Changes of forest-tundra vegetation distribution in Kanentiavr key site (Kola Peninsula) since 1960

Valentina I. Kravtsova

Alexandra R. Loshkareva

Faculty of Geography, Moscow State University

The goal of investigation

to answer the question:

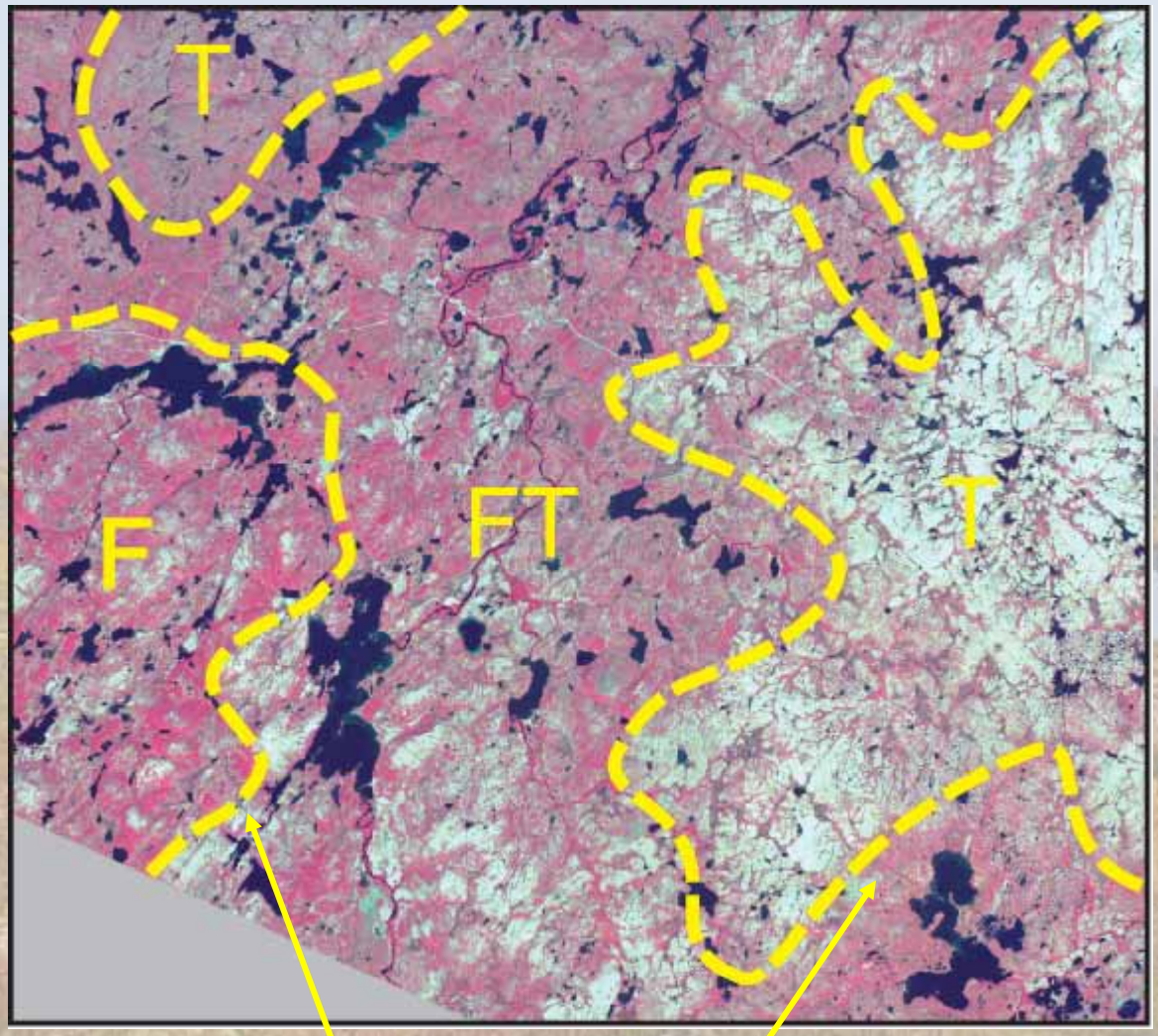
Are there any changes in boundaries and character of forest-tundra transition zone at Kola Peninsula for the last 50 years in context with climatic changes?

Investigations were carried out through remotely sensed images at the example of the Kanentiavr key site

Location of Kanentiavr key site at Kola Peninsula

Position 55 km to the east from Murmansk, 45 km south of Barents Sea shore.
Area 40x40 km, its center locates at 68º 50’ N, 34º 30’ E
Terrain of key site is a socle strata plain, with denudated hills (up to 300-350 m) and lakes in tectonic faults.
Three natural zones are combined here: forest, forest-tundra, tundra

Share of various types of vegetation in different natural zones in Kanentiavr key site



Northern forest line, Southern lichen tundra line

Forest zone (real forests, 5–10 m in height – 40%, sparse low scrub forests, 2-5 m in height, or shrub – 20%, swamps – 20%, dwarf shrub–lichen tundra at upper part of hills – 20%)

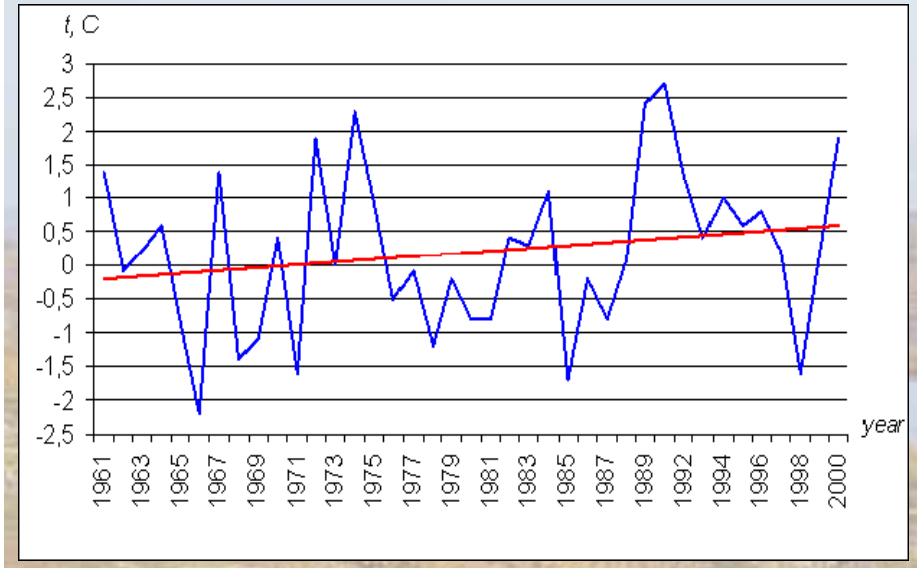
Forest-tundra zone (sparse low scrub forests or shrub – 60%, draft-shrub–mosses tundra, swamps and grass – 20%, real forests 10%, dwarf shrub –lichen tundra – 10%)

Tundra zone (dwarf shrub – lichen tundra – 70%, swamps and grass –20%, shrub and dwarf shrub – mosses tundra – 10%)

Changes of climatic conditions during the period under investigation (1960–2000)

