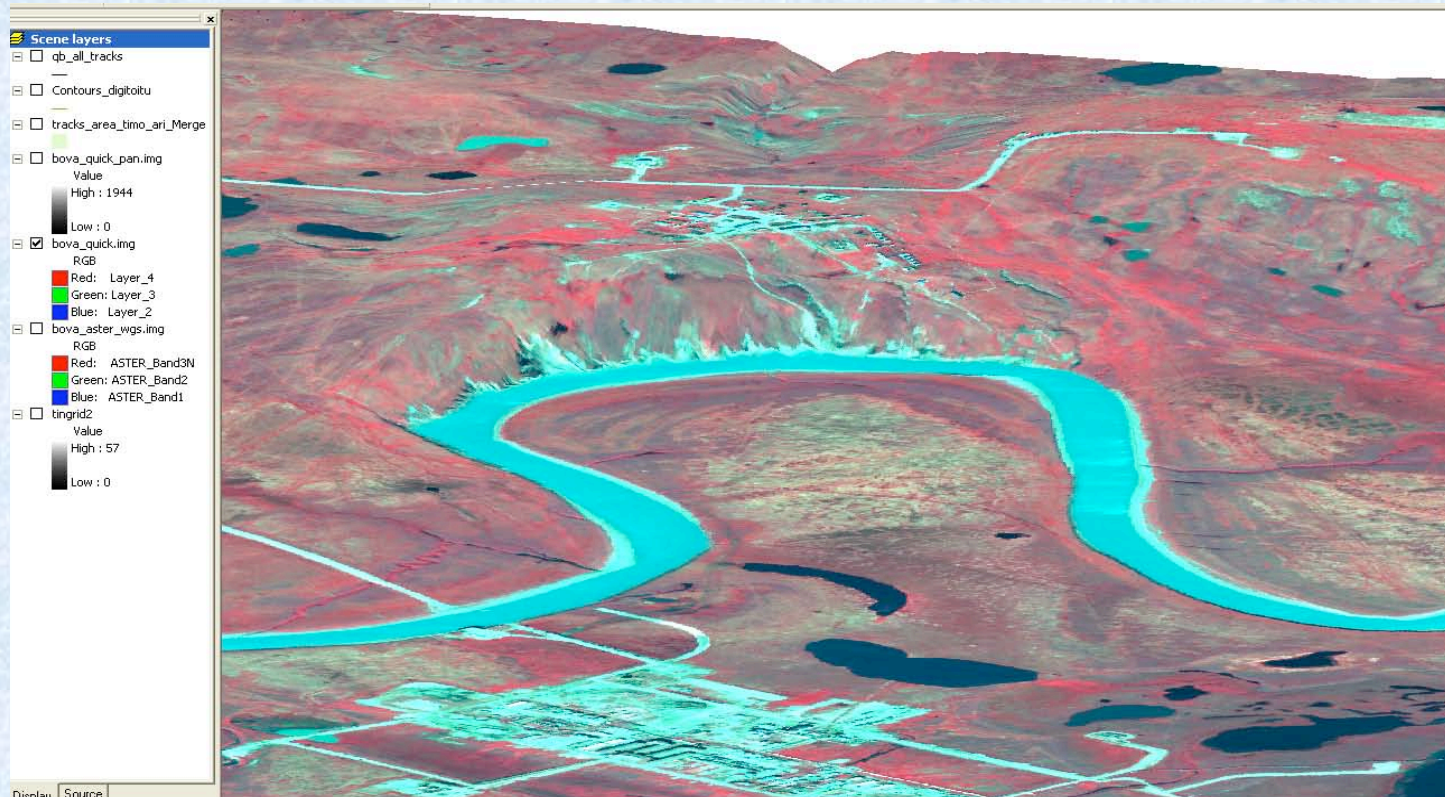


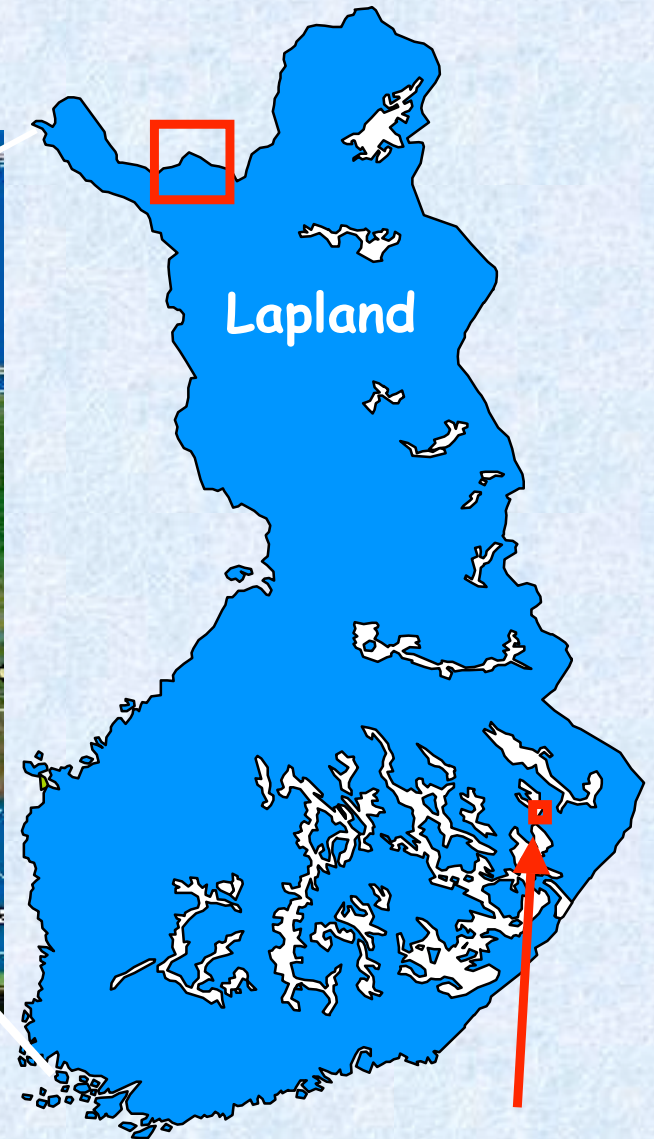
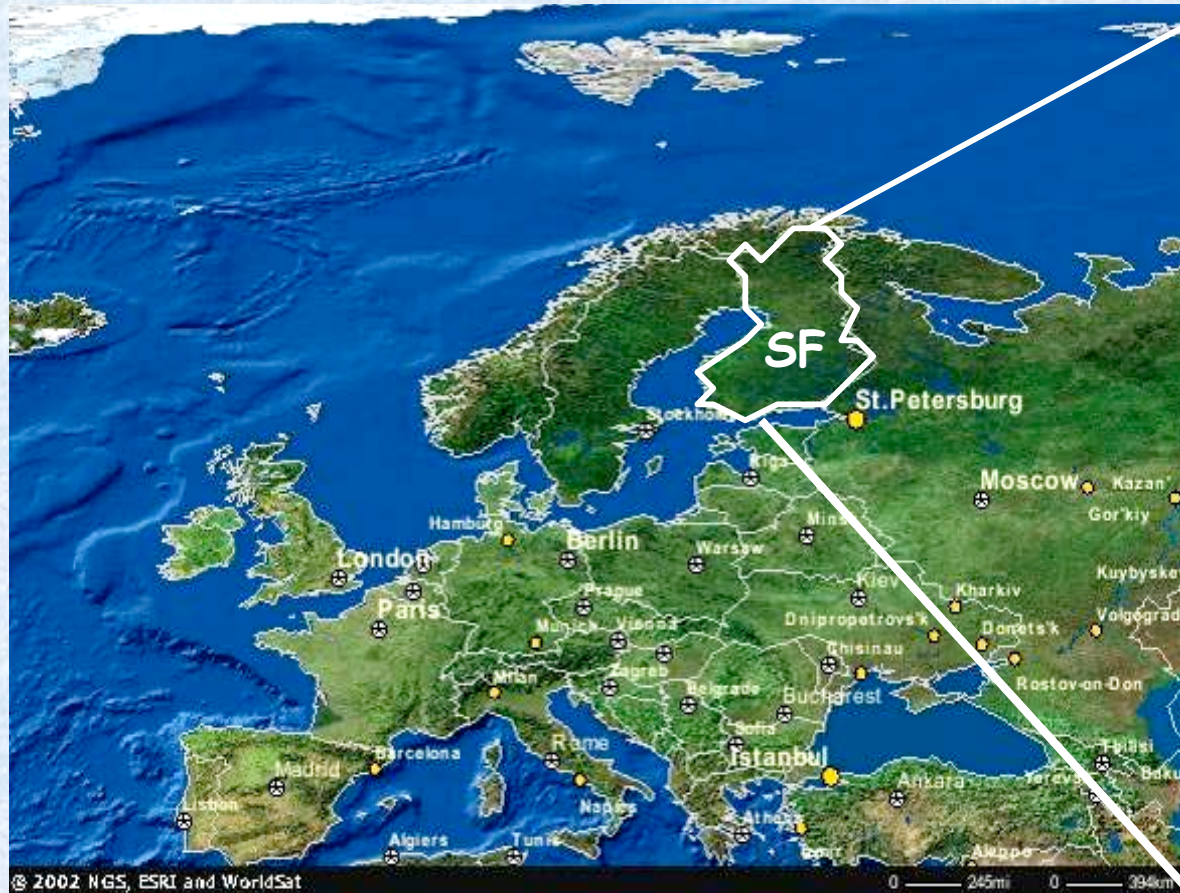
Remote sensing of land-use /land-cover change in the Bovanenkovo gas field on the Yamal peninsula, Russia



