



EARTH CRYOSPHERE INSTITUTE

Tyumen Scientific Centre SB RAS



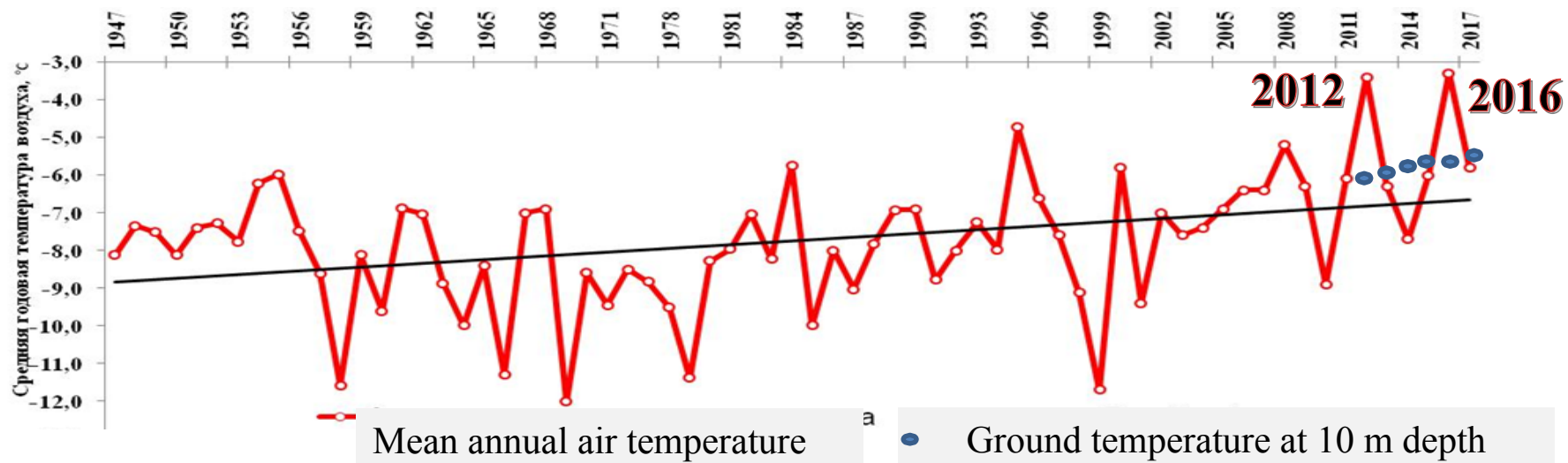
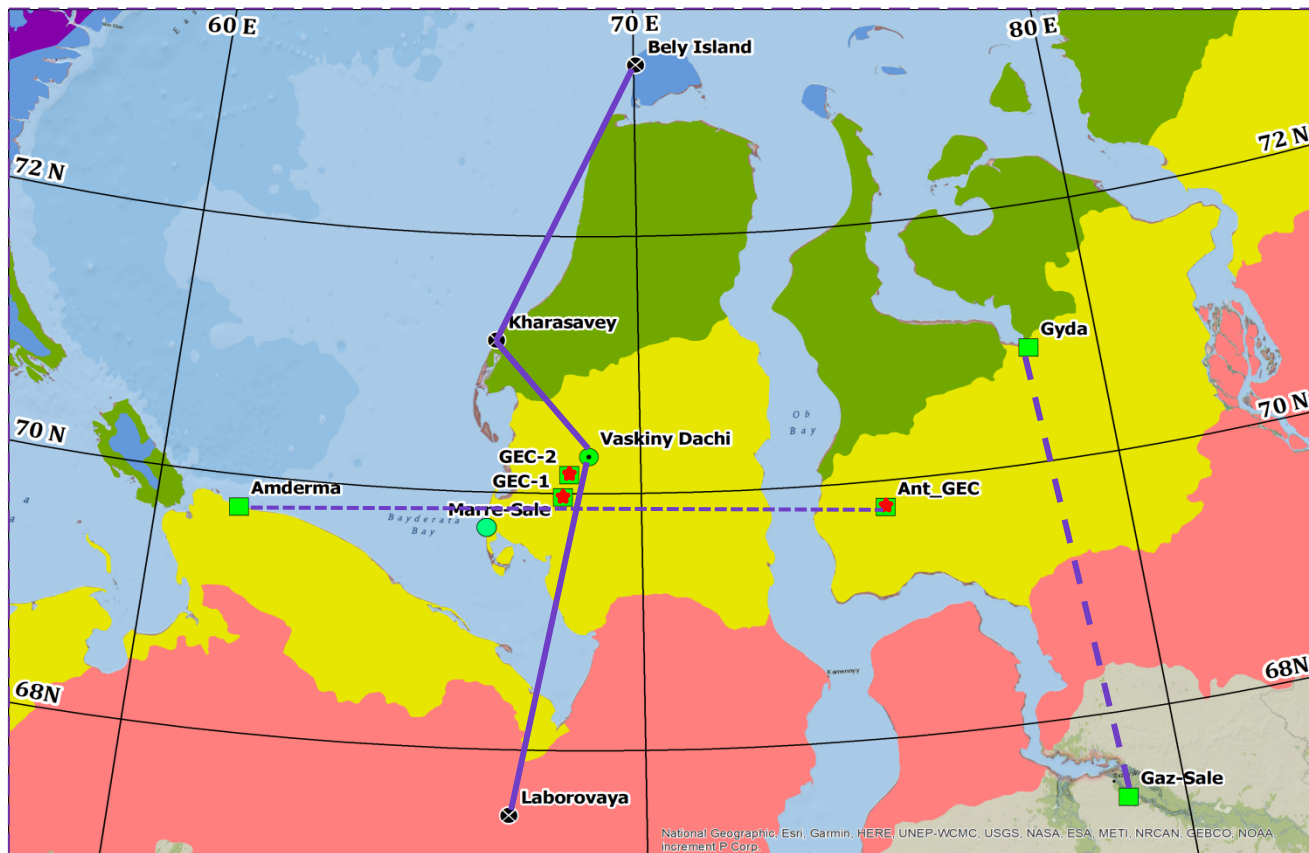
RESPONSE OF PERMAFROST ENVIRONMENT TO NATURAL CHANGES AND HUMAN IMPACT IN THE NORTH OF WEST SIBERIA (YAMAL-NENETS AUTONOMOUS OKRUG)

