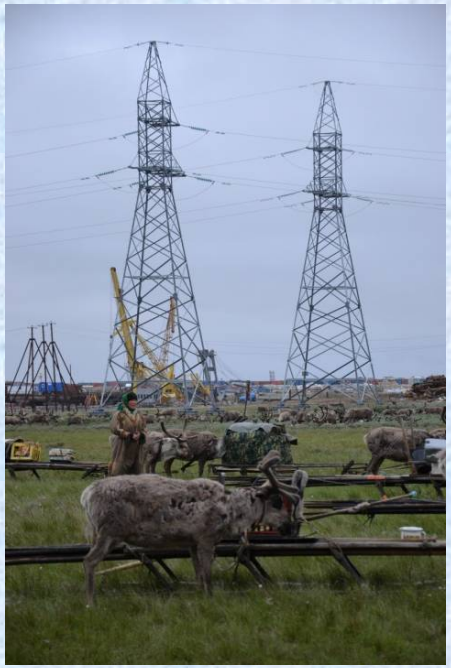
Drivers of landcover changes in tundra reindeer pastures of Yamal, west Siberia



Arctic Science Summit Week 2017

Prague, Czech Republic 3 April 2017

UNIVERSITY OF EASTERN FINLAND

T. Kumpula[1], M. Macias-Fauria[2], A. Skarin[3], M. Verdonen[4], P. Korpelainen[4], B. Forbes[5].

[1]Department of Geographical and Historical studies, joensuu, Finland.

[2]School of Geography and the Environment- University of Oxford-, Oxford, United Kingdom.

[3]Department of Animal Nutrition and Management-, Uppsala, Sweden.

[4]Department of Geographical and Historical Studies, Joensuu, Finland.

[5]Arctic Centre- University of Lapland-, Rovaniemi, Finland.

ARCTIC CENTRE

RAPID ARCTIC TRANSITIONS DUE TO INFRASTRUCTURE & CLIMATE

RATIC

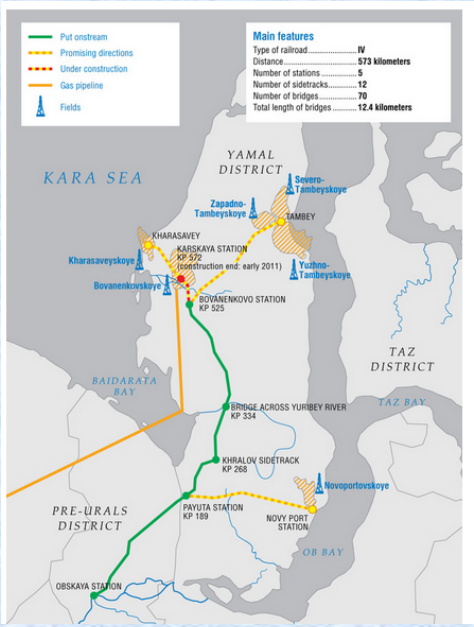
IASC

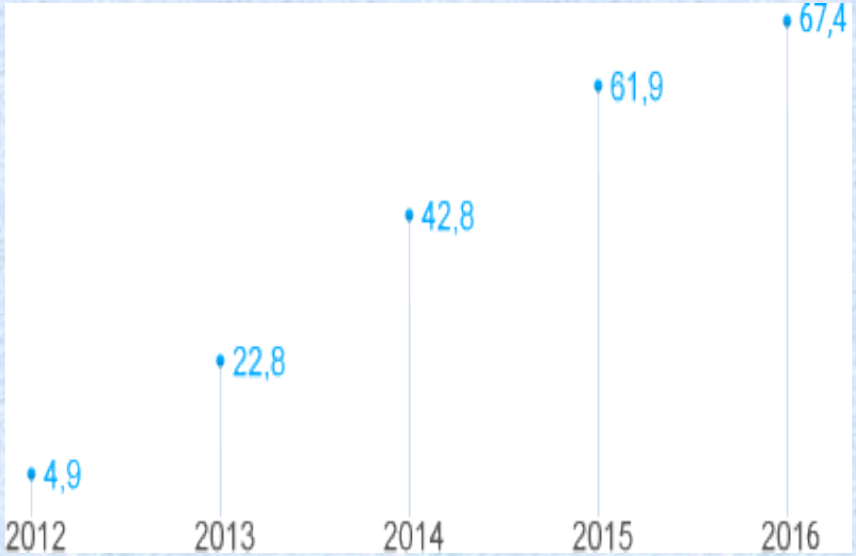
Drivers of land cover and land use change on Yamal:

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

Infrastructure development in Yamal

- Yamal peninsula in West Siberia both natural and anthropogenic changes have occurred during the past 40 years.
- Bovanenkovo gas field (BGF) was discovered 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'
- In 2006 Gazprom launched a new plan for production and in October 2012 gas production began in BGF.