Workshop:
Yamal Land-Cover Land-Use Change Workshop
Moskova, 28-30 January 2008

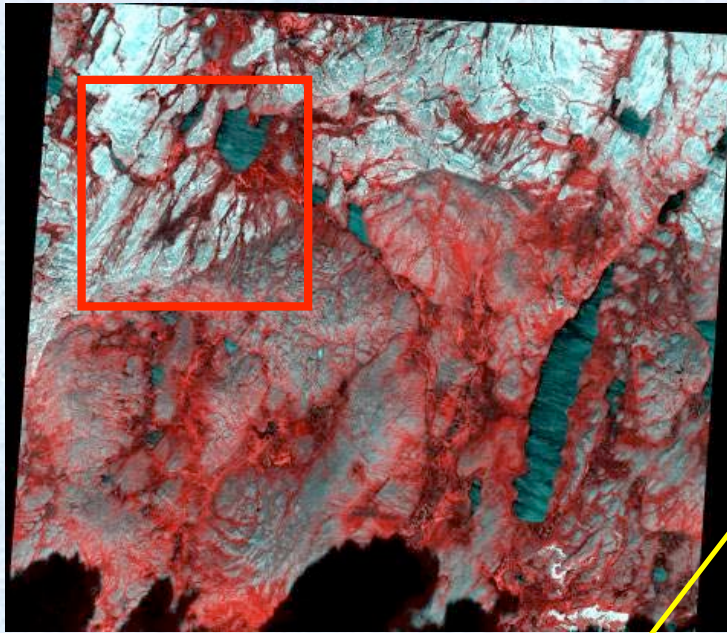


Timo Kumpula
Department Of Geography
University of Joensuu

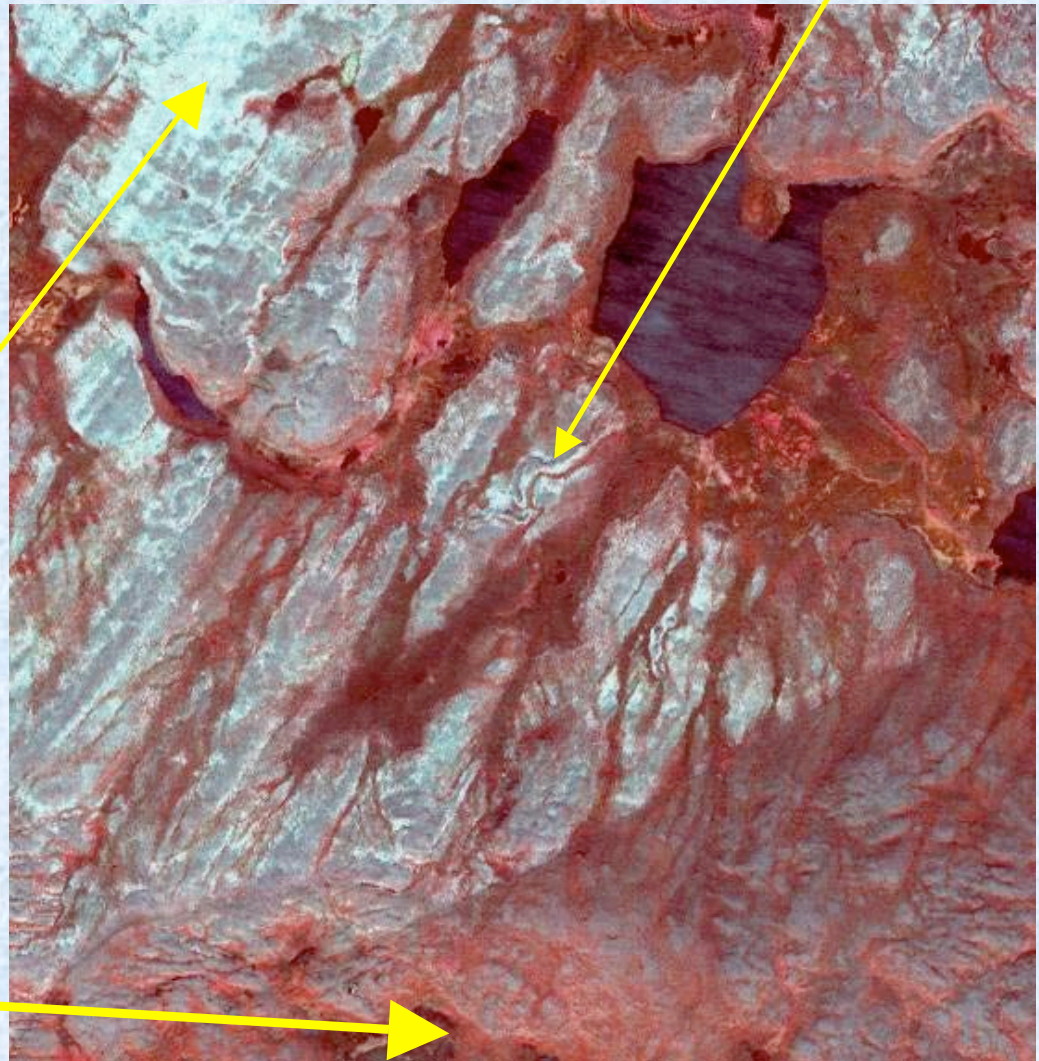


Joensuu

Jauristunturit research area



depression with thick snow cover



low grazed
lichen pasture

Heavy trampled and
grazed lichen
pasture

Lichen dominated winter pastures



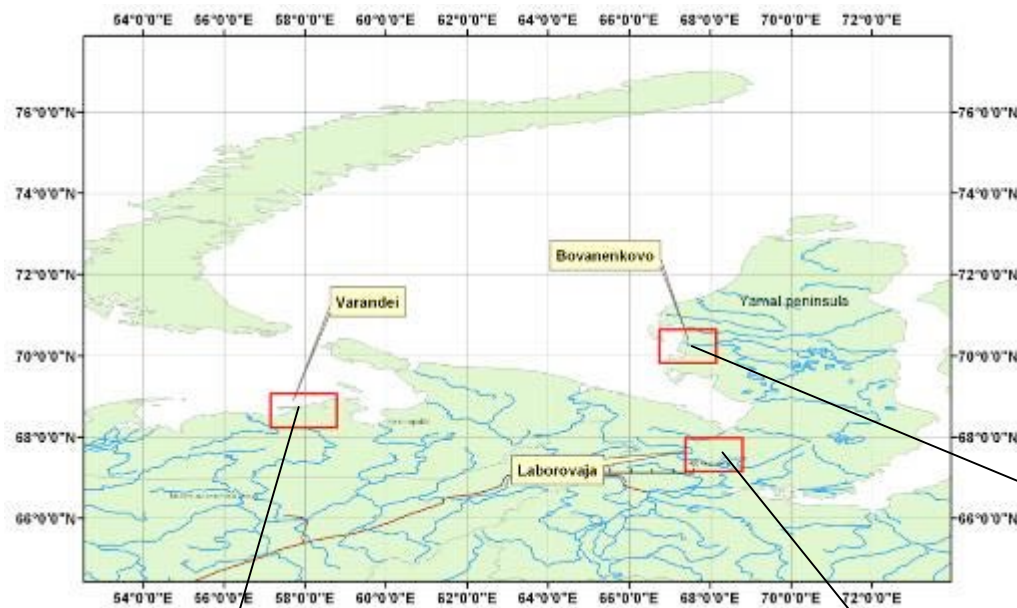
Cladina stellaris



**Crustacea
lichens +
shrubs**



Cladina stellaris
Betula nana



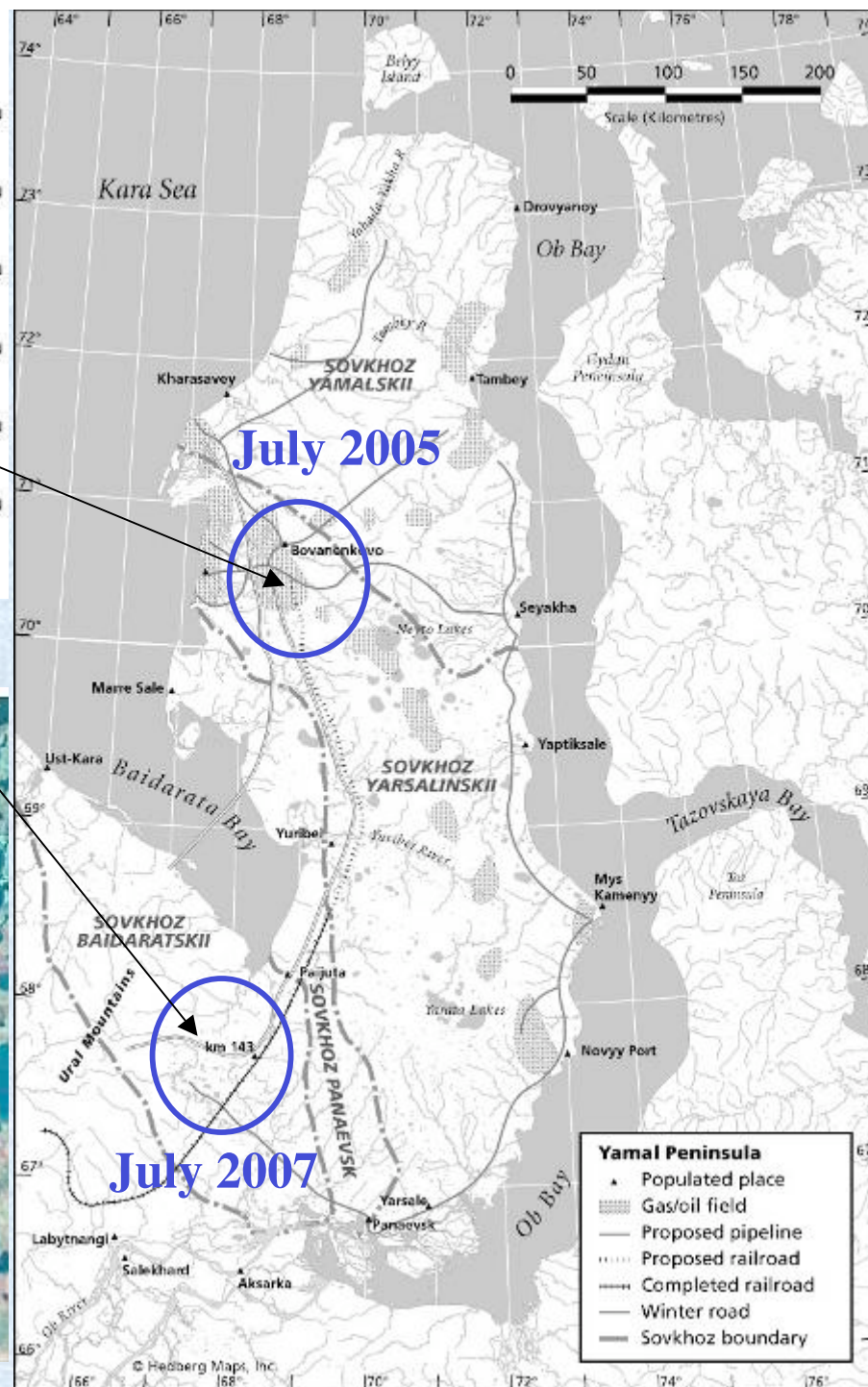
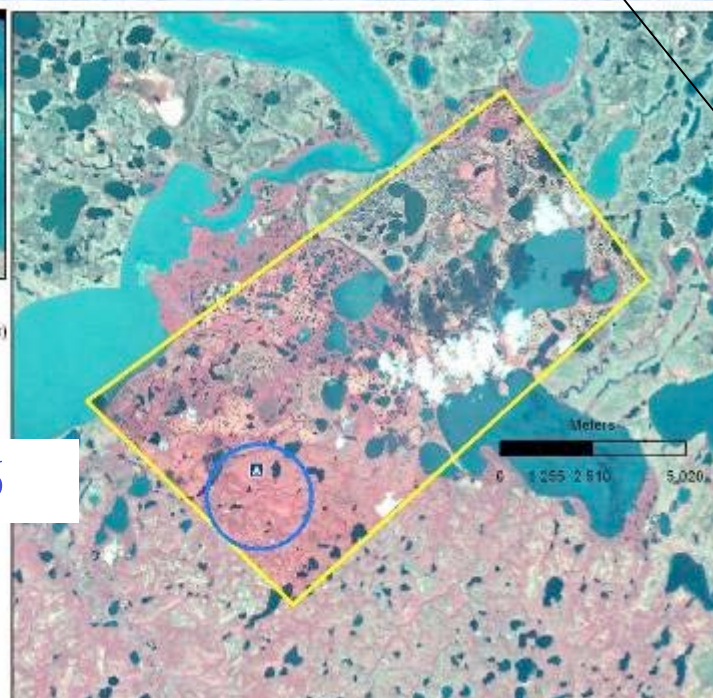
Research areas



Study area:
Extensive field study area (yellow box)
Data: Quicbird-2 image 2.8.2005

Larger area:
Data: Landsat TM 1988

July 2006



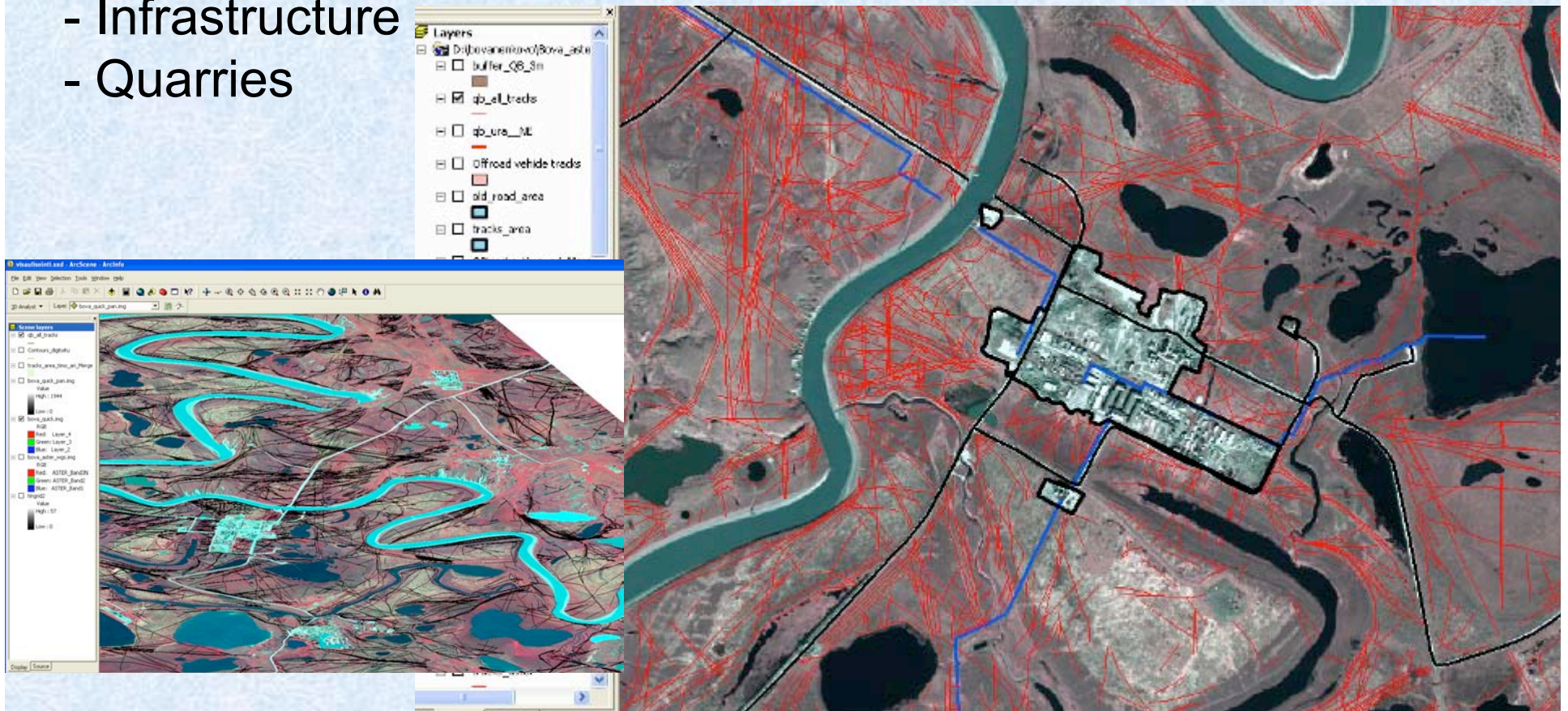
Remote sensing data

- | | |
|--------------------------|-----------|
| • Landsat TM 1984 | 28 August |
| • Landsat TM 1988 | 07 August |
| • Landsat ETM 1999 | 07 July |
| • Landsat ETM 2000 | 08 July |
| • Landsat MSS 1985 | 28 July |
| • SPOT 1993 | 29 July |
| • SPOT 1998 | 19 July |
| • ASTER TERRA 2001 | 24 July |
| • Quickbird-2 2004 | 28 July |
| • Corona 1969 (south of) | ?? July |

