Rapid Arctic Transitions related to Infrastructure and Climate Change (RATIC) Workshop: Arctic Change 2014, Ottawa,

Landcover changes in the Bovanenkovo gas field and Cultural Resilience of Social-ecological Systems of the Nenets

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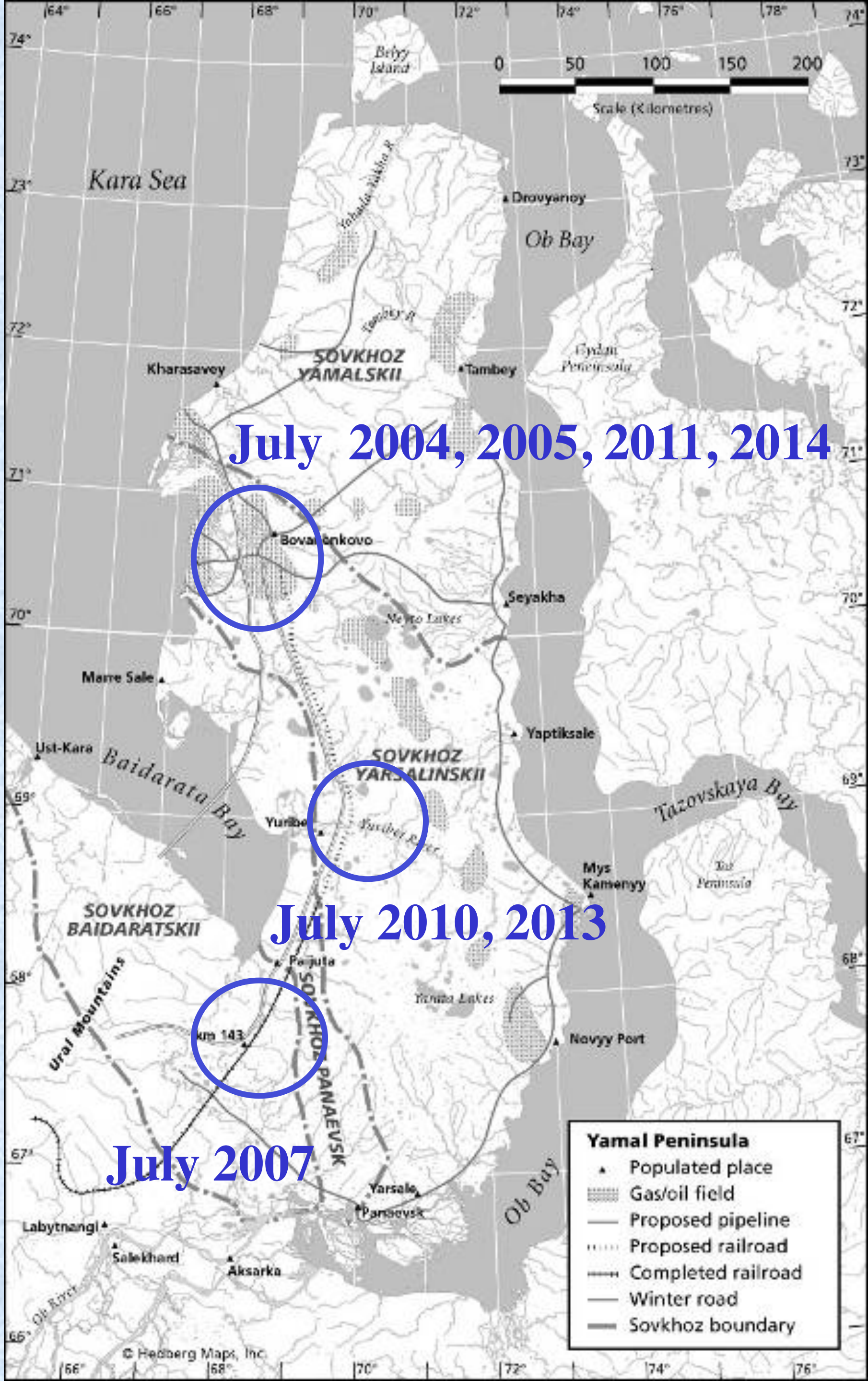
Reindeer herding areas of Northwest Eurasia

Research sites in Yamal

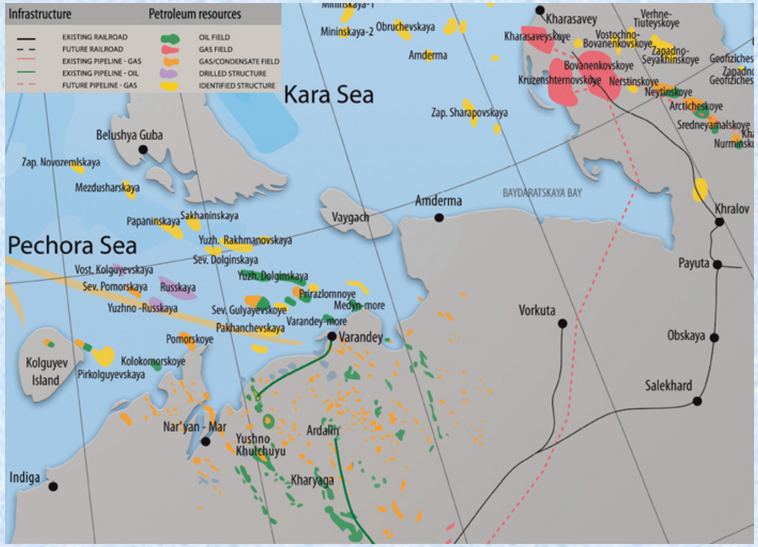
- Bovanenkovo, Mordy-jaha
- Yuribei river
- Laboravaja