Gas production from Bovanenkovskoye field, billion cubic meters

http://www.gazprom.com/about/production/projects/deposits/bm/

Continuing development in Yamal

- Sabetta-Tambey production zone is comprised of six fields
- Yamal LNG is a Liquefied Natural Gas plant at Sabetta,
- VIS TransStroy will build railroad 2017:

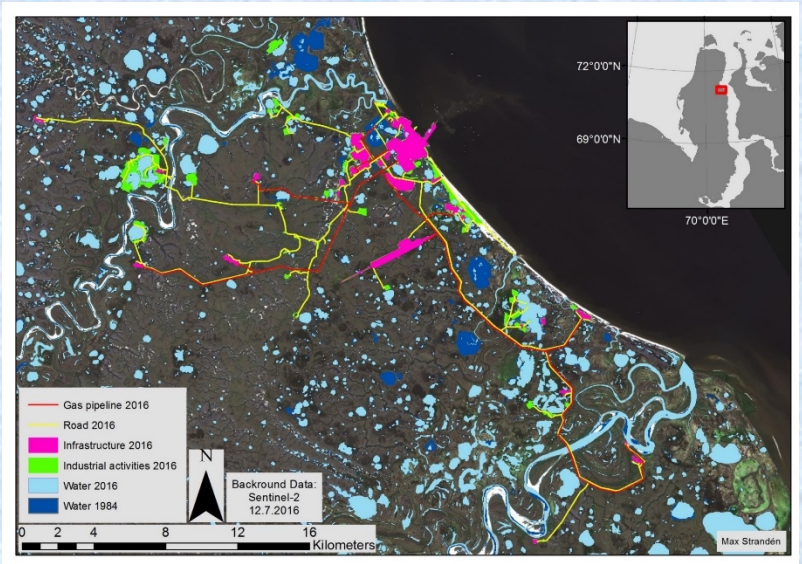
  Bovanenkovo-Sabetta 170 km
- Novoportovskoye: oil and gas condensates

More Yamal railway in the pipeline. Photo: Gazprom.ru

World's northernmost railway gets extension, will be connected with Arctic port Sabetta

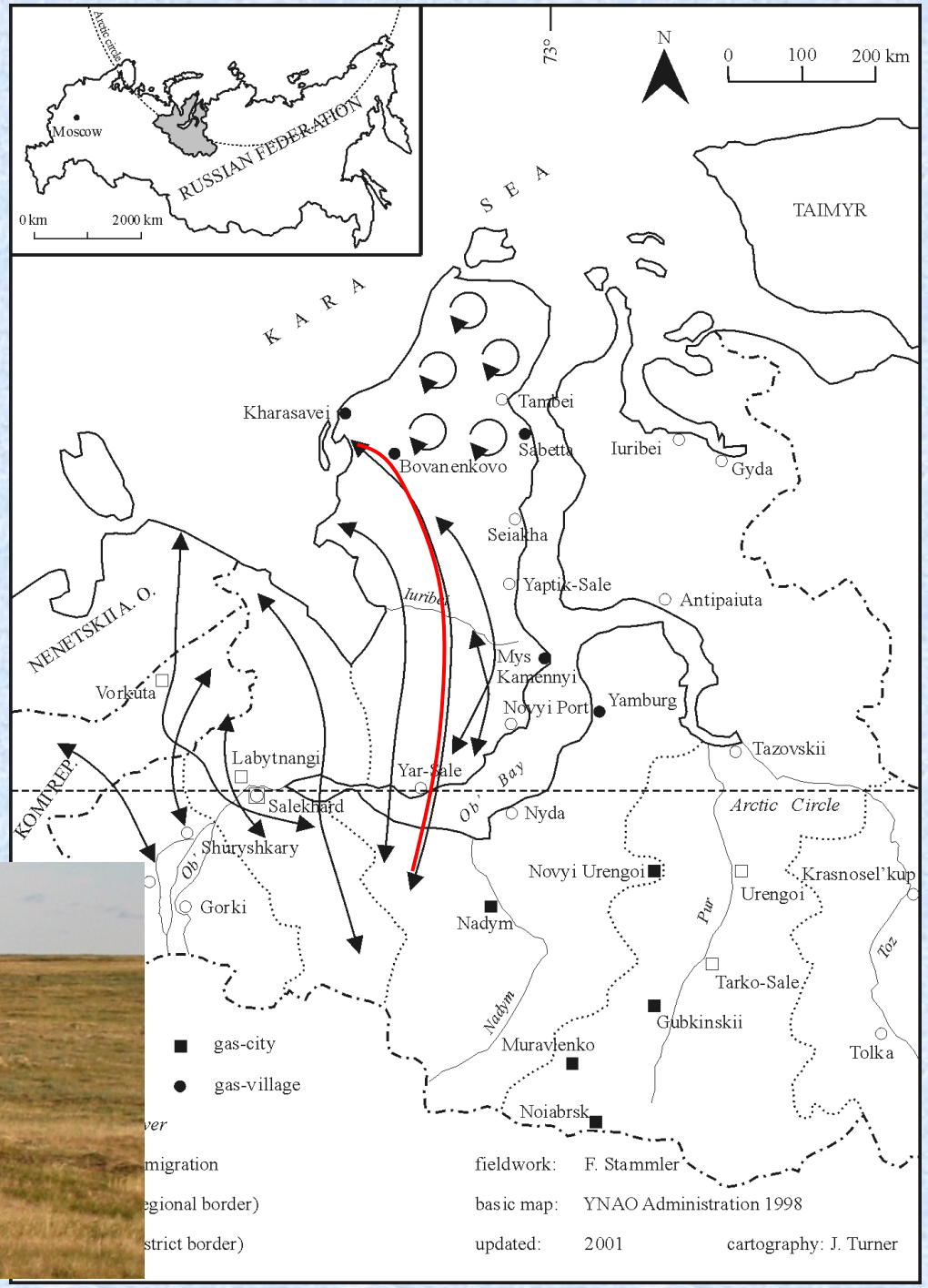
Construction of another 170 km of rail across the Yamal Peninsula will start in 2017, regional leader Dmitry Kobylkin says.