Visual interpretation of impacts, digitizing:

-Digital elevation model from 1: 100 000 maps

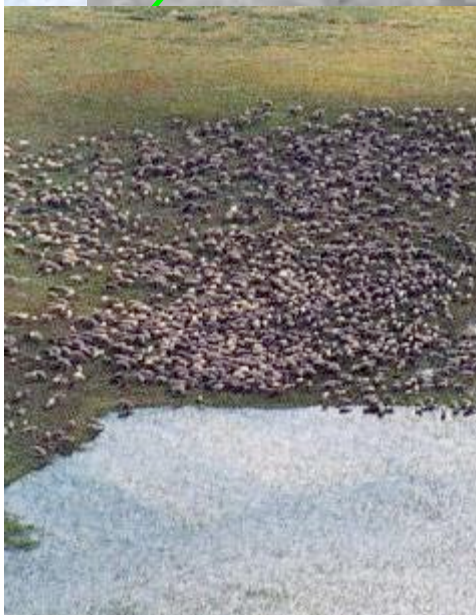
- Road network
- Pipeline network
- Off road vehicle track network
- Infrastructure
- Quarries

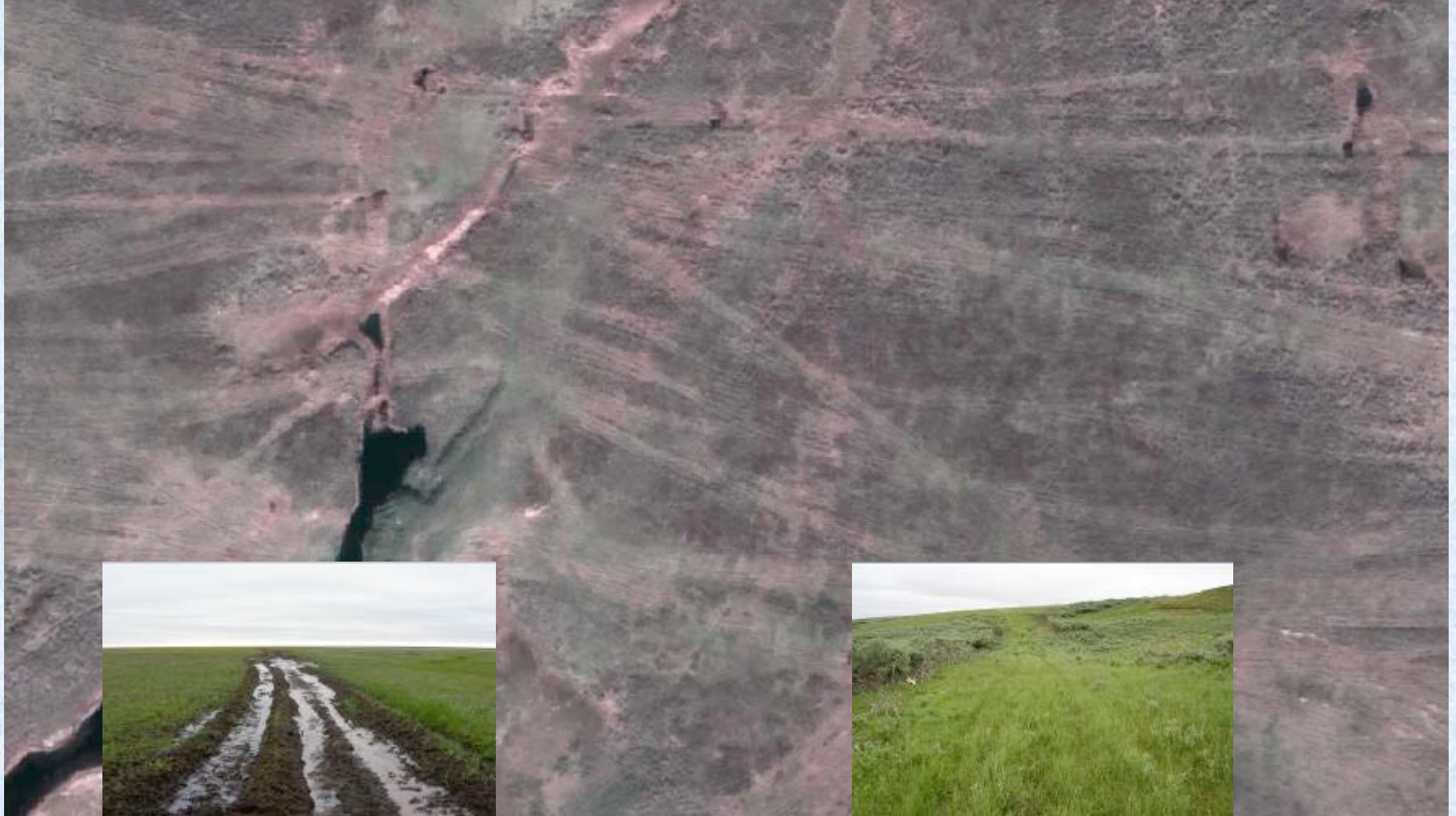


Detectivity	Field survey	Quickbird-2 Panchromatic	Quickbird-2 Multispectral	ASTER TERRA VNIR	Landsat TM	Landsat MSS
Impact						
Soil contamination, oil & chemicals	X	—	—	—	—	—
Removal of top soil and vegetation	XXX	XXX	XXX	XX	X	X
Quarries	XXX	XXX	XXX	XXX	XX	X
Garbage						
- metal	XX	—	—	—	—	—
- glass	X	—	—	—	—	—
- concrete	XXX	X	X	—	—	—
- wood	XXX	X	—	—	—	—
Pipelines	XXX	XX	X	—	—	—
Powerlines	XXX	XX	X	—	—	—
Roads	XXX	XXX	XXX	XXX	X	X
Offroad tracks	XX	XXX	XX	XX	X	X
Winter roads	XX	XX	XX	XX	X	—
Drill towers	XXX	XXX	XX	X	—	—
Barracks	XXX	XXX	XX	X	—	—
Trucks/Vehicles	XXX	XX	X	—	—	—
Changes in hydrology	XXX	XXX	XX	XX	X	X



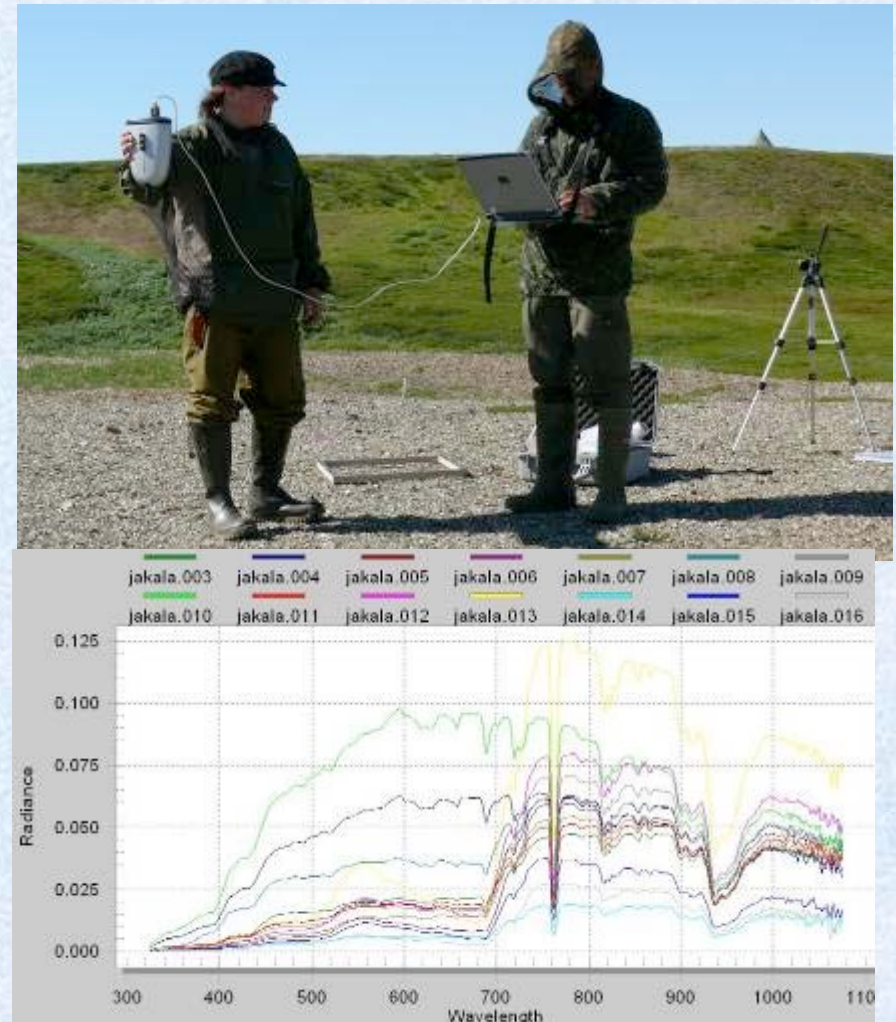
Quickbird-2 panchromatic
(63 cm resolution) 15.7.2004 (Yamal)
2 nd brigade from yarsalins
- 4 chums with sledges





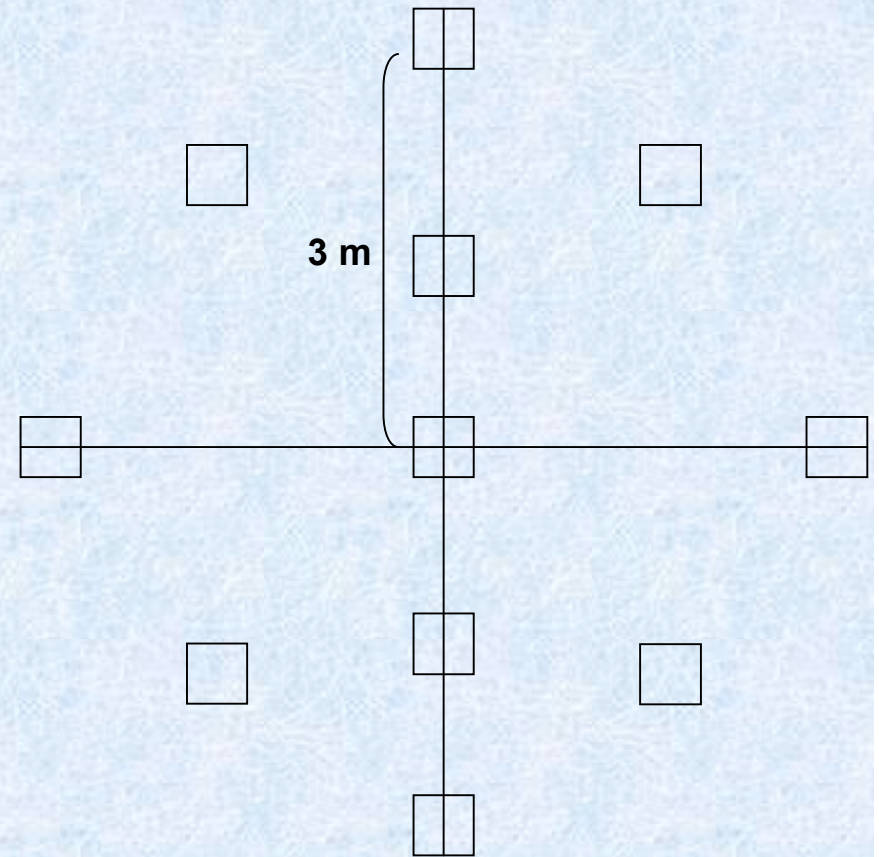
Spectrometer measurements Km 147

- ASD field spectrometer
reflectance 325- 1050 nm
- Measured reflectance:
 - main vegetation types
 - main bare ground types
 - main species



