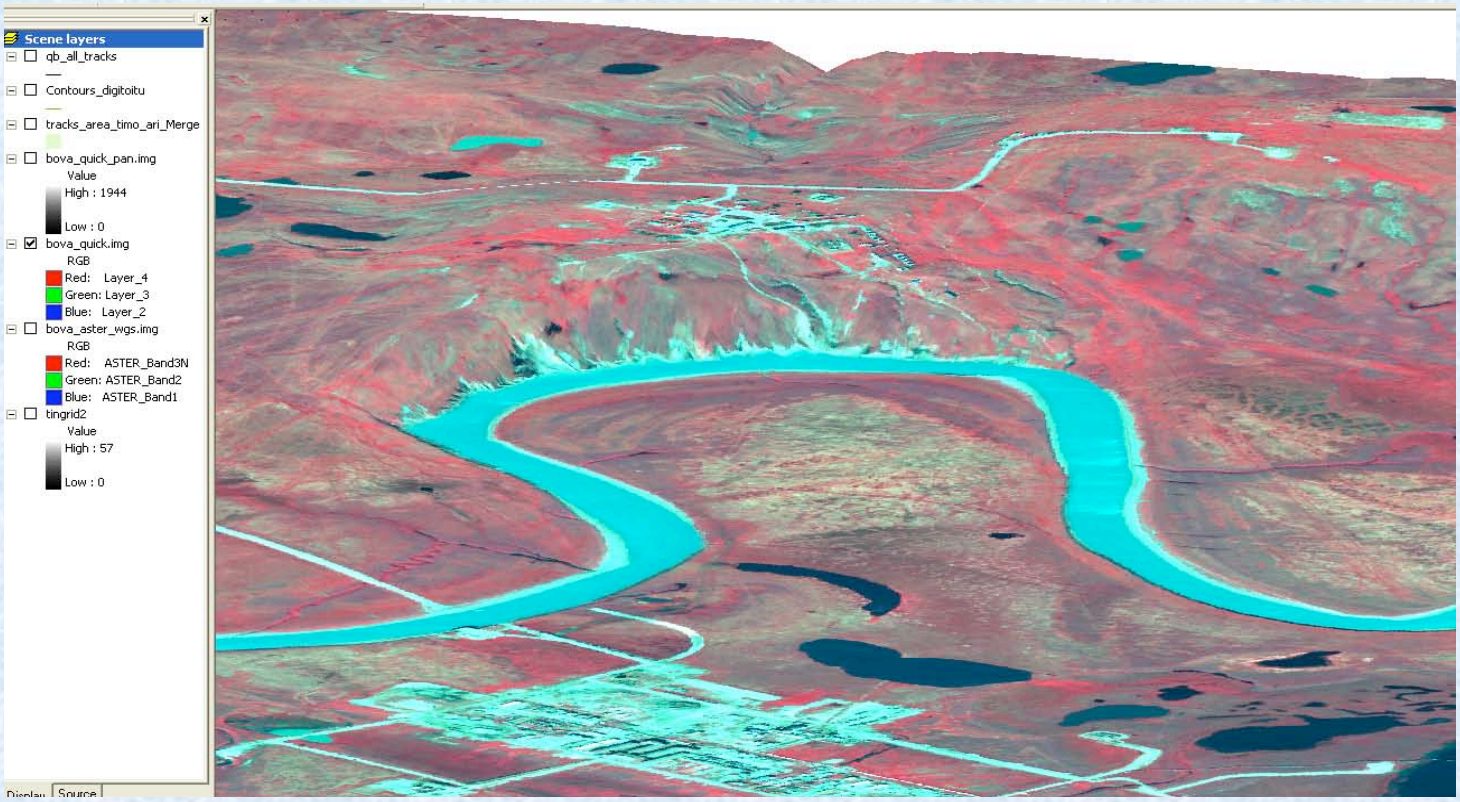
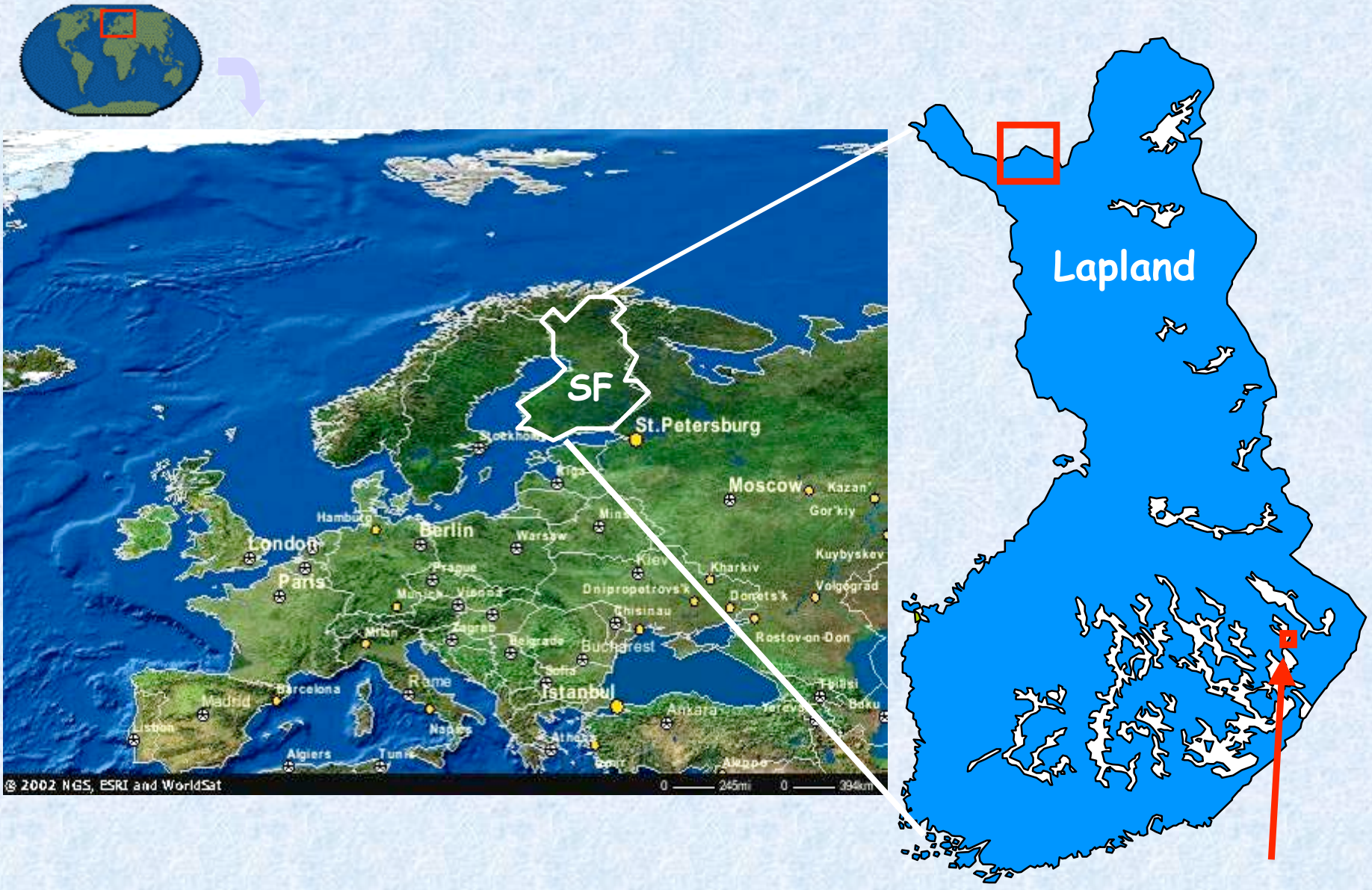
Remote sensing of land-use /land-cover change in the Bovanenkovo gas field on the Yamal peninsula, Russia

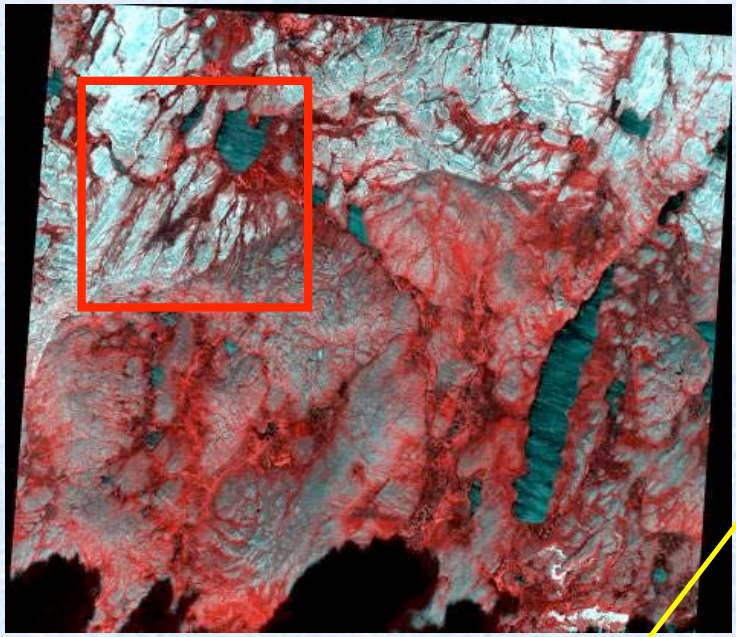


Workshop:
Yamal Land-Cover Land-Use Change Workshop
Moskova, 28-30 January 2008

Timo Kumpula
Department Of Geography
University of Joensuu


SF
St.Petersburg
Moscow
Kazan
Gor'kiy
Kuybyskev
Volgograd
Kharkiv
Donets'k
Rostov-on-Don
Dnipropetrovs'k
Kiev
Minsk
Warsaw
Berlin
Hamburg
London
Paris
Prague
Munich
Vienna
Zagreb
Milan
Belgrade
Bucharest
Sofia
Chisinau
Rome
Naples
Madrid
Barcelona
Lisbon
Algiers
Tunis
Istanbul
Ankara
Athens
Izmir
Aleppo
Yerevan
Tbilisi
Baku
Lapland
Joensuu
© 2002 NGS, ESRI and WorldSat
0 245mi
0 394km