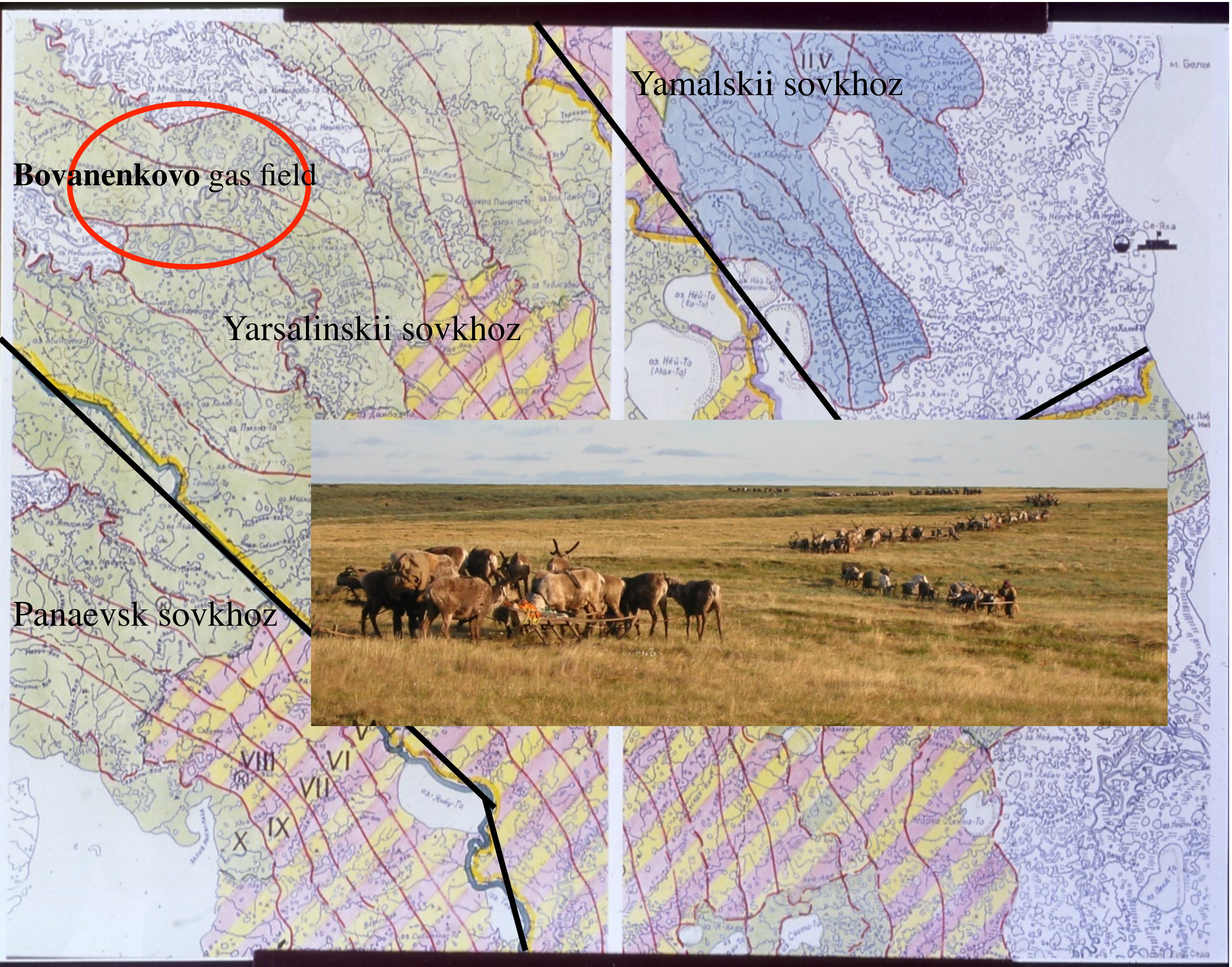
Drivers of land cover and land use change on Yamal:

- 1) anthropogenic: petroleum related expansion of infrastructure and traffic
- 2) anthropogenic-natural: intensification of reindeer husbandry, impact to vegetation
- 3) natural: climate change related, changes in snow conditions, changes in vegetation, intensification of permafrost melting related processes, e.g. cryogenic landslides and thawing lakes

Bovanenkovo gas field



- Bovanenkovo gas field was found in 1972
- Geological surveys of the gas field began to accelerate in 1980’s
- The first construction phase started in 1987
- 2002 Gazprom identified the Yamal Peninsula as a region of strategic interest to the company’
- Bovanenkovo Gas Field (BGF) opened at the end of 2012