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Rapid Arctic Transitions due to Infrastructure and Climate Workshop

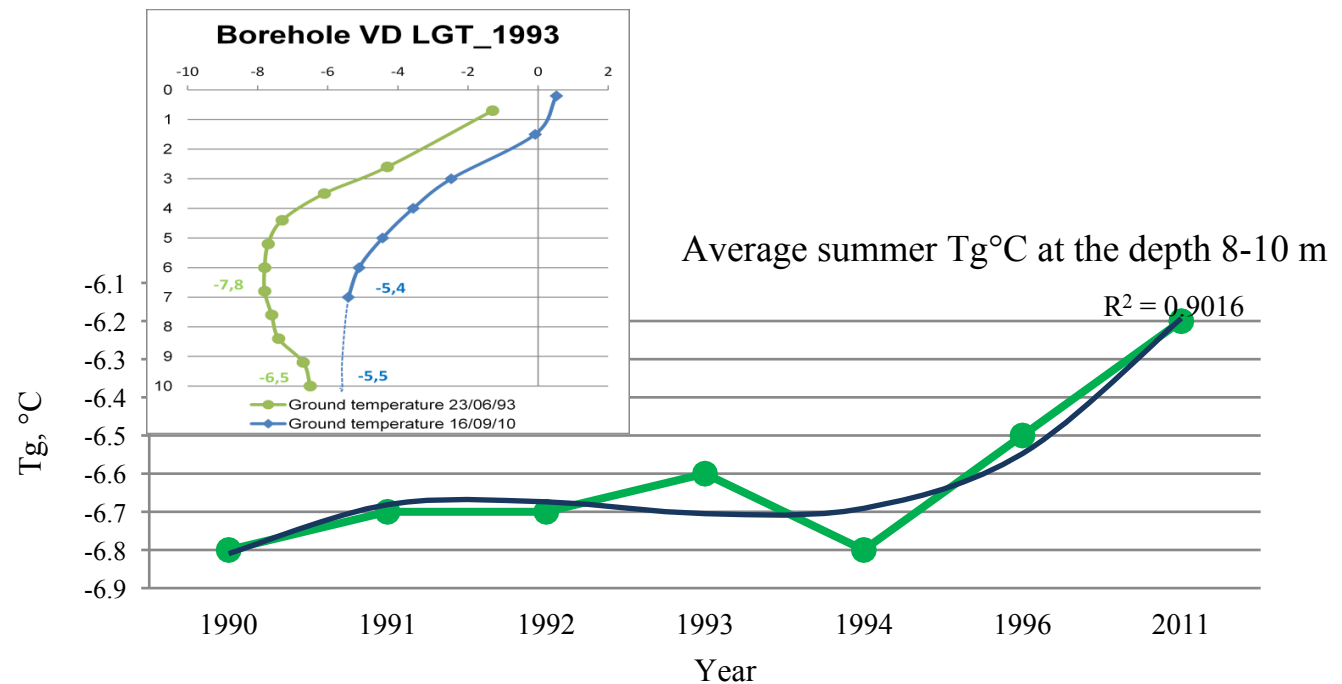
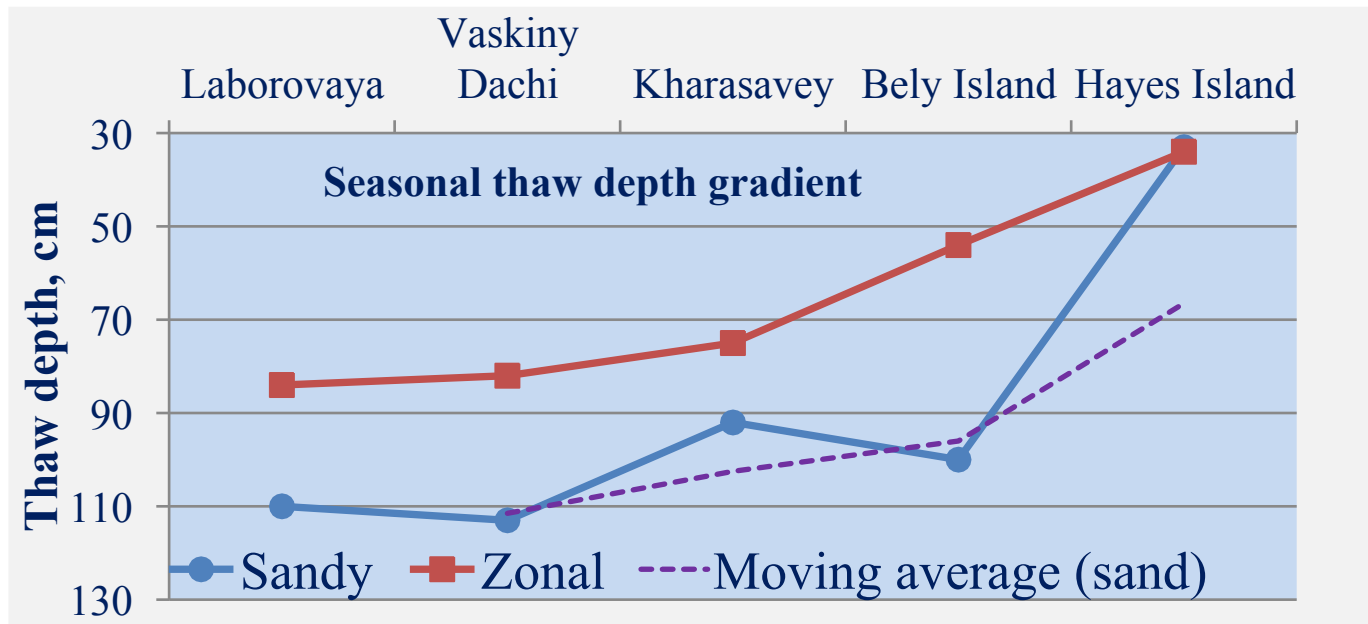
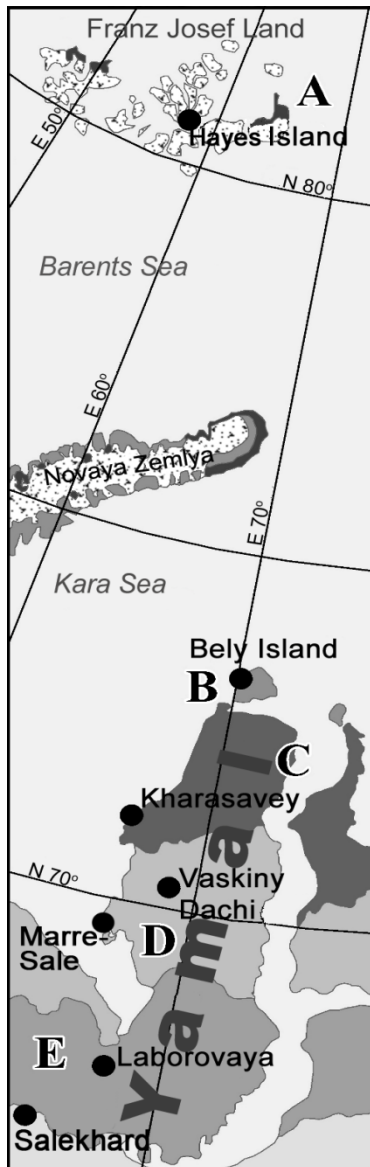
26 May 2019, 9:00–18:00