Field measurements:

- 11 sites/types
- 11 measurements per site
- 1m height
- 10 degree lens (17 cm on ground)
- cloud free days
- 10:30-13:00



Species measurements: dry and wet

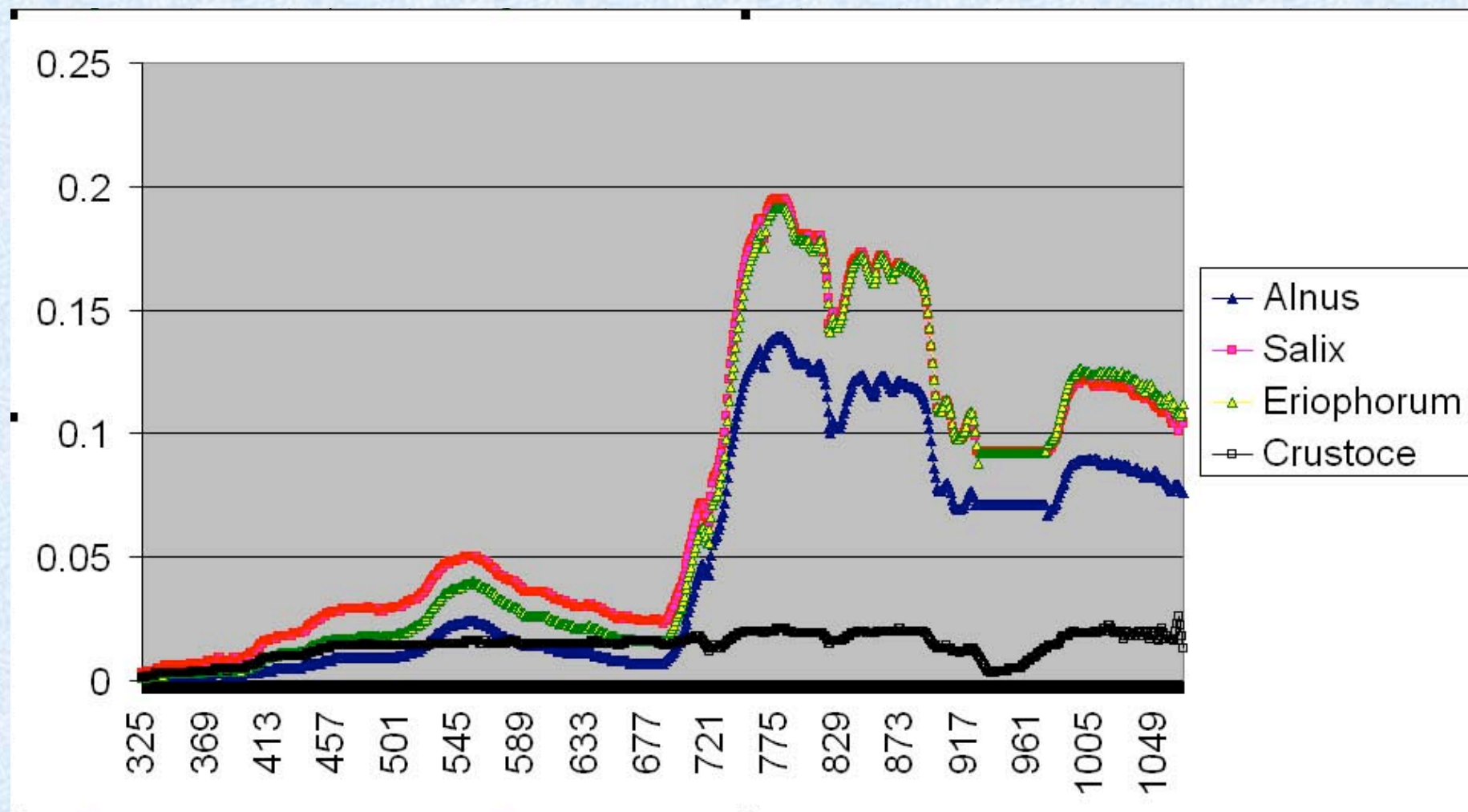
- *Alnus*
- *Dryas*
- *Empetrum*
- *Equisetum*
- *Salix lanata*
- *Salix polaris*
- *Arctostaphylos alpina*
- *Vaccinium vitis-idaea*
- *Vaccinium uliginosum*
- *Betula nana*
- *Festuca*
- *Polytrichum*
- *Aulacomnium*
- *Sphagnum*
- *Dicranum*
- *Racomitrium*
- Crustaceous lichens

+

- Sand
- gravel
- Quarry



ASD field spectrometer reflectance 325- 1050 nm of individual species

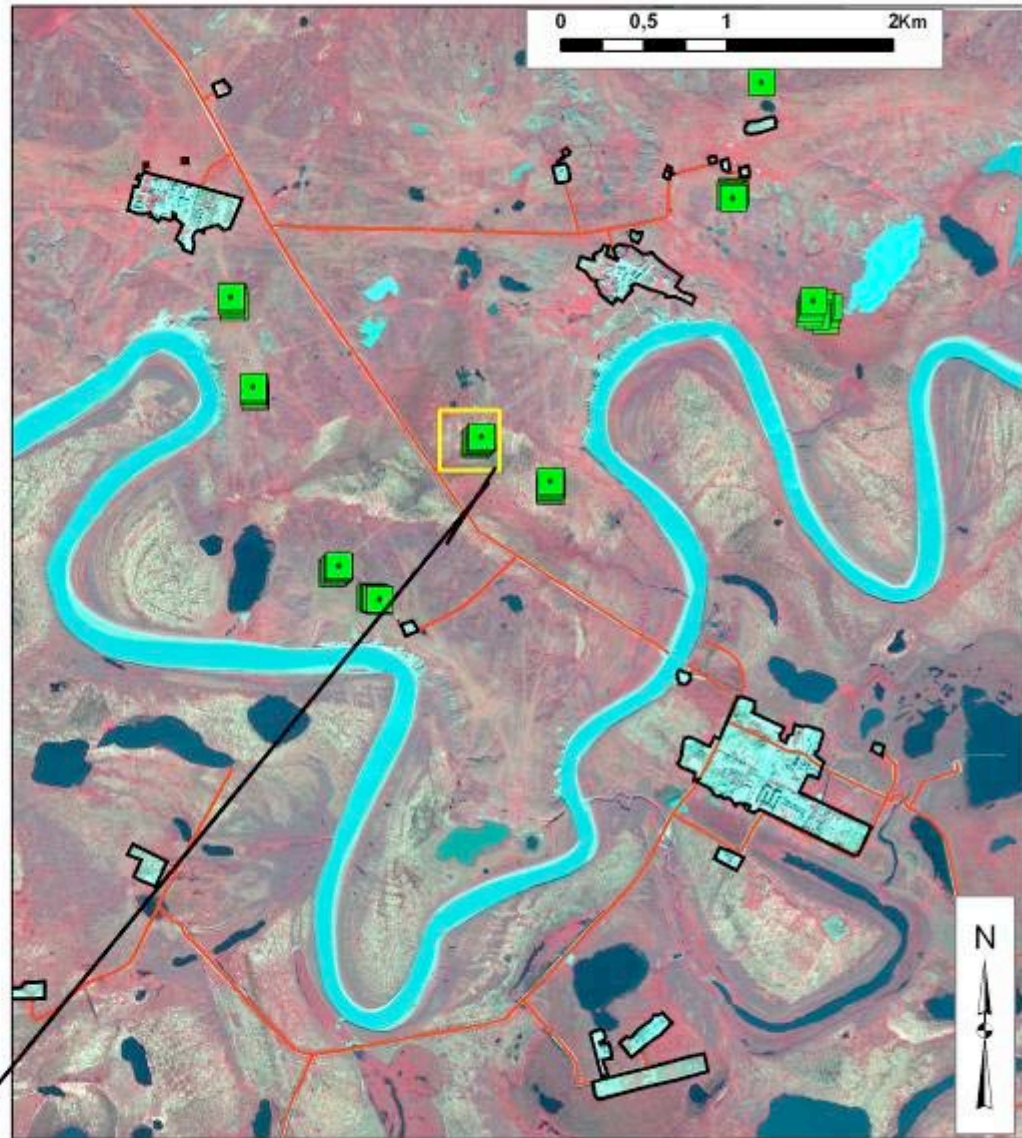
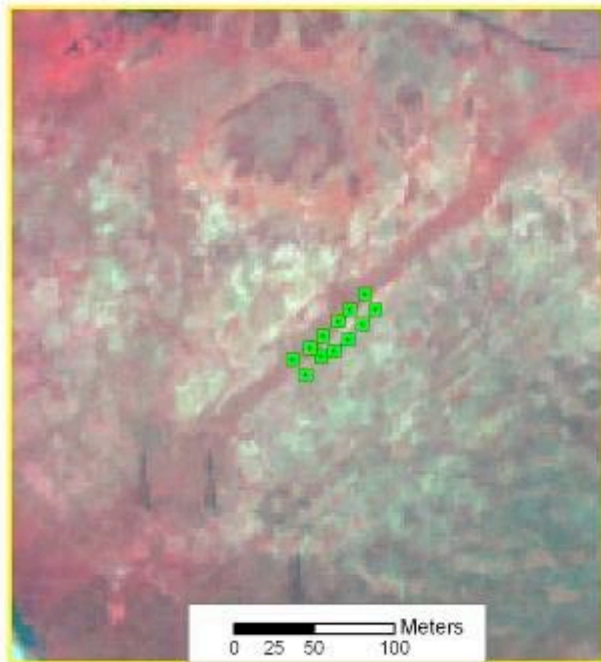


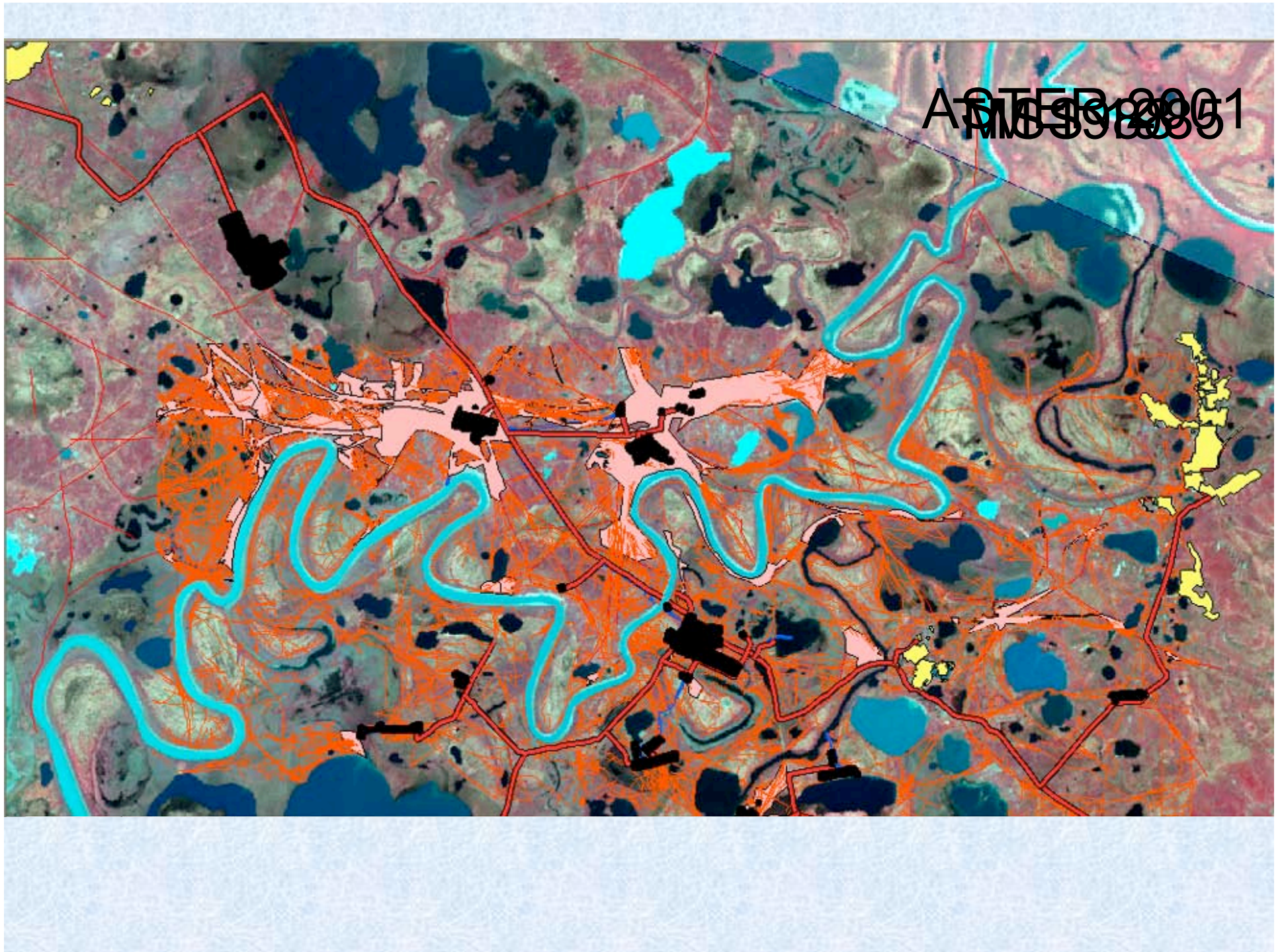
Anu Pajunen biomass and species diversity data:

Bovanenkovo gas field

- Field points 2005
- Infrastructure
- Road network

Satellite data:
Quickbird-2 image 15.7.2004
(2,4 m resolution)





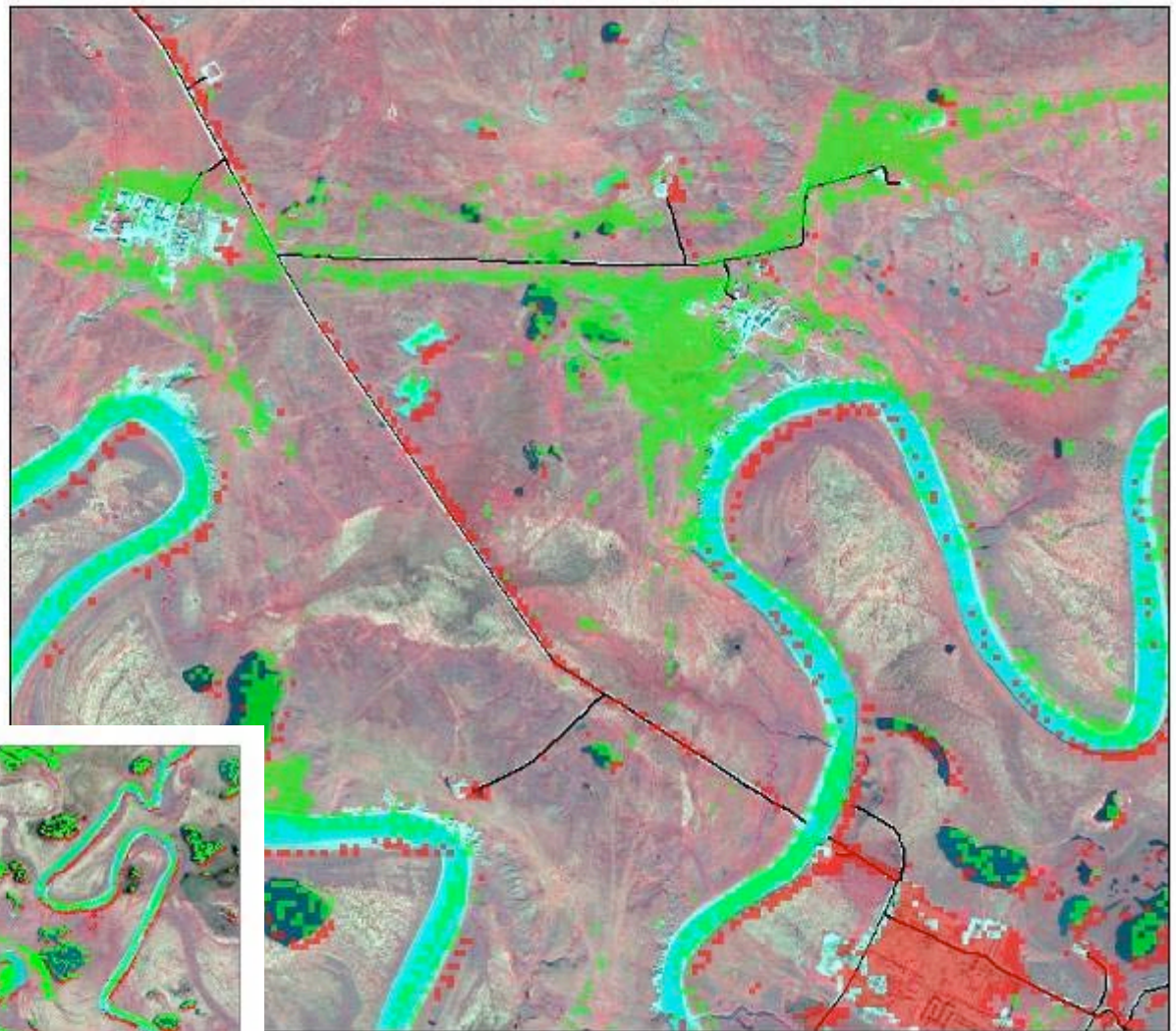
1988-1999 NDVI

Legend

high_ndvi_88_99.img

Class_Names

- Background
- Decreased
- Increased
- Some Decrease
- Some Increase
- Unchanged
- Main_road

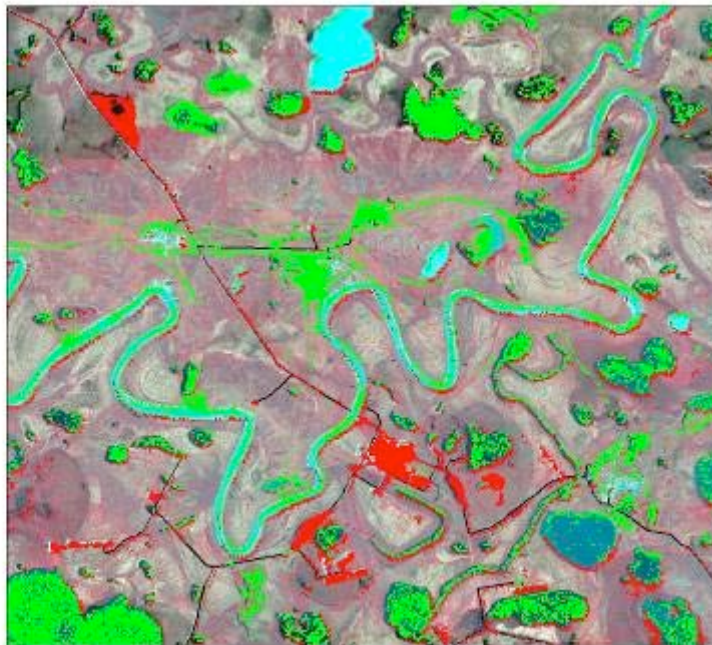


Legend

high_ndvi_88_99.img

Class_Names

- Background
- Decreased
- Increased
- Some Decrease
- Some Increase
- Unchanged
- Main_road