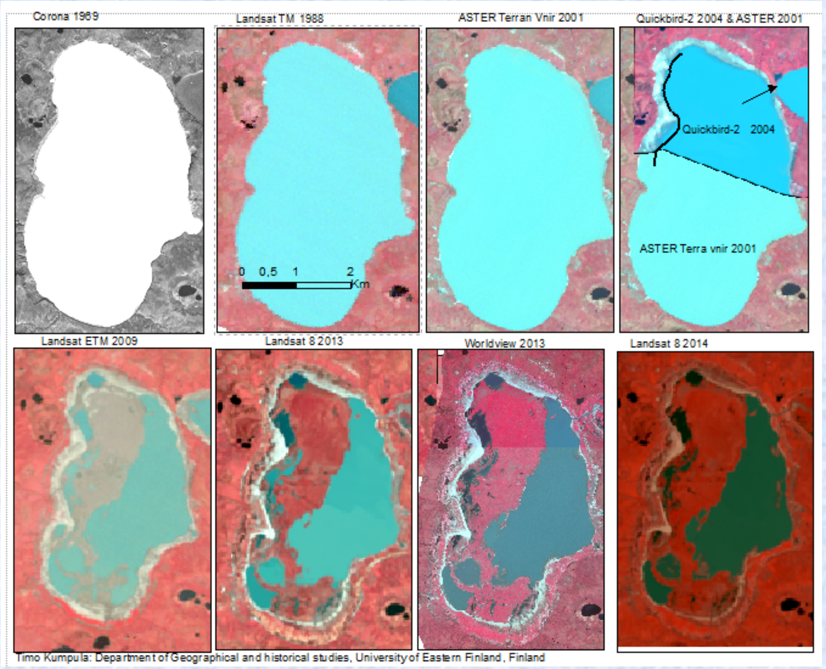

Yamalskii sovkhoz
Bovanenkovo gas field
Yarsalinskii sovkhoz
Panaevsk sovkhoz

Data collection and analysis

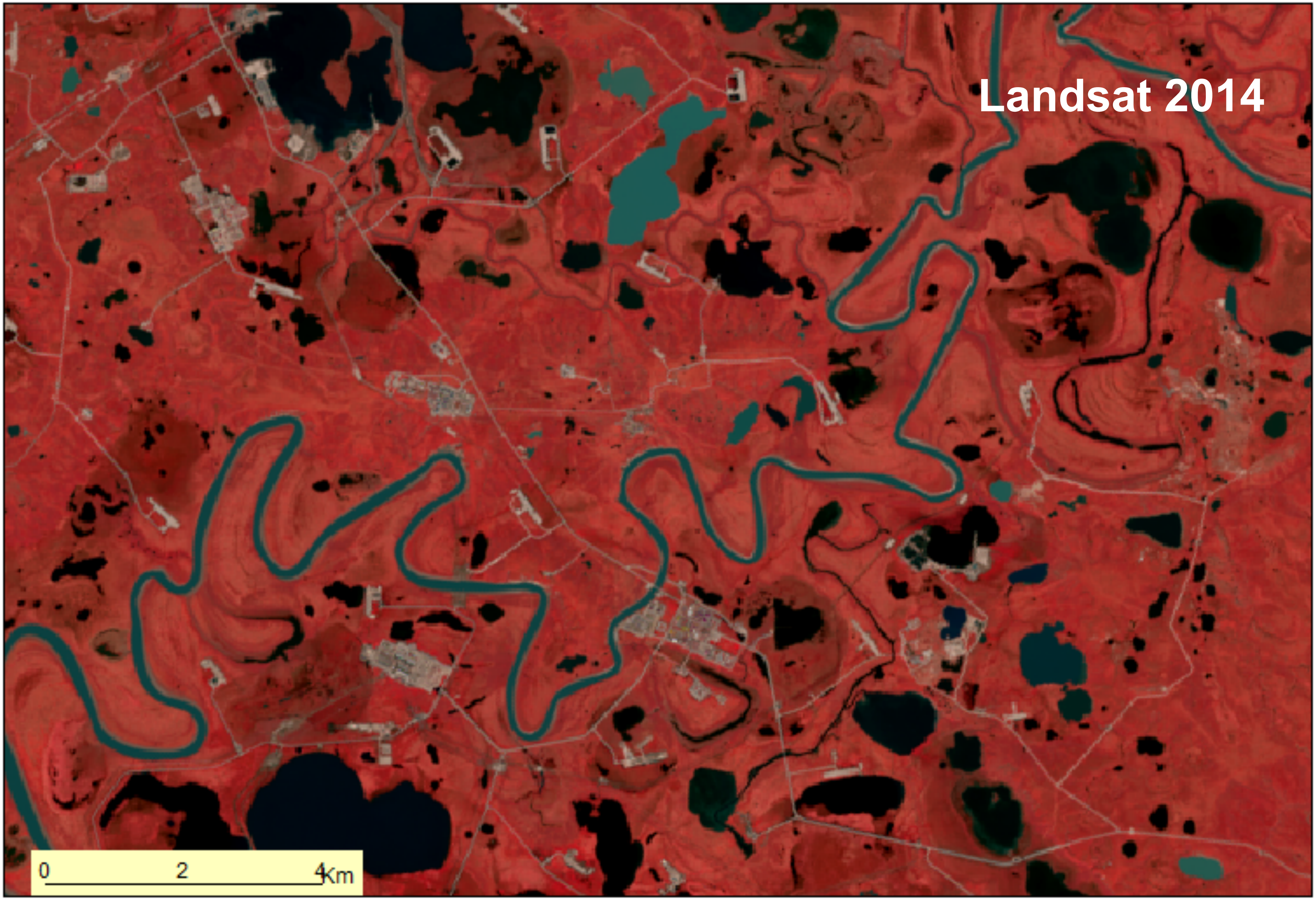
- Ground truth for image analysis, (LAI, Spertrometer)
- Vegetation mapping
- Biomass collection
- Dendrochronical data *(salix*) collection
- Participatory observation
- Interviews

Remote sensing data

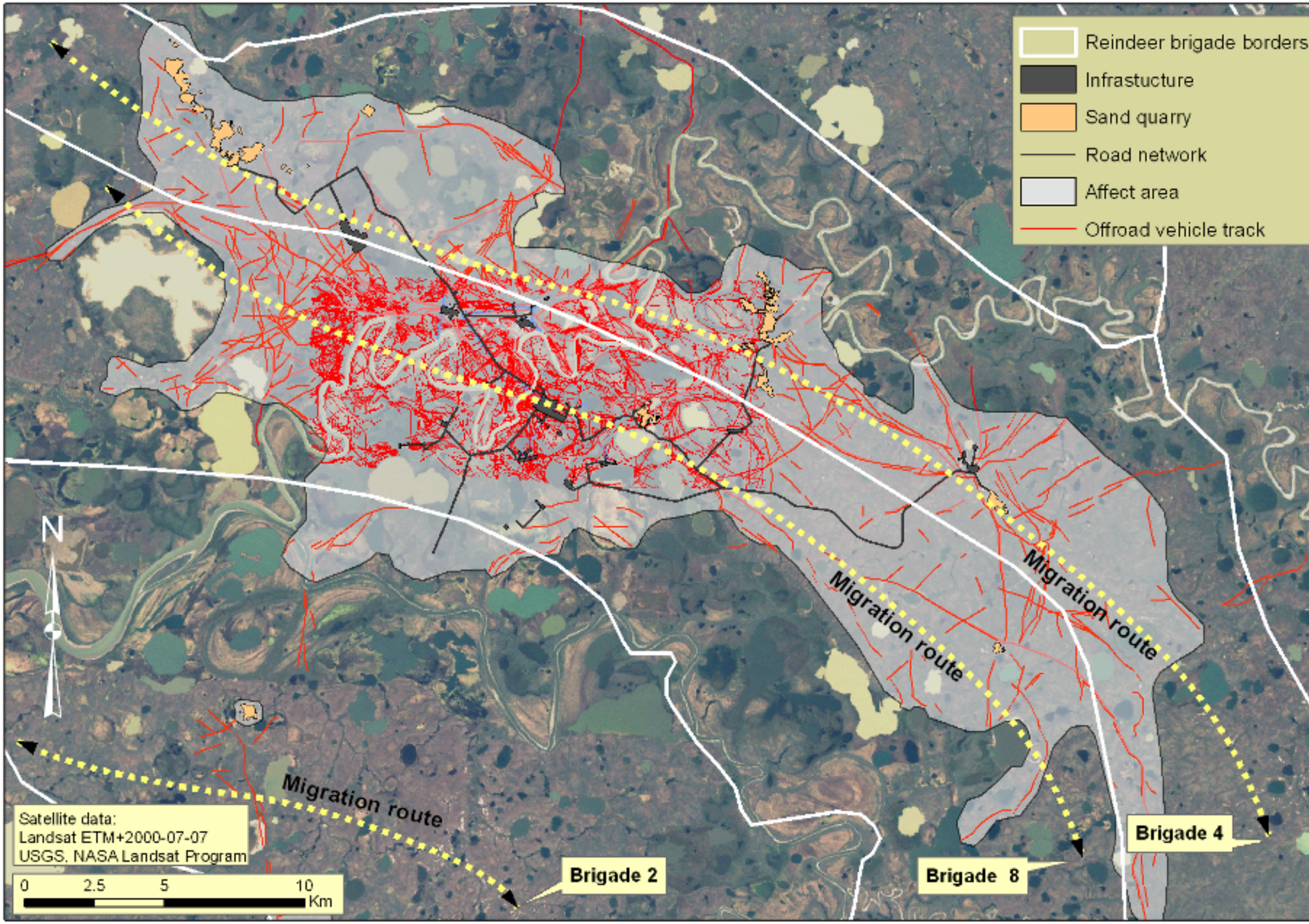
- Corona 1969
- Aerial photographs 1970’-1990’s
- Landsat TM 1985 28 August
- Landsat MSS 1985 28 July
- Landsat TM 1988 07 August
- Landsat TM 1990 20 july
- Landsat TM 1994 1 August
- SPOT 1993 29 July
- SPOT 1998 19 July
- Landsat ETM 1999 July
- Landsat ETM 2001 July
- ASTER TERRA 2001 21 July
- Quickbird-2 2004 15/28 July
- Landsat TM 2009 July
- Landsat TM 2011 15 July
- Landsat ETM8 2013 July
- Worldview-2 2013 15 July
- Landsat 2014 July
- Terra XS 2014 July
- ALOS prism DEM 2007