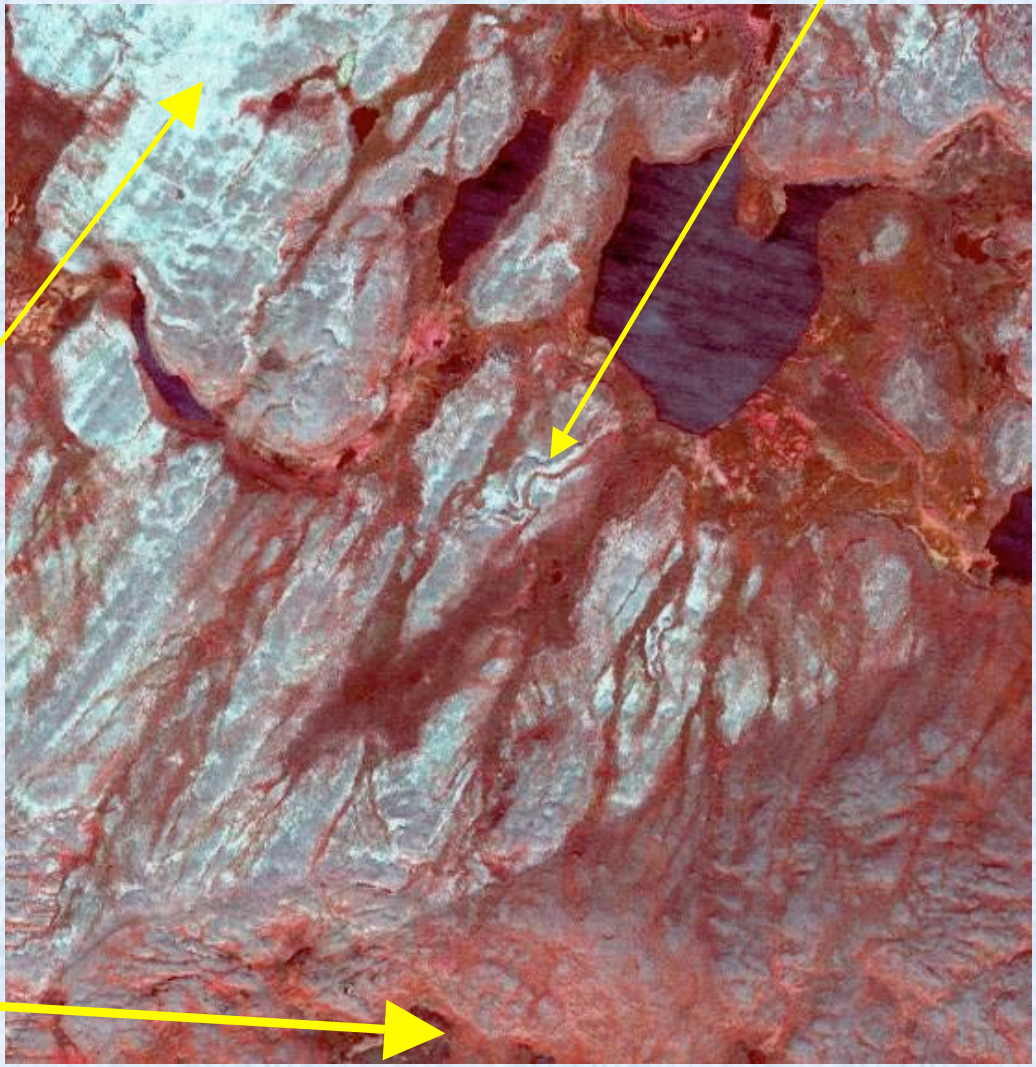
Jauristunturit research area



depression with thick snow cover

low grazed
lichen pasture

Heavy trambled and
grazed lichen
pasture



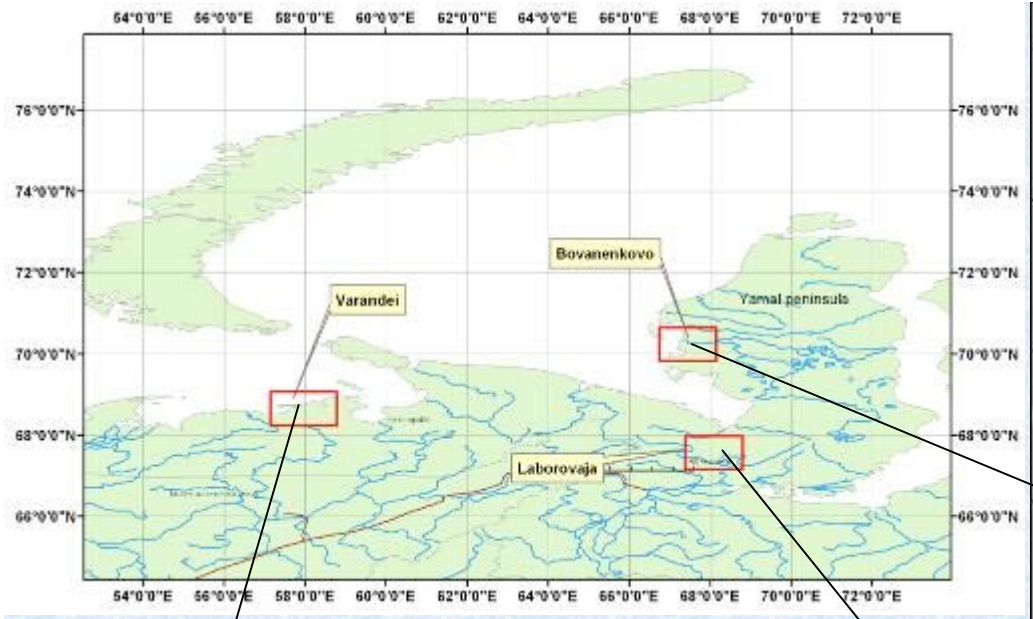
Lichen dominated winter pastures

Cladina stellaris

↓

Crustacea lichens + shrubs

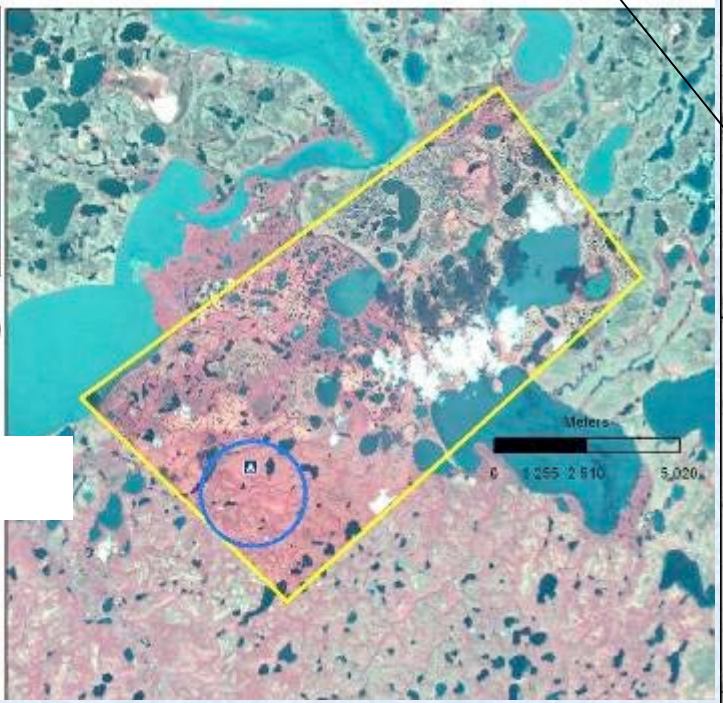
Cladina stellaris
Betula nana



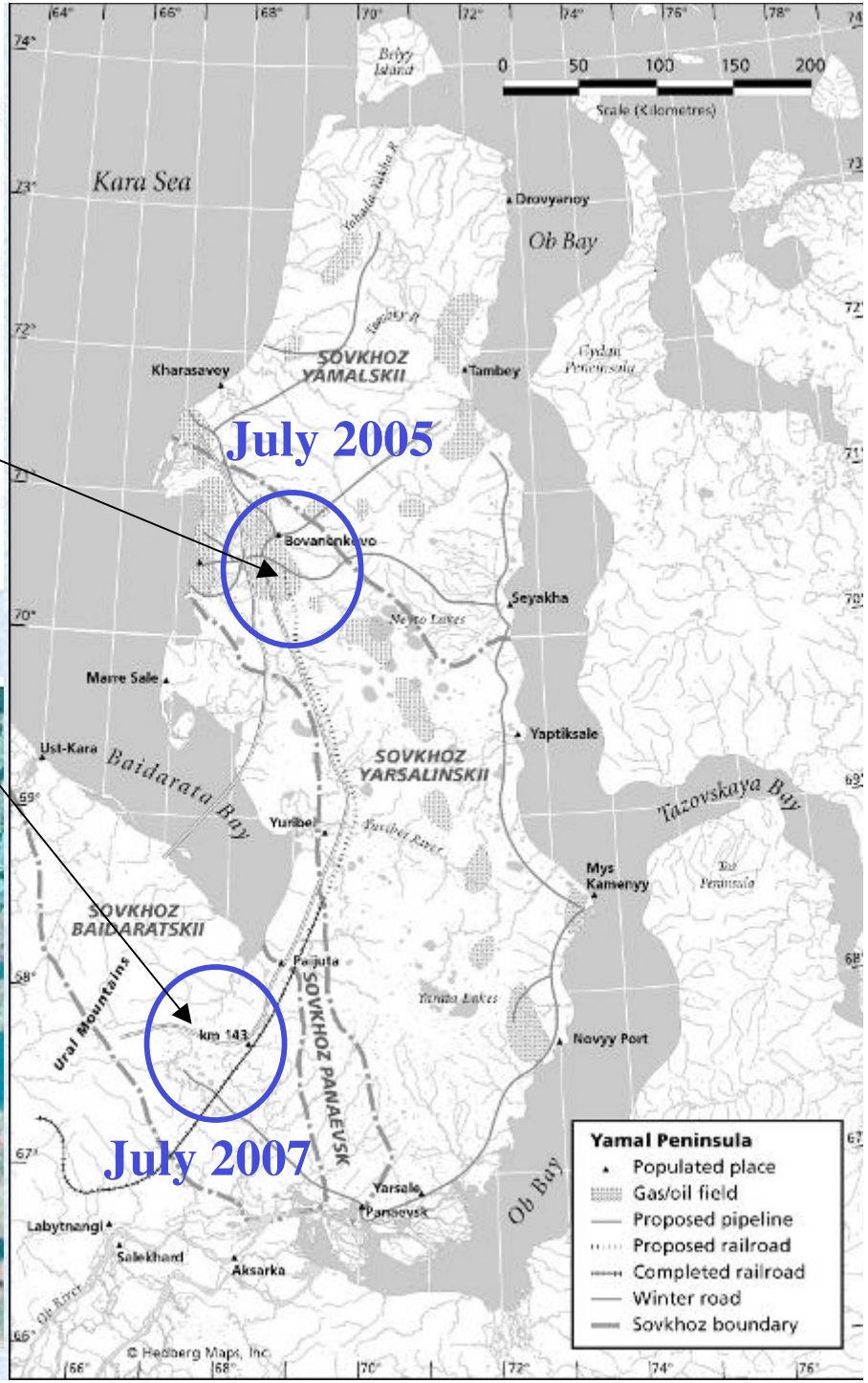
Research areas

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

Larger area:
Data: Landsat TM 1988



July 2006



July 2005

July 2007

Remote sensing data

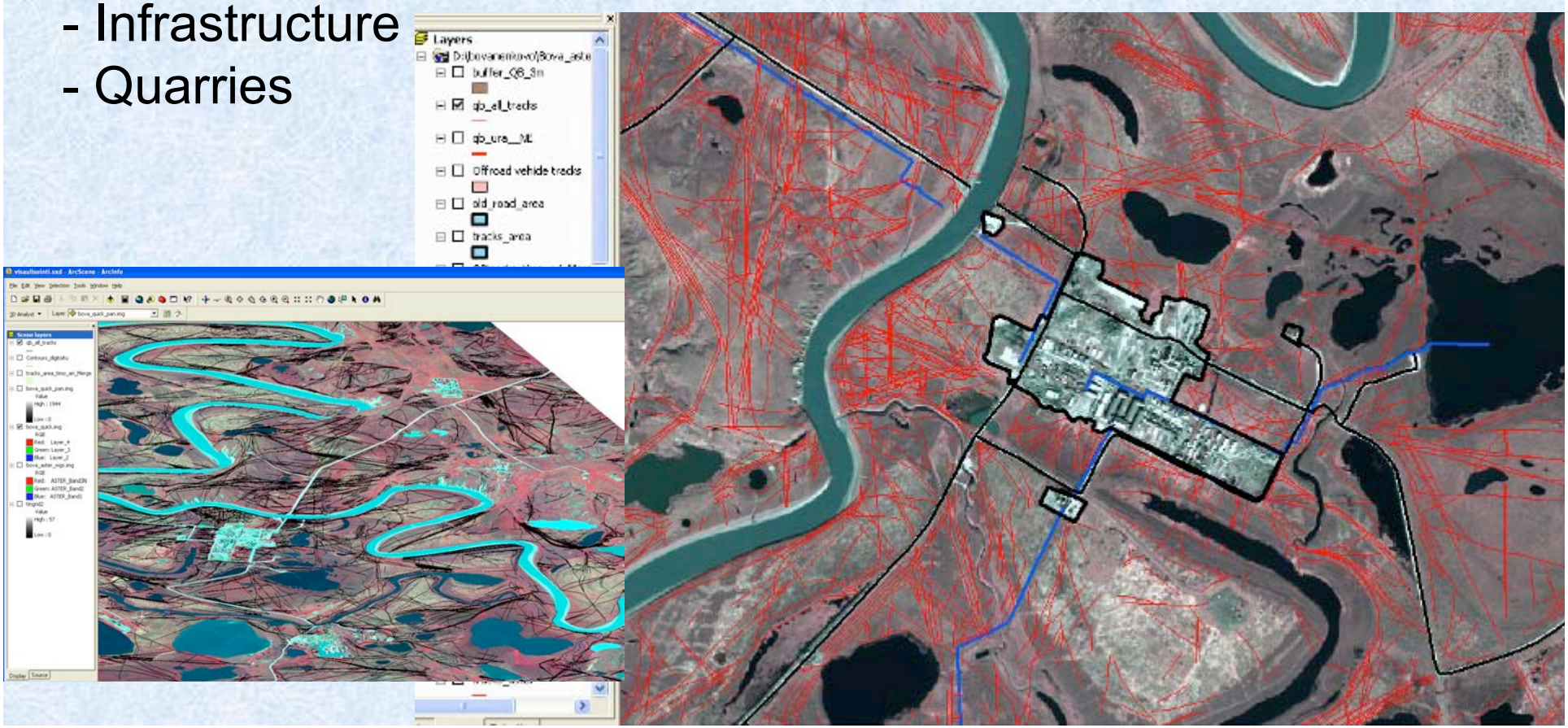
• Landsat TM 1984	28 August
• Landsat TM 1988	07 August
• Landsat ETM 1999	07 July
• Landsat ETM 2000	08 July
• Landsat MSS 1985	28 July
• SPOT 1993	29 July
• SPOT 1998	19 July
• ASTER TERRA 2001	24 July
• Quickbird-2 2004	28 July
• Corona 1969 (south of)	?? July