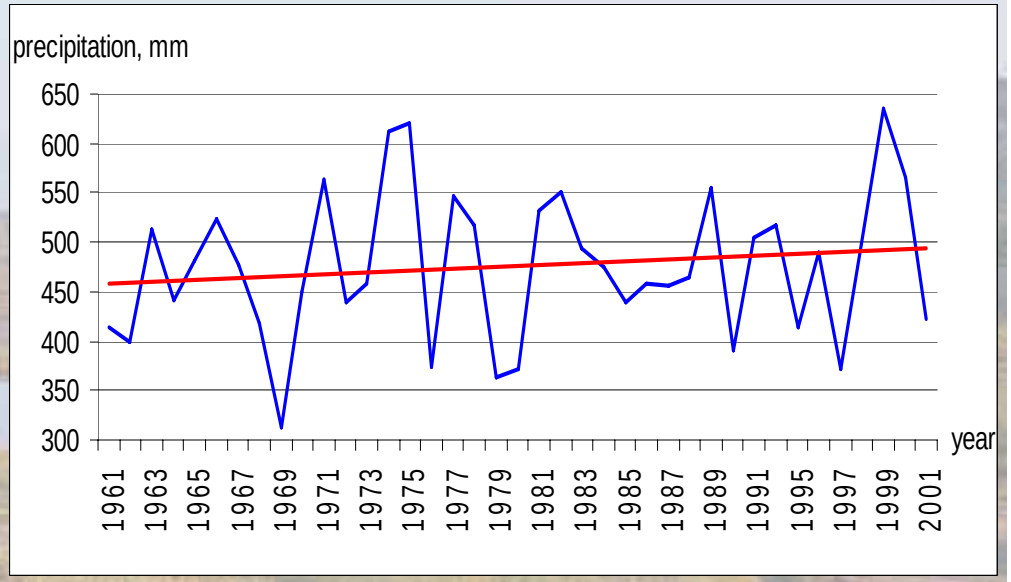
Meteostation Murmansk

Temperature



1960–2000 in total, warming by 0.7°

Precipitation



1960–2000 in total, increasing by 50 mm

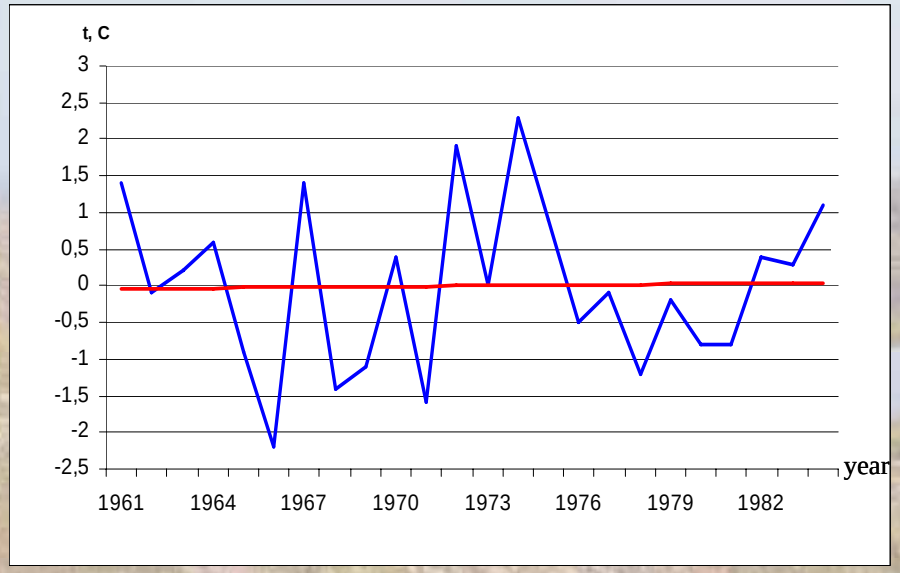
Trend line

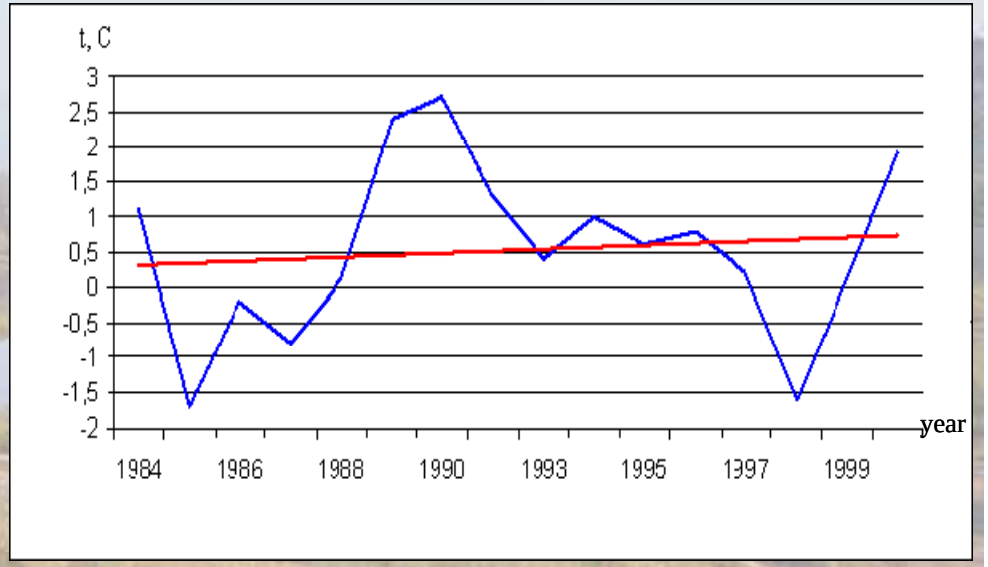
Mean annual air temperatures

Changes of climatic conditions during the period under investigation (1960–2000)

Meteostation Murmansk

Temperature





1961–1984, no warming

1984–2000, warming by 0.7º

Mean annual air temperatures

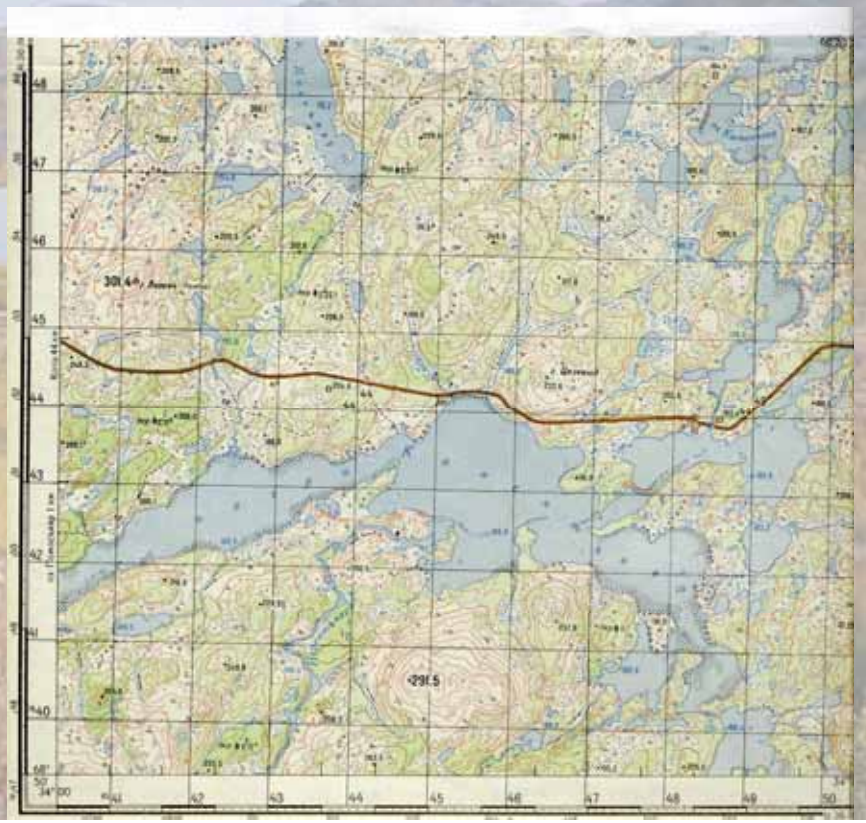
Trend line

Materials for multitemporal comparison
1960–1984

For the whole area of the key site:
topographic maps – 1962 (air survey 1961), 1:100 000
- 1990 (air survey 1984) 1:50 000

For 4 control and test sites:
air photos, R = 1m – 1961, 1:50 000
- 1984, 1:30 000

Additional materials for the whole area:
high altitude airphotos 1986, 1:200 000
Corona satellite images 1986, 1:200 000



Materials for multitemporal comparison 1984–2004

For 4 test sites:

Air photos 1961(1984), R=1 m

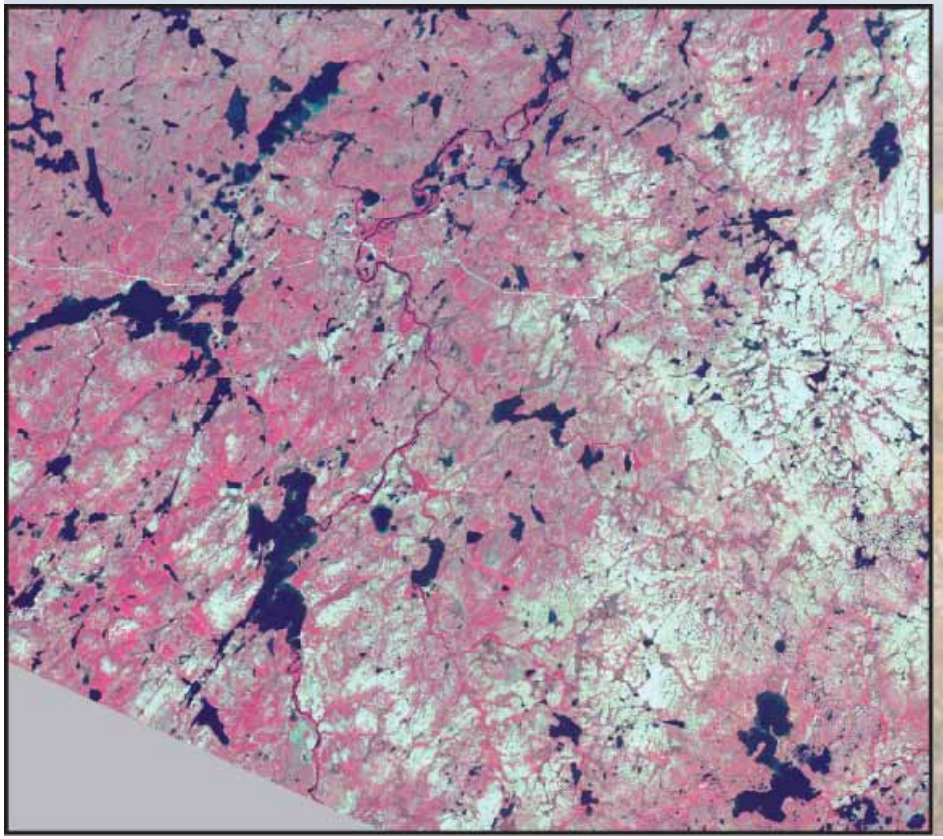
Satellite Terra/ASTER image, 2004 R=15 m

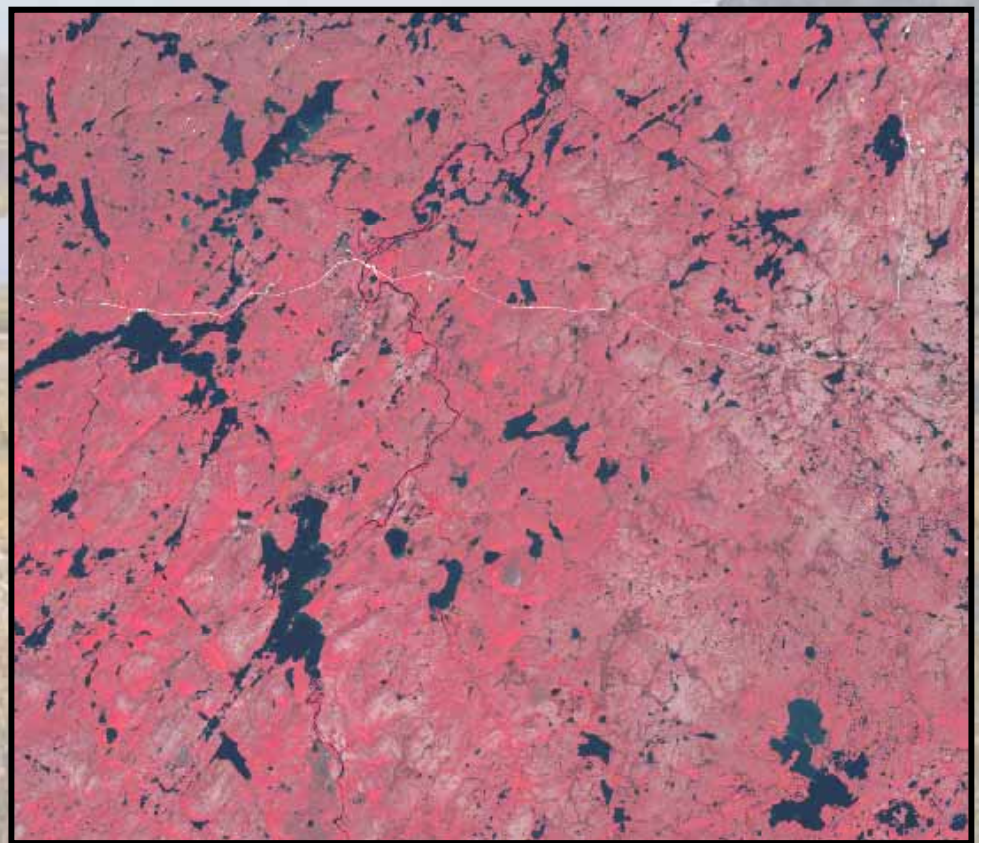
Additional materials:

Landsat/TM

Landsat/ETM+

Landsat/ETM+ in Google Earth





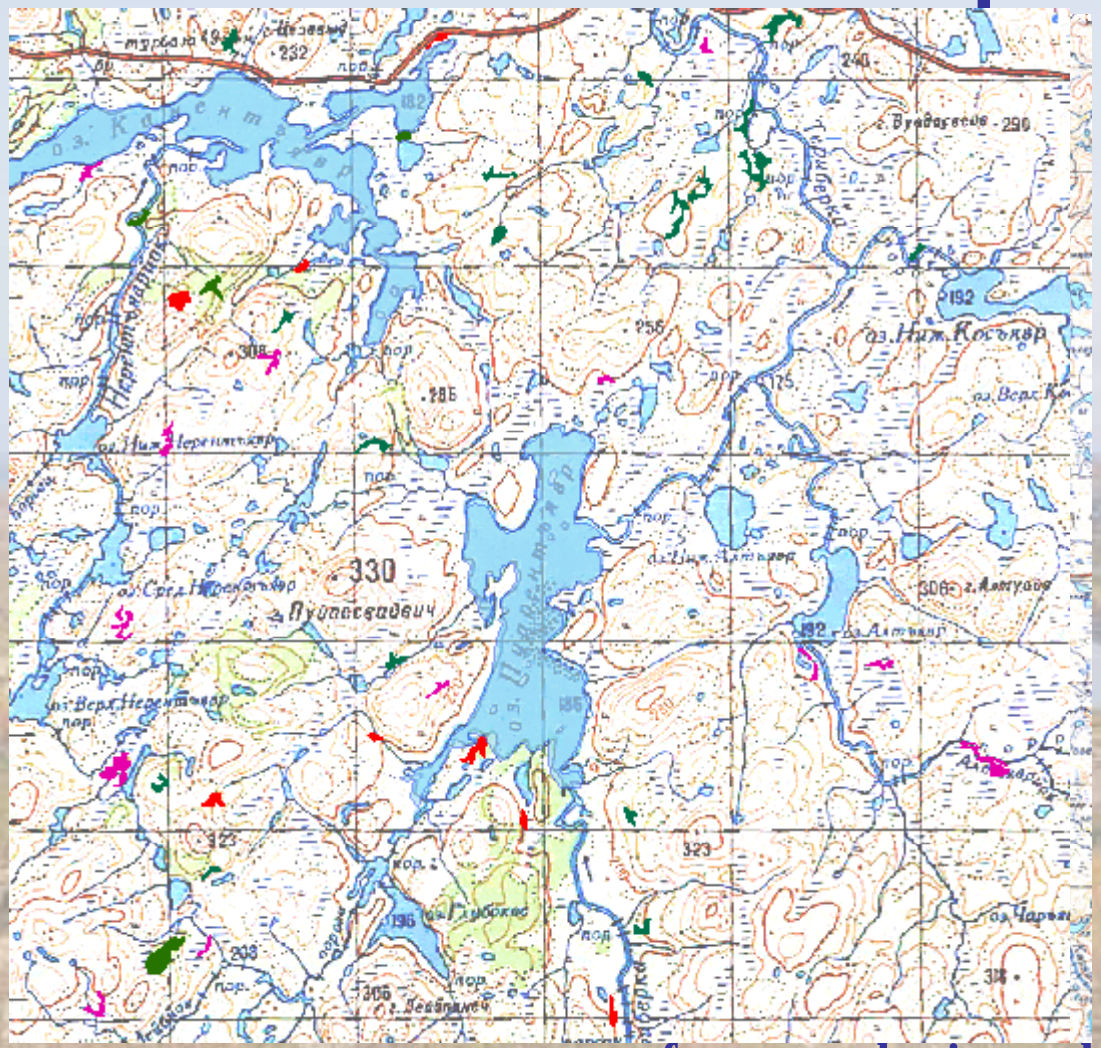
Discovering changes in boundaries and character of forest-tundra transition zone

For the first period of 1961-1984 a comparison of topographic maps, transformed to common scale and overlaid, was carried out.

