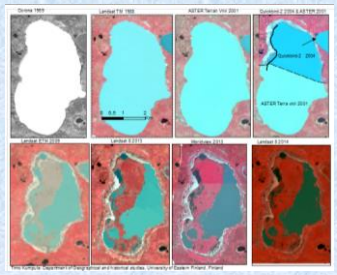
# Arctic Tundra land cover and biomass change on the Central Yamal peninsula, Russia



**ArcticBiomass Workshop, 20-23 Ocrobertember 2015, Svalbard**

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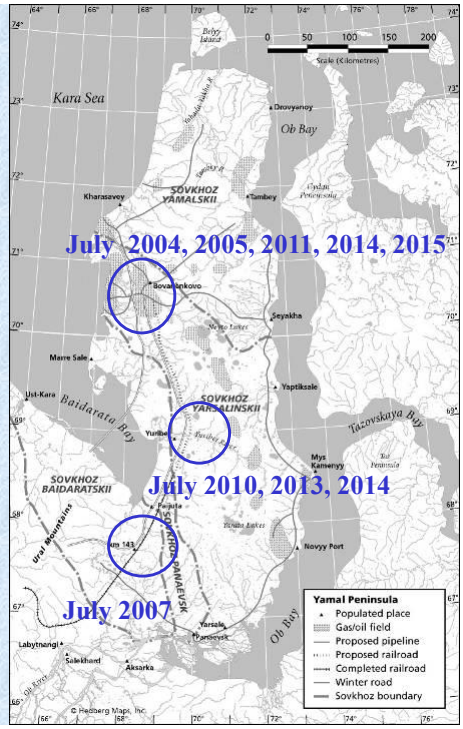
UNIVERSITY OF EASTERN FINLAND

## Past and ongoing projects

- 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)
- ***Resilience in Social-Ecological Systems of Northwest Eurasia – RISES*** (Finnish Academy 2012-2016) (Bruce Forbes)
- ***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)
- Terra XS data Project: Combining remote sensing and field studies for assessment of landform dynamics and permafrost state on Yamal (Annett Bartsch)