GIS database collection

Visual interpretation of impacts, digitazing:

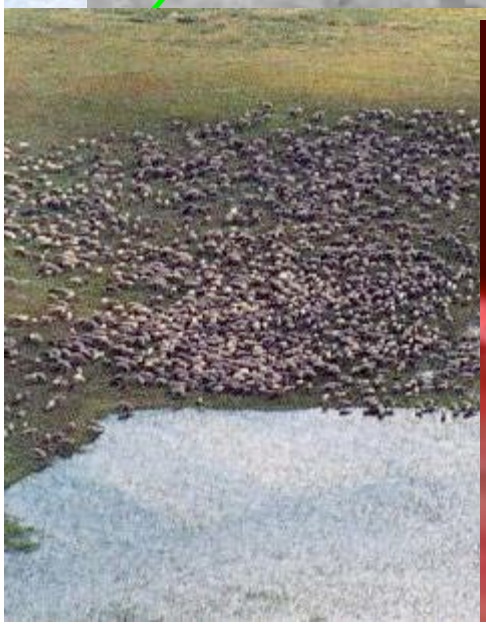
-Digital elavation modell from 1: 100 000 maps

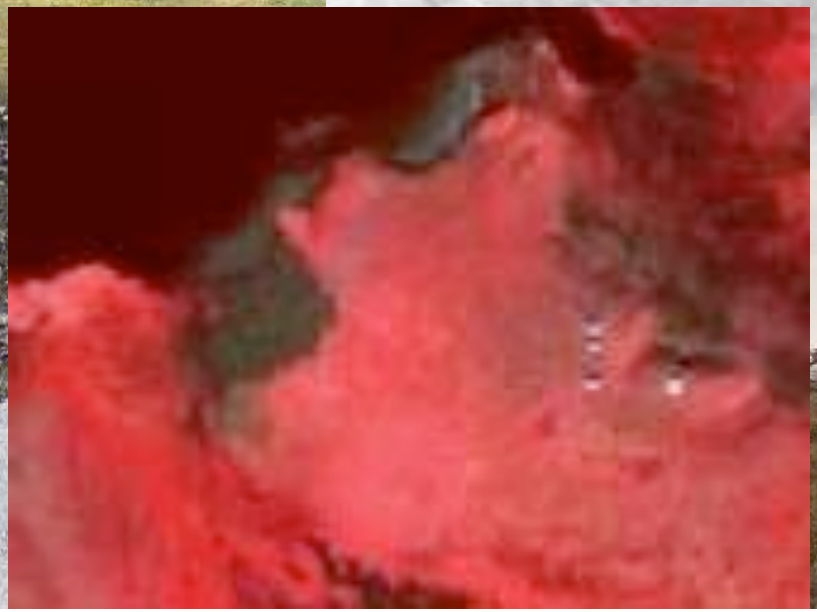
- Road network
- Pipeline network
- Off road vehicle track network
- Infrastructure
- Quarries



Detectivity / Impact	Field survey	Quickbird-2 Panchromatic	Quickbird-2 Multispectral	ASTER TERRA VNIR	Landsat TM	Landsat MSS
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

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

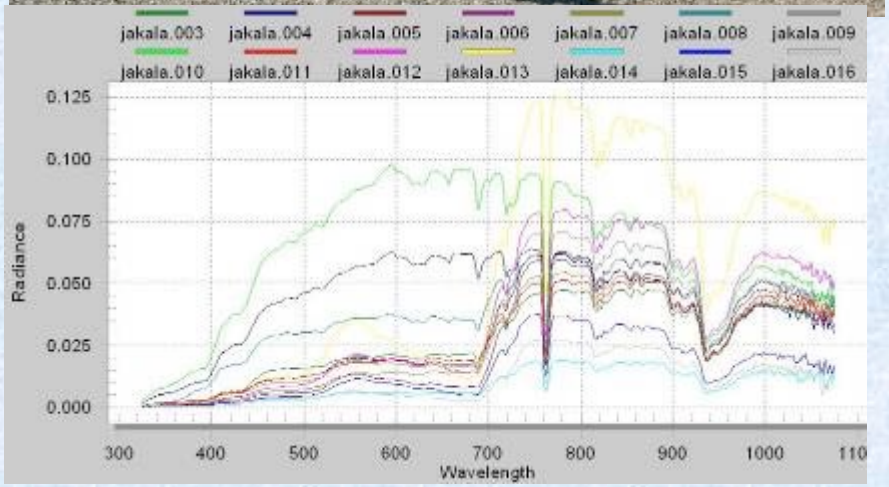




Spectrometer measurements Km 147

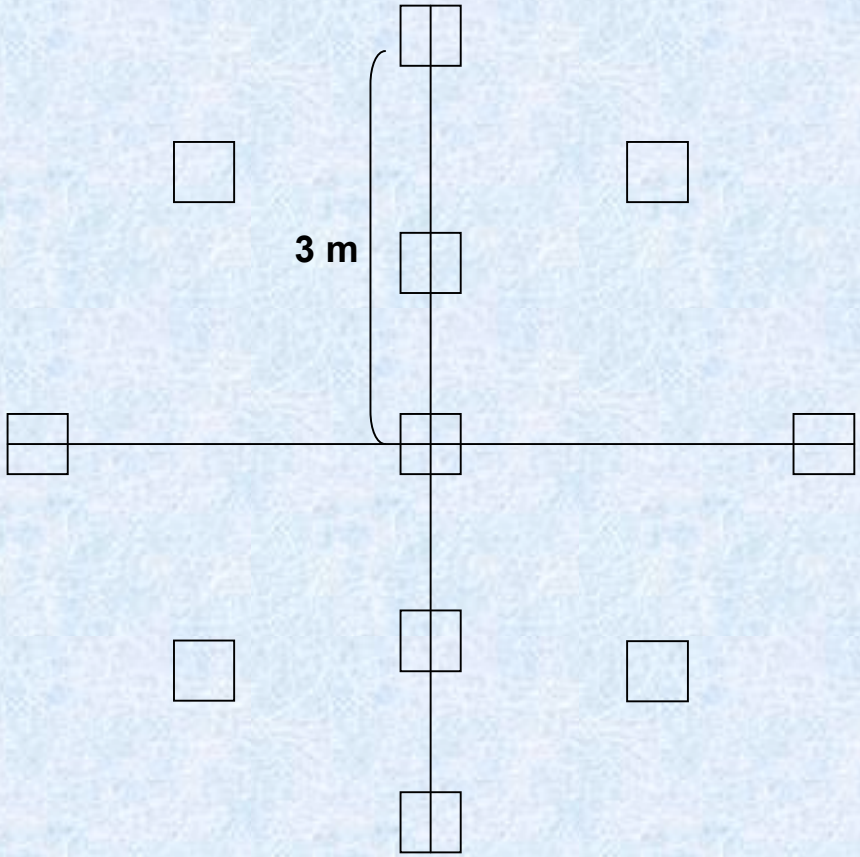
- ASD field spectrometer
  reflectance 325- 1050 nm