Appearance and disappearance of forests and low scrub-forests/shrub plots were checked; all of them were digitized and mapped.

Originals of compared maps were in different scale, so correction for cartographic generalization was made (filtration of plots with area <4 mm^2 in accordance with official instructions for topographic maps compilation).

Map of changes in distribution of forest and low scrub-forest plots



- birch forests instead of forest-tundra
- forest-tundra instead of lichen tundra
- forest-tundra instead of birch forests
- lichen tundra instead of forest-tundra

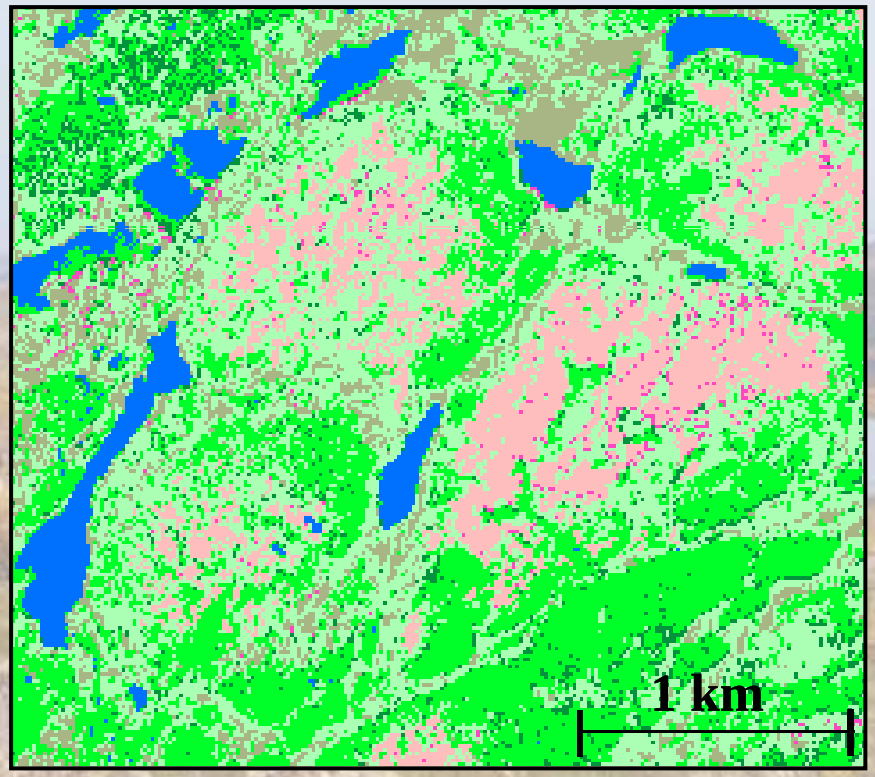
Here we represent results of checking changes in vegetation plots after correction for generalization:

The map of changes shows: Appearance of forest and low curve-forests – 43 plots (red), 4 km^2 in total area; Disappearance of them – 31 plots (green), 3 km^2 in total area.

BUT

Verification of this map by comparison of air photos 1961 and 1984 for 4 test sites had shown no changes for this period.

Checking results of multitemporal maps comparison by air photos 1961 - 1984



No changes:

- Birch forests
- forest-tundra
- Dwarf shrub-lichen tundra
- lakes

Overlay of classified photos shows no changes

Conclusions for the first stage of investigations:

comparison of air photos 1961 and 1984 shows no changes in vegetation distribution for the first period, when no warming was observed;

topographic maps of the scale 1:50 000–1:100 000 can not be used for our goals.

Changes of vegetation for the second period 1984–2004

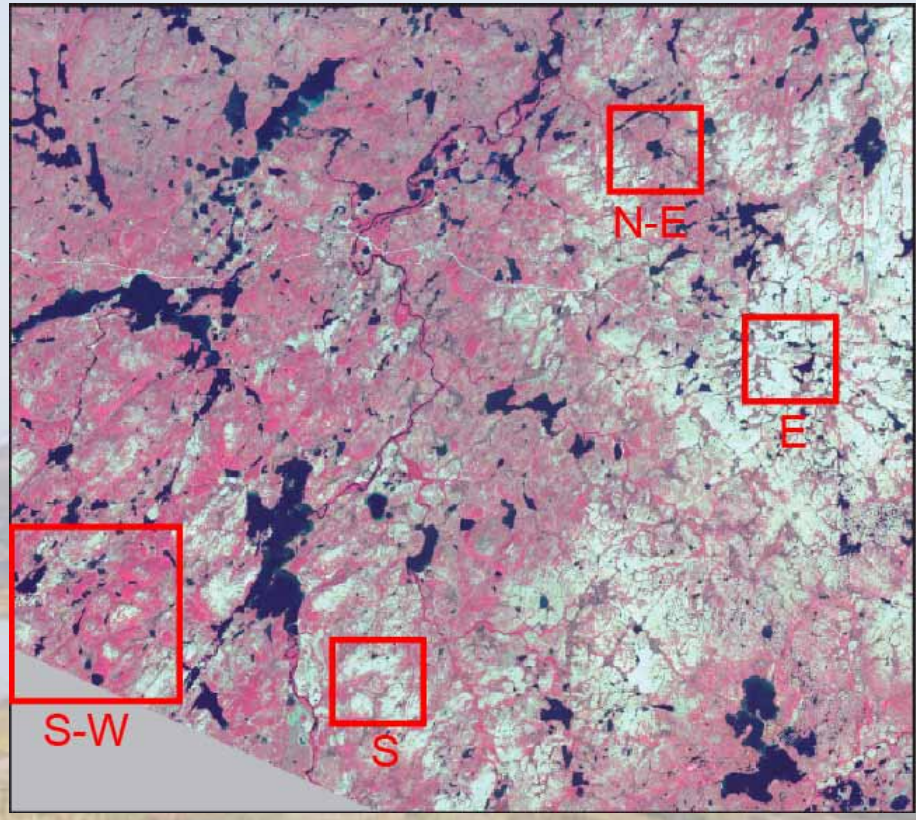
For the second period 1985–2004, when the warming was noted, the comparison between airphotos 1961(1984) and ASTER images was made for test sites located in different natural zones:

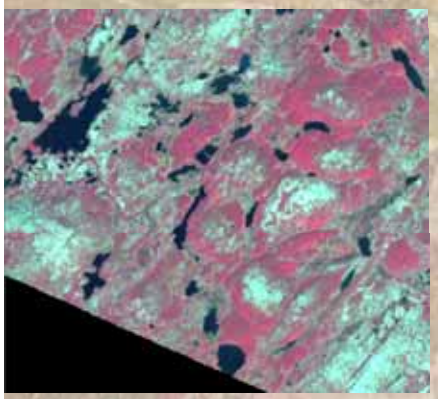
1 – S-W, in forest zone, near the northern forest line;

2 – S, inside forest-tundra zone;

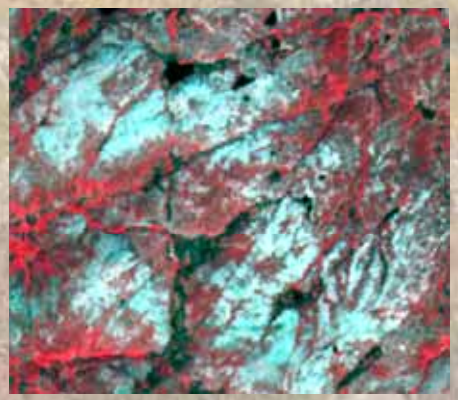
3 – E, in lichen tundra zone, in its central part;

4 – N-E, in lichen tundra zone, lowlands near its southern boundary.