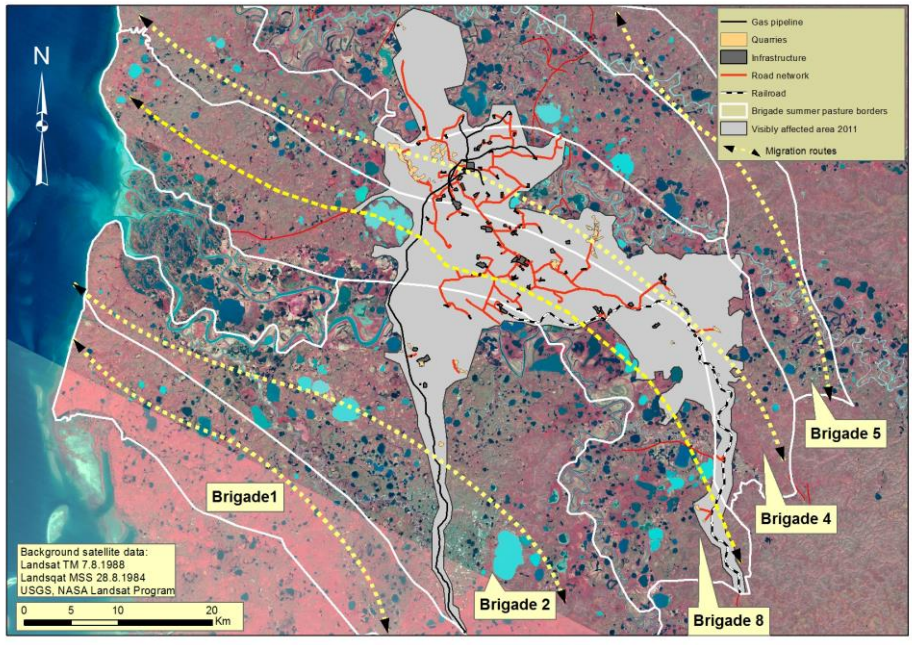
## Research sites in Yamal

- **Bovanenkovo, Mordy-jaha**
- **Yuribei river**
- **Laboravaja**

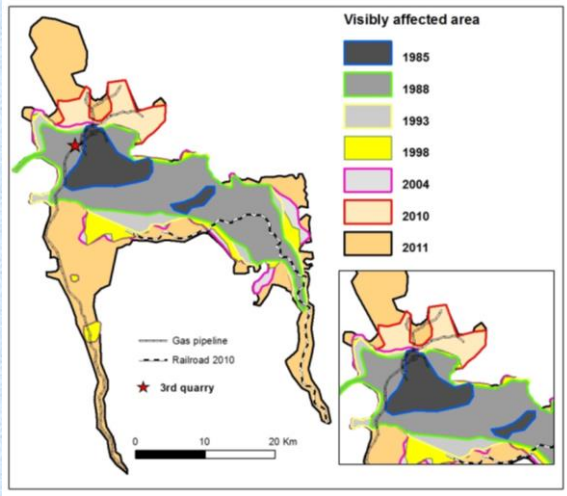



**Drivers of land cover and land use change on Yamal:**

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



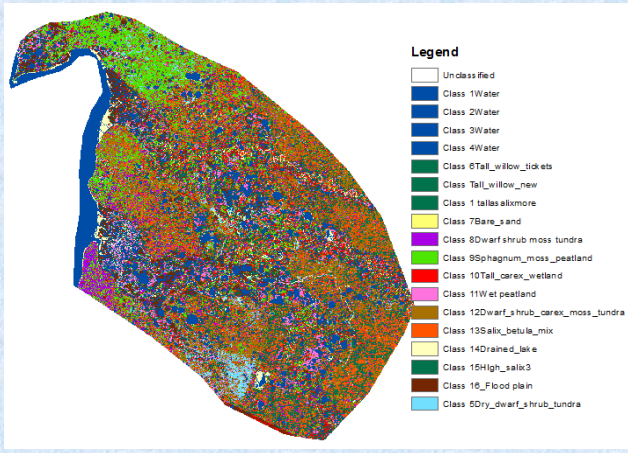

**Kumpula et al. (2012)** ***Remote sensing***




## Remote sensing data

- Corona 1969
- KH-9 1976
- Aerial photographs 1970'-1990's
- Landsat TM 1984 28 August
- Landsat MSS 1985 28 July
- Landsat TM 1988 07 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
- MODIS

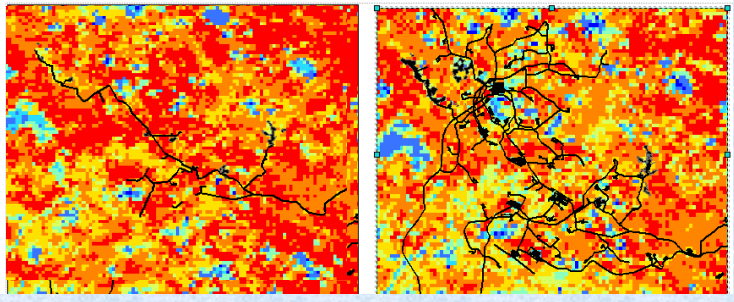
## Lancover classification of Yarsalinksi sovkhoze summer and autumn pastures




Landsat TM data 1988 & 2012

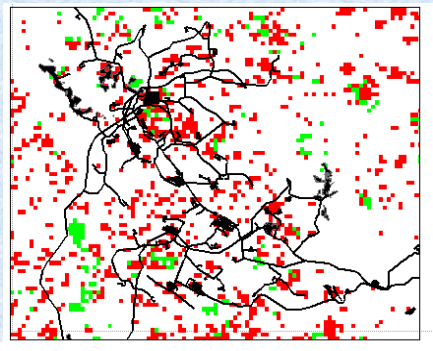
-> change detection
-> reindeer use of pastures (GPS) data
-> reindeer shrub - interaction

