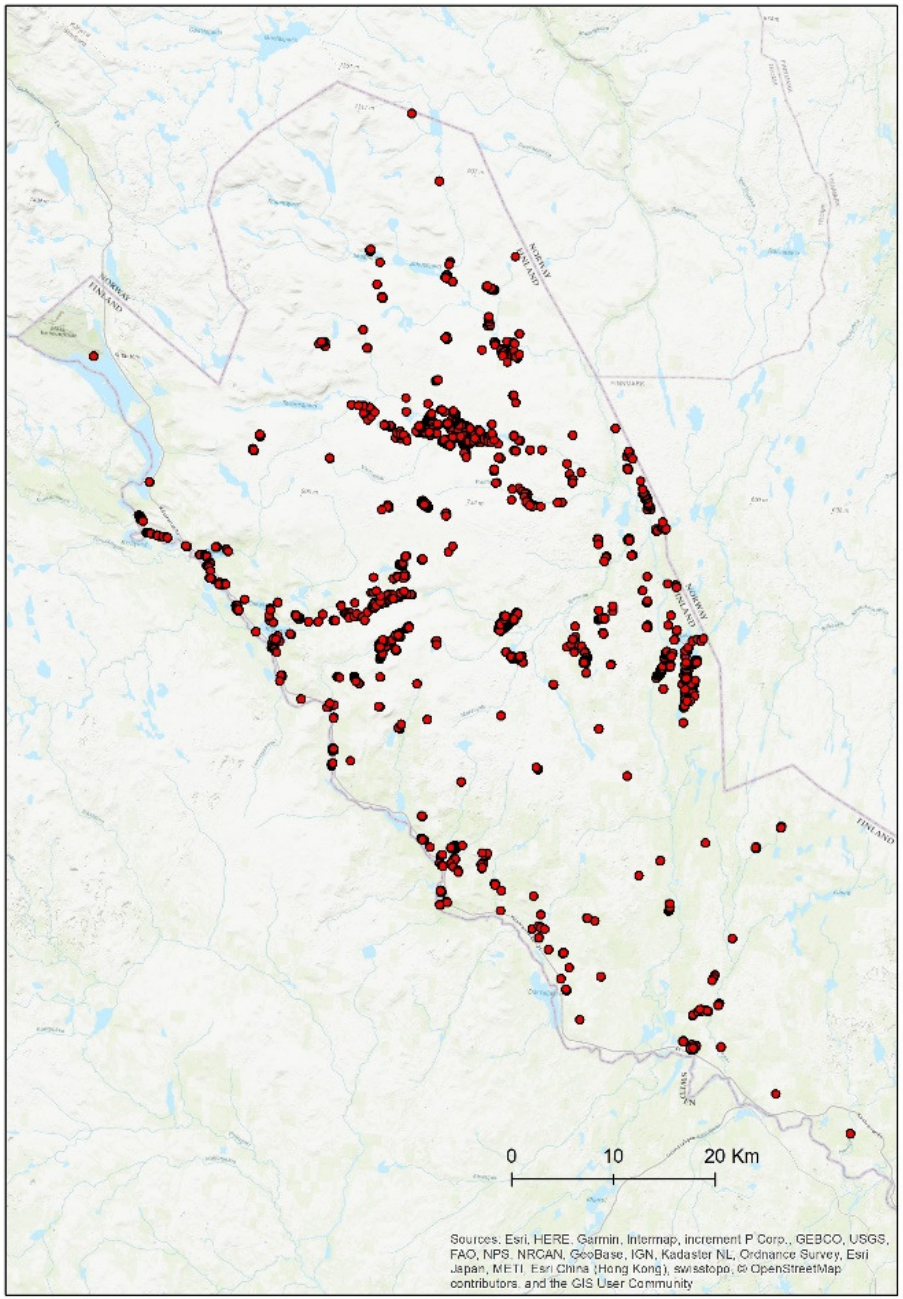
Remote sensing data

- 1950's images black & white
- False colour 1980's –>
- Orthophotos 2012



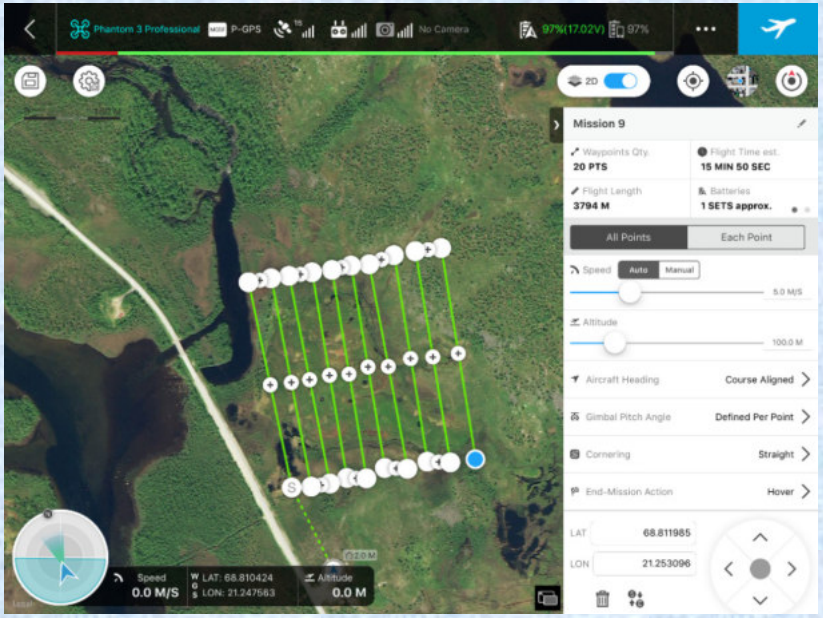
- Distribution of palsas
  - 2027





Palsa monitoring sites UAS:

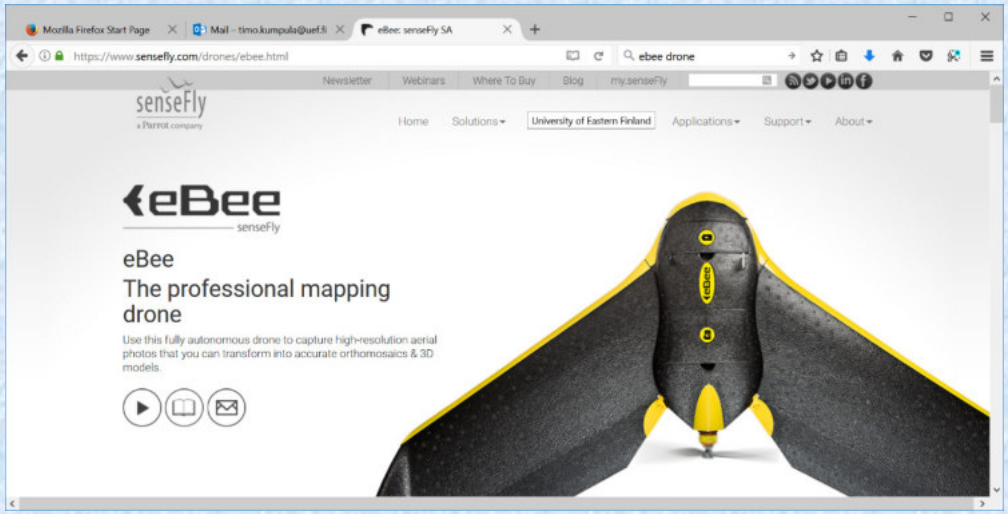
- **June (mid) and August/Sept**
  - 17 sites
  - 3 sites since 2015
  - 6 sites 2016
  - 6 sites 2017
  - 2 sites 2018
- **2 Hilden sites**



Drone fleet:

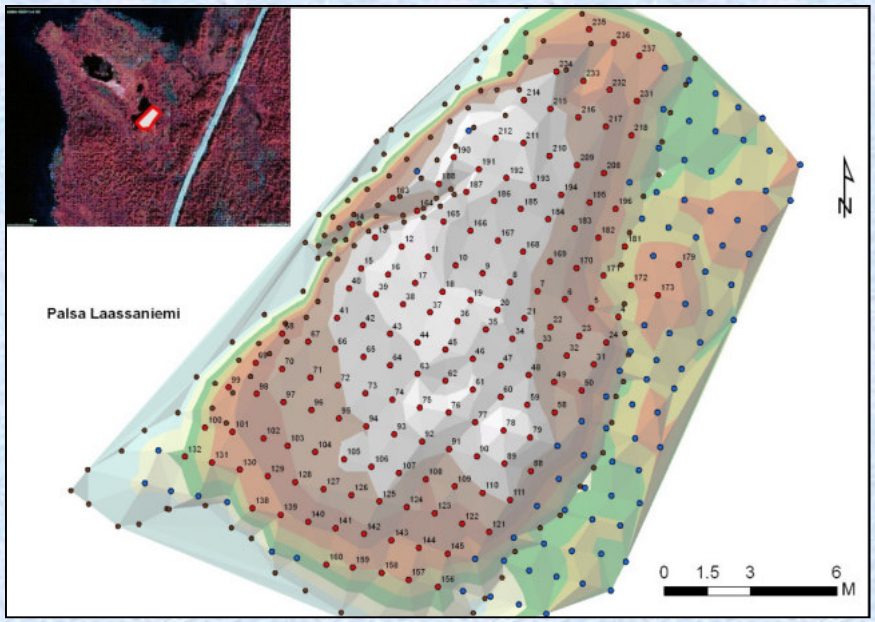
- **Phantom-3 pro**
- **Ebee +**
- **Matrice 210**
- **Phantom-4 pro**
- **Mavrik steady drone**
- **Mavic pro**
- **Disco parrot**

- **Sensors**
  - **Micasense rededge M**
  - **Parrot sequoia**
  - **Zenmuse XT (FLIR)**



Real Time Kinematic GPS data

- Two palsa were measured using RTK GPS (TopCon) with xyz accuracy of one cm.
- A measurement grid with two meter interval was defined over the palsa (ca. 220 points/palsa)
- Measurements have been carried out yearly August/Sept (2007-2018).
- Active layer depth of each point have been measured