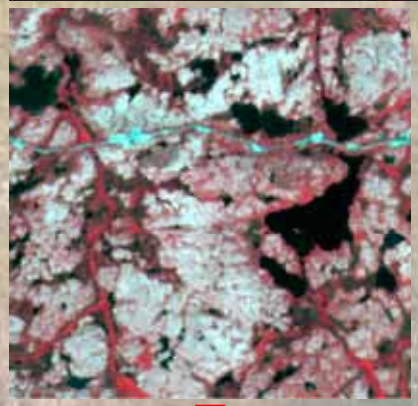




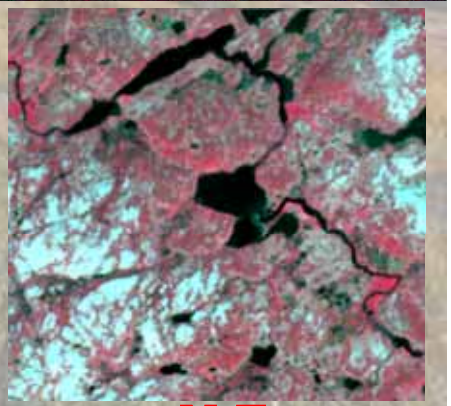
S-W



S



E

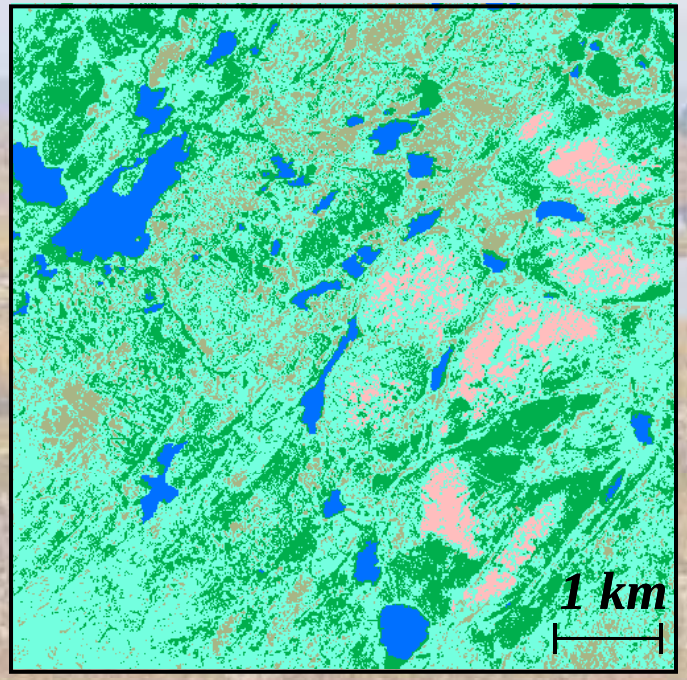


N-E

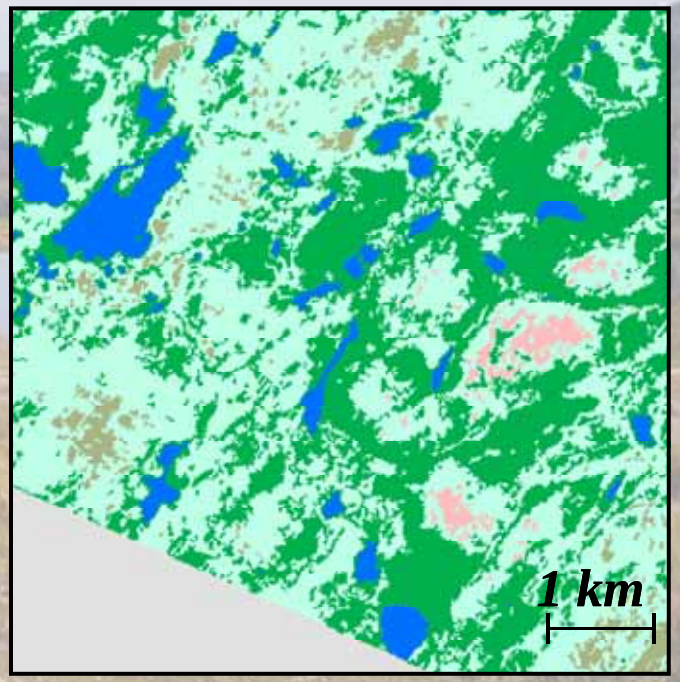
Changes of vegetation in SW test site

Air photo 8 August 1961 and satellite image ASTER 30 July 2004, classified into:

- birch forests
- forest-tundra
- dwarf shrub-lichen tundra
- lakes



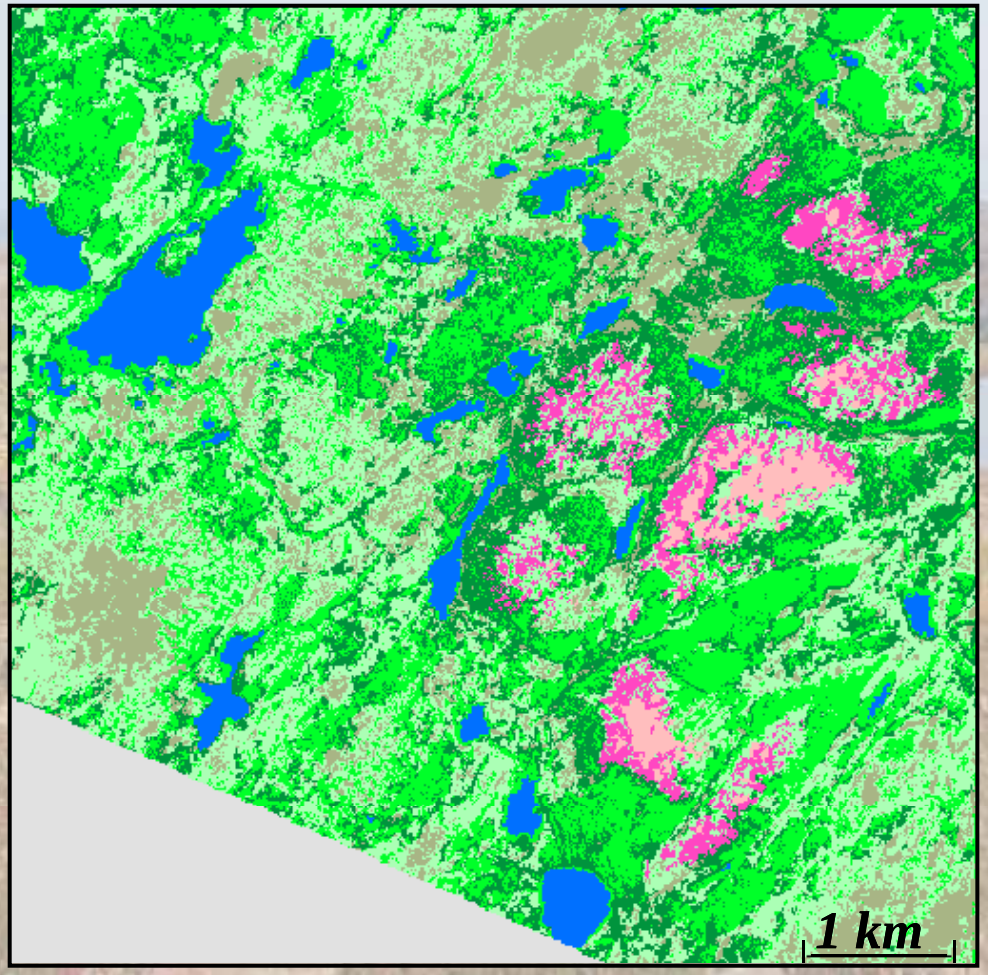
Air photo 8 August 1961



ASTER 30 July 2004

Changes of vegetation in SW test site

Map of changes in distribution of vegetation is compiled as a result of overlay of classified images of 1961 and of 2004:



Changes:

- Birch forests instead of forest-tundra
- forest-tundra instead of lichen tundra