Tambey-Sabetta field development



Yamal reindeer herding, basic facts:

- **Reindeer herding survived best (from soviet arctic indigenous peoples) from Soviet period**
- **Almost 300 000 reindeer on the Yamal Peninsula, managed by more than 1000 fully nomadic households**
- **Traditional migration between summer-winter pastures (up to 1300 km/year)**

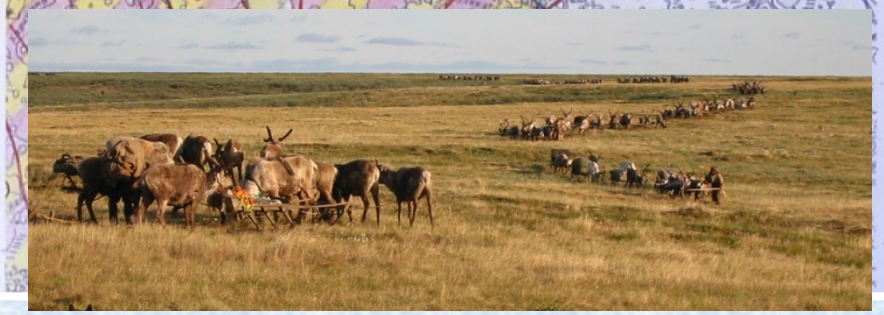


Bovanenkovo gas field

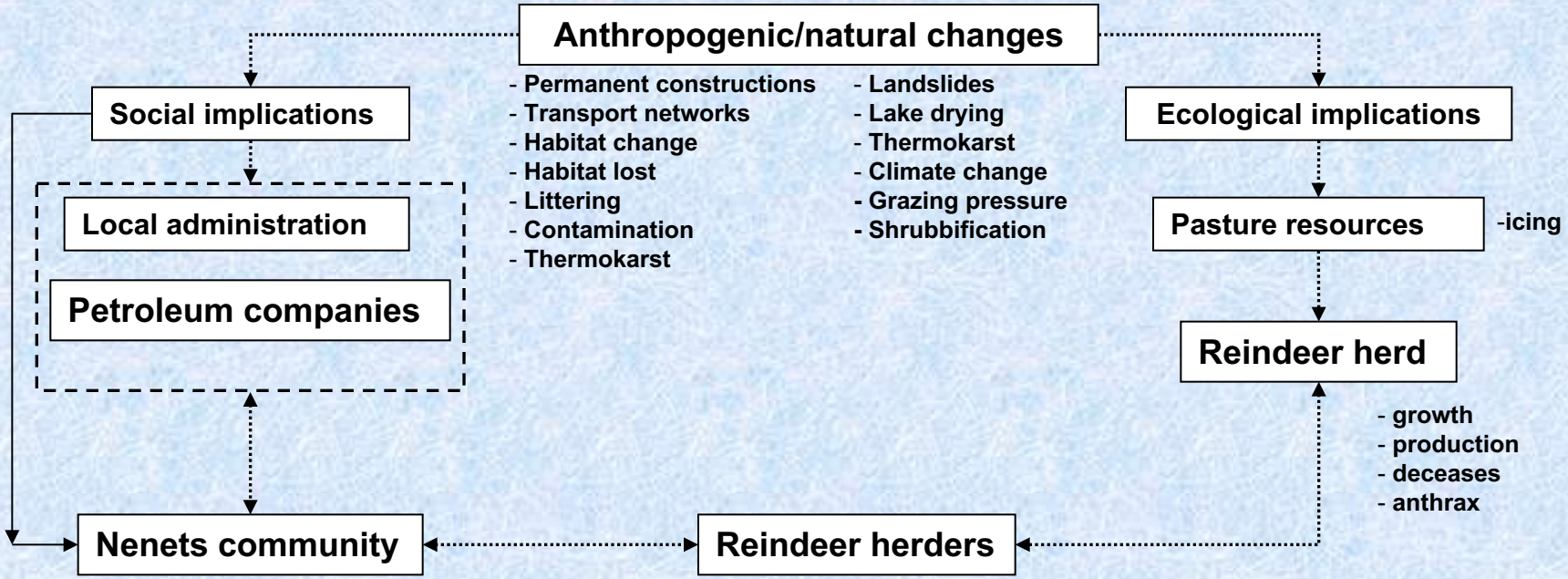
Yamalskii sovkhoz

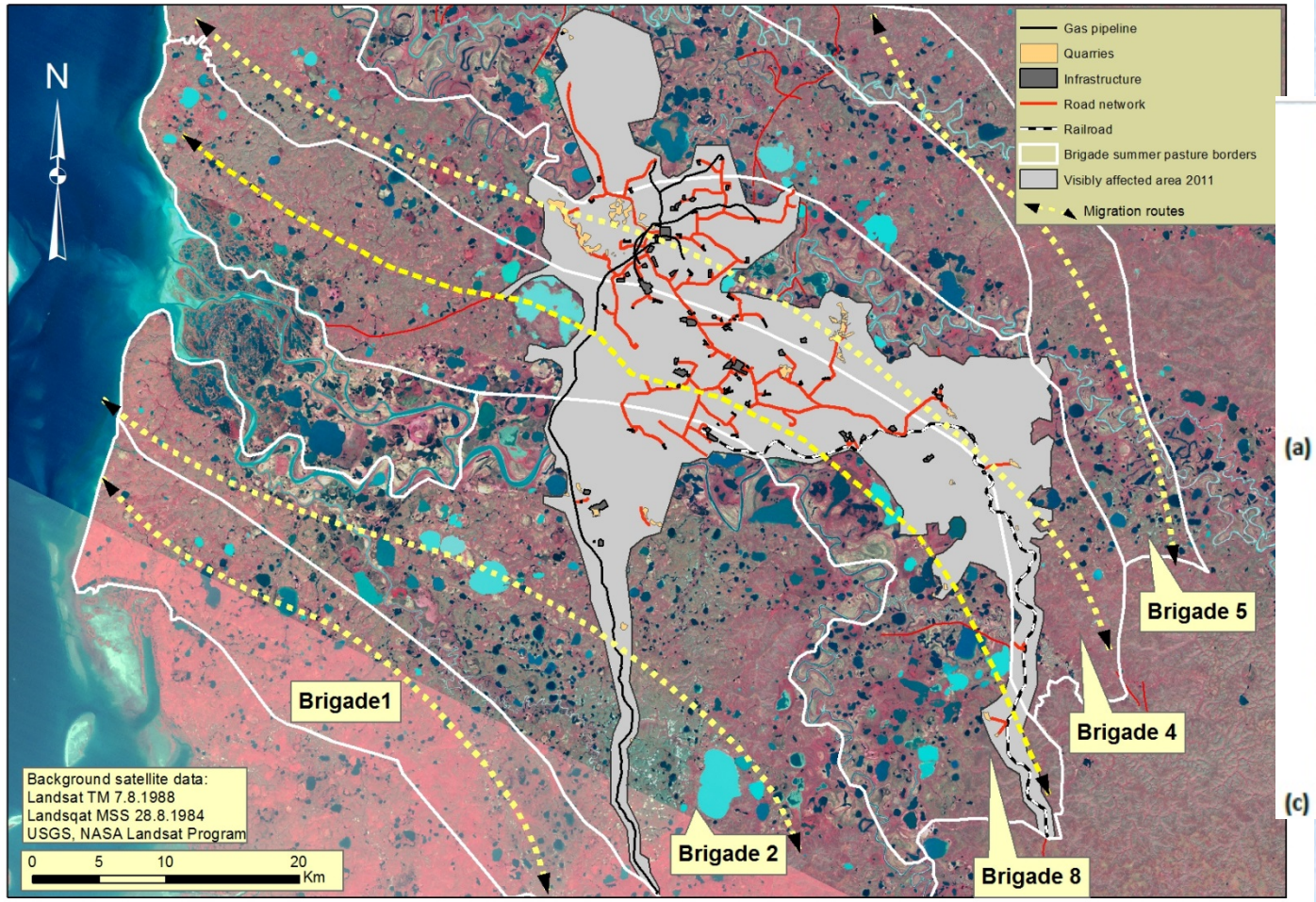
Yarsalinskii sovkhoz

Panaevsk sovkhoz



Land-use and landcover change drivers and implicatios to reindeer pastures in the Yamal.



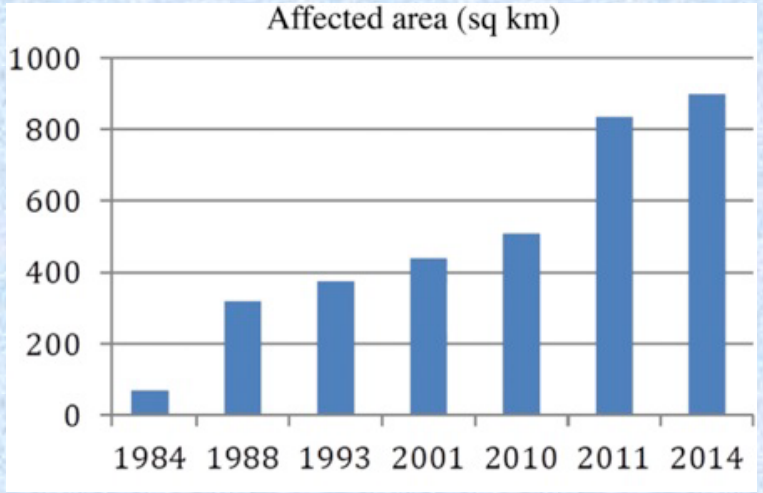


Kumpula et al. (2012) *Remote sensing*

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 km^2		0.4	0.6	1.9	1.9	2.1	5.4	9.8	**12,0 km^2**
Main roads length km		2	49	80	81	81	154	212	**12,0 km^2**
Road area coverage km^2		0.6	1.8	2.9	3	3	5.8	8.0	**9,5 km^2**
Sand quarries km^2		1.8	3.5	3.5	3.5	4.3	6.6	9	**131 km**
Pipeline right of way km						16	16	103	**6,6 km^2**
Pipeline corridor km^2						0.6	0.6	4.4	**59 km**
Railroad km								59	**3,6 km^2**
Railroad area coverage km^2								3.6	**1 km^2**
Off-road track length km	38	348	380	410	590	2,400	2,989	3,136	**904 km^2**
Off-road track area coverage km^2	3	14	16	17	24	44	49	54	**37,7 km^2**
Disturbed vegetation 1988–2011 km^2		1.9						0.3	
Airport km^2								1	
Visibly affected area km^2	70	320	375	420	440	451	509	836	
Permanently changed area km^2		2.8	5.9	8.4	8.3	8.9	18.4	36.1	