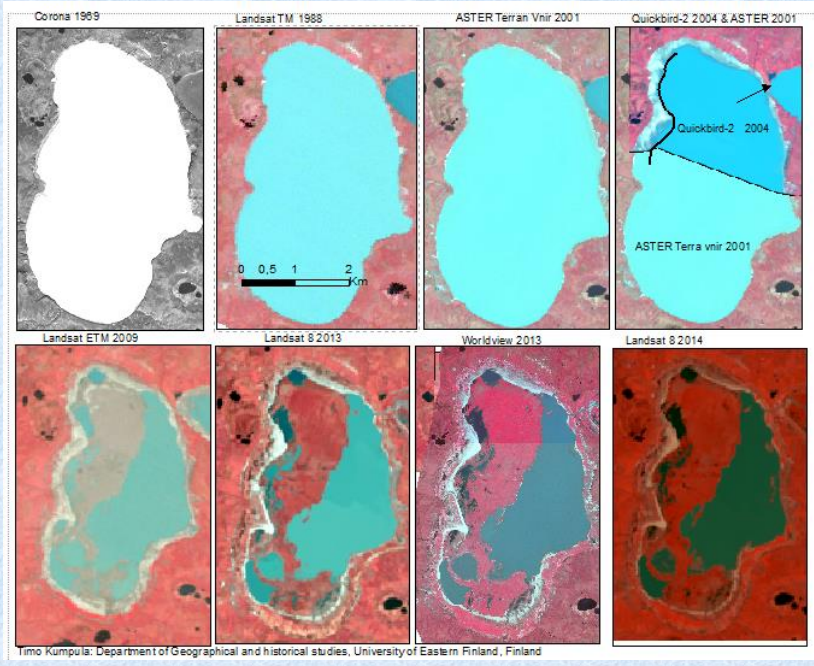
## 2001 MODIS NDVI 2014



**MODIS NDVI difference:**

- Red decrease in NDVI
- Green increase in NDVI




Corona 1969
Landsat TM 1988
ASTER Terran Vnir 2001
Quickbird-2 2004 & ASTER 2001
Quickbird-2 2004
ASTER Terra vnir 2001
0 0,5 1 2
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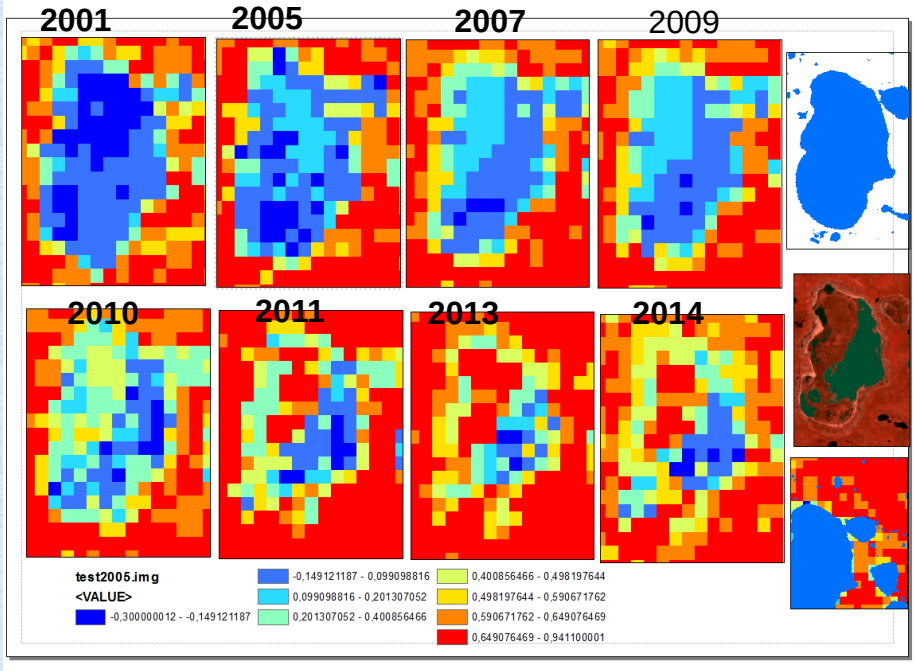
Landsat ETM 2009
Landsat 8 2013
Worldview 2013