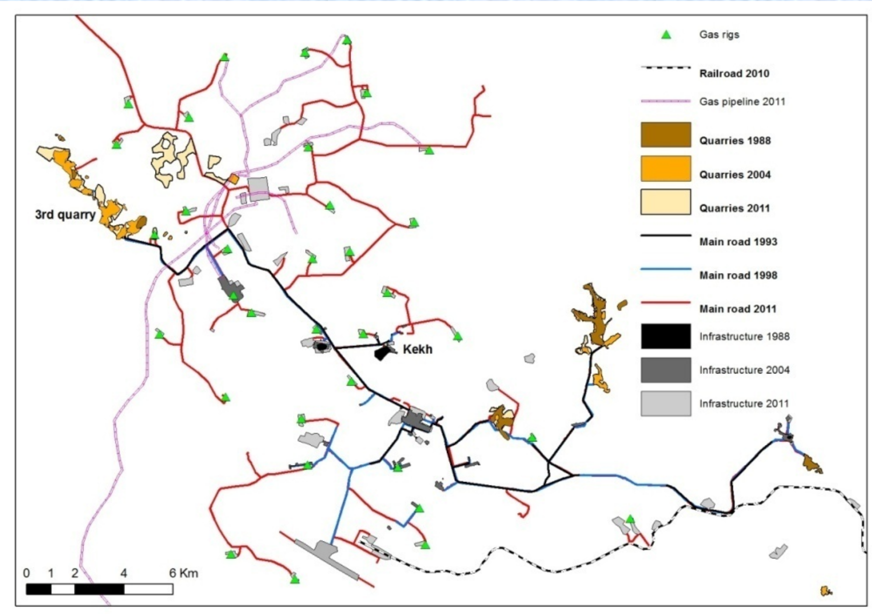

Quicbird-2 panchromatic
(63 cm resolution) 15.7.2004 (Yamal)
4 chums with sledges