	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
Area affected 2016 km^2	**332**	**318**	**162**



Reindeer pasture mapping (vegetation classification)

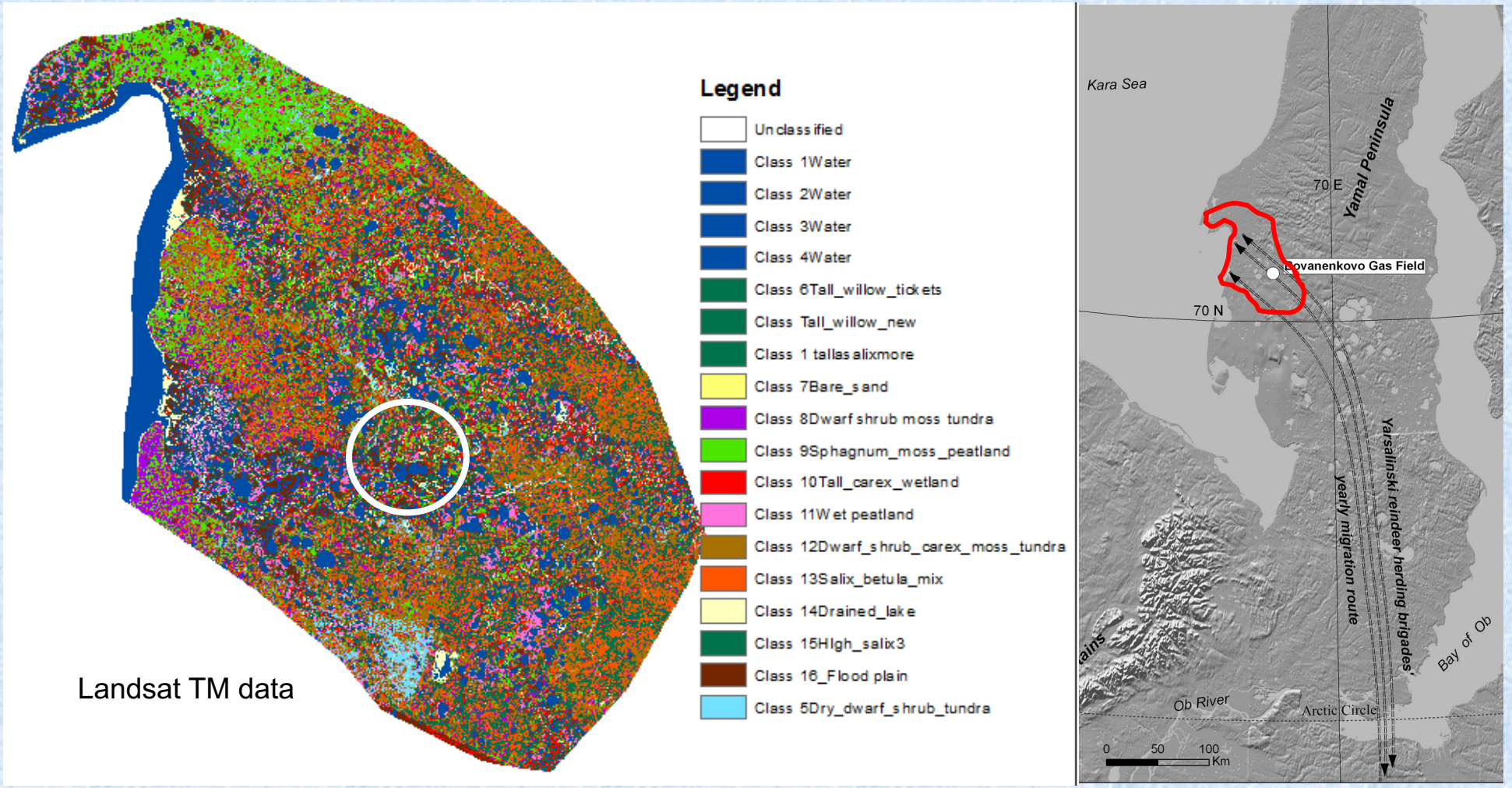
*"Ecological research and assessments of herbivores' impacts on rangelands **produce essential information on the quality and quantity of fodder sources** (Oksanen 1978; Väre et al.1996; Bråthen & Oksanen 2001; Olofsson et al. 2002)."*

Focuses on vegetation, especially lichen

- Carrying capasity --- Overgrazing

- Methods
  - Classification of landcover types
  - Vegetation coverage, biomass, quality
  - Remote sensing based classifications
- Local knowledge disregarded
  - Herders maybe interviewed, but not engaged
- Problems of classification of reindeer pasture
  - What is a class? (vegetation type class vs. reindeer pasture use class)
  - Are they relevant?
  - As they base on classification of vegetation and RS imagery—>The actual use of pastures blurs
  - Other factors difficult to map without local knowledge
    - Snow conditions, insect harassment, wind exposure, traditions, local agreements