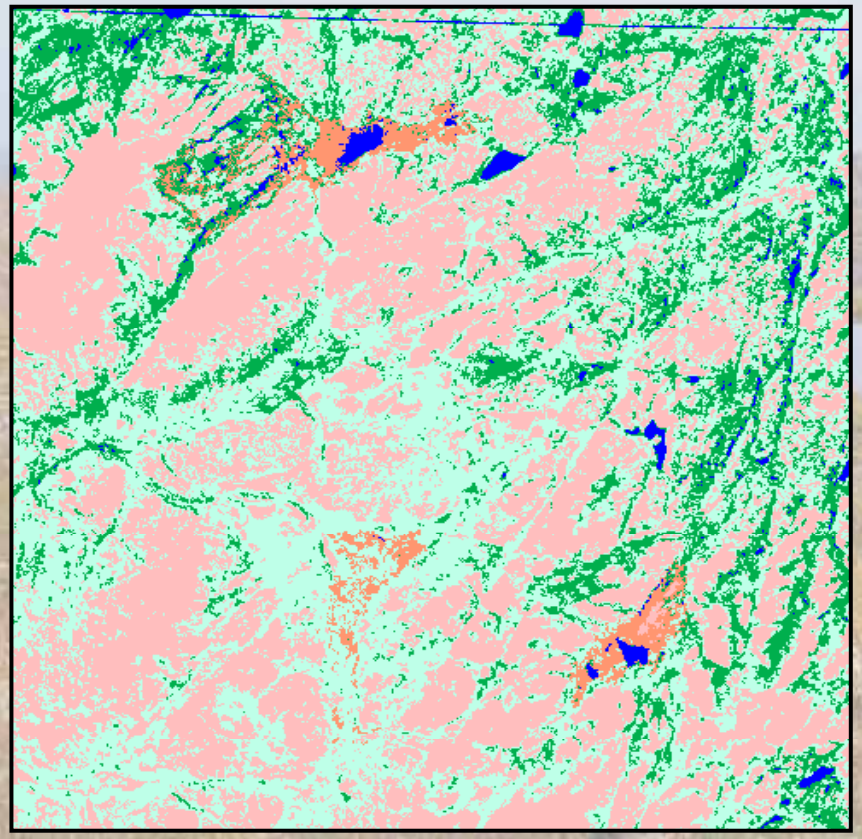
No changes:

- Birch forests
- forest-tundra
- Dwarf shrub-lichen tundra
- Stone surface and swamps
- lakes

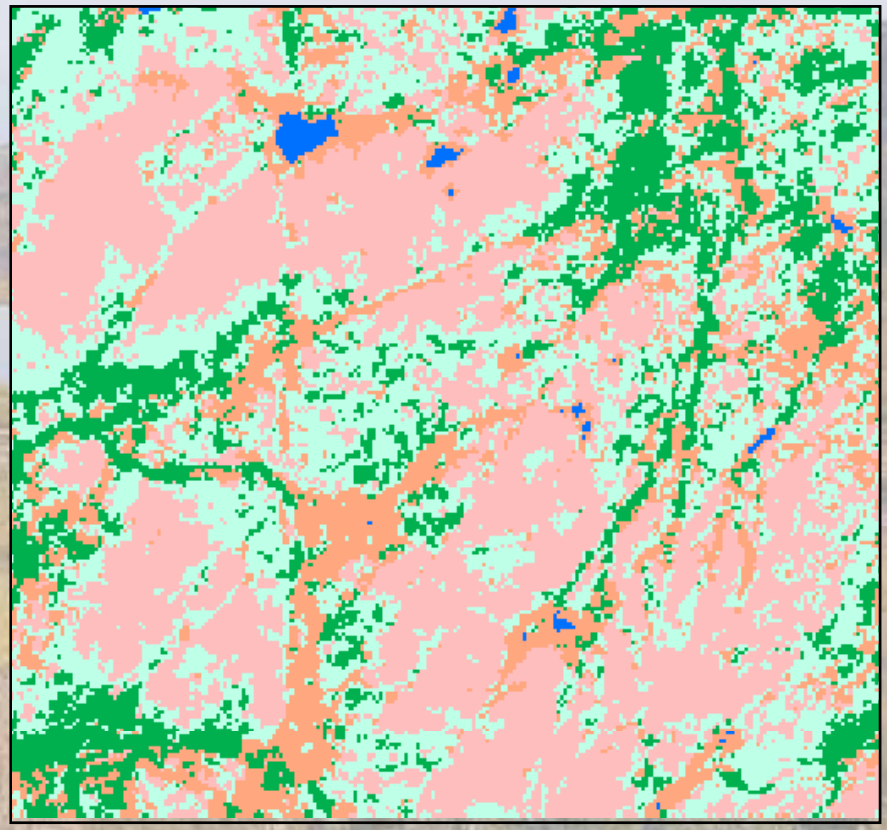
Changes of vegetation in S test site

Air photo of 8 August 1961 and satellite image ASTER of 30 July 2004, classified to:

- birch forests
- forest-tundra
- dwarf shrub-lichen tundra
- swamps
- lakes



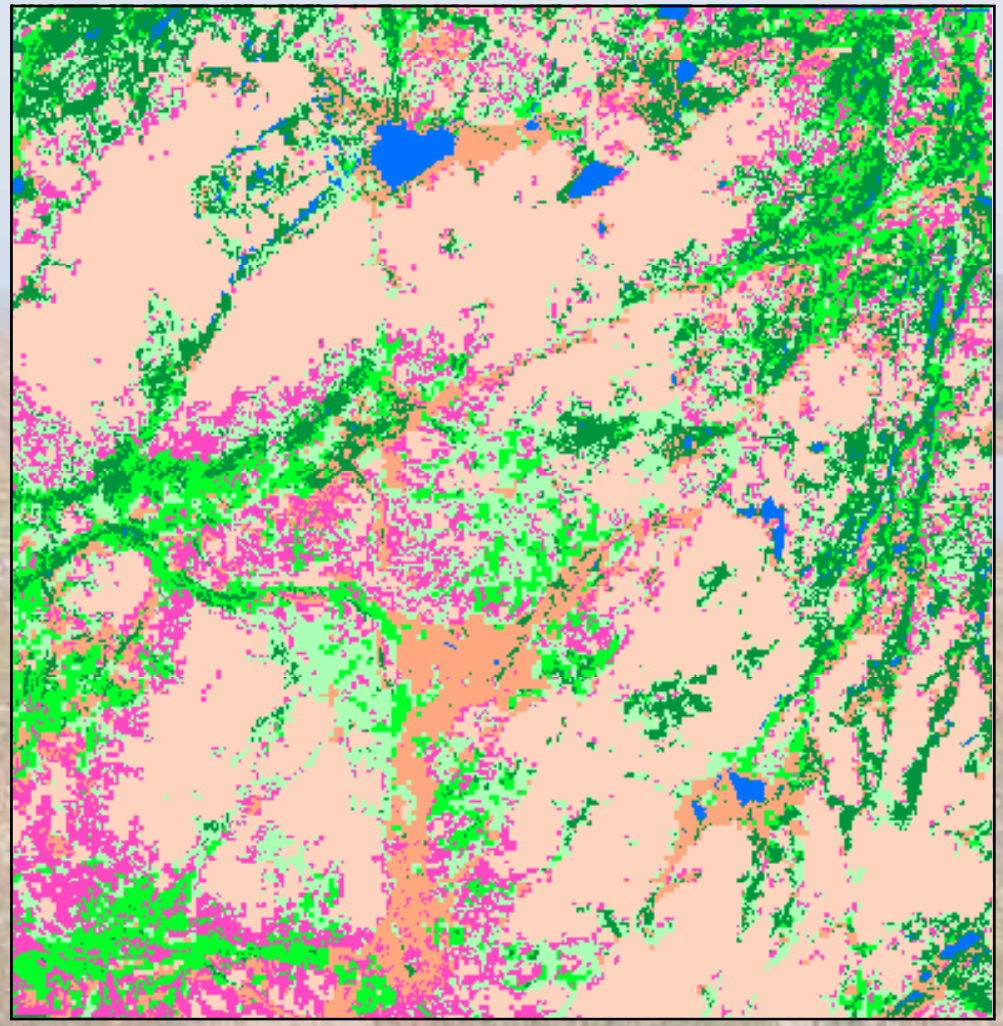
Air photo 8 August 1961



ASTER 30 July 2004

Changes of vegetation in S test site

Map of changes in distribution of vegetation is compiled as a result of overlay of classified images of 1961 and 2004:



Changes:

- thickening of shrub and dwarf-shrub vegetation in forest-tundra
- forest-tundra instead of lichen tundra