1984-1988 NDVI change

Legend

— Main_road

high_ndvi_84_88.img

Class_Names

□ Background

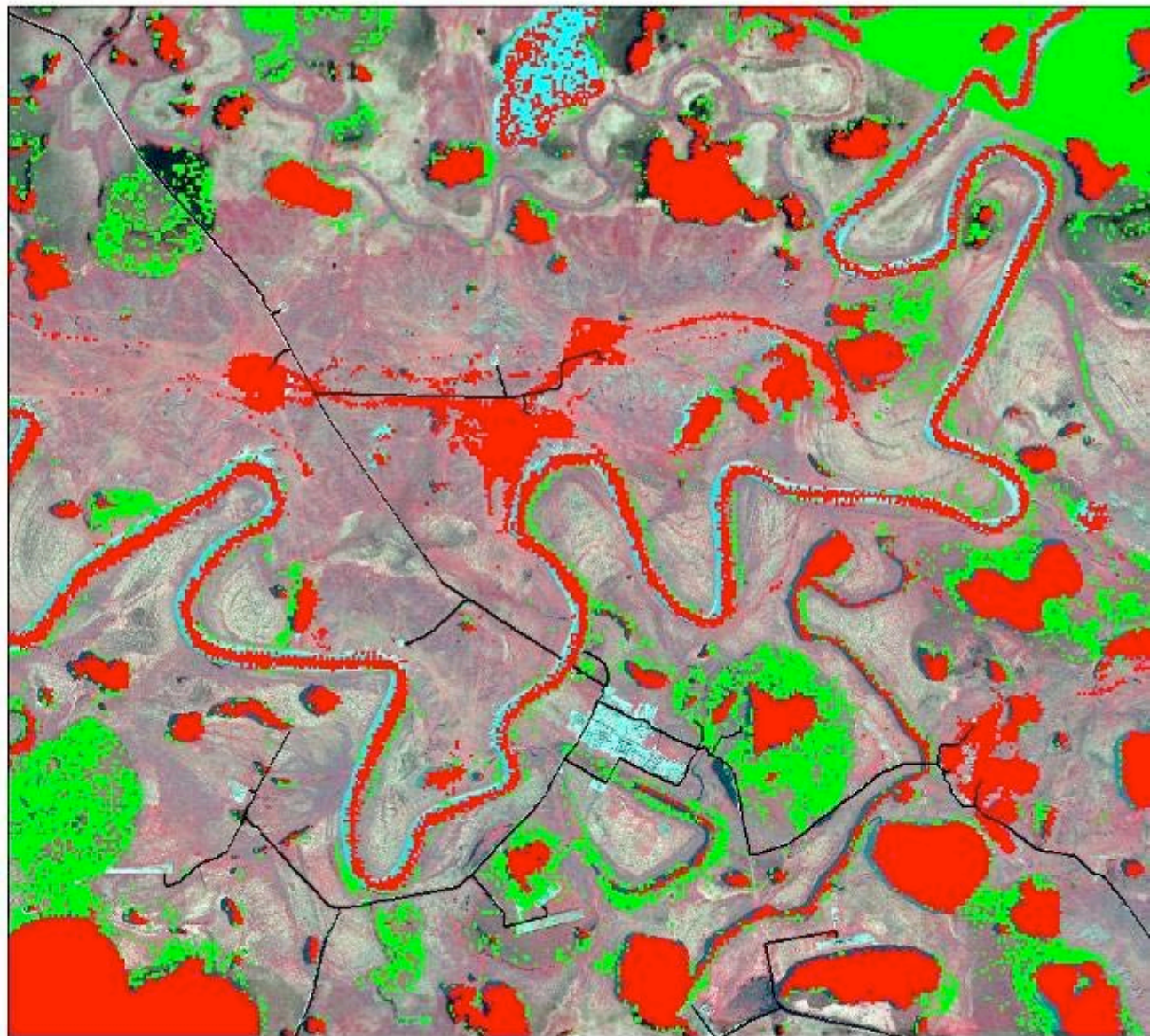
■ Decreased

■ Increased

□ Some Decrease

□ Some Increase

□ Unchanged




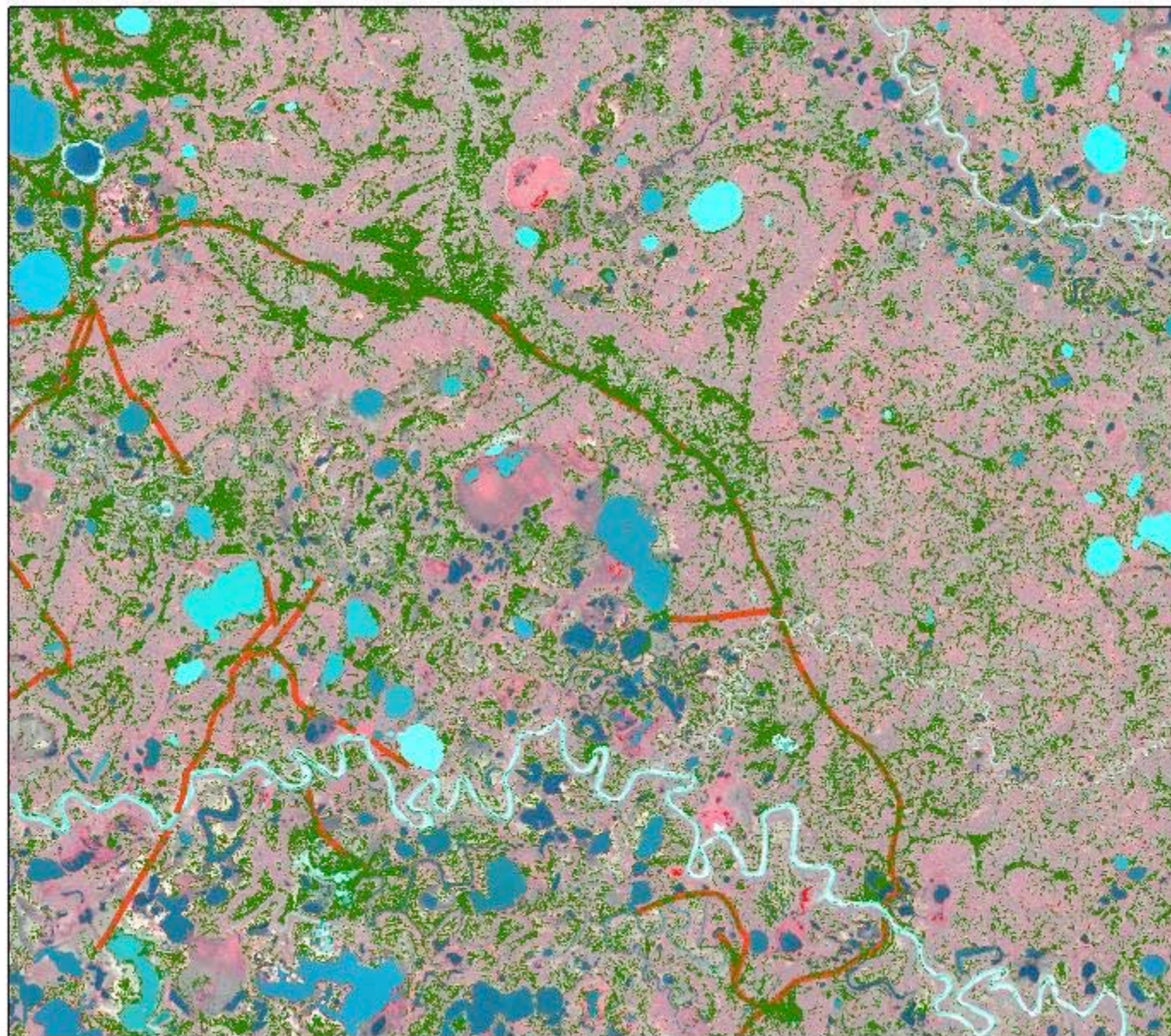
Kharasavei-Bovanenkovo 1988-2001

Legend

high_88_00_15.img

Class_Names

-  Background
-  Decreased
-  Increased
-  Some Decrease
-  Some Increase
-  Unchanged
-  tracks_TM_88
-  Main_road





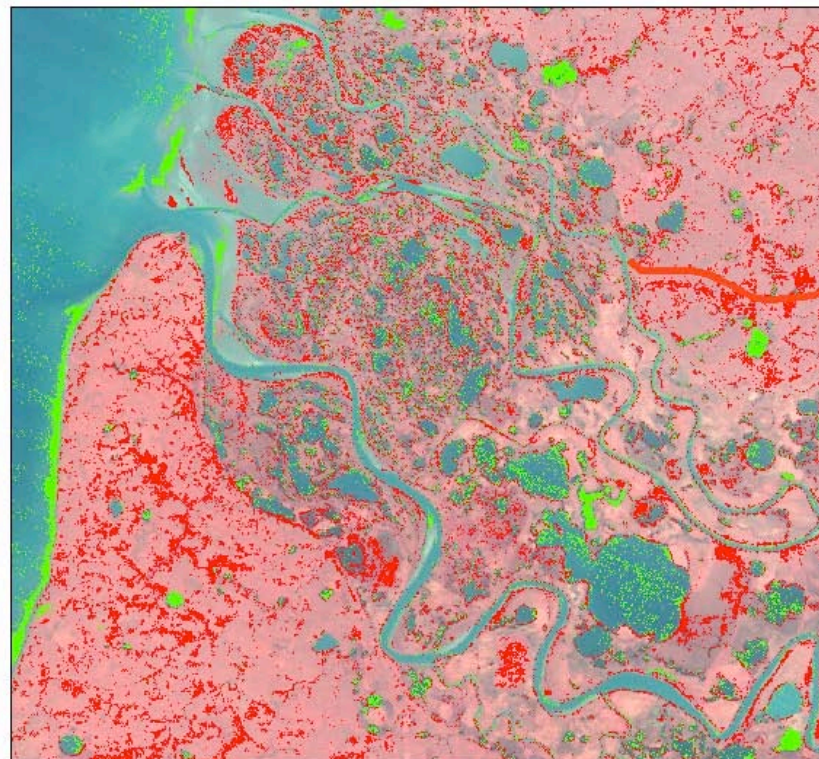
Legend

— Main_road

high_88_00_15.img

Class_Names

- Background
- Decreased
- Increased
- Some Decrease
- Some Increase
- Unchanged



Legend

high_ndvi_88_01.img

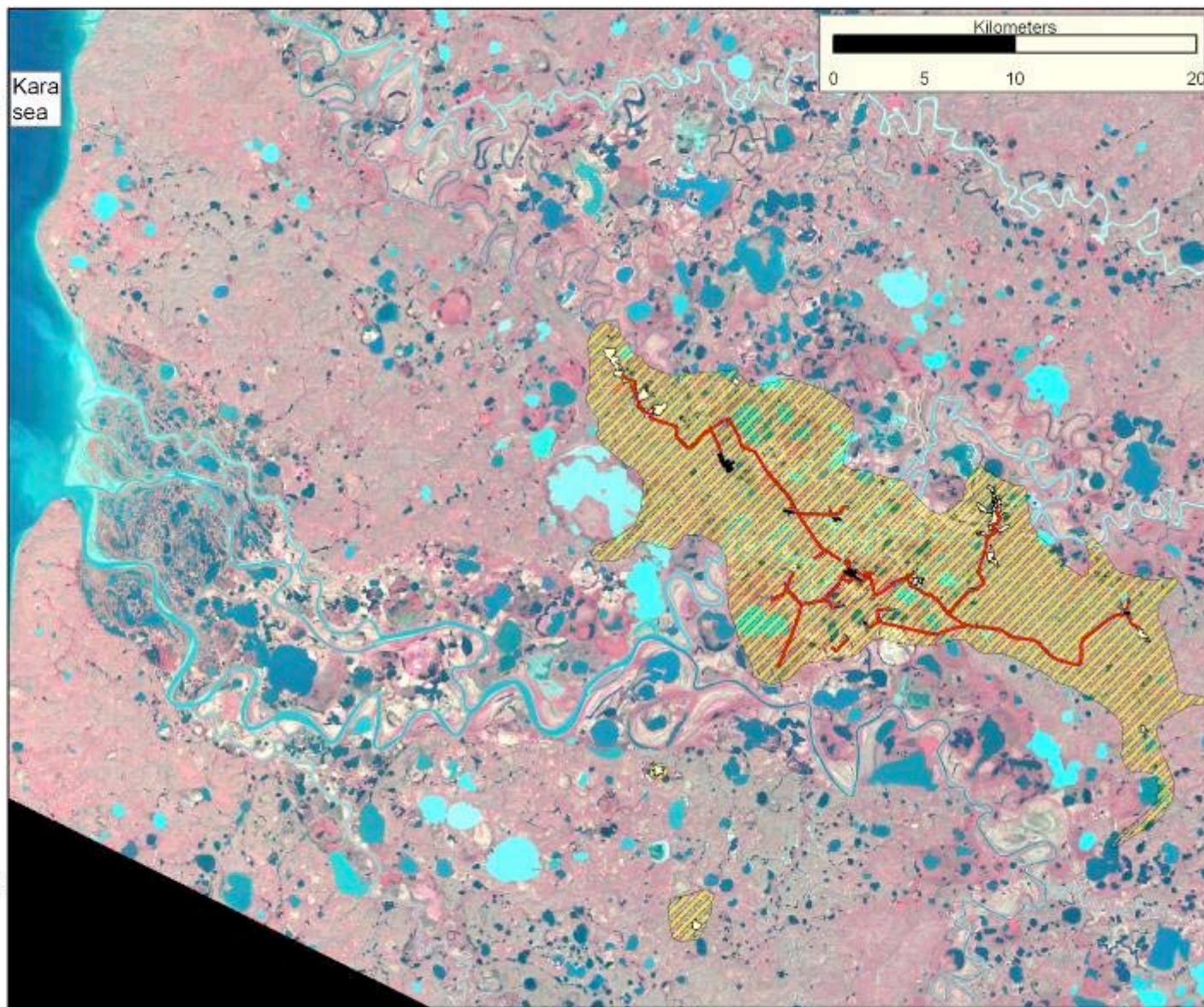
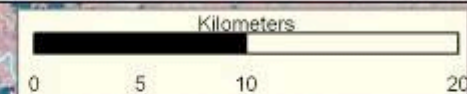
Class_Names

- Background
- Decreased
- Increased
- Some Decrease
- Some Increase
- Unchanged
- Main_road

Bovanenko gas field

Petroleum exploration related activity

-  Main road network
-  Zone of effected area
-  Sand quarries
-  Active infrastructure



Digitized from:
Quickbird-2 image 15.7.2004
(2.4 m resolution)
Aster Terra VNIR image 21.7.2001
(15 m resolution)

Background image:
Landsat TM 07.08.1988

In Bovanenkov gas field:

Visually interpreted affected area covers 448 km²

Premanently changed

Infrastructure 2,1 km²

Quarries 4,3 km²

Road 79 km 2,9 km²

Total 9,3 km²

Changed vegetation (mainly shrubs to graminoids)

Off road tracks: 2500 km (Quickbird-2 & ASTER image)