Yarsalinksi sovkhoze summer and autumn pastures in the BGF area

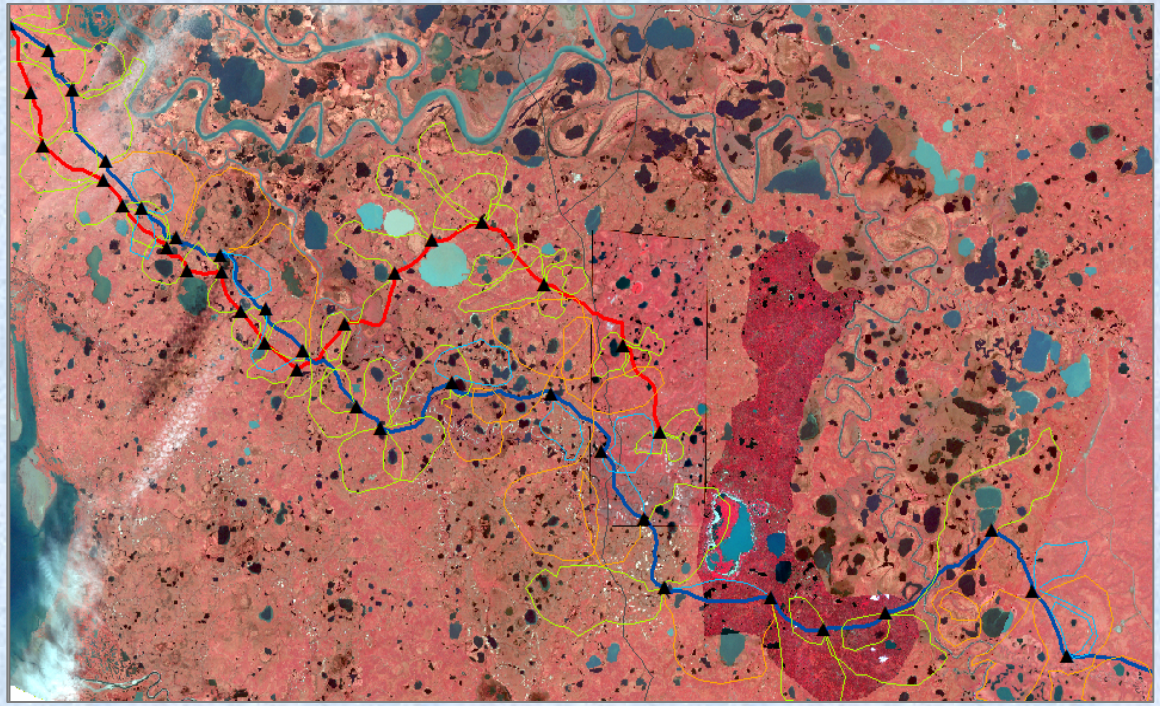


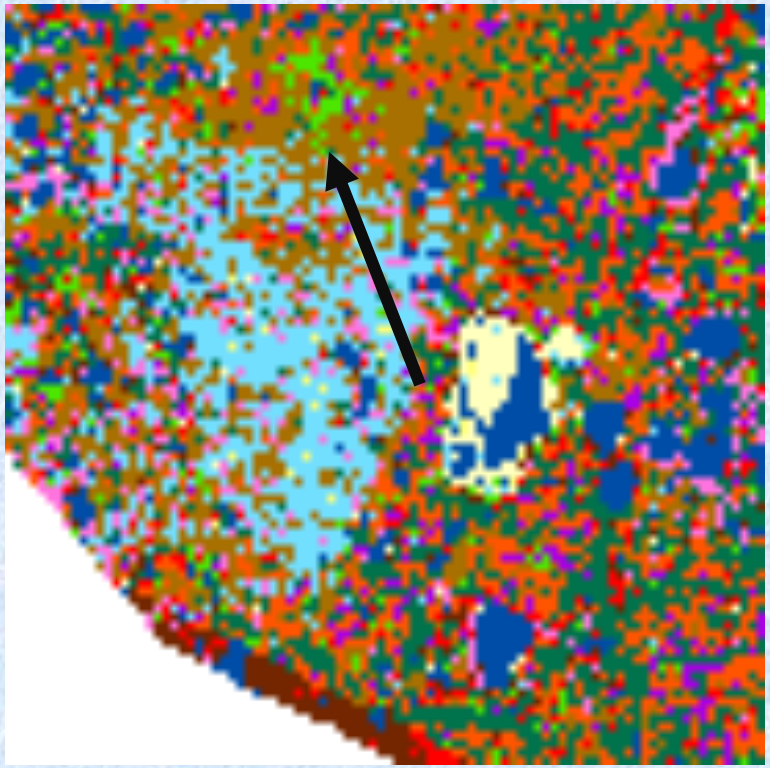
Mapping of Yarsalinksi Sovkhoze summer pasture

- **Satellite image based**
- **Field data (vegetation)**
- **Interviews with herders**

How reindeer herders defines pastures in certain period of year?
What are the key main reasons selecting certain pasture?