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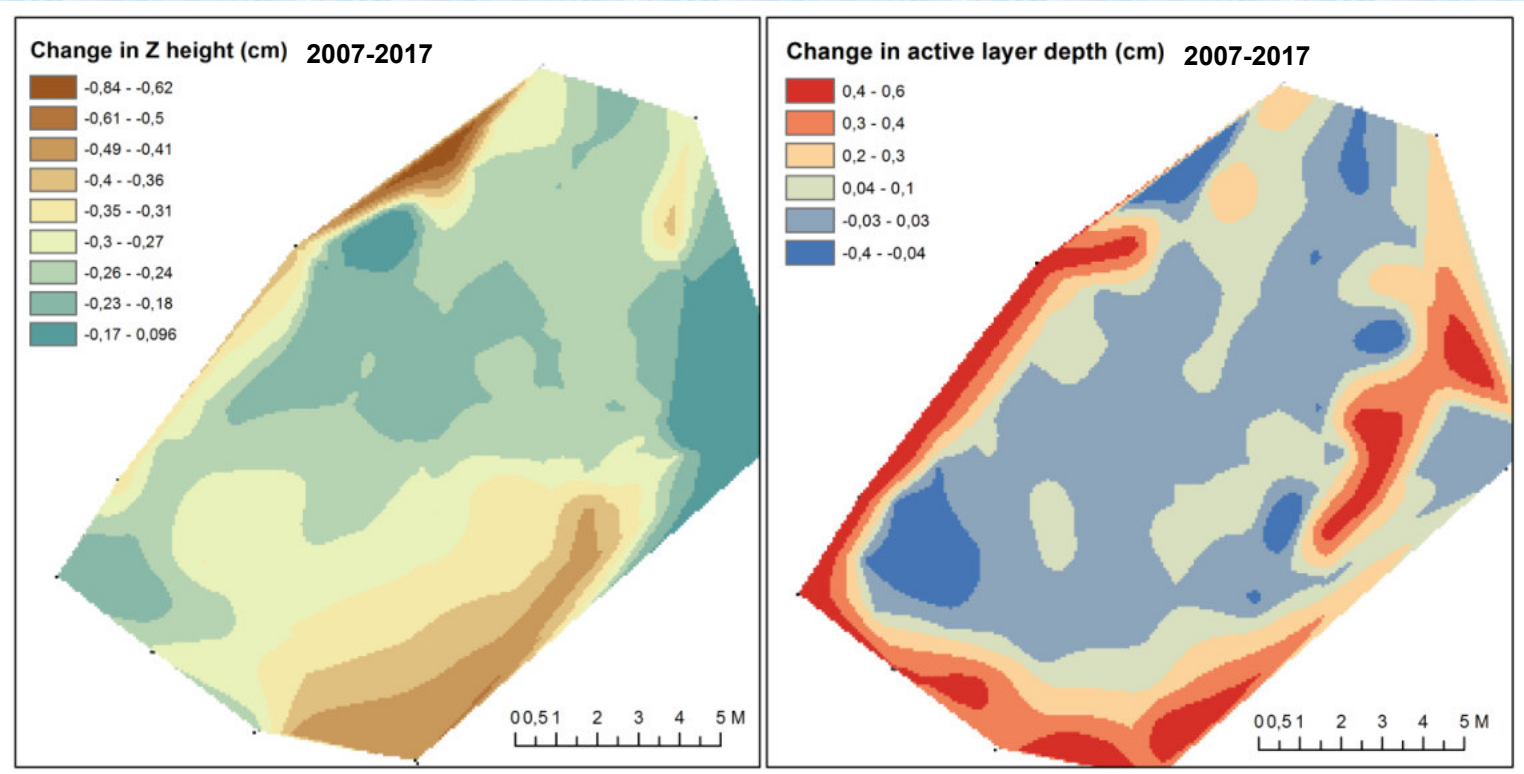
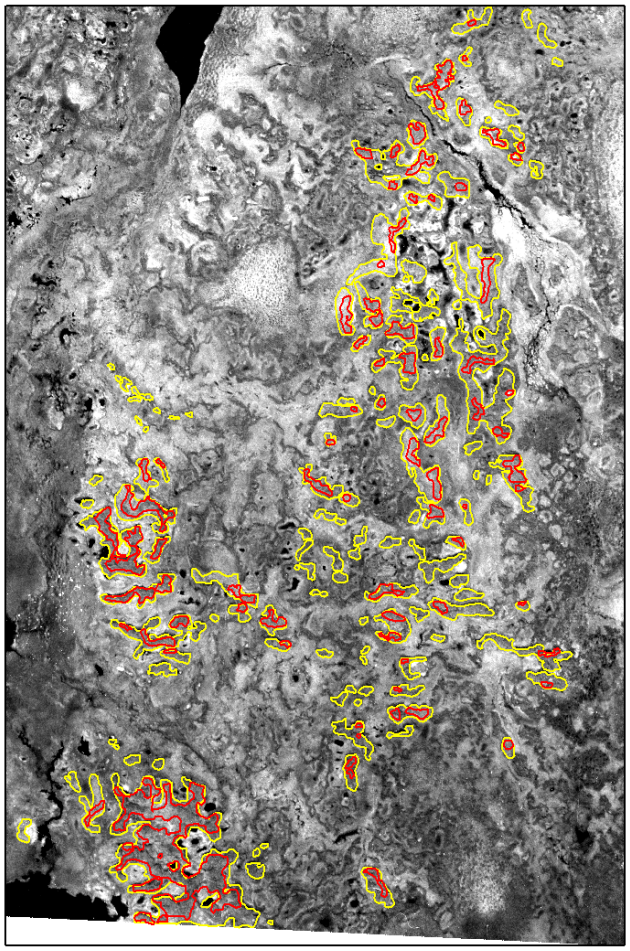
RTK results