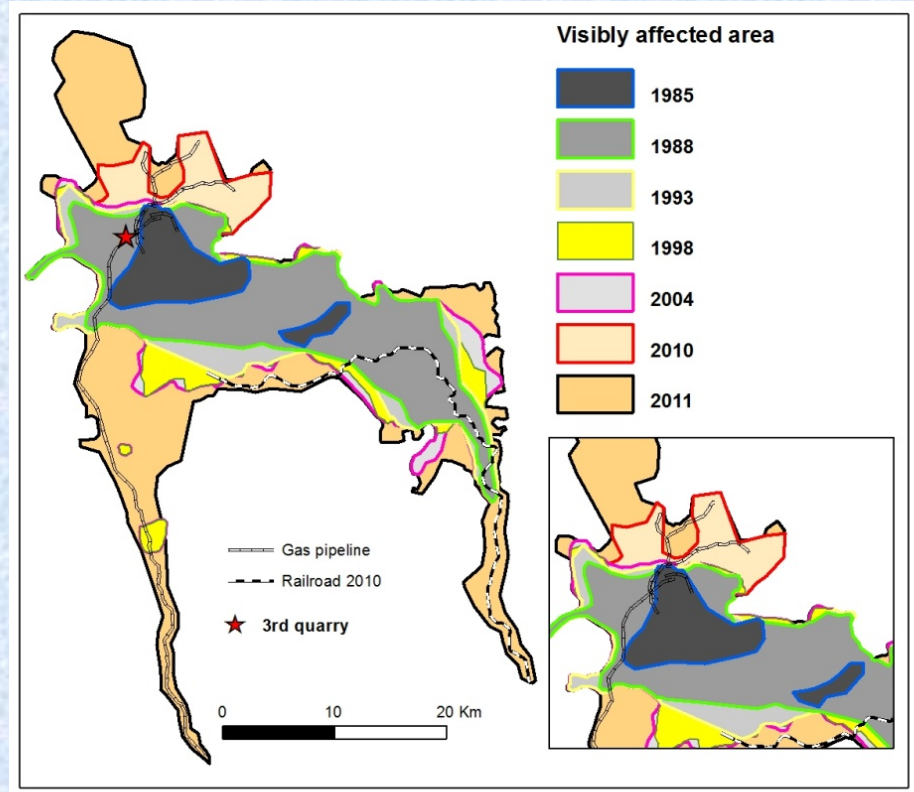


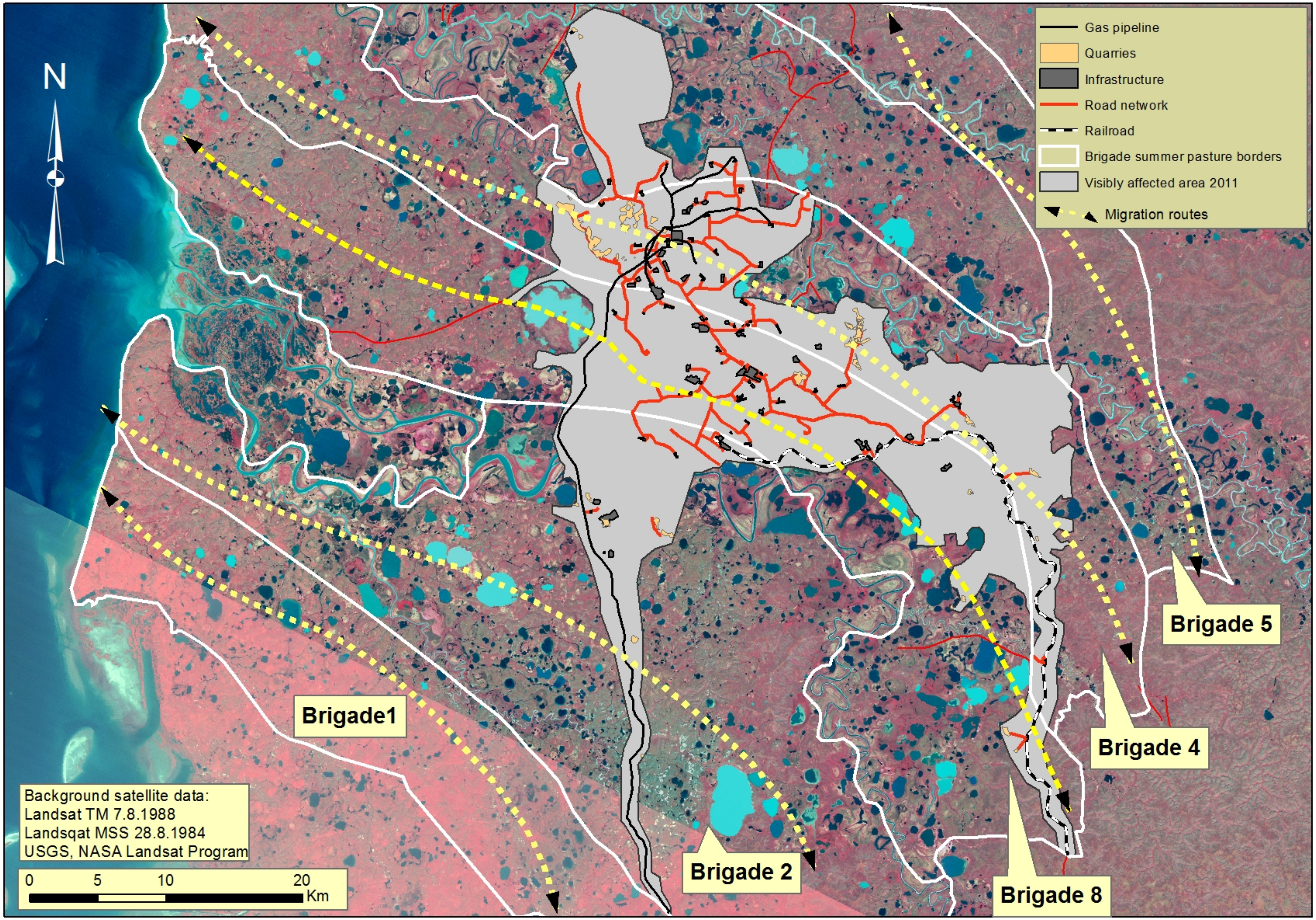
Landsat 2014
0
2
4Km



Forbes, Stammler, Kumpula, Meschtyb, Pajunen & Kaarlejärvi (2009).


Gas rigs
Railroad 2010
Gas pipeline 2011
Quarries 1988
Quarries 2004
Quarries 2011
Main road 1993
Main road 1998
Main road 2011
Infrastructure 1988
Infrastructure 2004
Infrastructure 2011
3rd quarry
Kekh
0 1 2 4 6 Km


Visibly affected area
1985
1988
1993
1998
2004
2010
2011
Gas pipeline
Railroad 2010
3rd quarry
0 10 20 Km



Kumpula et al. (2012) ***Remote sensing***

Impacts of Bovanenkovo gas field to brigades 2, 4 and 8 of Yarsalinski sovhoz:

Brigade 4:

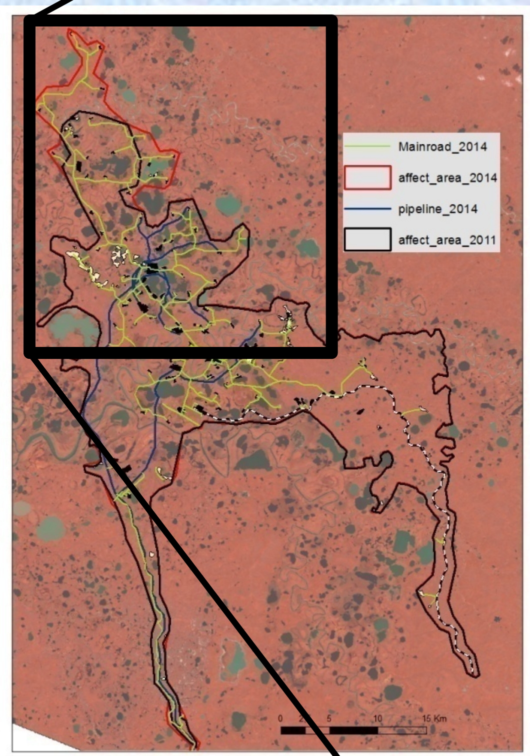
- Summer pasture July-August 1019 km^2
- 225 km^2 in Bovanenko gas field affected area

Brigade 8:

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

	Brigade 4	Brigade 8	Brigade 2
area affected 2004 km^2	**225**	**200**	**29**
area affected 2010 km^2	228	240	29
area affected 2011 km^2	300	295	147
Area of summer pasture km^2	1019	796	1208

2014



Mainroad_2014
affect_area_2014
pipeline_2014
affect_area_2011
0 2.5 5 10 15 Km

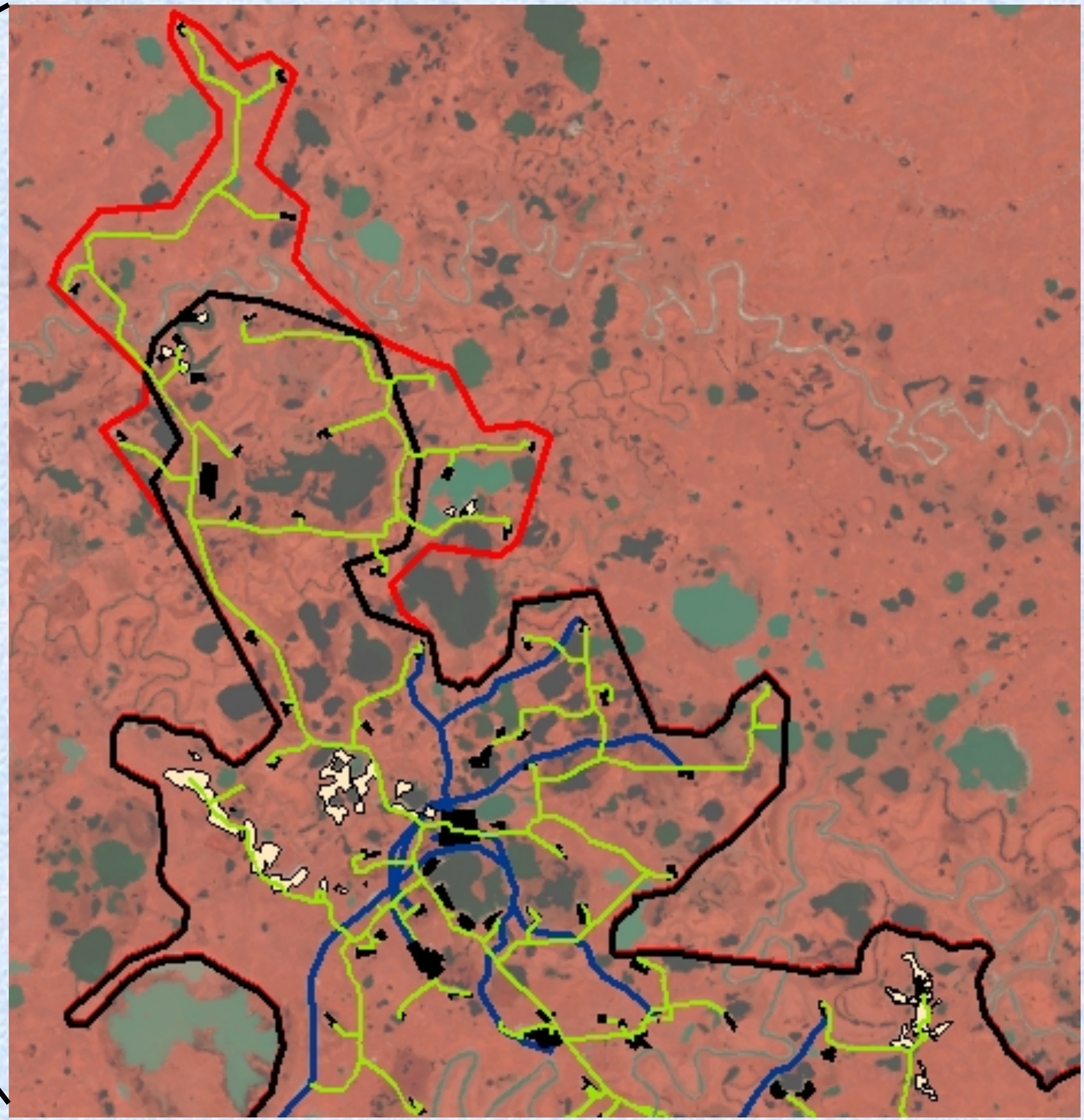


Table 3. Estimations of the spatial extent of industrial impacts. Satellite images used are Landsat MSS/TM/ETM, SPOT, ASTER VNIR, Quickbird-2 and GeoEye.