- Reindeer herders to "**classify" pastures according to the seasons**.
- The plants that are very tasty for reindeer are quite often "hidden" in the main vegetation class according which we classify satellite images.





Migration routes, camp sites and reindeer pastures digitised with Vasilii Serotetto in June 2015.

Reindeer pastures seasonality

Summer

- Reindeer grazing in areas with a lot of green vegetation, willows etc. (old landslides!).
- Changing pastures every few days.
- Reindeer gain weight.

Early Autumn

- Moving to pastures with more lichen.
- Planning route so that there is enough of green vegetation for reindeer on the way
- "**Transition period": one day reindeer graze on lichen pastures and** on the next day in areas with last green vegetation

Spring

- Calving pastures until beginning of June.
- Reindeer don't stay on lichen pastures, because **they look for first green plants,** scatter and it is difficult to keep them together.

- Reindeer graze in river basins, where vegetation stays green longer. Green vegetation can be found also on landslides sometimes.
- Where there is no more fresh plants (shoots), reindeer eat roots, mushrooms, lichens.

Late Autumn

Winter

- Winter (lichen) pastures are divided for 3 years (one year one area, next year another, third year third area, and then again first area…).
- In Nadym rayon there is no strong winds and snow is soft.
- Chum stays in one place

BIOLOGY LETTERS

rsbl.royalsocietypublishing.org

Research

Cite this article: Forbes BC *et al.* 2016 Sea ice, rain-on-snow and tundra reindeer

Global change biology

Sea ice, rain-on-snow and tundra reindeer nomadism in Arctic Russia

Bruce C. Forbes[1], Timo Kumpula[2], Nina Meschtyb[1], Roza Laptander[1], Marc Macias-Fauria[4], Pentti Zetterberg[3], Mariana Verdonen[2], Anna Skarin[5], Kwang-Yul Kim[6], Linette N. Boisvert[7], Julienne C. Stroeve[8,9] and Annett Bartsch[10,11]

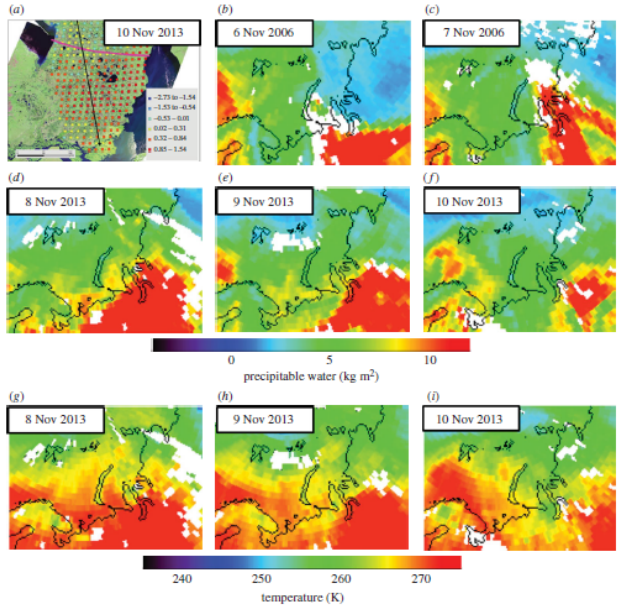
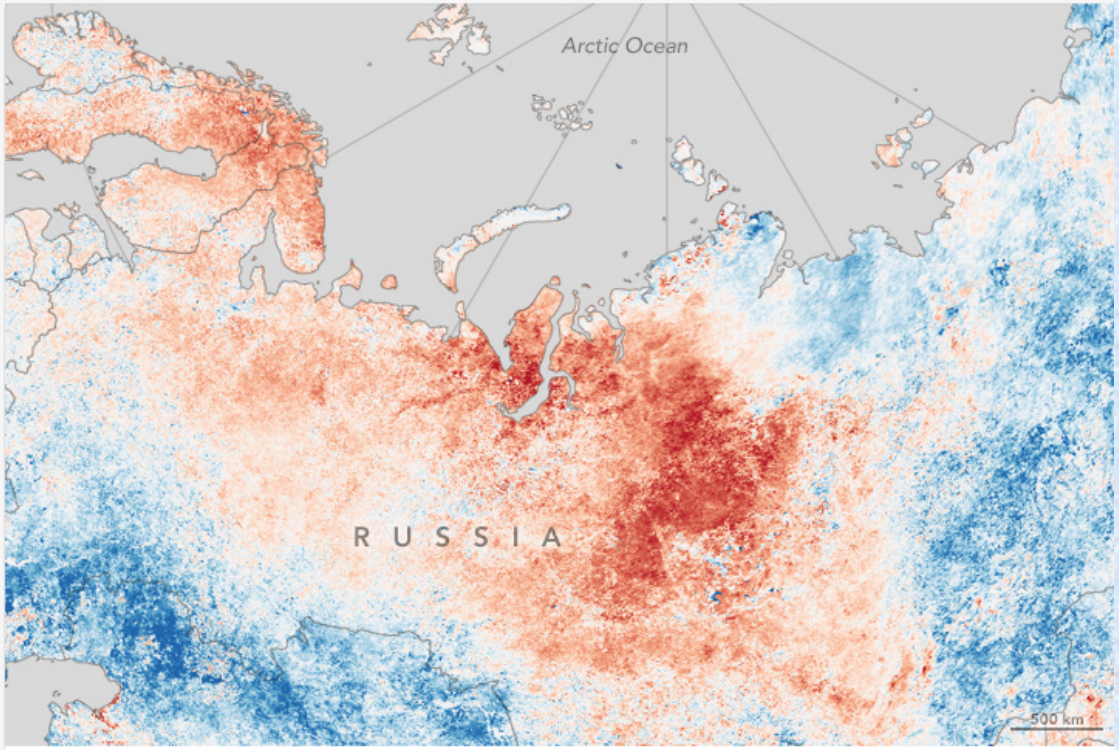