- 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



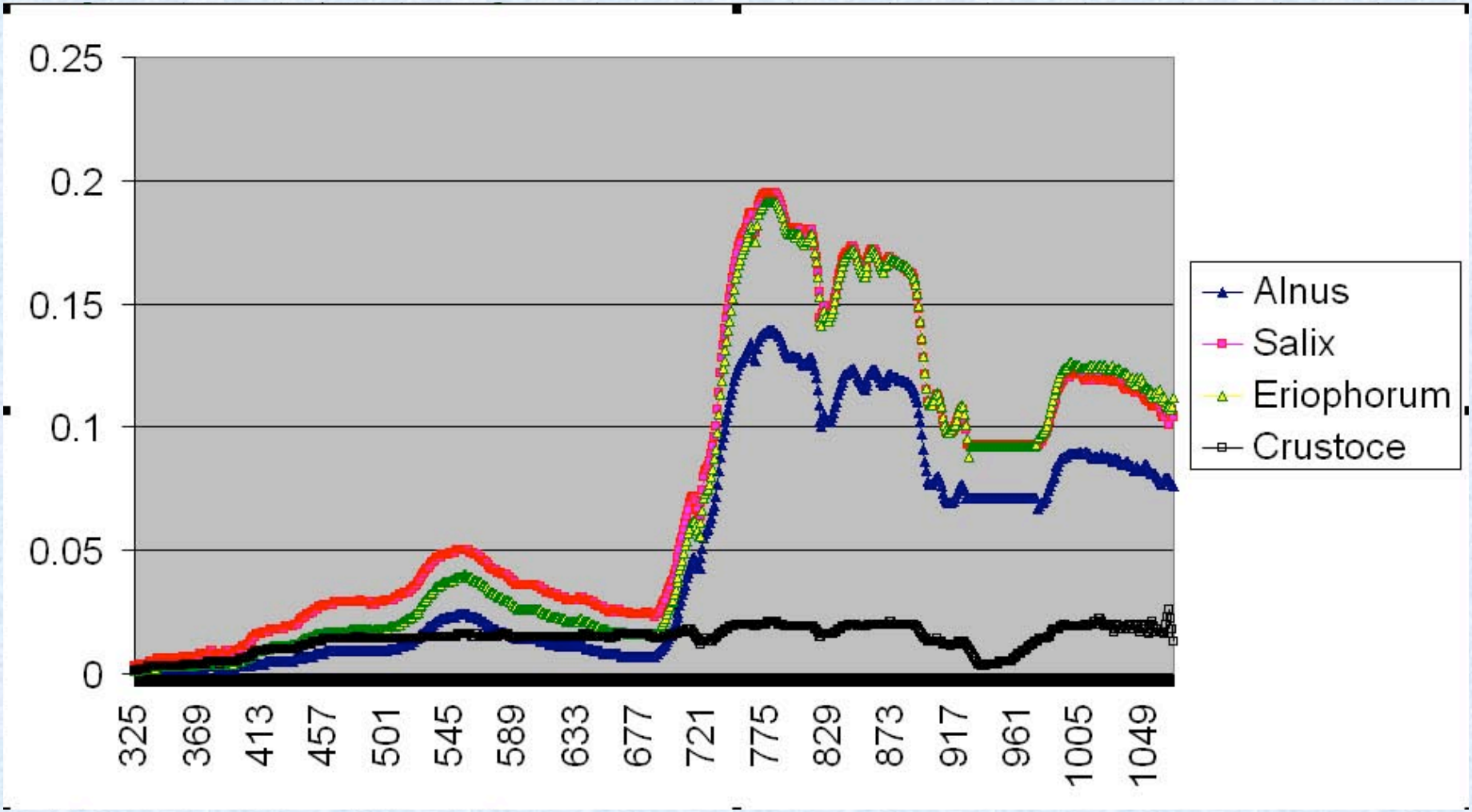
Species measurements: dry and wet

- 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

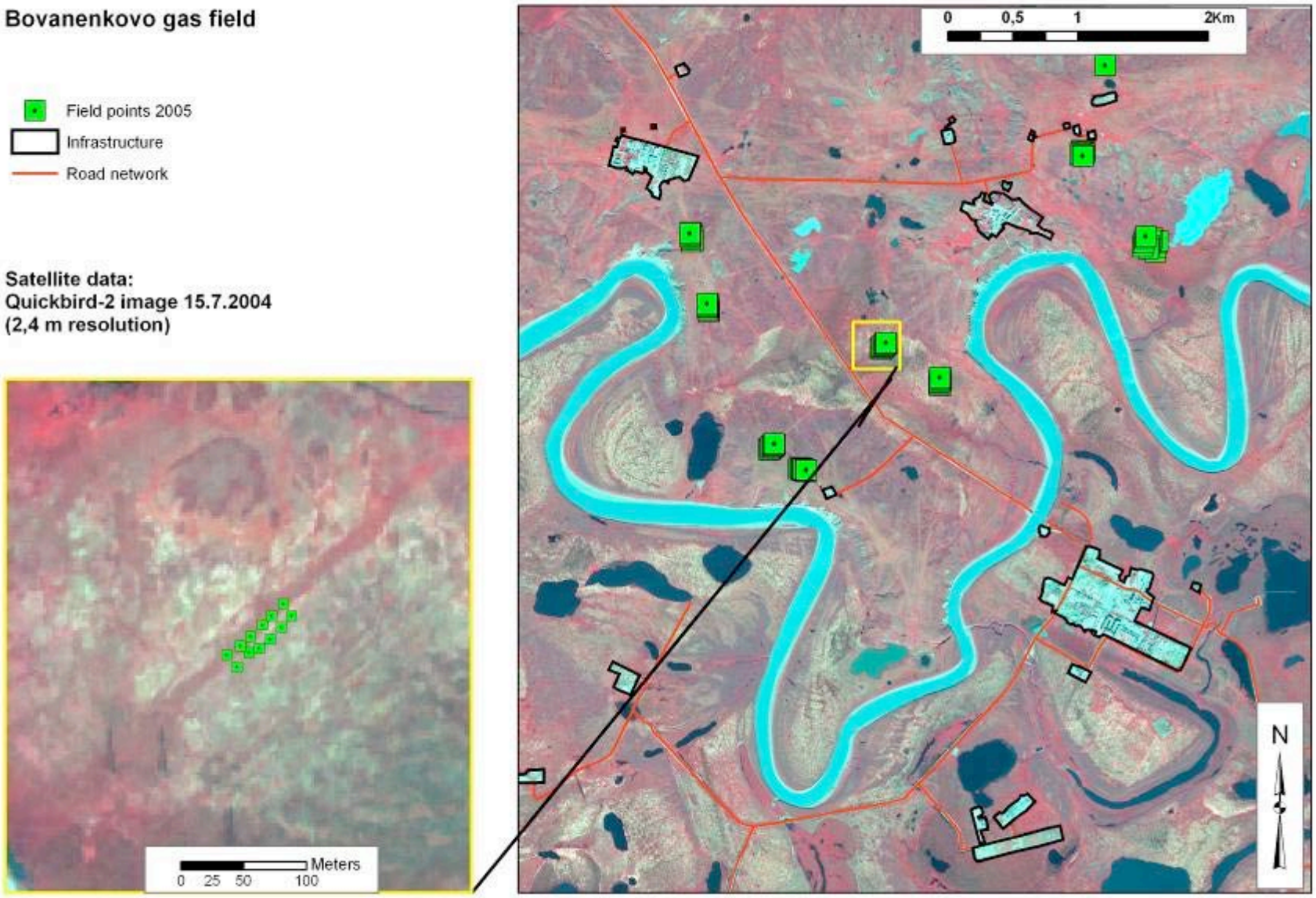
+

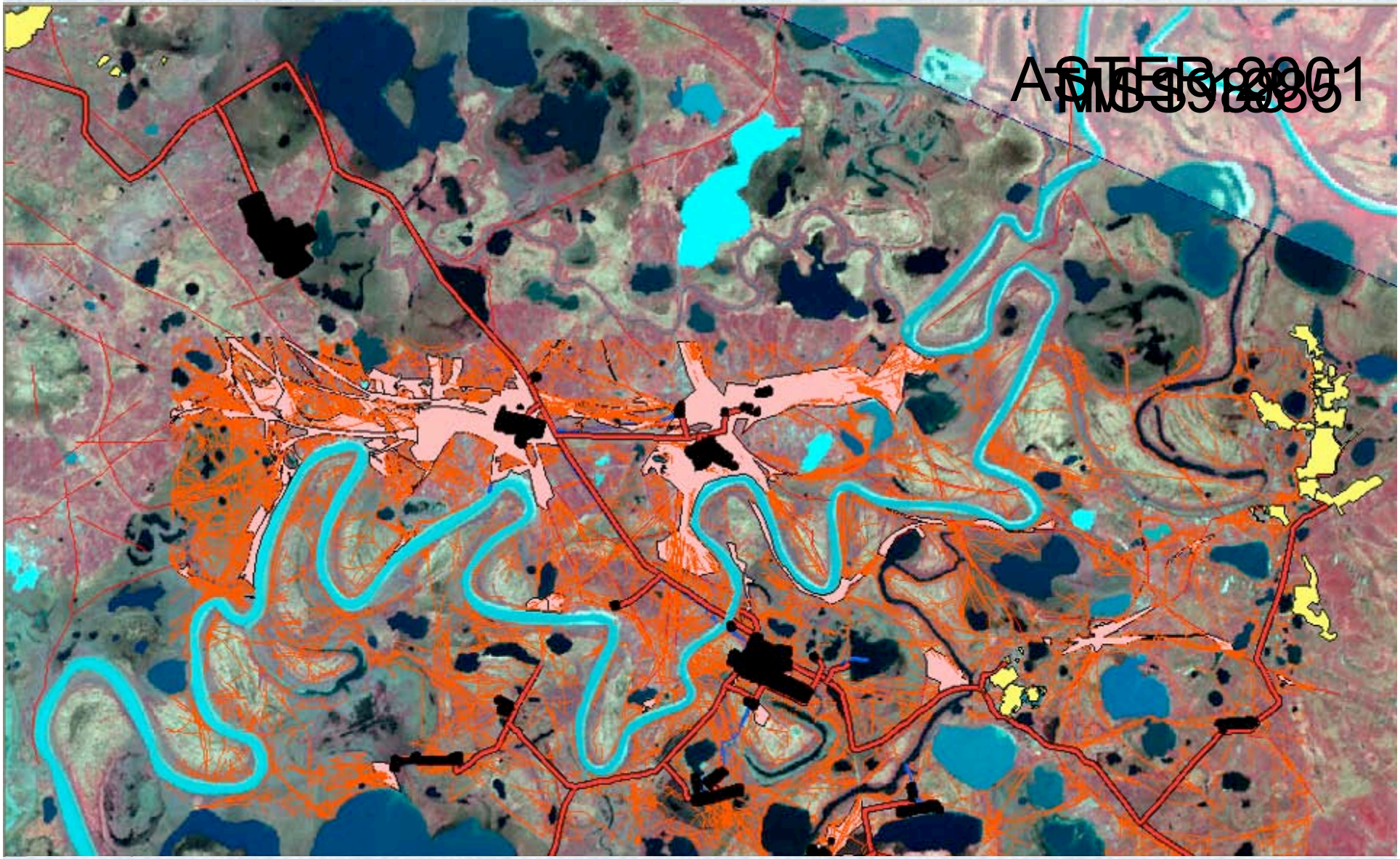
- Sand
- gravel
- Quarry

ASD field spectrometer reflectance 325- 1050 nm of individual species



Anu Pajunen biomass and species diversity data:




AFTER 2001

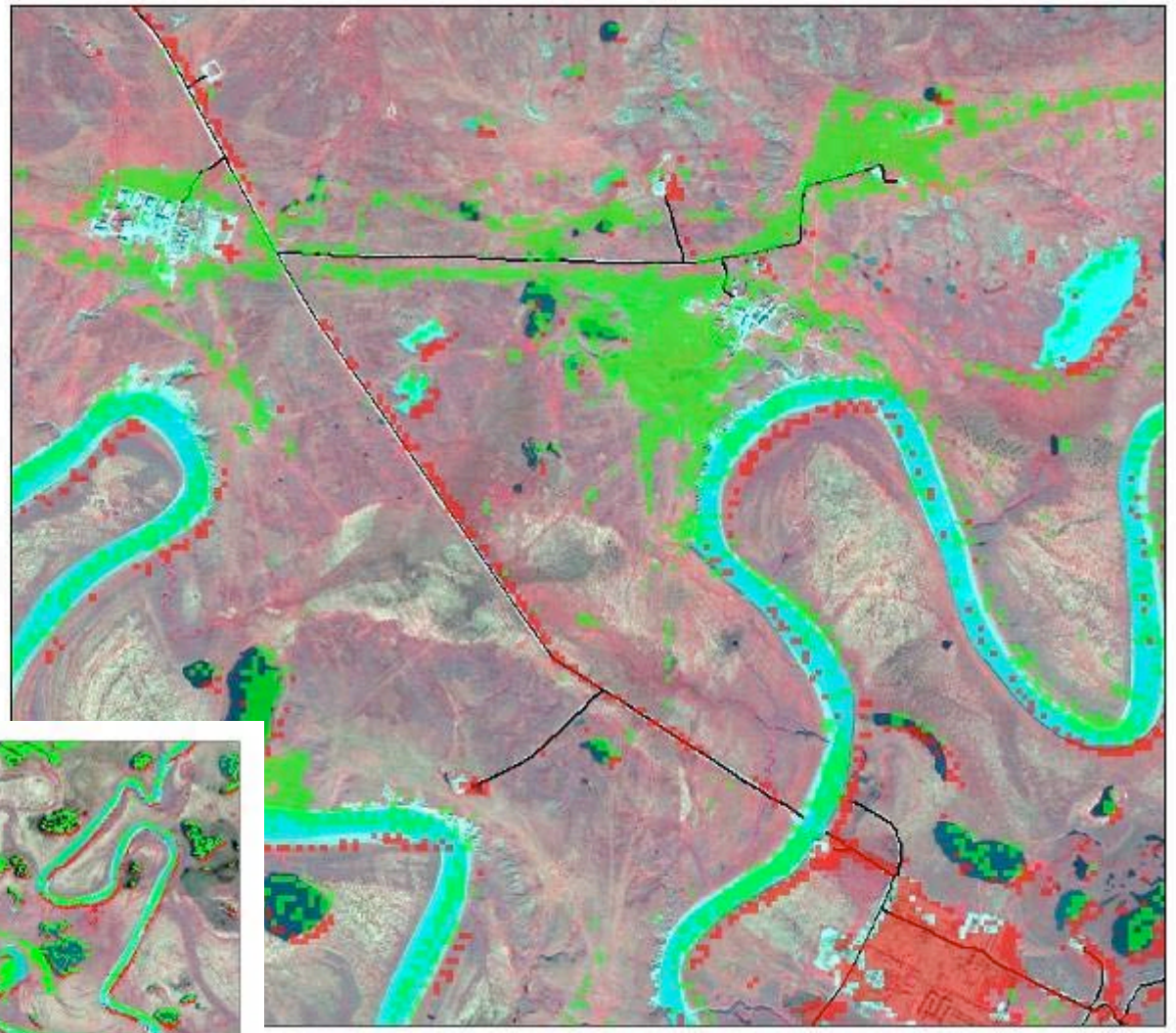
Legend

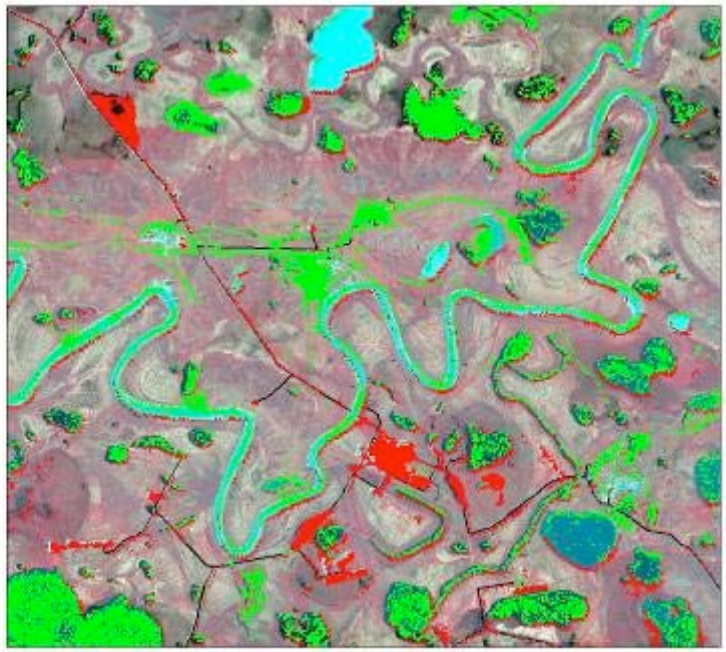
high_ndvi_88_99.img

Class_Names

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

1988-1999 NDVI



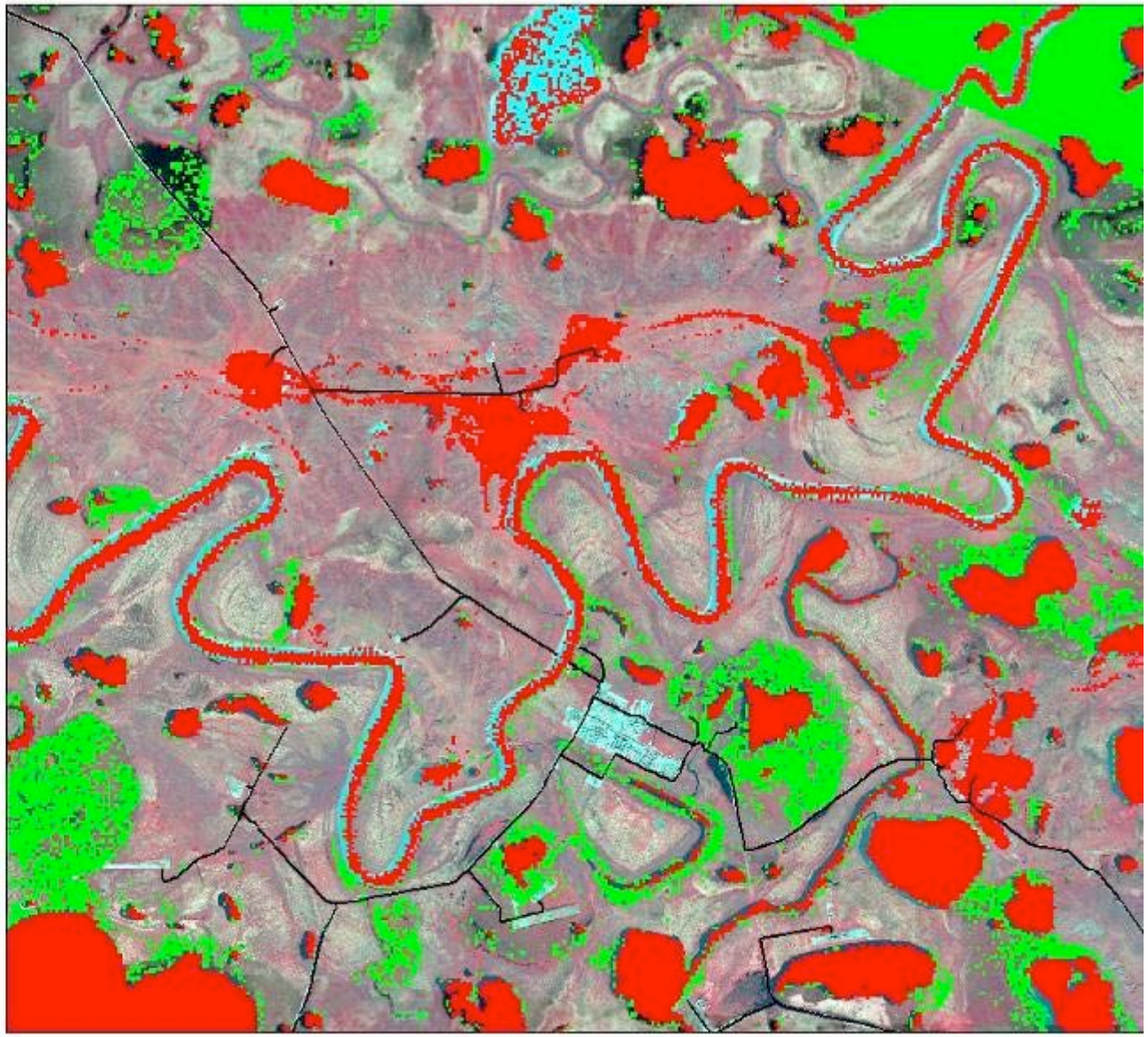


Legend

high_ndvi_88_99.img

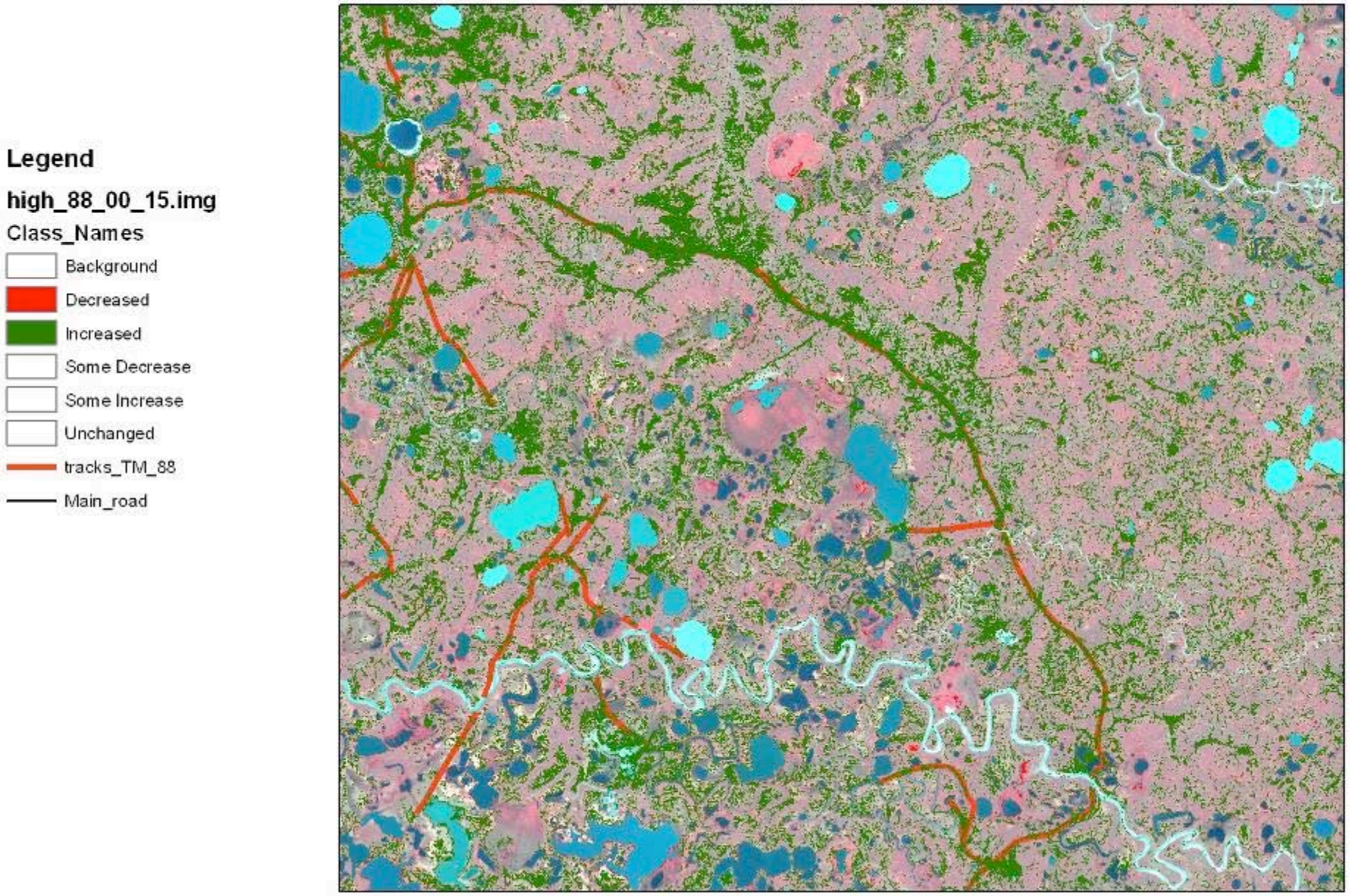
Class_Names

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



1984-1988
NDVI change

Kharasavei-Bovanenkovo 1988-2001



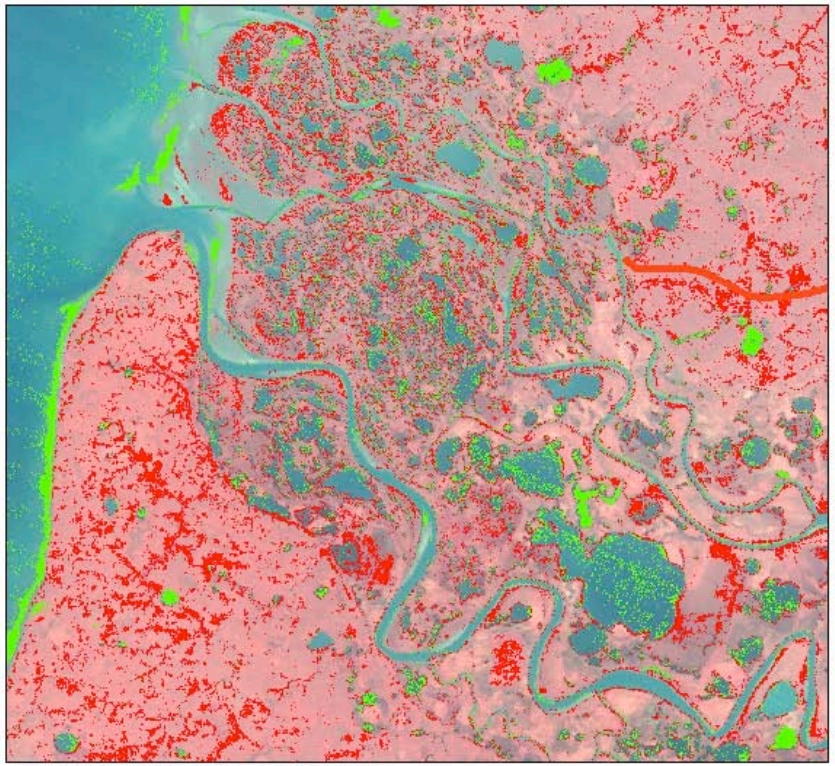
Legend

Main_road

high_88_00_15.img

Class_Names

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



Legend

high_ndvi_88_01.img

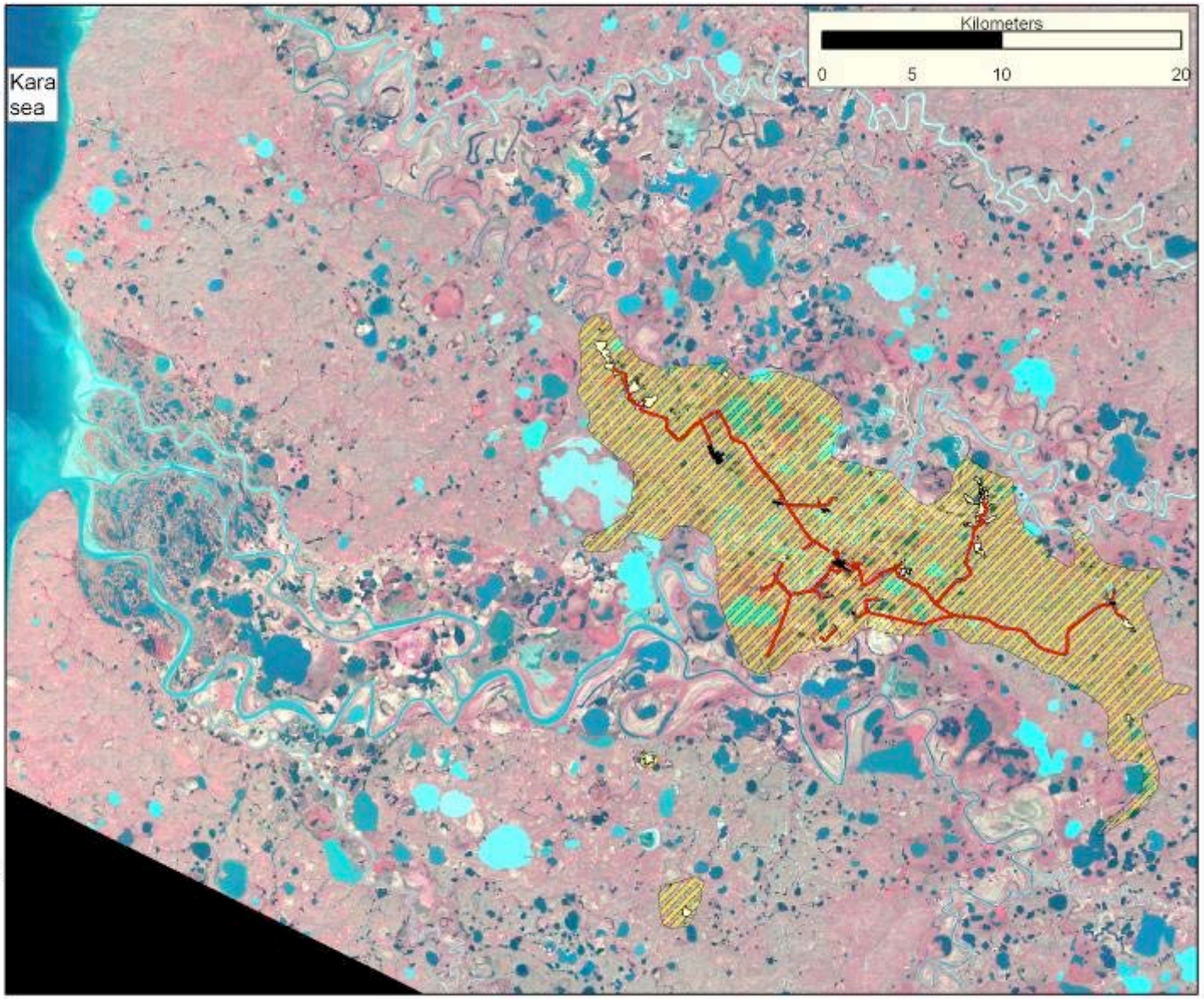
Class_Names

- 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)