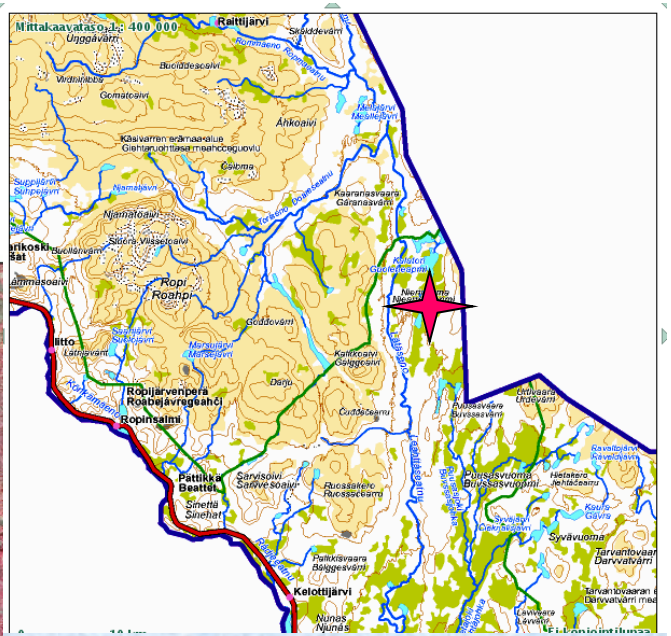
- The decay on the edge it is up to 20 cm/year.
- Active layer depth on the top of the palsa have been relatively stable (50-60 cm)

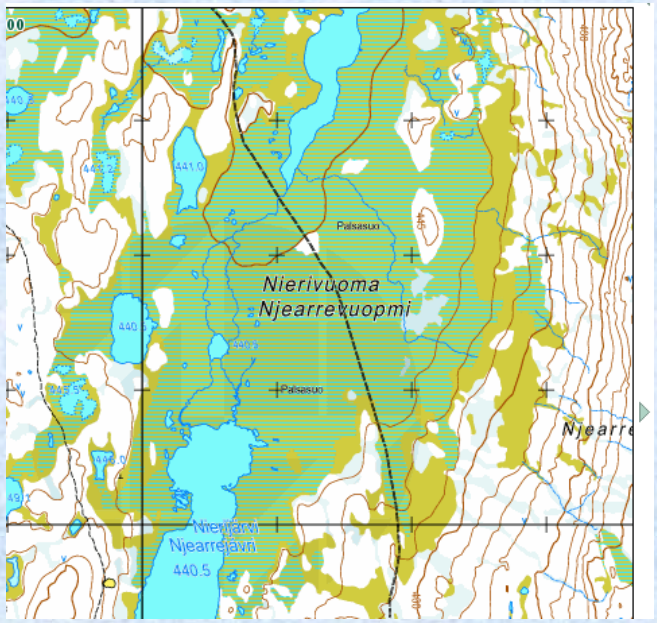


A change raster calculated from 2007 and 2017 height (Z) values. Height of the palsa has decreased significantly. On the top of the palsa decrease have been 30-50 cm in 10 years. This indicates that this palsa will vanish this rate in about 5-10 years. Decay is fastest on the side of the pond (84 cm) which speeds up the palsa decay.