Landsat 8 2014
Timo Kumpula: Department of Geographical and historical studies, University of Eastern Finland, Finland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2007
2009
2010
2011
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2014
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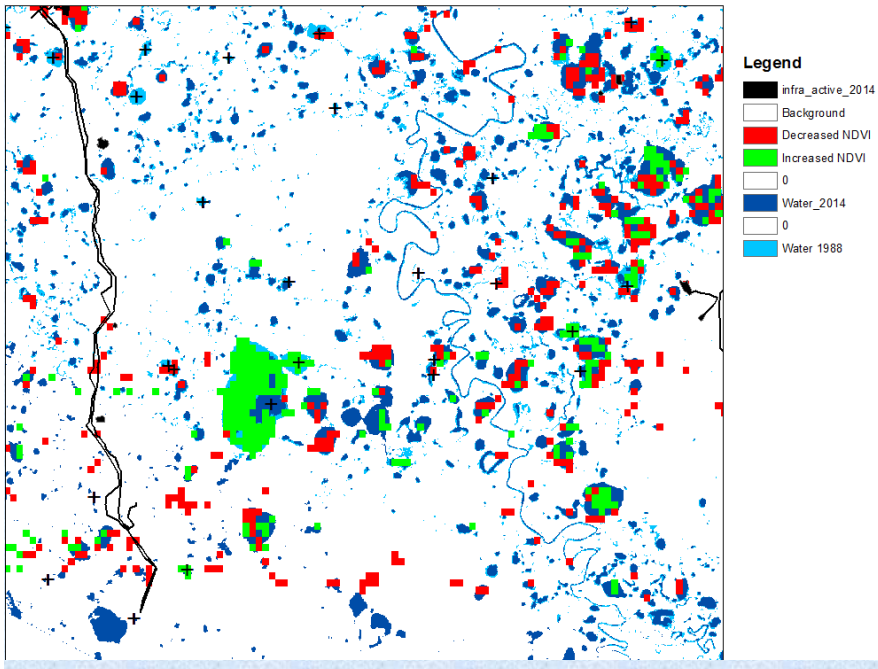
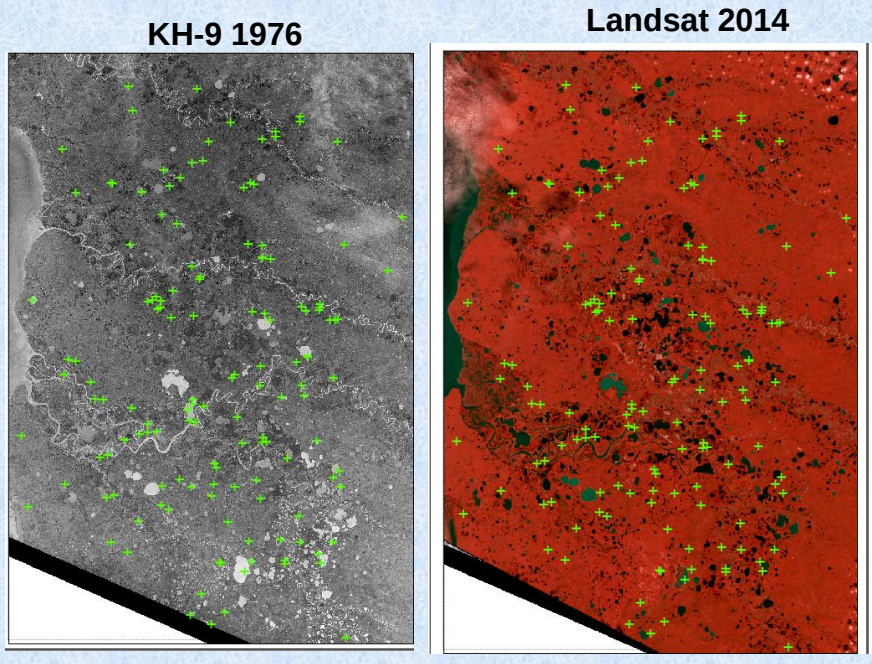
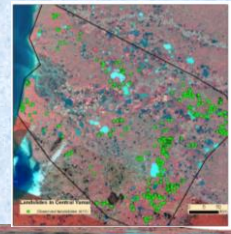