Figure 1. ASCAT detected backscatter difference (dB), southern Yamal Peninsula 10 November 2013. Pink line borders severely iced pasture area; black arrow indicates reindeer herders' southward migration. (*a*) AIRS daily total precipitable water from (*b–c*) 6–7 November 2006 and (*d–f*) 8–10 November 2013 and 925 hPa temperature from (*g–i*) 8–10 November 2013 for the BKS region. White is missing data and black outlines the coasts.

Bruce Forbes: tomorrow 11:30 (Virgo)

EARTH OBSERVATORY
Where every day is Earth Day

Home | Images | Global Maps | Features | News & Notes



Land Surface Temperature Anomaly (°C)

≤-12 0 ≥12

download large image (3 MB, JPEG, 2400x2400) acquired July 20 – 27, 2016

Warm weather is to be expected in the summer, but the oppressive heat that affected several regions in the summer of 2016 went well beyond warm. In June and July, people in Siberia, the Middle East, and North America faced extreme heat waves.

Parts of Siberia, where cool weather usually lingers even during summer, saw temperatures that would have been more fitting for the tropics. In July, a rare outbreak of anthrax even occurred in the Yamal Peninsula after hot weather melted permafrost and exposed the carcass of a reindeer. Since the outbreak began, the bacteria has killed one child and more than 2,300 reindeer.

Experts: Anthrax outbreak in Yamal is first sign Arctic may be in danger

Society & Culture August 05, 2016, 18:15 UTC+3

Global warming is capable of triggering more cases of various diseases, whose infectious agents have remained preserved in permafrost soil for centuries, microbiologists and climatologists said

Scientists warn anthrax just one threat as Russian permafrost melts

Posted 11 Aug 2016, 7:51am

7720548 : A veterinarian checks deer outside Yar-Sale town at Yamal Peninsula. (AFP/Russian Emergency Ministry)

The Siberian Times

'Baikal...I have never seen water that cle my life'
Ian Frazier,

Home News Features Business City Focus Sport Culture Science Health & Lifestyle Ecology Weird & Wo

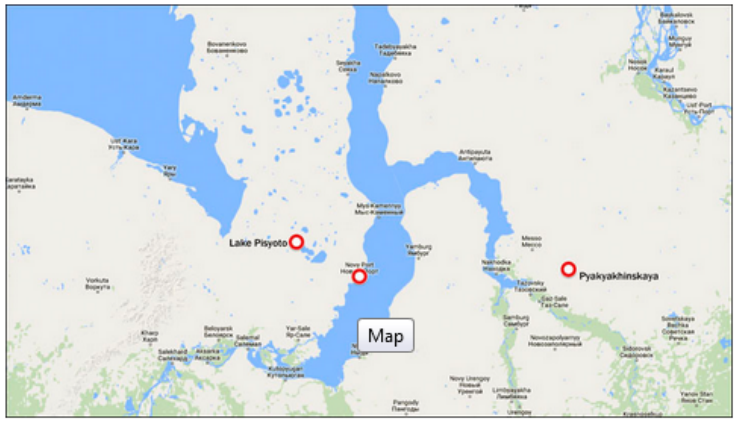
UPDATED First anthrax outbreak since 1941: 9 hospitalised, with two feared to have disease

By The Siberian Times reporter

26 July 2016

Four children among those in intensive care, as locals undergo mass evacuation and quarantining, while reindeer herd decimated.

Previously, only one focal point was acknowledged, around Lake Yarato.



Now it is clear that there were a total of two outbreaks on the Yamal peninsula, and a third east of the Gulf of Ob. Picture: The Siberian Times

Drivers of change conclusions

- The main driver of change is petroleum extraction that with construction of Bovanenkovo gas field has caused increasing permanent changes to pasture themselves but by expansion of infrastructure resulting the changes to use and usability of pastures.
- Reindeer herders have experienced the impacts either directly or undirectly as a loss of pasture or as obstacles on the migration route. Or as increasing grazing pressure in surrounding areas.
- Impacts of oil and gas are in the early phase and new plans will be operating
- Warming summer and winter conditions (ROS and Icing of pastures)
- Changes in vegetation →changes in pasture use
- Overgrazing narrative←→ Pasture mapping ←→ policy implications?
- →Changing conditions of reindeer husbandry → Future of reindeer herding?

Work is based on following projects:

•NASA LULCC project: Land-cover and Land-use Changes on the Yamal Peninsula, Russia (Skip Walker) (2014-2017) the NASA LCLUC Gran No.t NNX14AO90G

•Resilience in Social-Ecological Systems of Northwest Eurasia – RISES (Finnish Academy 2012-2016) (Bruce Forbes)