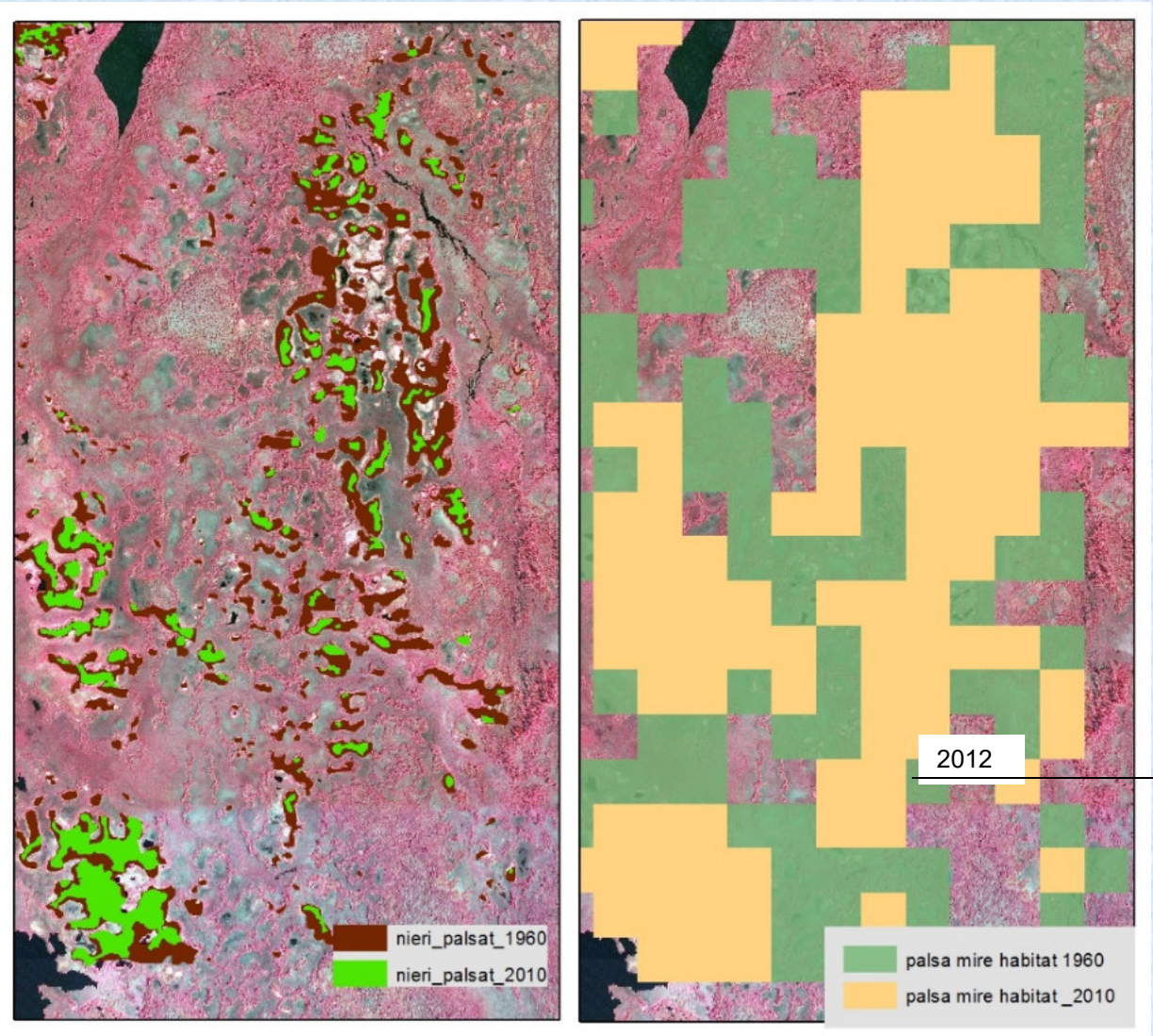
Nierivuoma





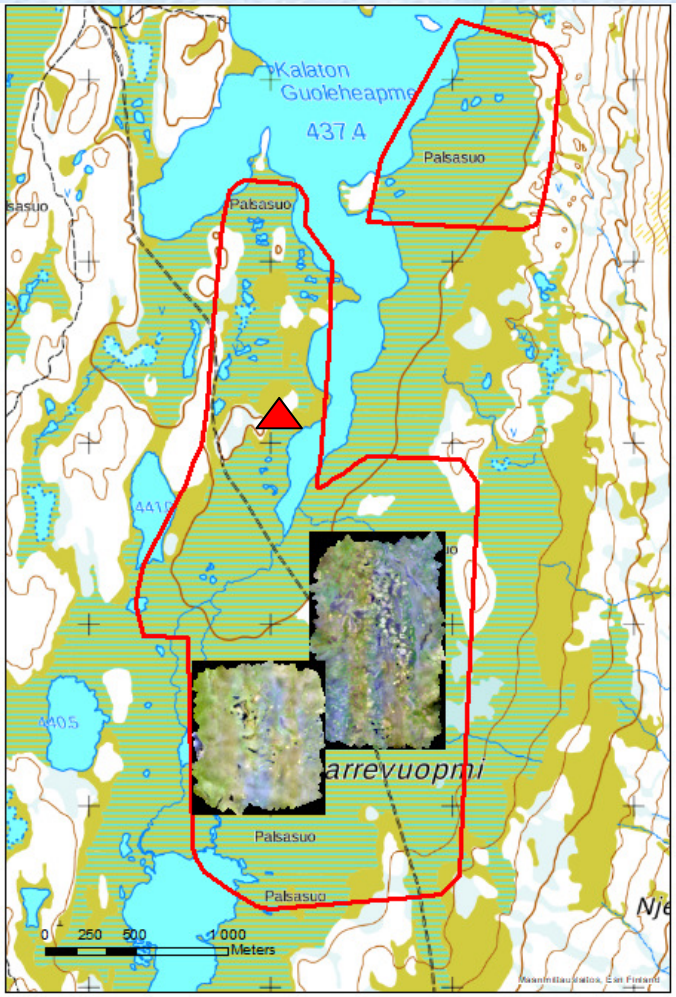


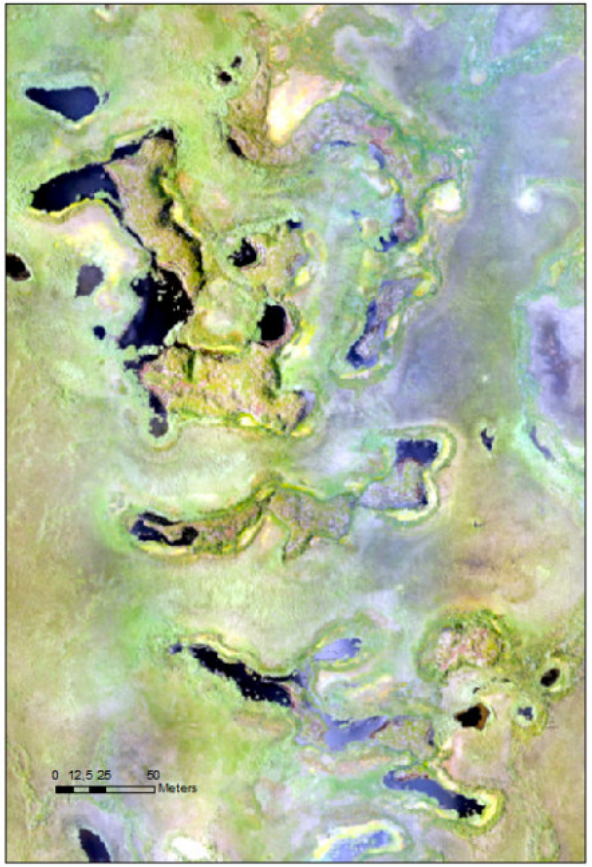
0 0,125 0,25 0,5 0,75 1 Km

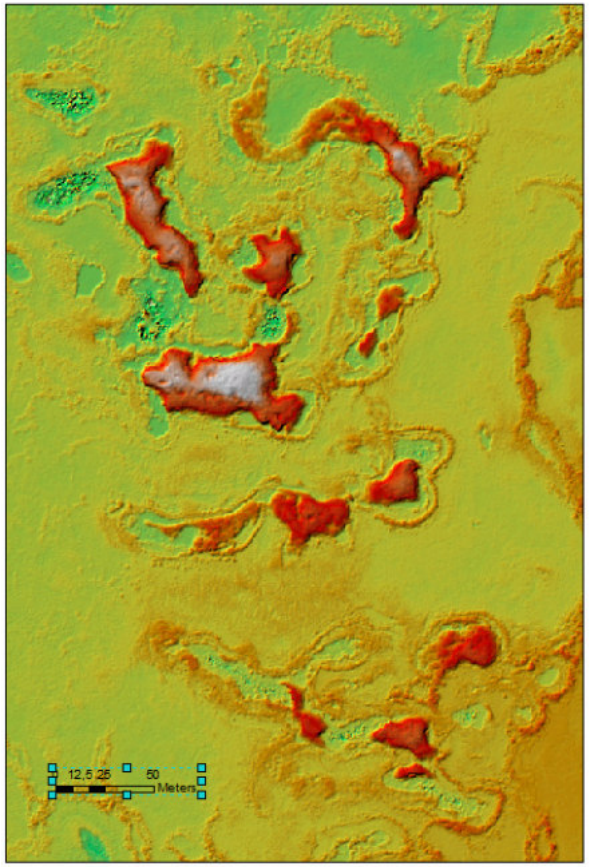


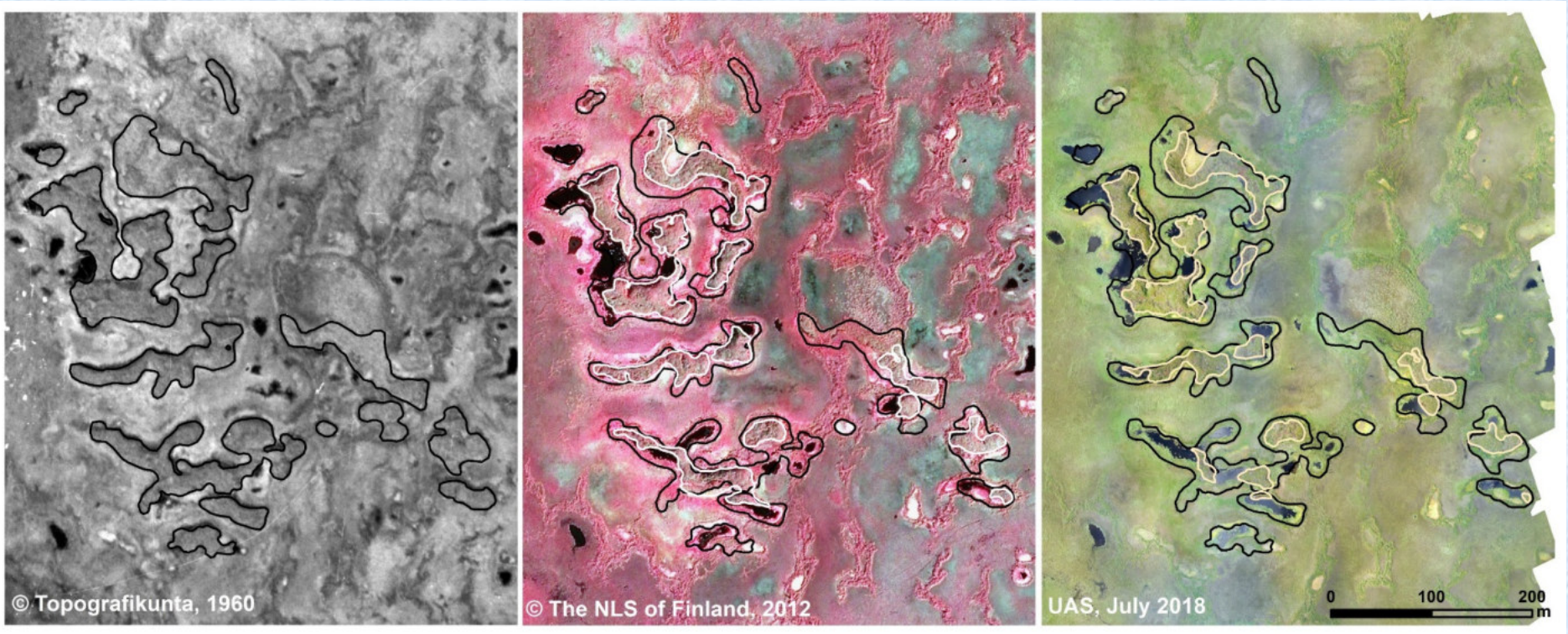
Decaying of the palsa in Nierivuoma peatland 1960-2010. From aerial photograph we interpreted 279 individual palsas in Nierivuoma peatland basin. These palsa covered 36 hectraes. From 2012 image only 132 palsas were found and they covered 11,1 hectares.
Habitat analysis with 1 ha grid shows decrease from 251 hectares down to 127 hectares.