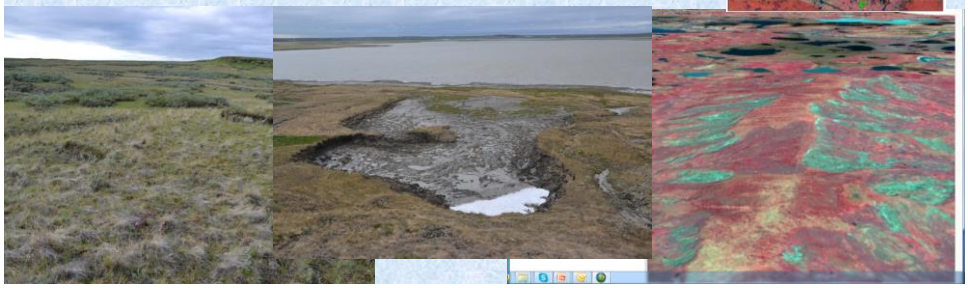




157 lakes disappeared or shrinked 4 new lakes

## Landslides in central Yamal,

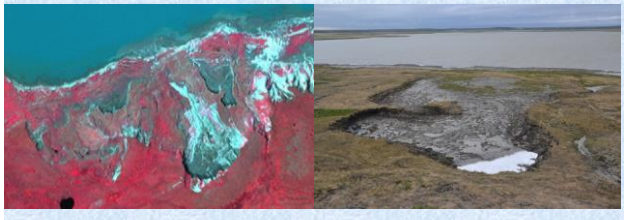
- Mapping of landslides with remote sensing
- The key research area is located on west bank of Mordy-jaha river where landslides can be found along the north-south ridge which is about 20 km long and 2-4 km width
- In late **1980's occurred a major** landslide event



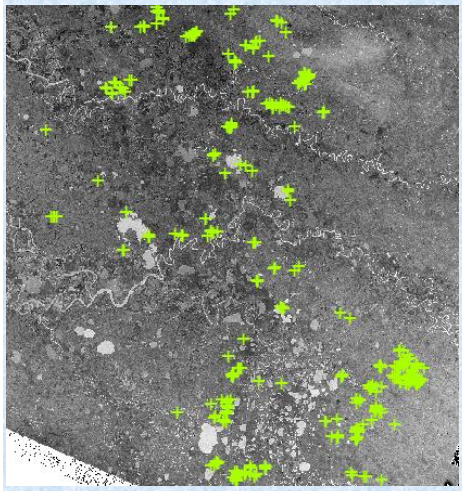


## Focus of the research

- 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
- Anthropogenic disturbance