Covers area of 24 km²

Total change 33 km²

Bovanenkovo gas field

Yarsalinskii sovkhhoz

Panaevsk sovkhos

Yamalskii sovkhos

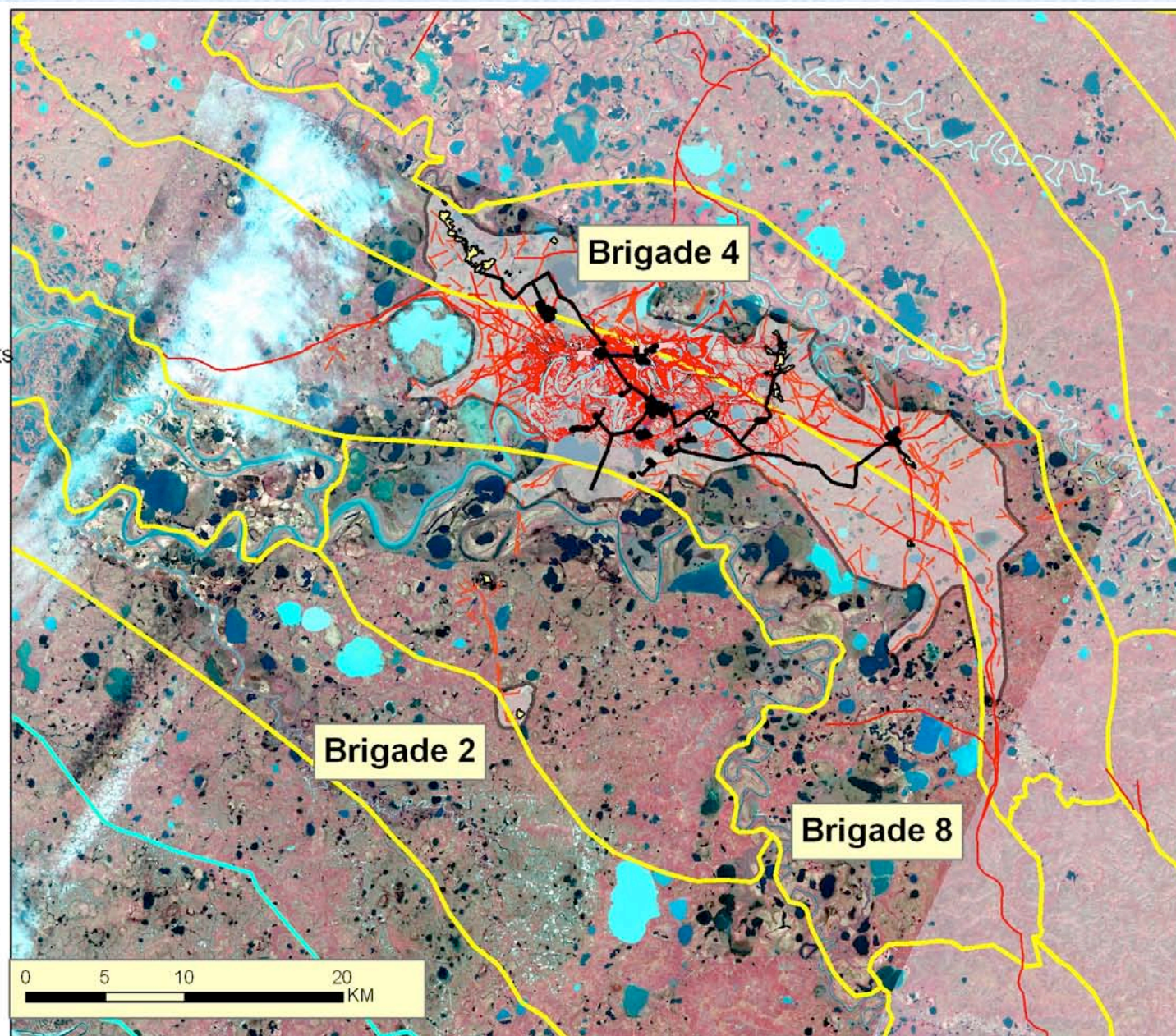


Legend

- Infrastructure
- Quarries
- Road network
- Brigade borders
- Offroad vehicle tracks
- Affected area

Datasource:
ASTER TERRA VNIR image
21.7.2001 (15 m resolution)

Quickbird-2 image 15.7.2004
(2.4 m resolution)



Impacts of Bovanenkovo gas field to brigades 4 and 8 of Yarsalinski sovhoz:

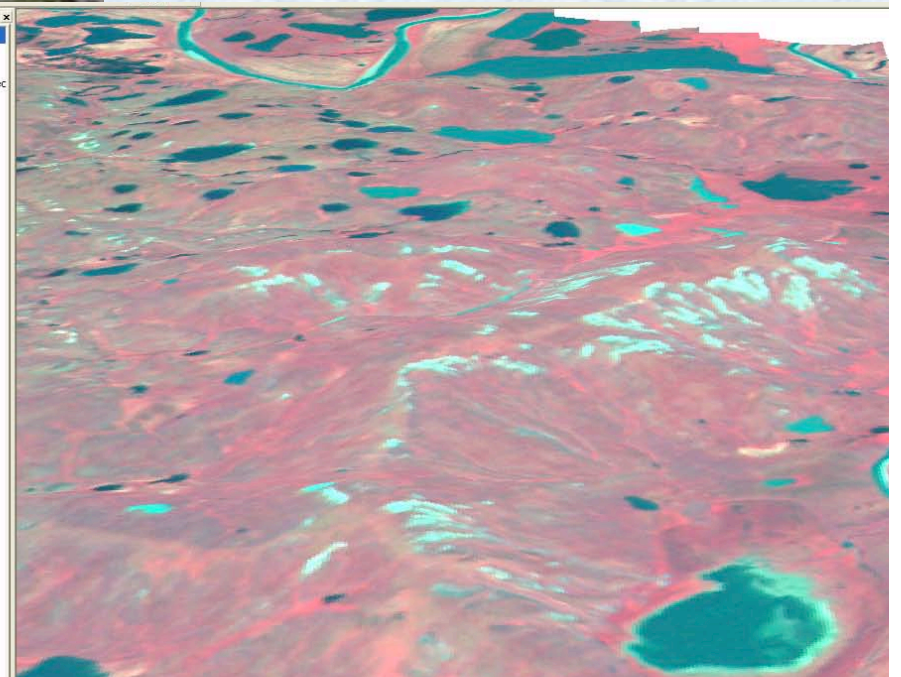
Brigade 4:

- Summer pasture July-August 1019 km²
- 225 km² in Bovanenko gas field affected area

Brigade 8:

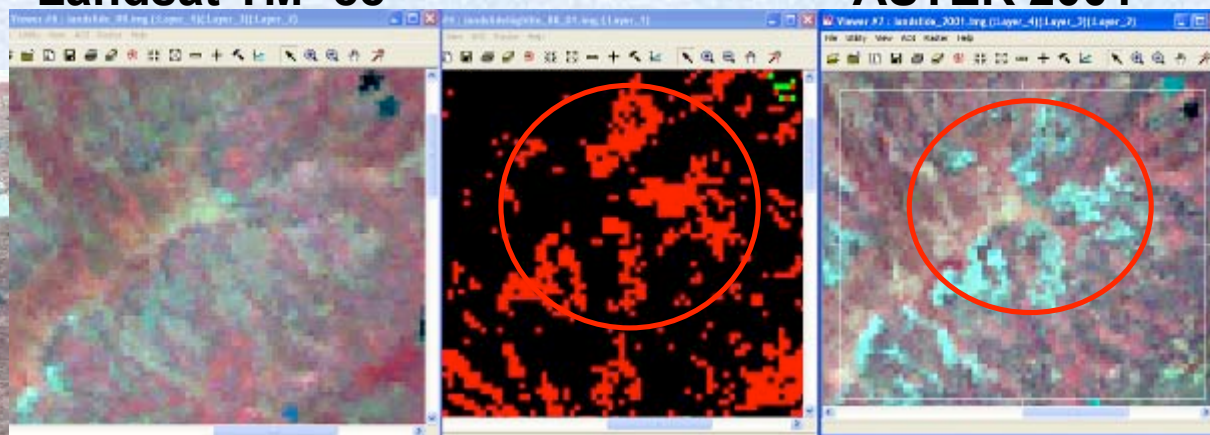
- Summer pasture July-August 796 km²
- 200 km² in Bovanenko gas affected area

Landslides in Bovanenkenovo region

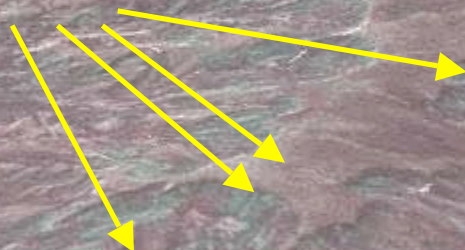


Landsat TM -88

ASTER 2001



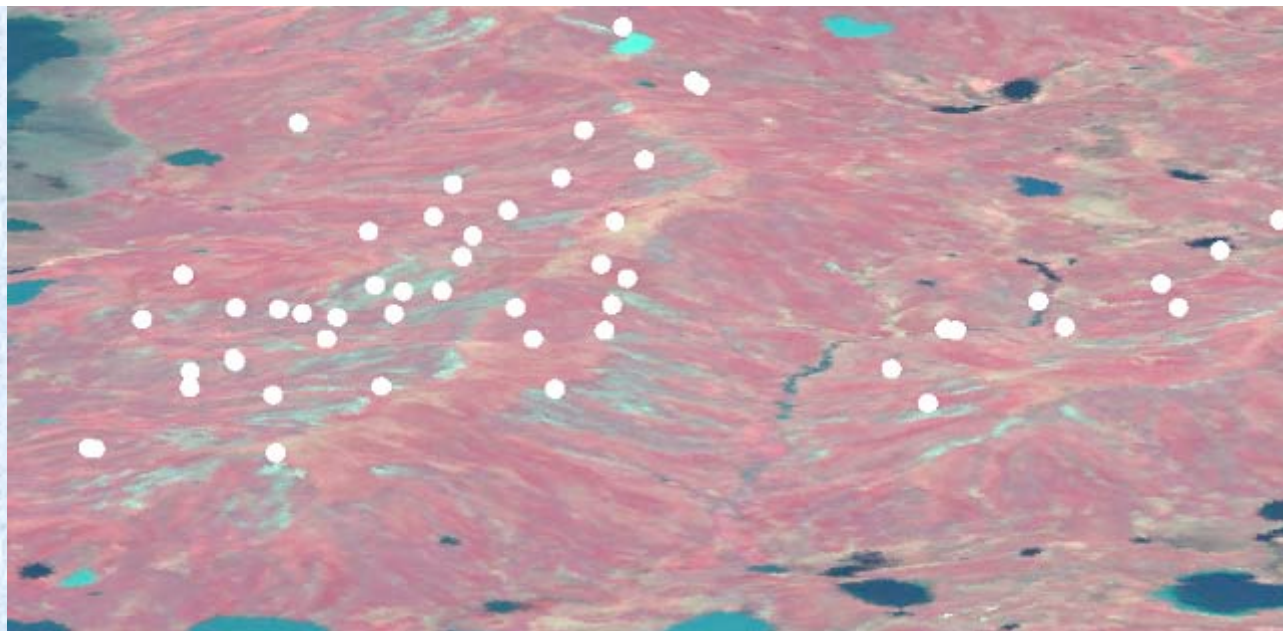
Landslide activity 1989-1990



Change 88-01
Red = Increase of bare soil

Corona 1969 & ASTER 2001 combination with DEM

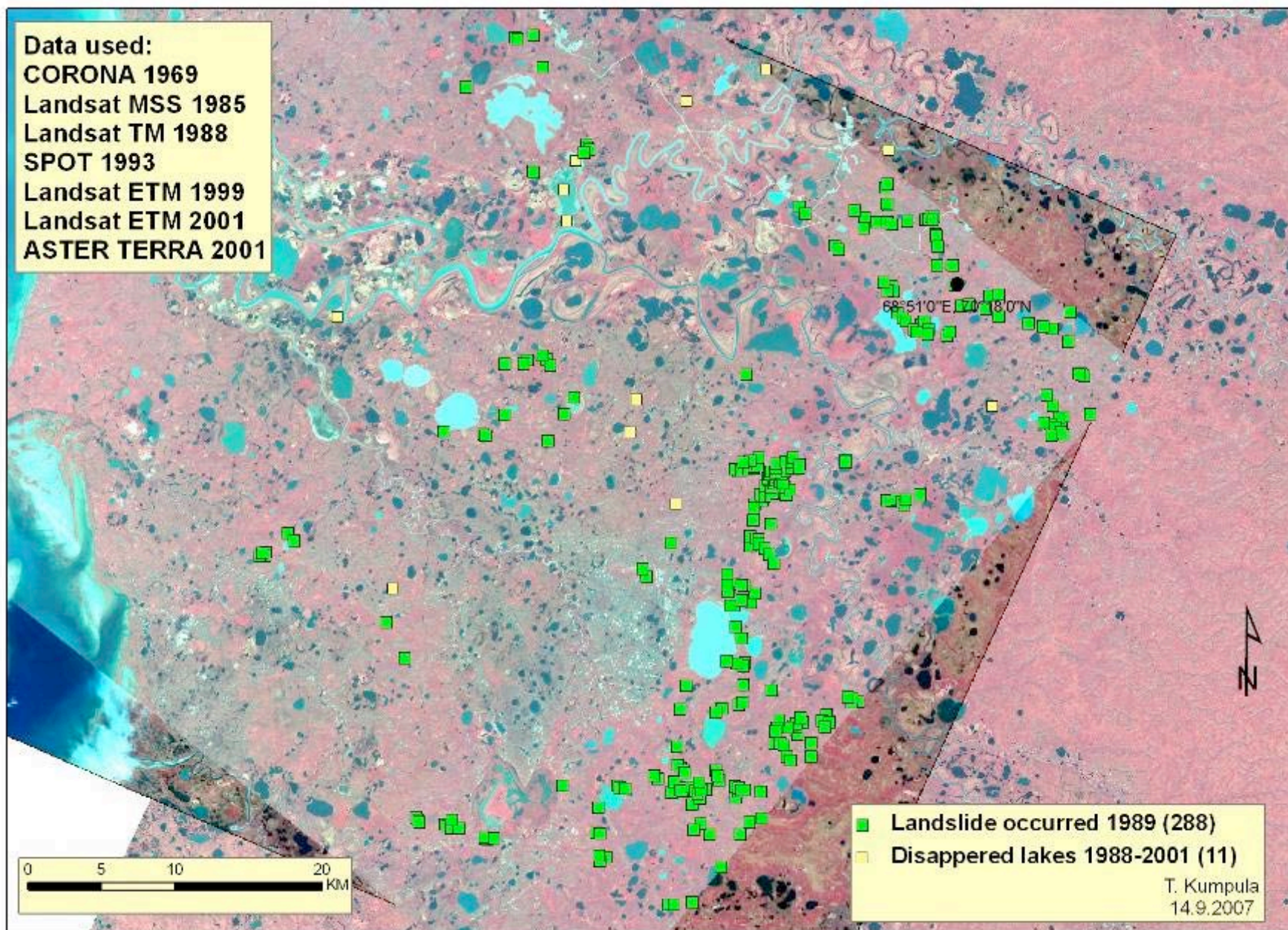
ASTER 2001



Spot 1993



Data used:
CORONA 1969
Landsat MSS 1985
Landsat TM 1988
SPOT 1993
Landsat ETM 1999
Landsat ETM 2001
ASTER TERRA 2001