Satellite/year	MSS	TM	SPOT	SPOT	ASTER	Quicbird-2	GeoEye/ETM	TM	Lands at 8
Form of activity	**1984**	**1988**	**1993**	**1998**	**2001**	**2004**	**2010**	**2011**	**2014**
Buildings & yards km²		0.4	0.6	1.9	1.9	2.1	5.4	9.8	12,0 km²
Main roads length km		2	49	80	81	81	154	212	
Road area coverage km²		0.6	1.8	2.9	3	3	5.8	8.0	12,0 km²
Sand quarries km²		1.8	3.5	3.5	3.5	4.3	6.6	9	9,5 km²
Pipeline right of way km						16	16	103	131 km
Pipeline corridor km²						0.6	0.6	4.4	6,6 km²
Railroad km								59	59 km
Railroad area coverage km²								3.6	3,6 km²
Off-road track length km	38	348	380	410	590	2,400	2,989	3,136	
Off-road track area coverage km²	3	14	16	17	24	44	49	54	
Disturbed vegetation 1988–2011 km²		1.9						0.3	
Airport km²								1	1 km²
Visibly affected area km²	70	320	375	420	440	451	509	836	904 km²
Permanently changed area km²		2.8	5.9	8.4	8.3	8.9	18.4	36.1	37,7 km²

Kumpula et al. (2012) *Remote sensing*

Mutual coexistence: rhetoric vs. reality

While Nenets SESs have adapted well to a variety of pressures over the last few decades, can we identify cultural aspects of resilience that have helped them to persist?

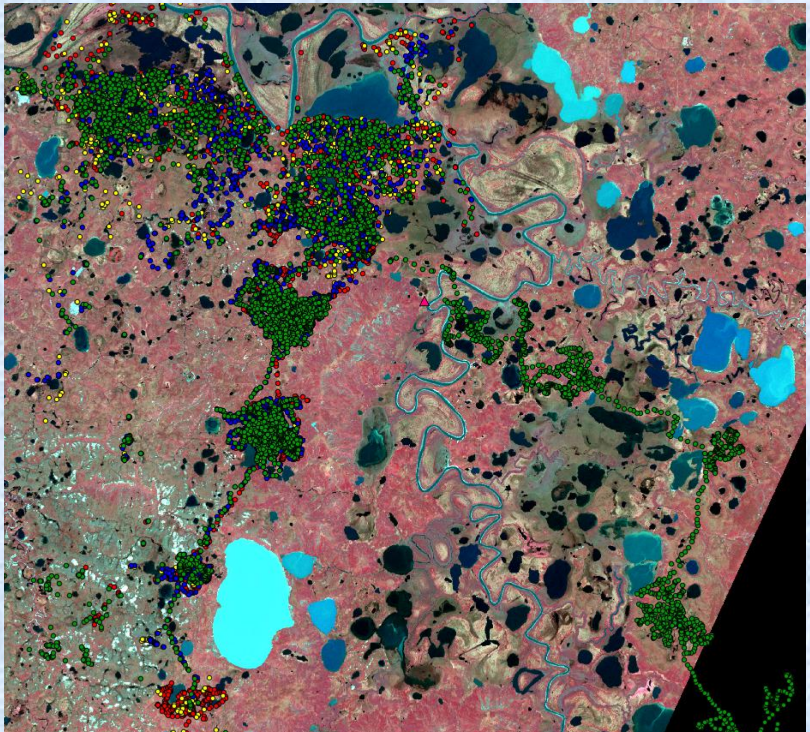
Forbes (2013) *Ecology and Society*

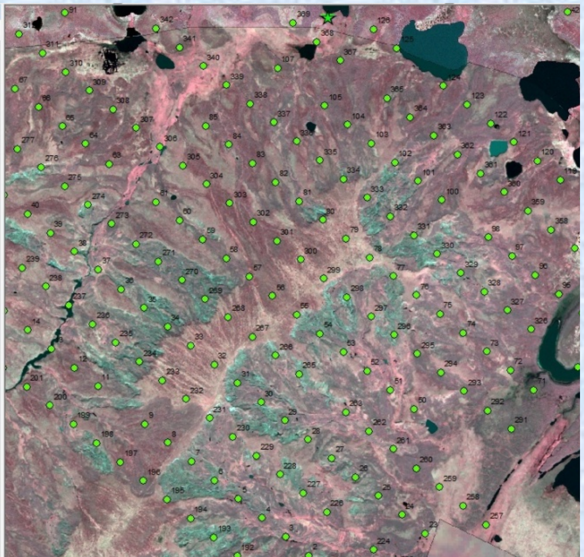
Factors contributing to resilience

- adaptation to use all available resources, such as fish and game
- the nomadic tundra population is growing and herding popular among youth
- Accepting exogenous drivers (e.g. extreme weather events and or degradation of territory) and coping with them
- Institutions administering reindeer herding have remained flexible, especially on Yamal Peninsula
- This affects factors such as herd demography, mobility and energetics.
- Herders’ own (collective) agency is critical, most recently in the post-Soviet shift to smaller, privately managed herds to better utilize available pastures in a highly dynamic environment experiencing rapid socio-economic, climate and land use change

Reindeer grazing impact on tundra vegetation, willows and landslides

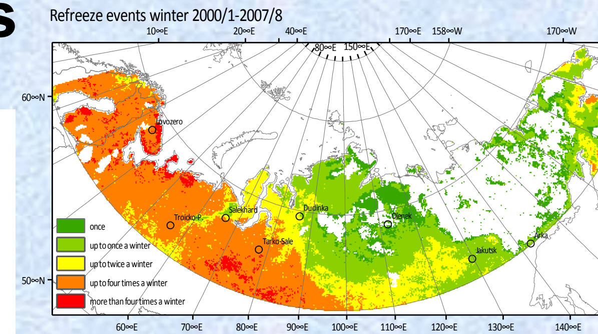
- Reindeer feaces pellet count
  - data collected in Mordy jaha in summer 2013 and 2014
- GPS collar monitoring of pasture use
  - GPS collars installed in March 2013
  - reading interval 1h (5 mins in summer)





Data collection:
Anna Skarin
(University of
Uppsala, Sweden)