Nierivuoma UAS campaign 2018





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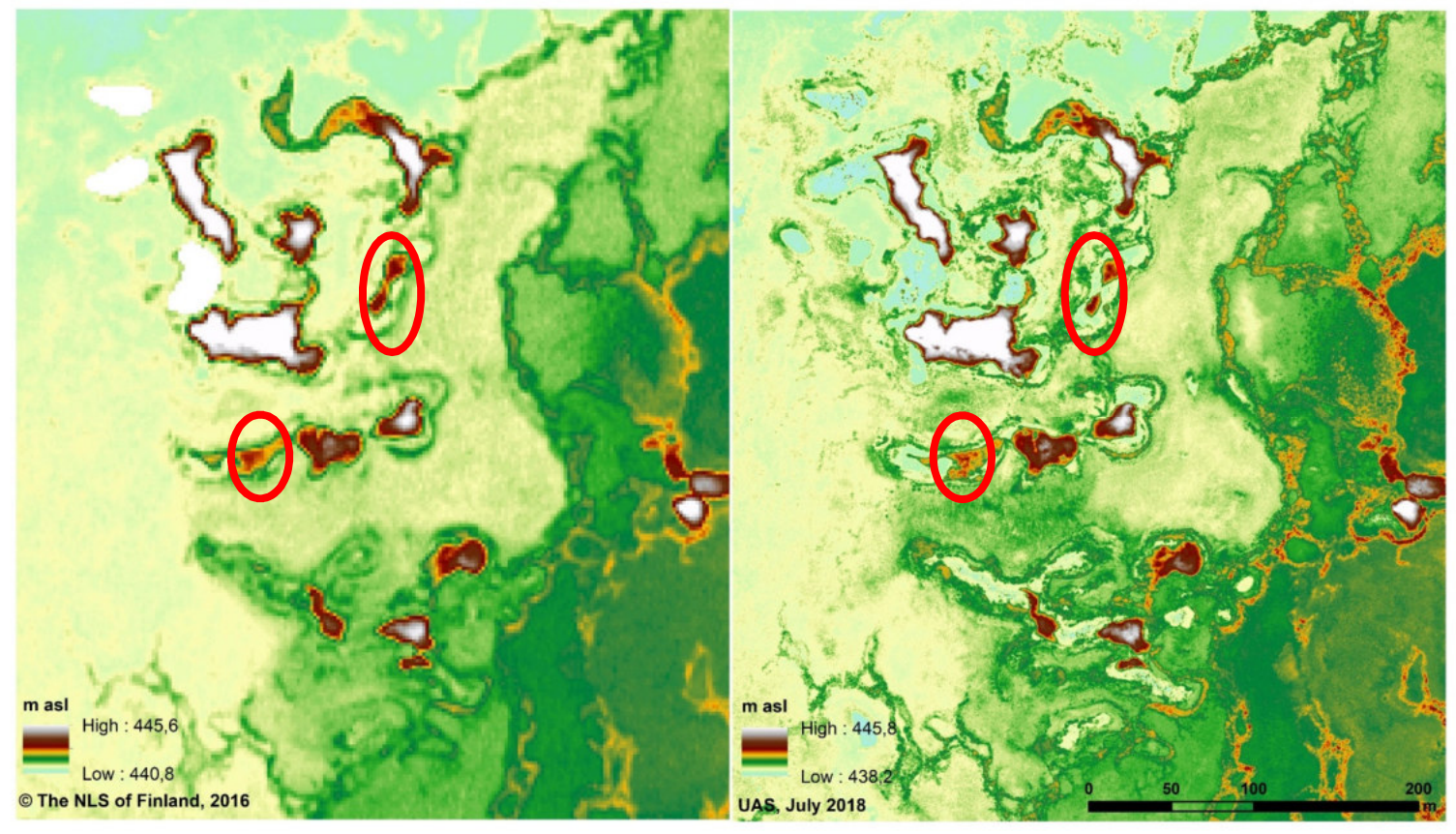
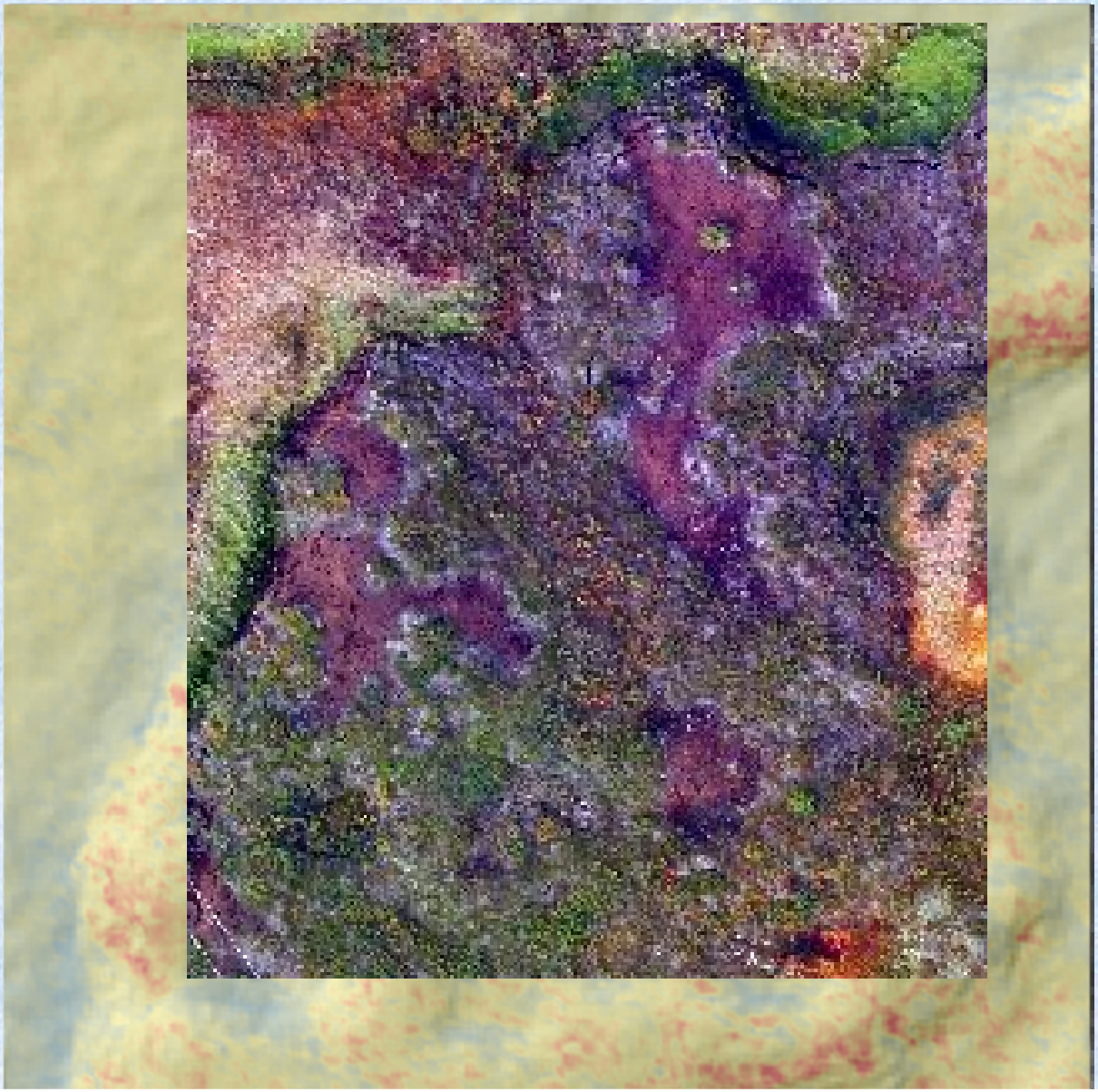


2 m resolution **6 cm resolution**

- **Zenmuse Xt**
  - **Thermal infrared sensor**
- **Bare turf surface**
  - **Active layer depth**



Conclusions

- Detailed RTK high accuracy GPS based palsa monitoring can follow accurately the development of palsa.
- In this research (2007-2017) of detailed field data collecting with expanded 50 years of aerial photographs we were able to follow accurately the decay of palsas in Käsivarsi area. On the basis of aerial photo survey palsa mire's have lost 50-60 % of palsa surface during the past 50 years.
- UAS has high potential in monitoring small sacle changes in palsasresearch -
  - Changes in topography, area, volume
  - Vegetation composition, structure
- With "rather" little effort (and money) it is possible to gather high quality data if certain procedures are followed (GCP, high overlap)

Kiitos /Thank you!