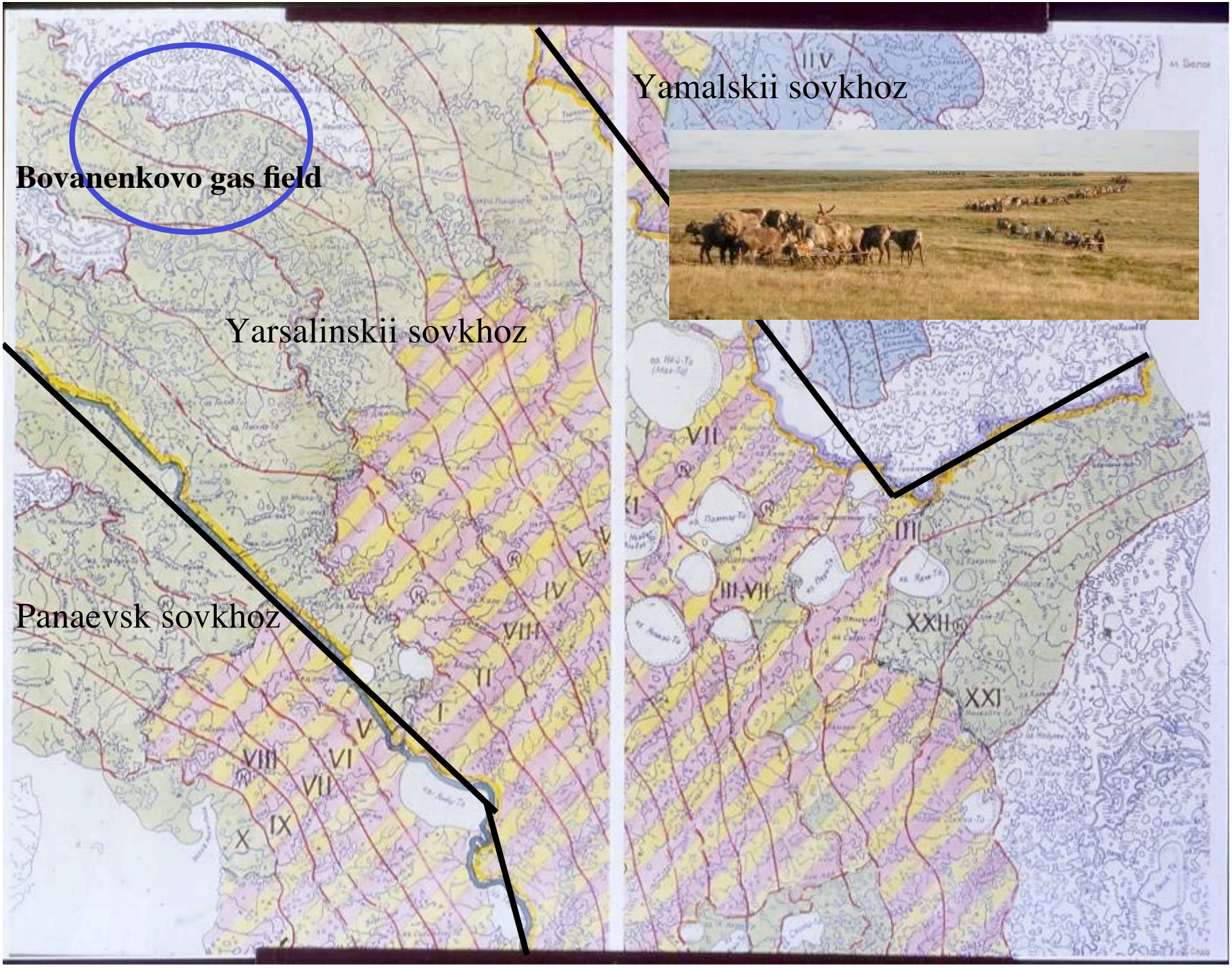
Background image:
Landsat TM 07.08.1988

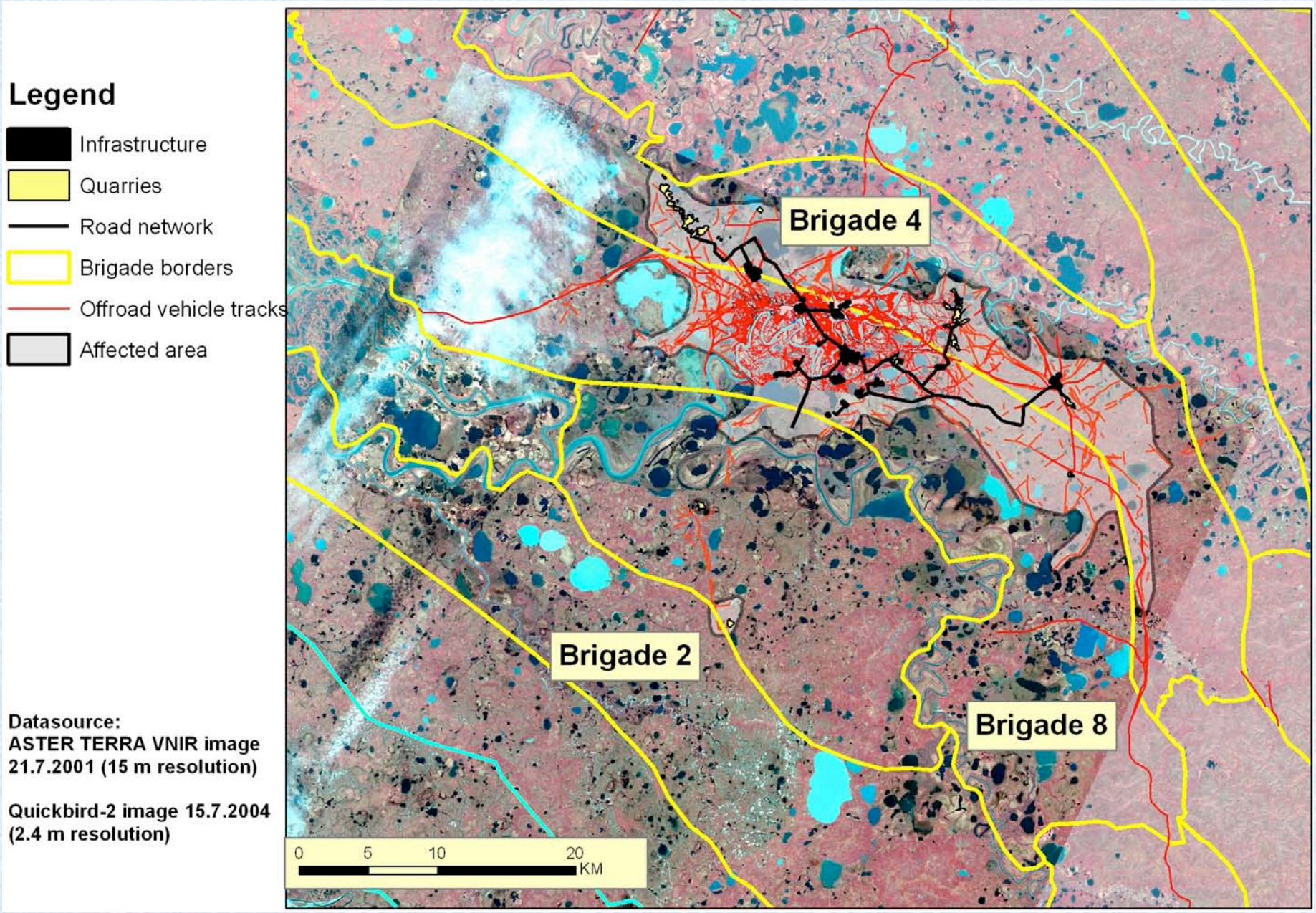
In Bovanenkovo gas field:
Visually interpreted affected area covers 448 km^2

Premanently changed
Infrastructure 2,1 km^2
Quarries 4,3 km^2
Road 79 km 2,9 km^2
Total 9,3 km^2

Changed vegetation (mainly shrubs to graminoids)
Off road tracks: 2500 km (Quickbird-2 & ASTER image)
Covers area of 24 km^2

Total change 33 km^2


Bovanenkovo gas field
Yamalskii sovkhoz
Yarsalinskii sovkhoz
Panaevsk sovkhoz


Legend
Infrastructure
Quarries
Road network
Brigade borders
Offroad vehicle tracks
Affected area
Brigade 4
Brigade 2
Brigade 8
0
5
10
20
KM
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:

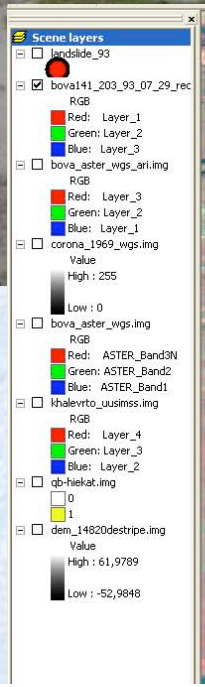
Brigade 4:

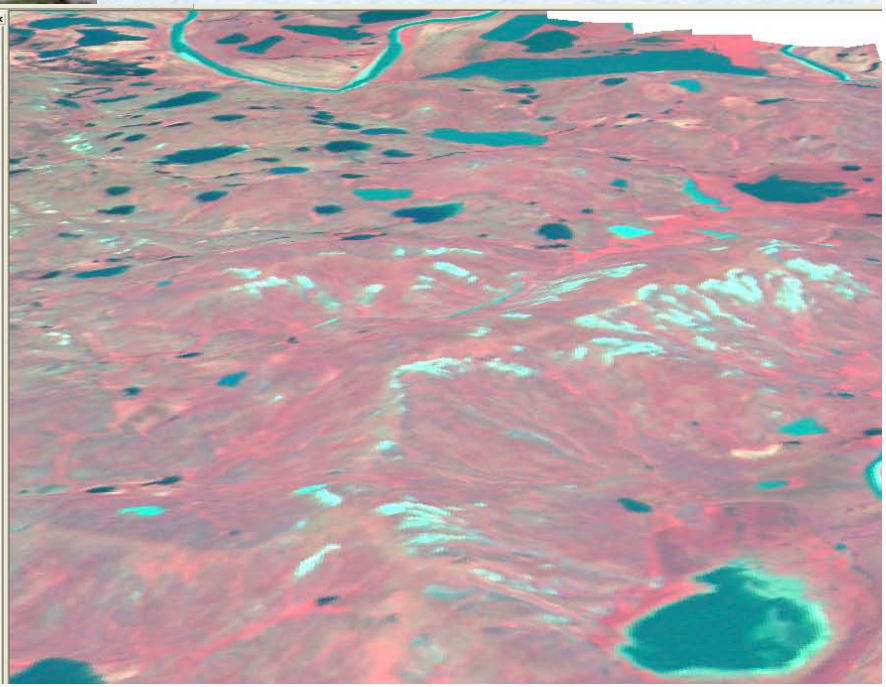
- Summer pasture July-August 1019 km^2
- 225 km^2 in Bovanenko gas field affected area

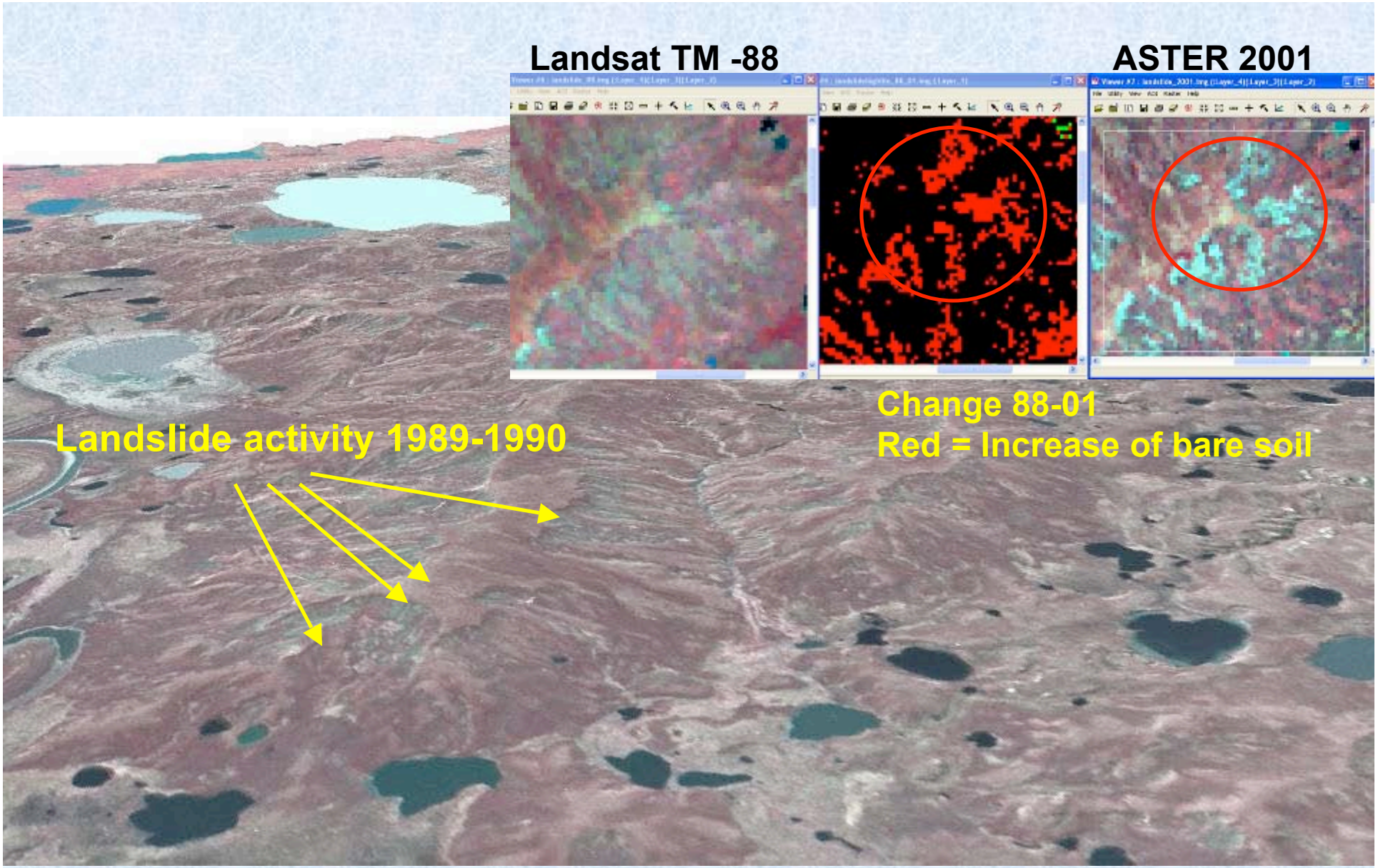
Brigade 8:

- Summer pasture July-August 796 km^2
- 200 km^2 in Bovanenko gas affected area

Landslides in Bovanenkovo region

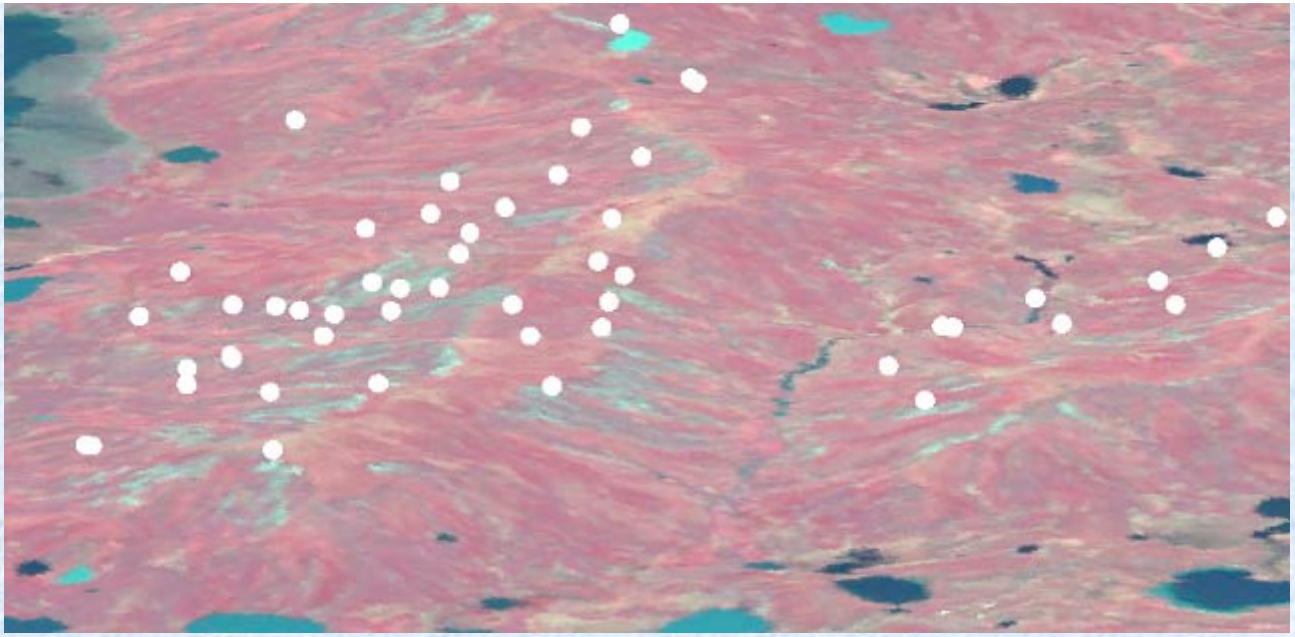




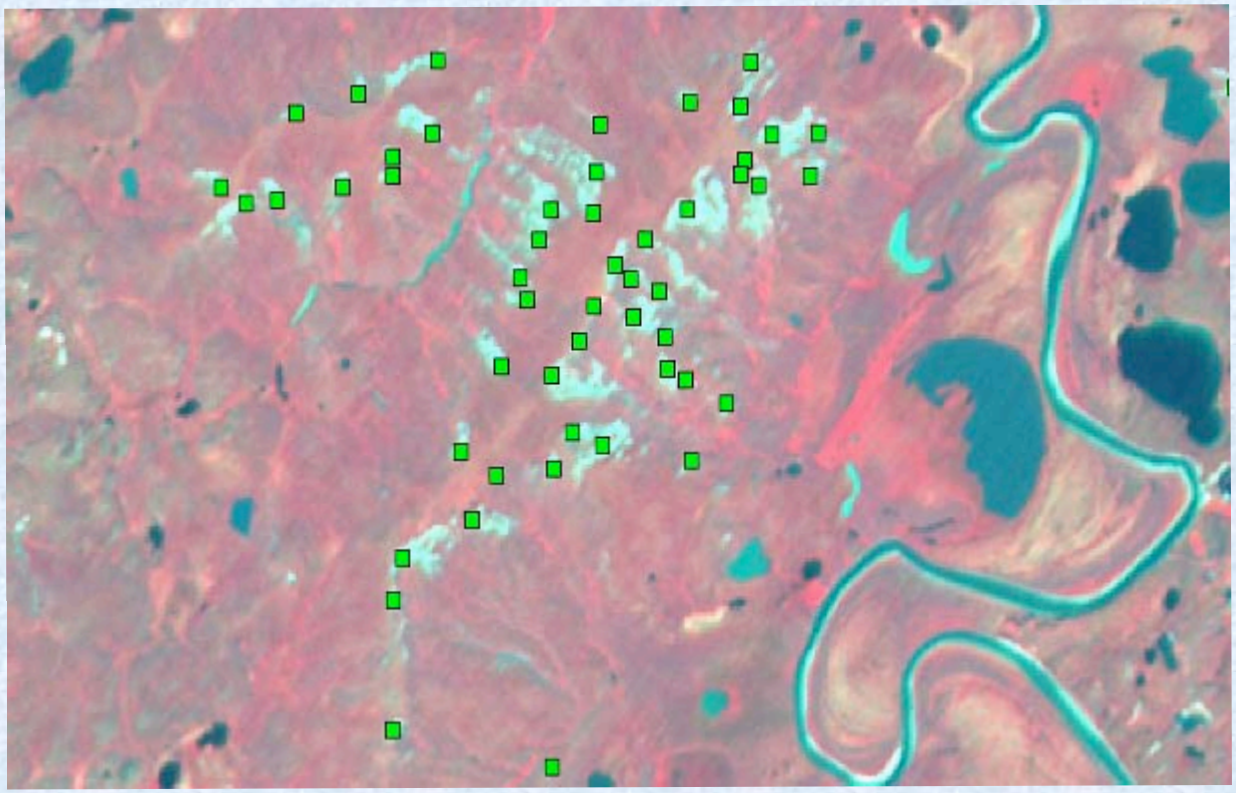


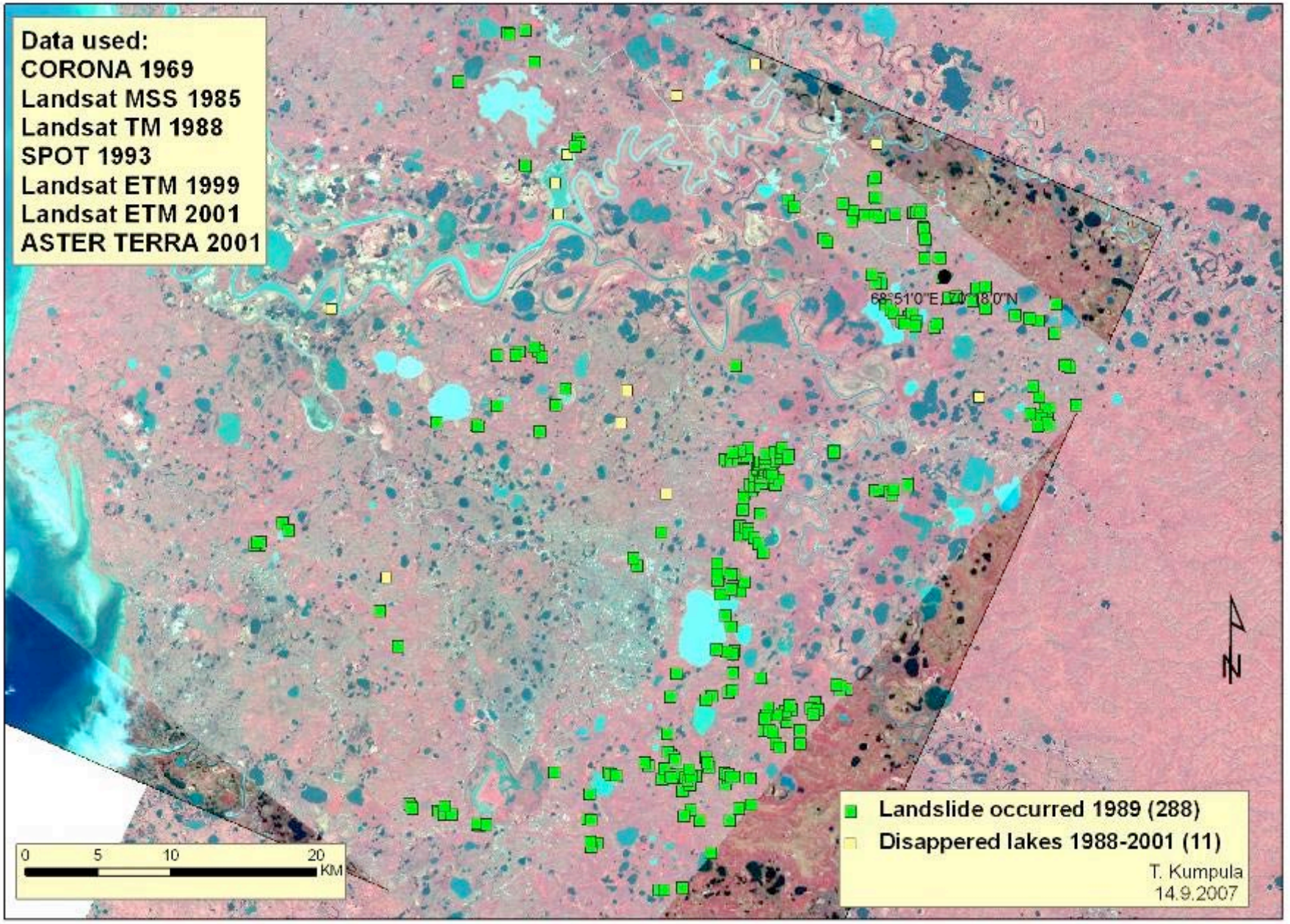
Corona 1969 & ASTER 2001 combination with DEM

ASTER 2001



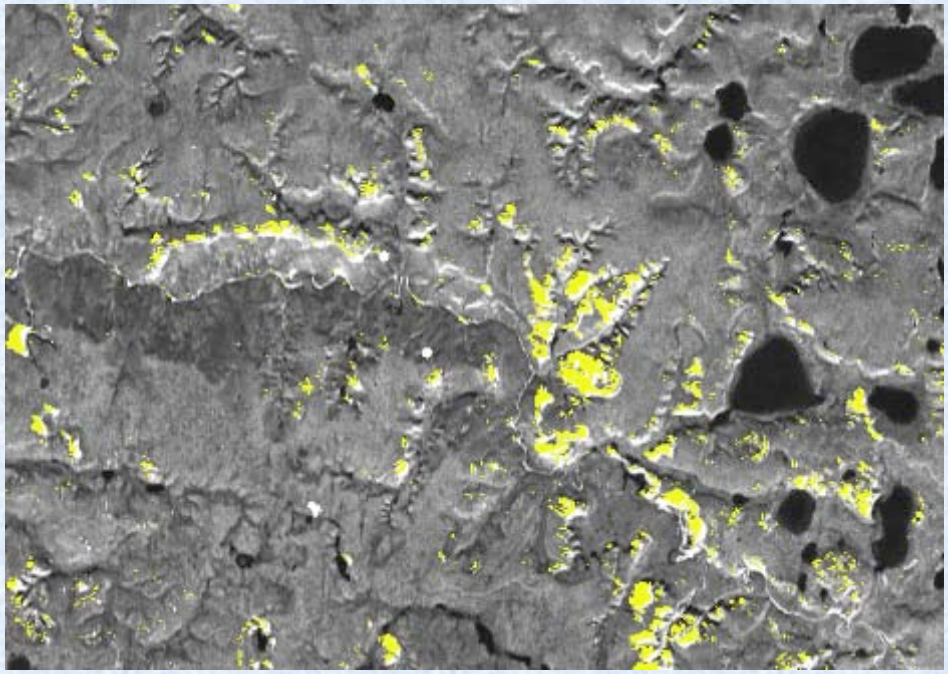
Spot 1993



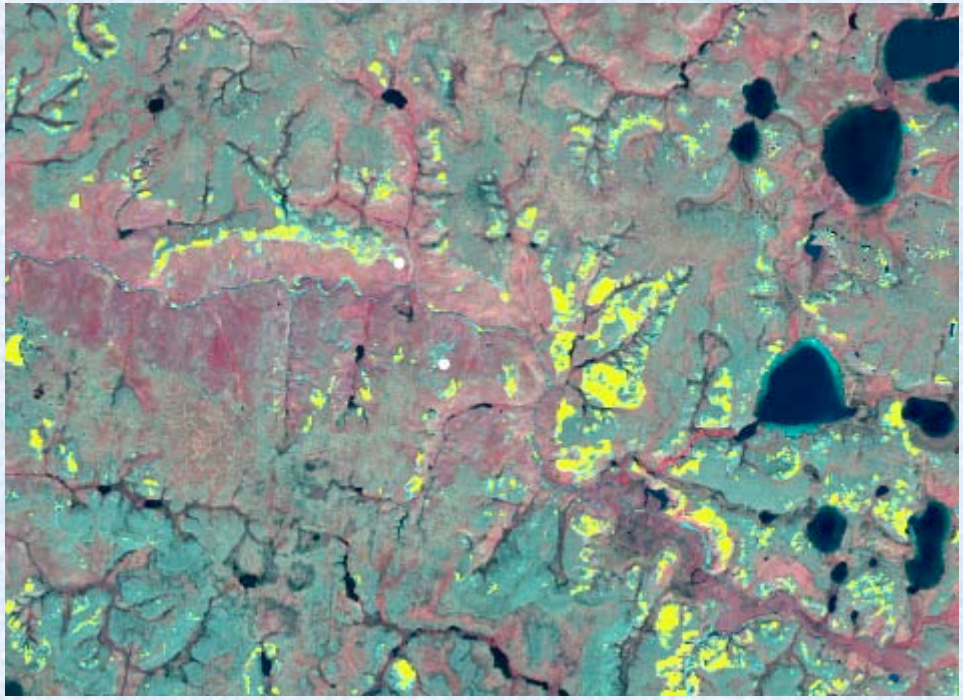

Data used:
CORONA 1969
Landsat MSS 1985
Landsat TM 1988
SPOT 1993
Landsat ETM 1999
Landsat ETM 2001
ASTER TERRA 2001
68°51'0"E
0 5 10 20
KM
Landslide occurred 1989 (288)
Disappered lakes 1988-2001 (11)
T. Kumpula
14.9.2007

Deflation areas

Corona 1969



Quickbird-2 2004

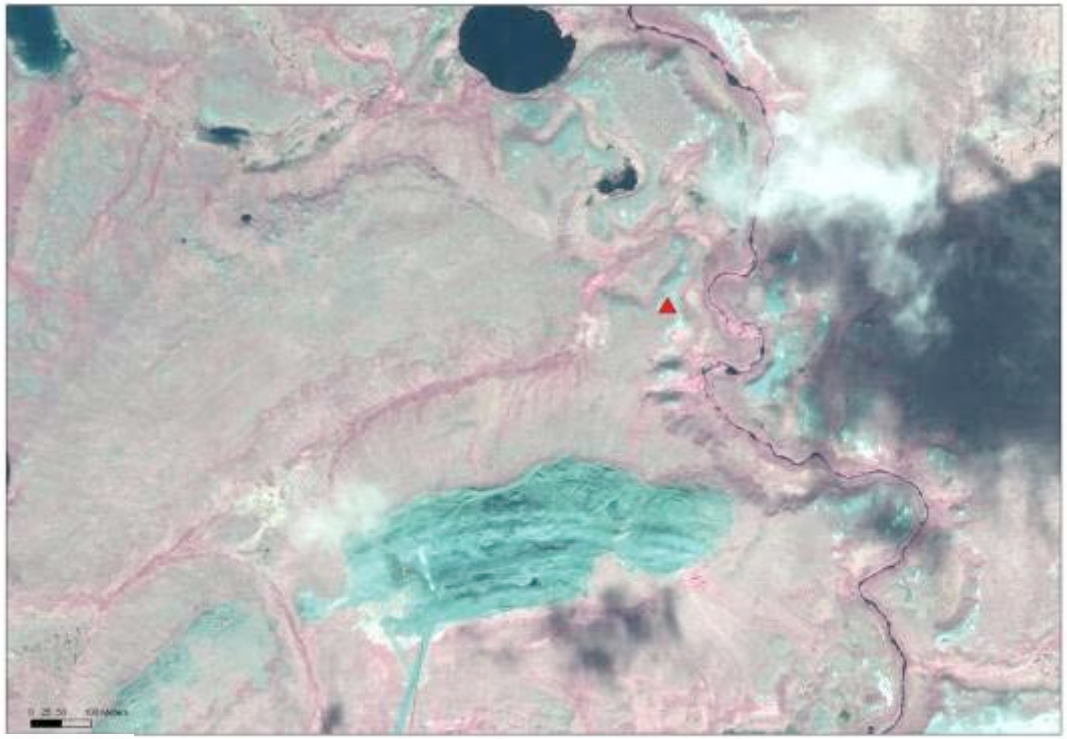


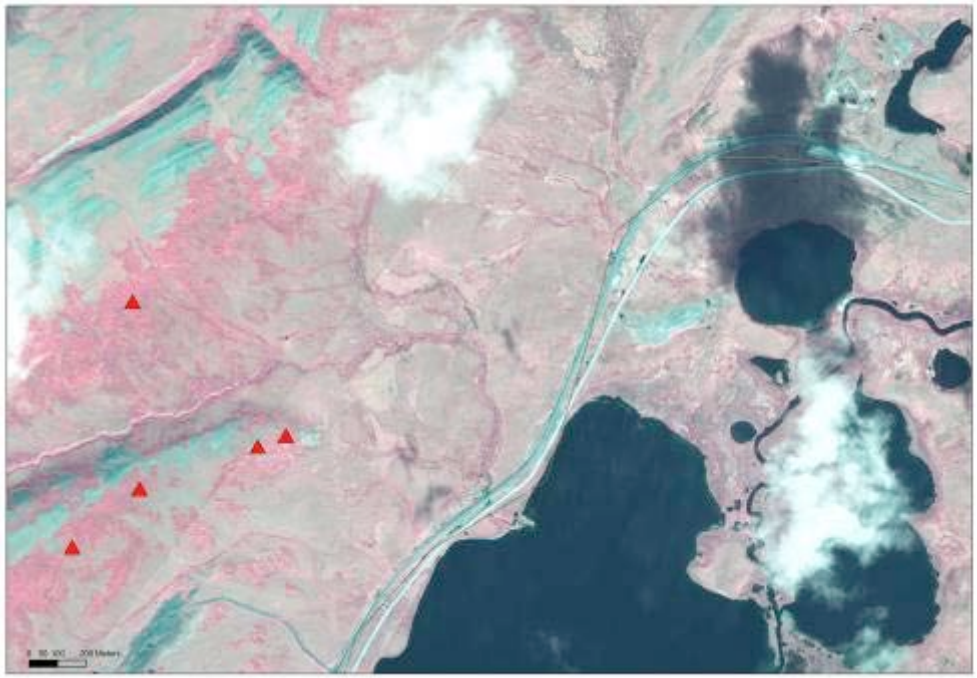
Conclusions…

- 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 gramioides. But hoof injuries and infections caused by metal and glass garbage, can be leathal 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!