Climate change impacts to reindeer herding
Rain on Snow (ROS) and icing of pastures



Ecological Applications, 20(8), 2010, pp. 2346–2358

Detection of snow surface thawing and refreezing in the Eurasian Arctic with QuikSCAT: implications for reindeer herding

Annett Bartsch,[1,5] Timo Kumpula,[2] Bruce C. Forbes,[3] and Florian Stammler[3,4]

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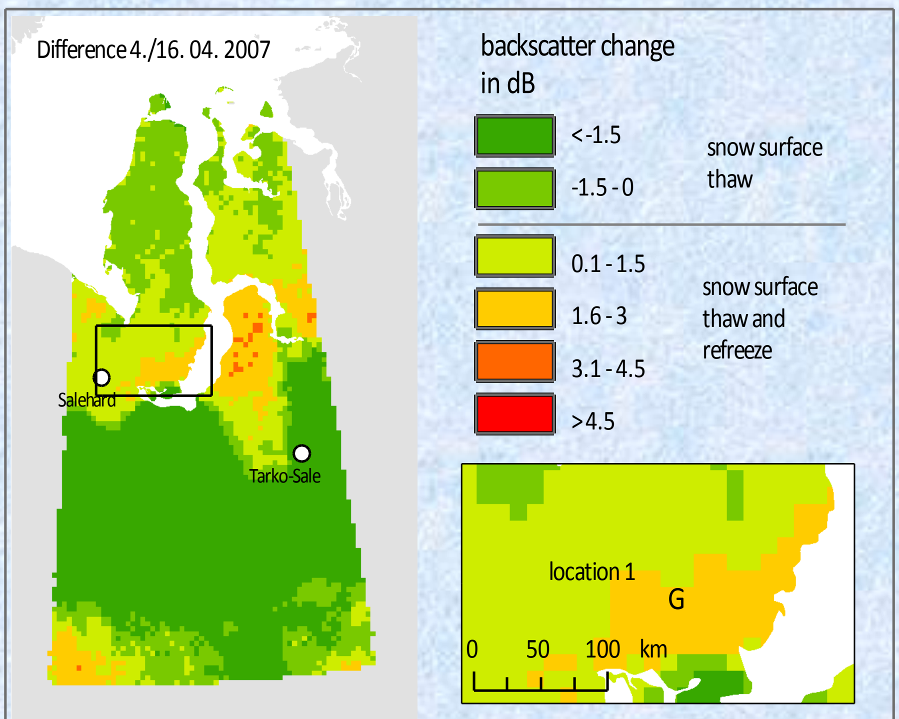
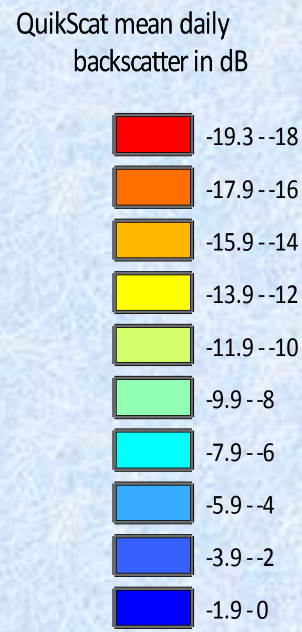
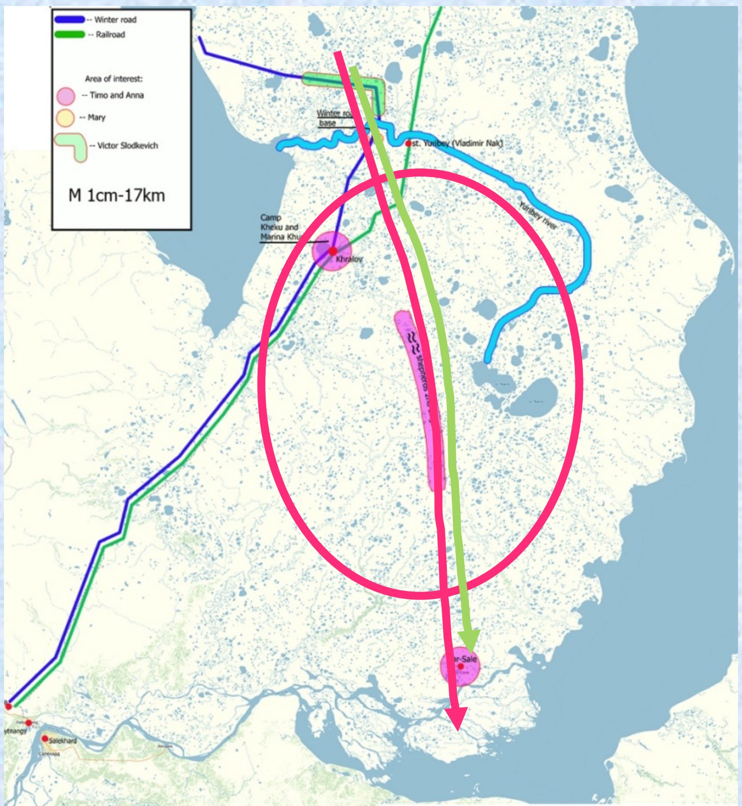
[3]*Arctic Centre, University of Lapland, Rovaniemi 96101 Finland*
[4]*Scott Polar Research Institute, Cambridge University, Cambridge CB21EP United Kingdom*

