



# Impacts of infrastructure and climate changes on reindeer herding in the Yamal, west Siberia.

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## Introduction

The traditional land use in the Yamal is reindeer herding mainly practiced by nomadic Nenets herders. The hydrocarbon industry is presently the source of most ecological changes in the Yamal peninsula and socio-economic impacts experienced by migratory Nenets herders who move annually between winter pastures at treeline and the coastal summer pastures by the Kara Sea (Fig 1).

In central Yamal peninsula which is permafrost area both natural and anthropogenic changes have occurred during the past 40 years (Fig 3). Mega size Bovanenkovo Gas Field was discovered in 1972 and it was opened in production in 2012 (Fig 4). We have studied gas field development and its implications to Nenets socio-ecological herding system (Fig 3). At the same time Yamal is impacted by the the climate warming. We have studied increase in shrub growth, cryogenic landslides and drying of lakes (Figs 3 & 5). One of the most dramatic implications from climate warming have been Rain-on-Snow (ROS) events (2007, 20013/2014). ROS in winter 2013/2014 caused large scale icing of pastures and ca. 60 000 reindeer starved to death (Fig2).

Nenets managing collective and privately owned herds of reindeer have proven adapt in responding to a broad range of intensifying industrial impacts at the same time as they have been dealing with symptoms of a warming climate and thawing permafrost phenomena (Fig 2&3). There is about 300 000 reindeer in the peninsula.



Fig 1. Reindeer herding migration routes in the Yamal peninsula.



Fig 2. On the left Extension of vast ROS event with icing of southern Yamal pastures on winter 2013/2014, about 27 000 sqkm was frozen and 60 000 reindeer were starved to death. On the right: Rain On Snow (ROS) may cause ice layer(s) that hinders reindeer ability to dig for fodder.

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 thaw related processes, e.g. cryogenic landslides and drying lakes on thawing permafrost
- 3) anthropogenic-natural: impact of reindeer herding on vegetation

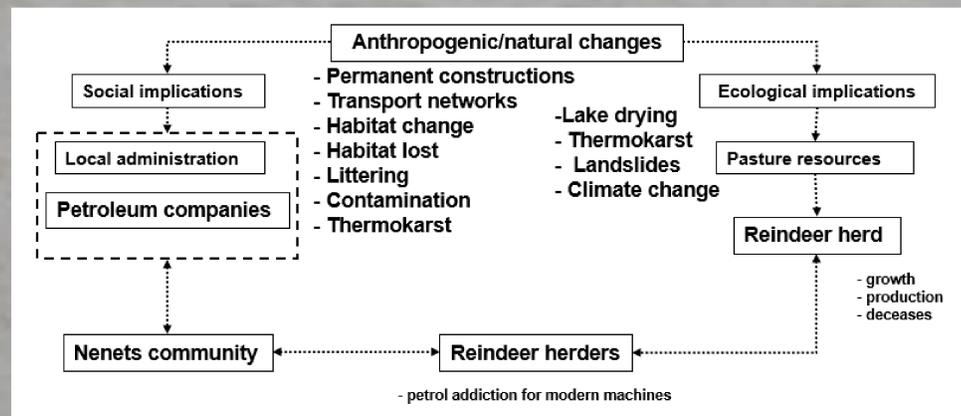


Fig. 3. Land-use and landcover change implications to reindeer pastures in the Yamal.

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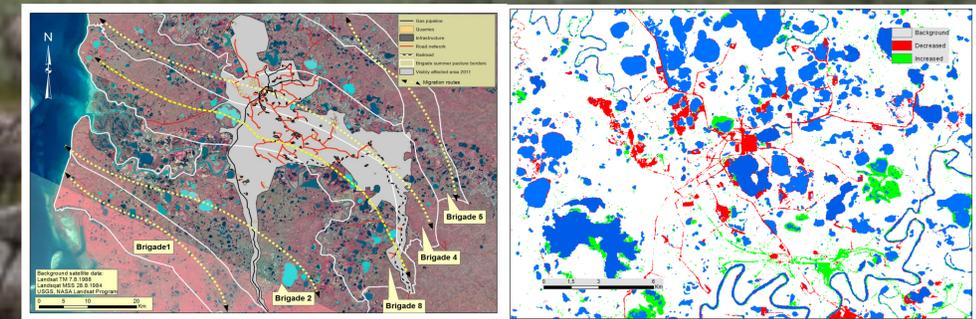


Fig 4. On the left Bovanenkovo gas field is overlapping with reindeer herding units (brigades). Brigades 4 & 8 are more affected by the gas field activities. Gas field causes direct loss of pastureland, decrease of pasture quality (garbage, noise disturbance) and on the other hand possibilities for trading (fish to goods). On the right Landsat image based change detection (1988-2014), shows expansion of the gas field after 2006 Yamal mega project launch.

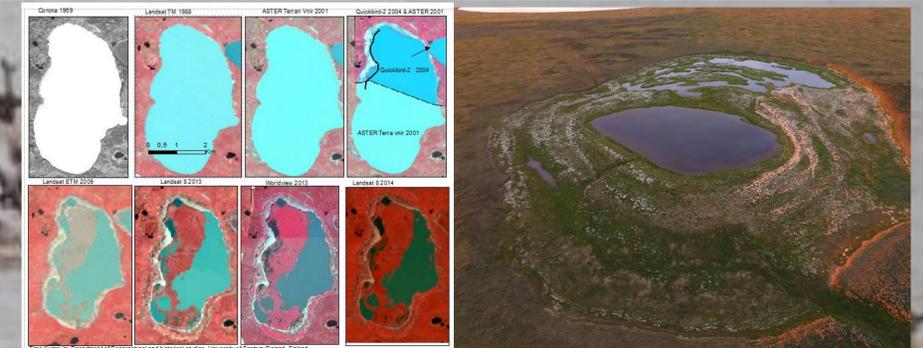


Fig 5. On the left lake Khalevto which drained in 2002-2004. Khalevto was a valuable fishing lake for herders. After drainage, most of the fish have disappeared. Within 5 years drained lake bottom became very good summer pasture with nutritious grasses and sedges. On the right a smaller lake which drained also in 2004, lake bottom is now full of cotton grass and sedges.

## Discussion/conclusion

The results of climate change together with the industrial development have a serious impact to the Nenets nomadic reindeer husbandry.

- Changes in migration routes and the way of working with reindeer.
- Increase of privately owned reindeer, degradation of sovkhوزه based grazing migration system.
- Quality of the pastures → less migration → less time for recovery from grazing.
- Climatic extremes e.g. Rain-On-Snow (ROS) can have fatal effects, → icing of the pastures in the winter → increased reindeer mortality and profitability of reindeer herding
- Drainage of lakes in Yamal have increased since 1960's :
  - Nenets herders have lost many important fishing lakes.
  - Drained lake bottoms have become good grazing grounds.

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