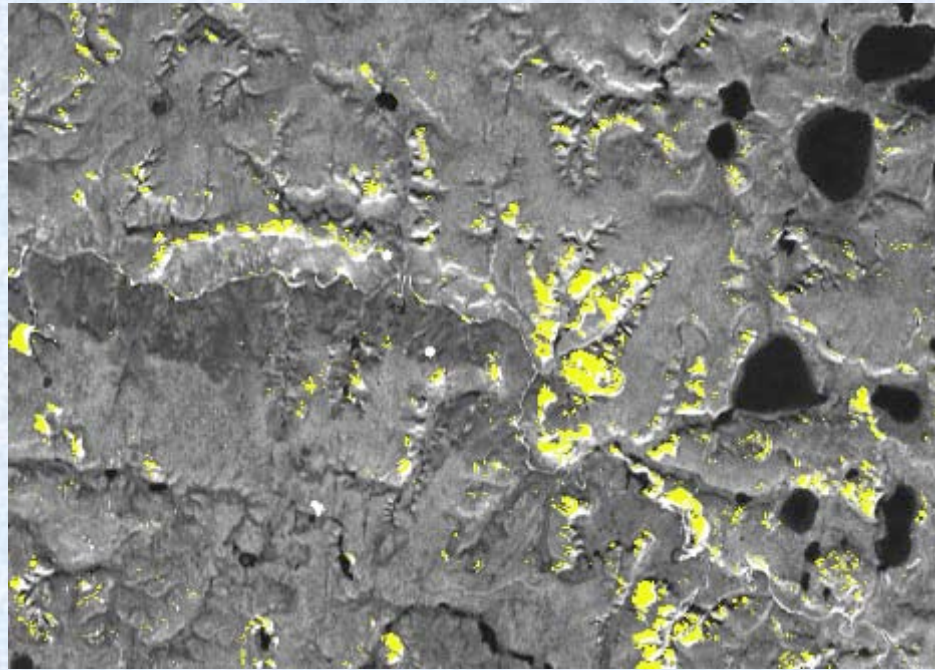


■ Landslide occurred 1989 (288)
■ Disappeared lakes 1988-2001 (11)

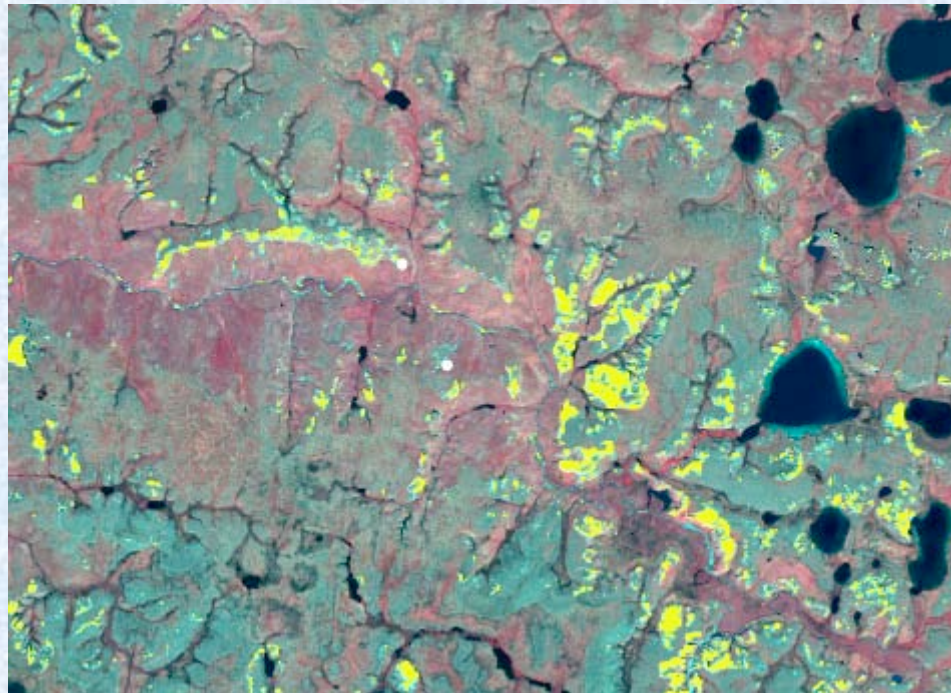
T. Kumpula
14.9.2007

Deflation areas

Corona 1969

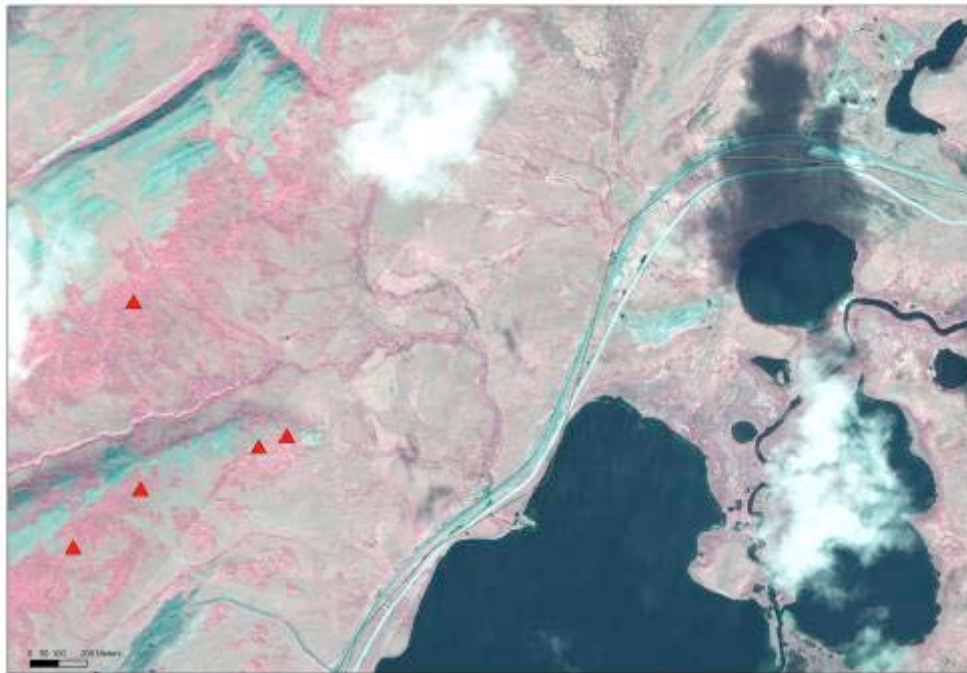
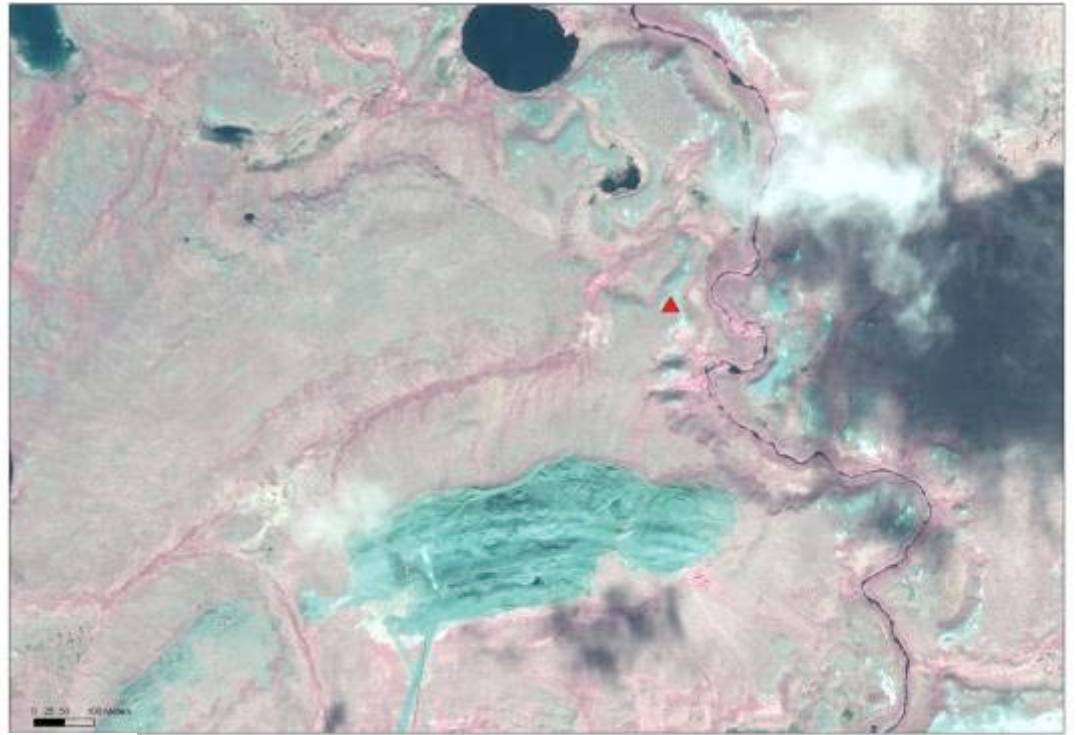
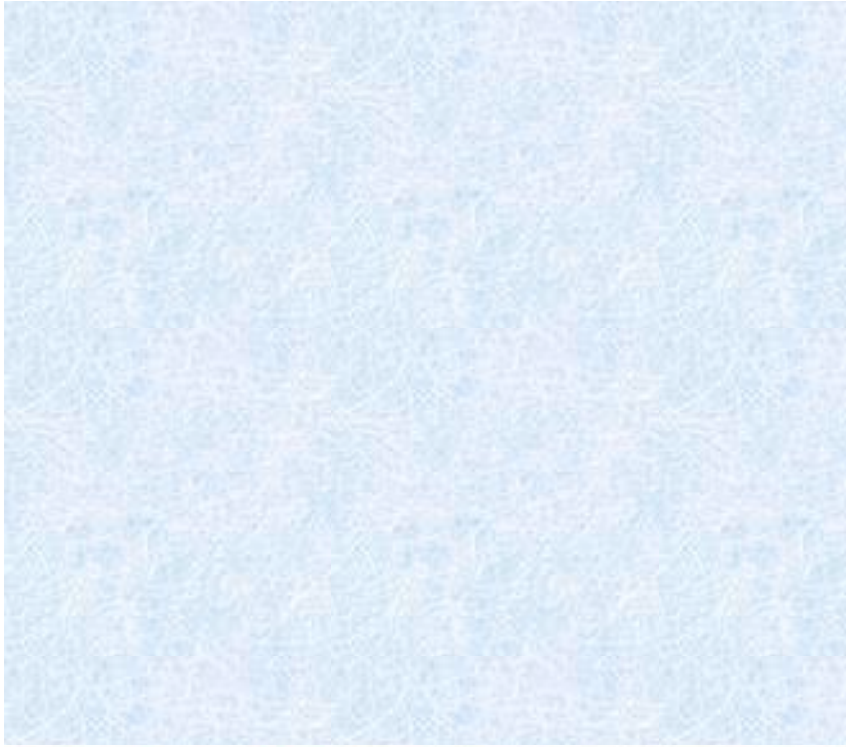


Quickbird-2 2004



Conclusions...

- Impacts of drilling sites are quite local, but may strongly affect neighbouring brigades which may experience increased grazing pressure when animals are forced onto their territory
- Old drilling sites, off-road vehicle tracks may have increased value in reindeer fodder by increased amount of graminoids. But hoof injuries and infections caused by metal and glass garbage, can be lethal to reindeer so herders avoid such places
- Constructions cause problem to migration, too low build pipelines, high road banks
- Plans: data analysis and paper writing → 20??



Kiitos tarkkaavaisuudestanne!