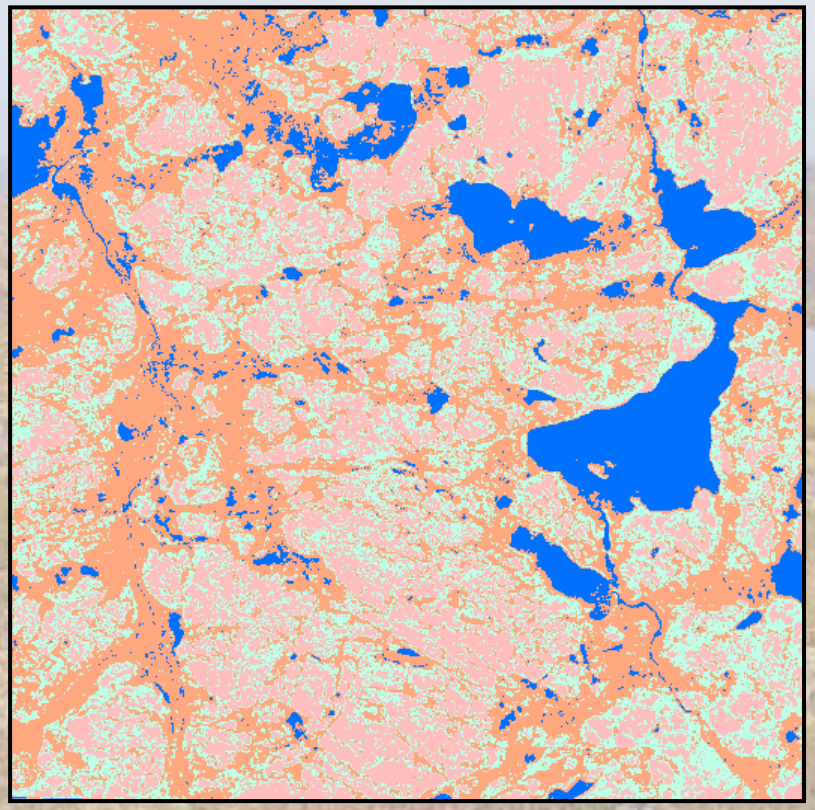
No changes:

- birch forests
- forest-tundra
- dwarf shrub-lichen tundra
- swamps
- lakes

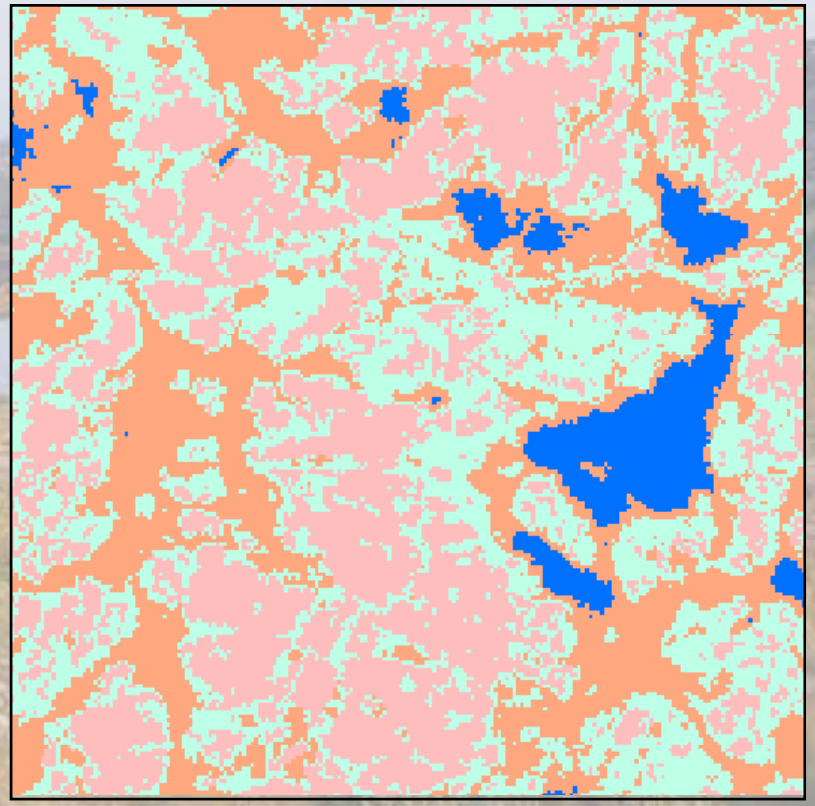
Changes of vegetation in E test site

Air photo of 8 August 1961.10.08 and satellite image ASTER of 30 July 2004, classified to:

- forest-tundra
- dwarf shrub-lichen tundra
- swamps
- lakes



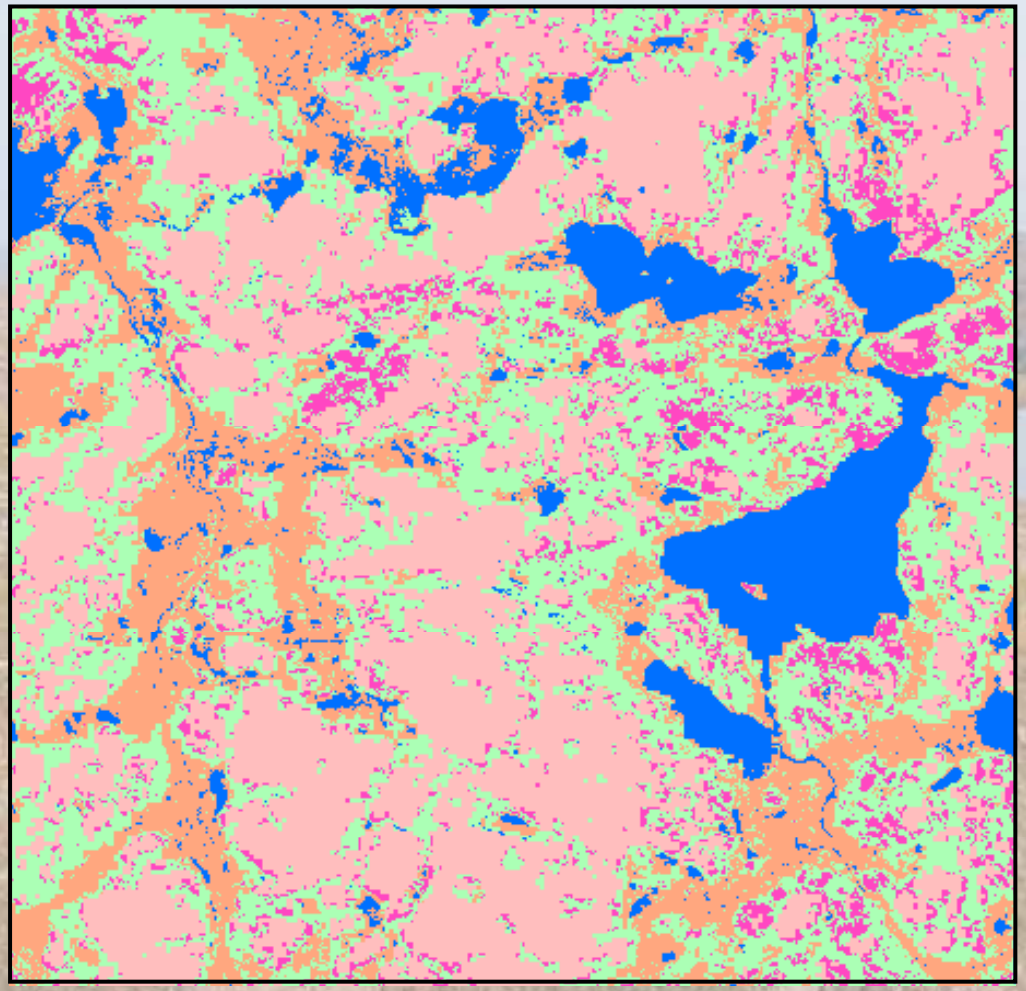
Air photo 8 August 1961



ASTER 30 July 2004

Changes of vegetation in E test site

Map of changes in distribution of vegetation is compiled as a result of overlay classified images of 1961 and of 2004:



Changes:

- forest-tundra instead of lichen tundra

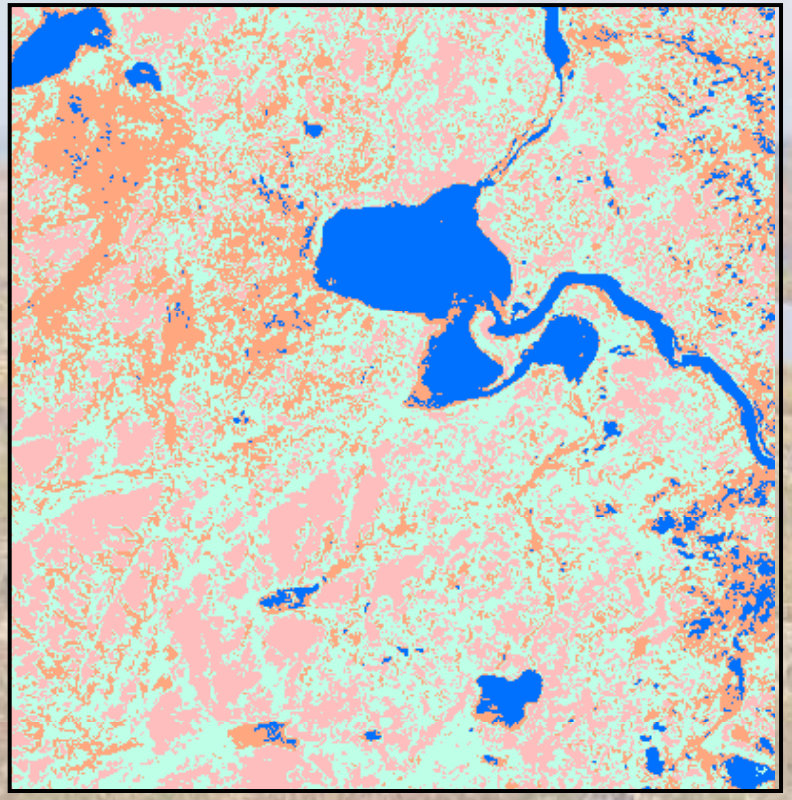
No changes:

- forest-tundra
- dwarf shrub-lichen tundra
- swamps
- lakes

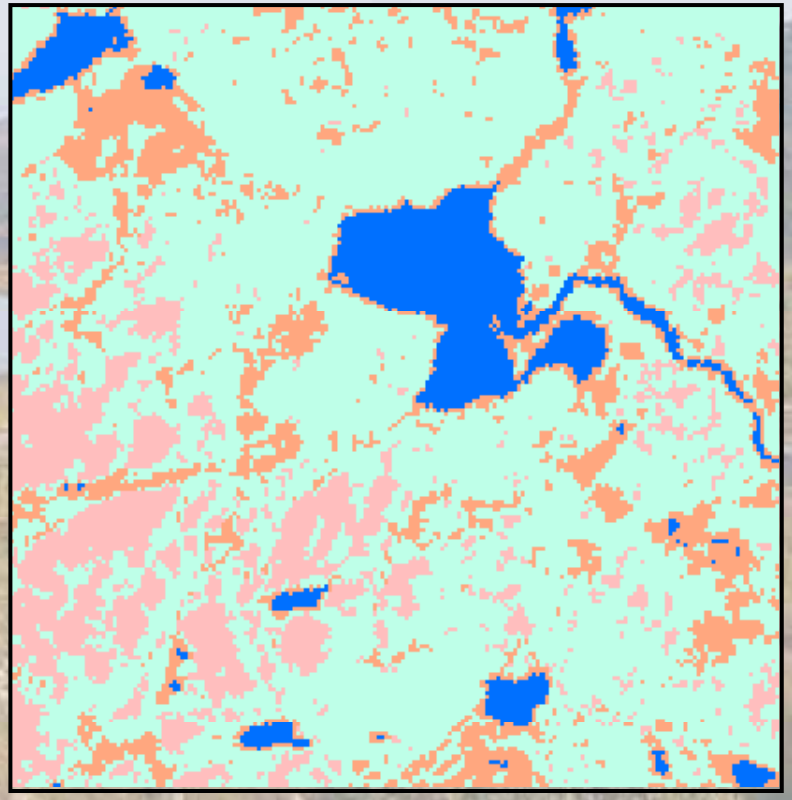
Changes of vegetation in NE test site

Air photo of 8 August 1961 and satellite image ASTER of 30 July 2004, classified to:

- forest-tundra
- dwarf shrub-lichen tundra
- swamps
- lakes



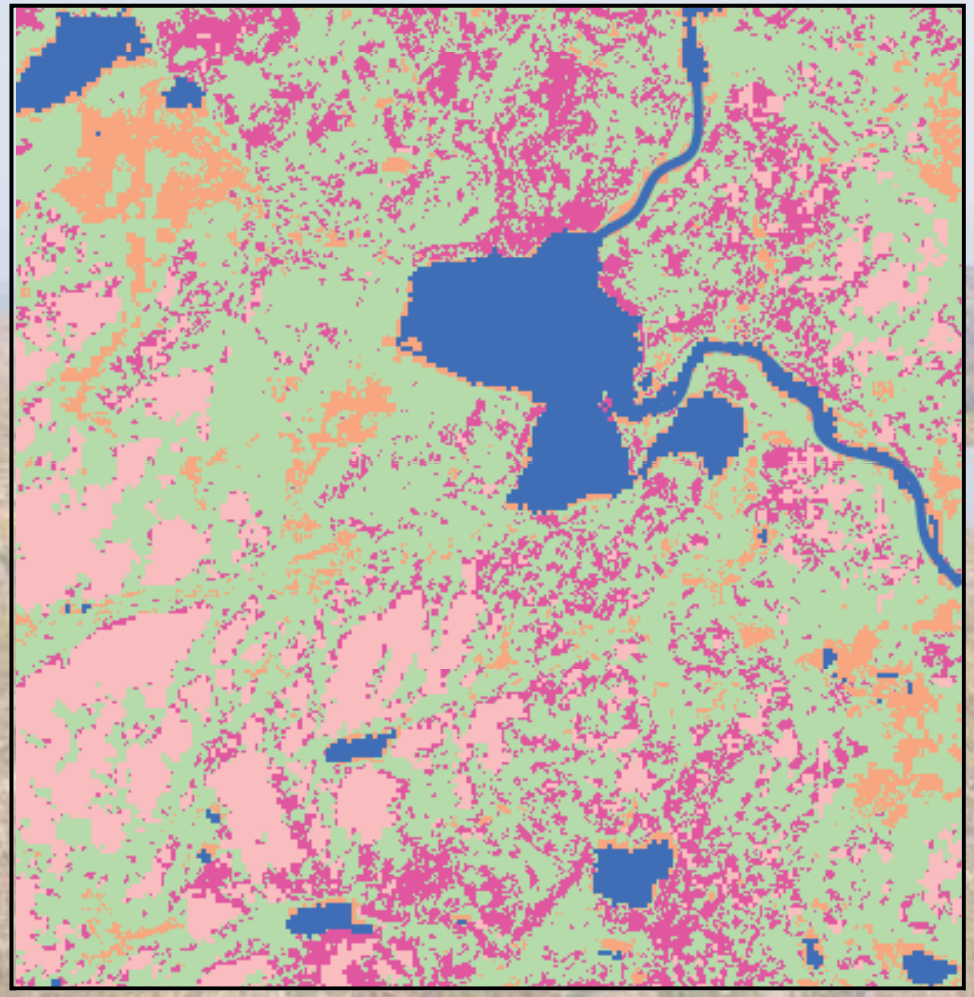
Air photo 8 August 1961



ASTER 30 July 2004

Changes of vegetation in NE test site

Map of changes in distribution of vegetation is compiled as a result of overlay of classified images of 1961 and of 2004:



Changes:

- forest-tundra instead of lichen tundra

No changes:

- forest-tundra
- dwarf shrub-lichen tundra
- swamps
- lakes

Conclusion

Forest-tundra vegetation distribution in Kanentiavr key site had not changed in the period 1961-1984, when no warming was observed, but it experimented noticeable changes in period 1984-2004, when the overall warming was 0.7°C.

Various kinds of changes were discovered in different parts of the territory:

- **In birch forests zone (S-W test site) increase of forest area takes place due to thickening of shrubs.**
- **Inside the forest-tundra zone (S test site) thickening of shrub and dwarf shrub vegetation is seen in some places.**
- **In dwarf shrub-lichen tundra zone (E test site) at elevated parts of the territory, there are practically no changes. But in the lowest part of the tundra zone (N-E test site) decrease of lichen area took place.**

These conclusions were made by multitemporal image analysis for the test sites. In future investigations we are planning to cover the whole territory of the key site.


Thank you for attention