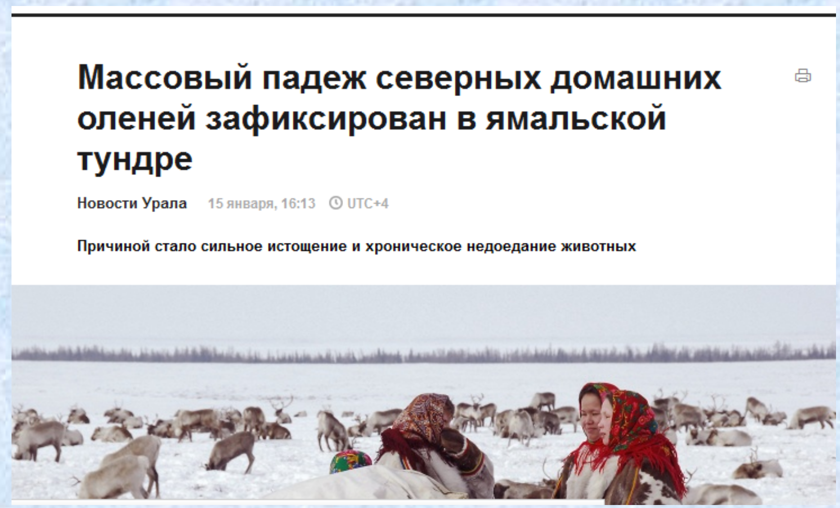




Rain on Snow and icing of pastures winter 2013-2014

-Large scale icing
-about 20 000 reindeer died




Массовый падеж северных домашних оленей зафиксирован в ямальской тундре

Новости Урала 15 января, 16:13 UTC+4

Причиной стало сильное истощение и хроническое недоедание животных

Worldview-2 19.7.2013

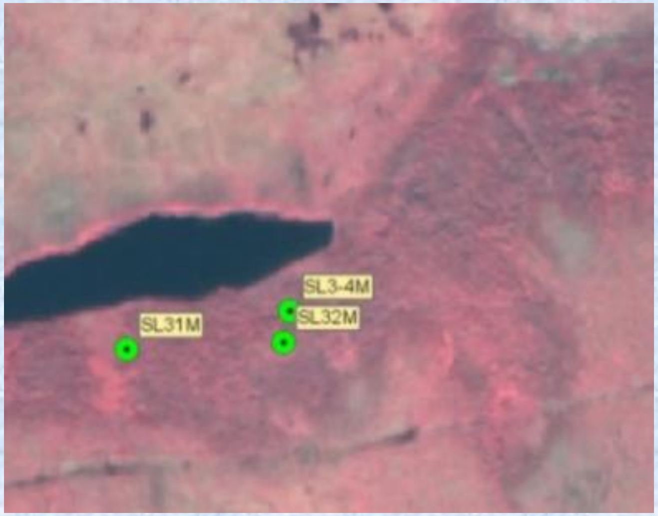
Deciduous shrub growth and the greening of the Arctic in West Siberia

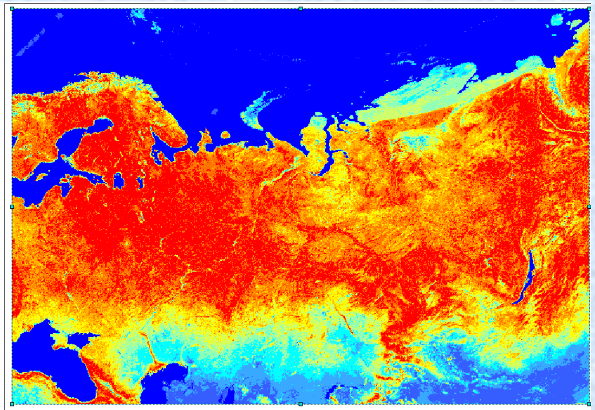
- Salix dendro data collection

- NDVI data were derived from
the NOAA AVHRR meteorological satellites.

-MODIS at 16-day intervals and 2000-2011
with 250m resolution

- Very High Resolution images from
Quickbird-2, and Worldview-2 (resolution
1-2,4 m)






nature climate change
LETTERS
PUBLISHED ONLINE: 3 JUNE 2012 | DOI: 10.1038/NCLIMATE1558

Eurasian Arctic greening reveals teleconnections and the potential for structurally novel ecosystems

Marc Macias-Fauria[1], Bruce C. Forbes[2]*, Pentti Zetterberg[3] and Timo Kumpula[4]

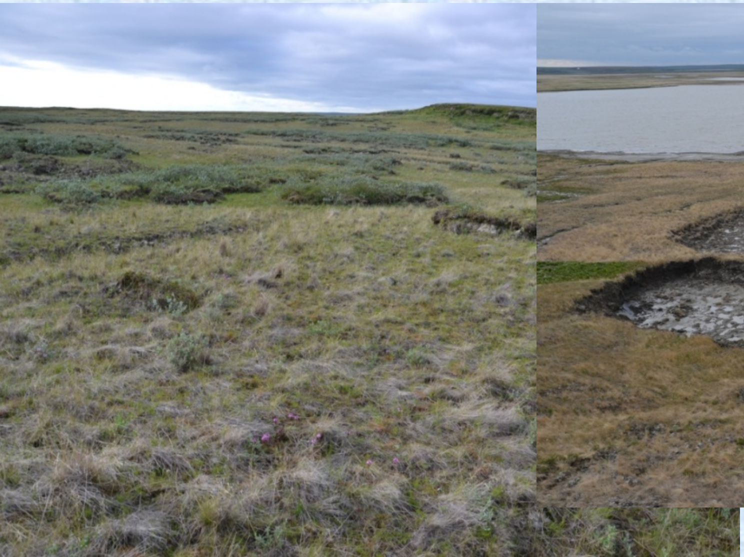
Past and ongoing projects

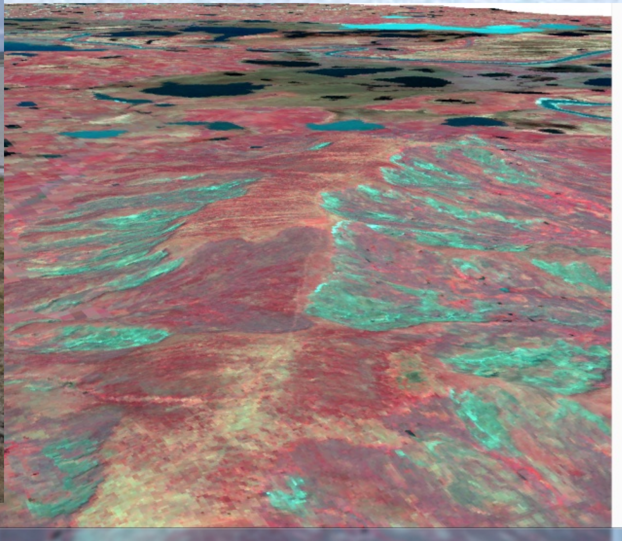
- NASA LULCC project: *Yamal LCLUC Synthesis: A synthesis of remote-sensing studies, ground observations and modeling to understand the social-ecological consequences of climate change and resource development on the Yamal Peninsula, Russia and relevance to the circumpolar Arctic* (Skip Walker) (2014-2016)
- *Resilience in Social-Ecological Systems of Northwest Eurasia – RIS*ES (Finnish Academy 2012-2016) (Bruce Forbes)
- Terra XS data Project: Combining remote sensing and field studies for assessment of landform dynamics and permafrost state on Yamal (Annett Bartsch)
- Study of petroleum explorations impacts to reindeer herding: *Environmental and Social Impacts of Industrialization in Northern Russia (ENSINOR)* (Finnish Academy 2004-2007) in YNAO and NAO (Bruce Forbes)
- NASA LULCC project: Land-cover and Land-use Changes on the Yamal Peninsula, Russia (Skip Walker) (2007-2012)

- Thank you!

Landslides in central Yamal, Mordy Jaha river

- Mapping of landslides with remote sensing
- The key research area is located on west bank of Mordy-jaha river where landslides can be found along the north-south ridge which is about 20 km long and 2-4 km width
- In late 1980’s occurred a major landslide event





- Landslide detection from optical multispectral and multiscale remote sensing imagery
- Field data collection of spectral characteristics (ASD spectometer)
- Landslide –willow (*salix*) dynamics (dendrochronology, biomass, Leaf Area Index LAI 2200)
- Landform dynamics, eg. lakes
- TerraXS data analysis:
  - landslide slope charateristics, willow thickets
  - Combining TerraXS with optical RS data analysis