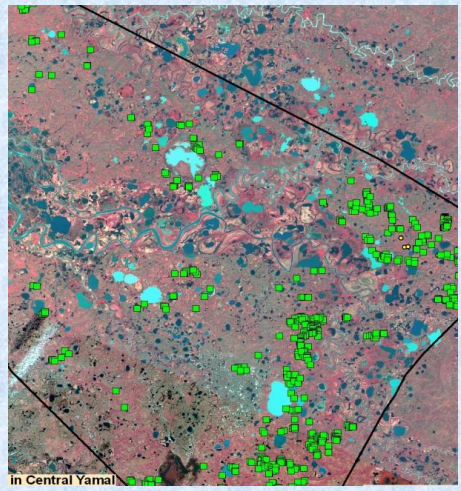


**1976**



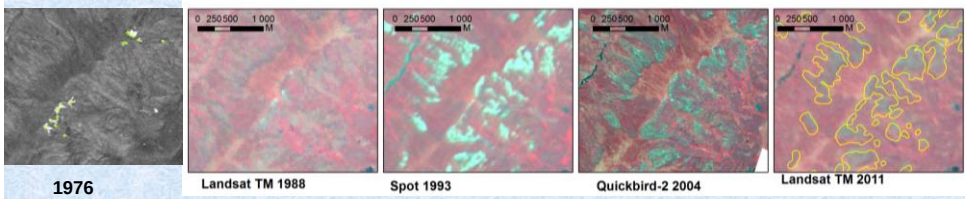
About 400 landslides

**1989**



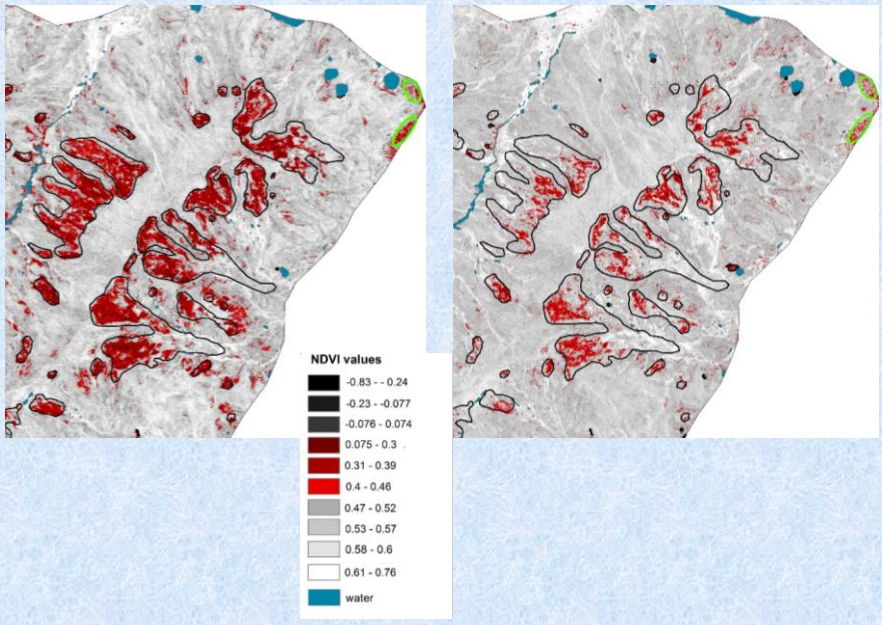

About 800 landslides

KH-9 image 1976,Landsat TM image from 1988 shows rigde with no recent landslides. From SPOT image (1993) landslides are clearly detectable. By 2011 vegetation succession process has advanced so that from Landsat TM imagery landslides have become difficult to distinquish.

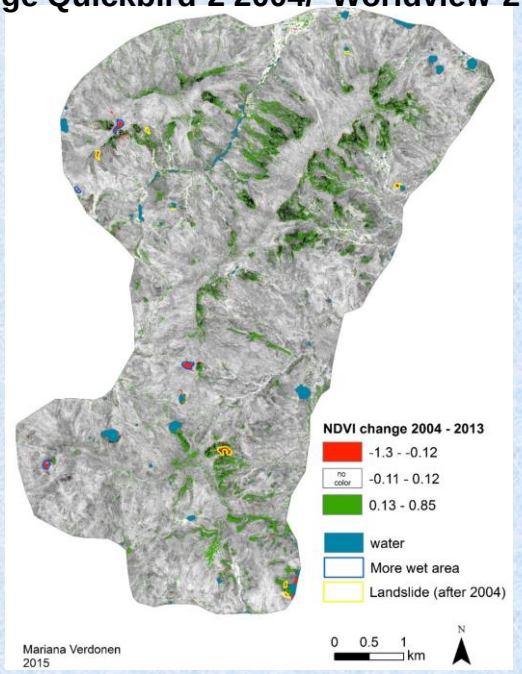



We detected about 800 landslides in our research area in Central Yamal which occurred in late 1980's and 400 in early 1970's

## NDVI change Quickbird-2 2004/ Worldview-2 2013




## NDVI change Quickbird-2 2004/ Worldview-2 2013



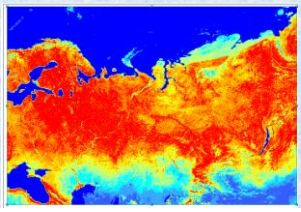
## Deciduous shrub growth and the greening of the Arctic in West Siberia

- Salix dendro data collection from several sites in Yamal

- NDVI data were derived from the NOAA AVHRR satellites.

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

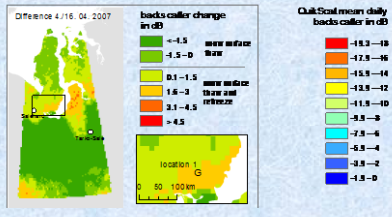
- Very High Resolution images from Quickbird-2, and Worldview-2 (resolution 1-2,4 m)


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

-2007-2008 event
-2013-2014 event






## Conclusions

- Rapid landcover changes due to the petroleum industry expansion. Development is just in the starting phase.
- Gas development has wide impacts to reindeer pastures, migration and herding society, eg. devaluation and shrinkage of pasture land.
- Climate change induced impacts related to landcover change are shrubbification, snow-ice conditions, lanslides, thawing lakes
- To study Land use and land cover change (LULCC) it requires multidisiplinary approach that we can combine anthropogenic disturbances, reindeer grazing impact, shrub increase-decrease, climate change impacts, landslides, lake changes, to create synthesis of LULCC dynamics in Yamal