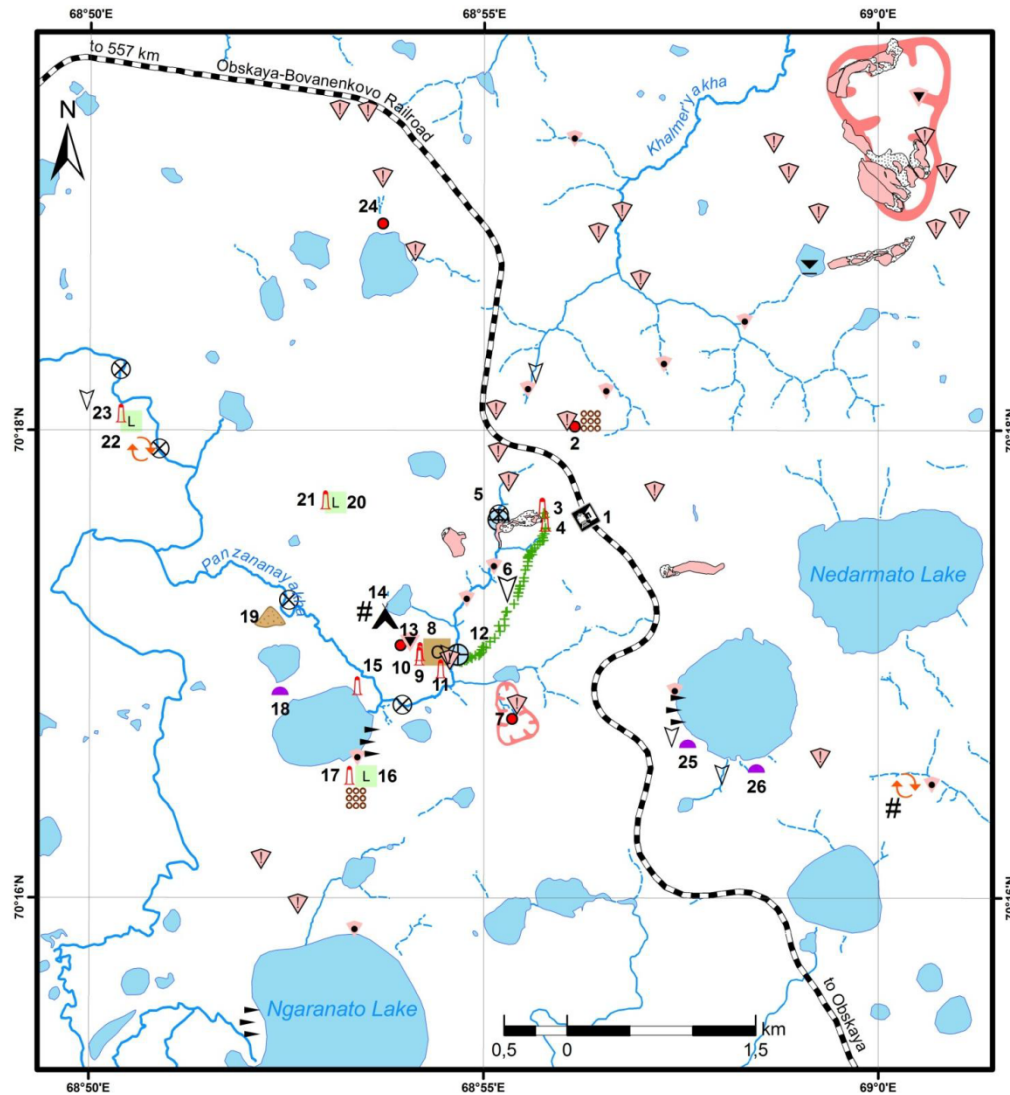
Before 2012

- Monitoring
 - Active layer thickness
 - Active-layer wetness occasionally
 - Active layer chemistry occasionally
 - Ground temperature
 - Vegetation dynamics on bare surfaces
 - Seasonal frost heave/subsidence occasionally
- Mapping
 - Landscape maps
 - Active-layer thickness maps
 - Landslide risk assessment maps

Before 2012



Before 2012



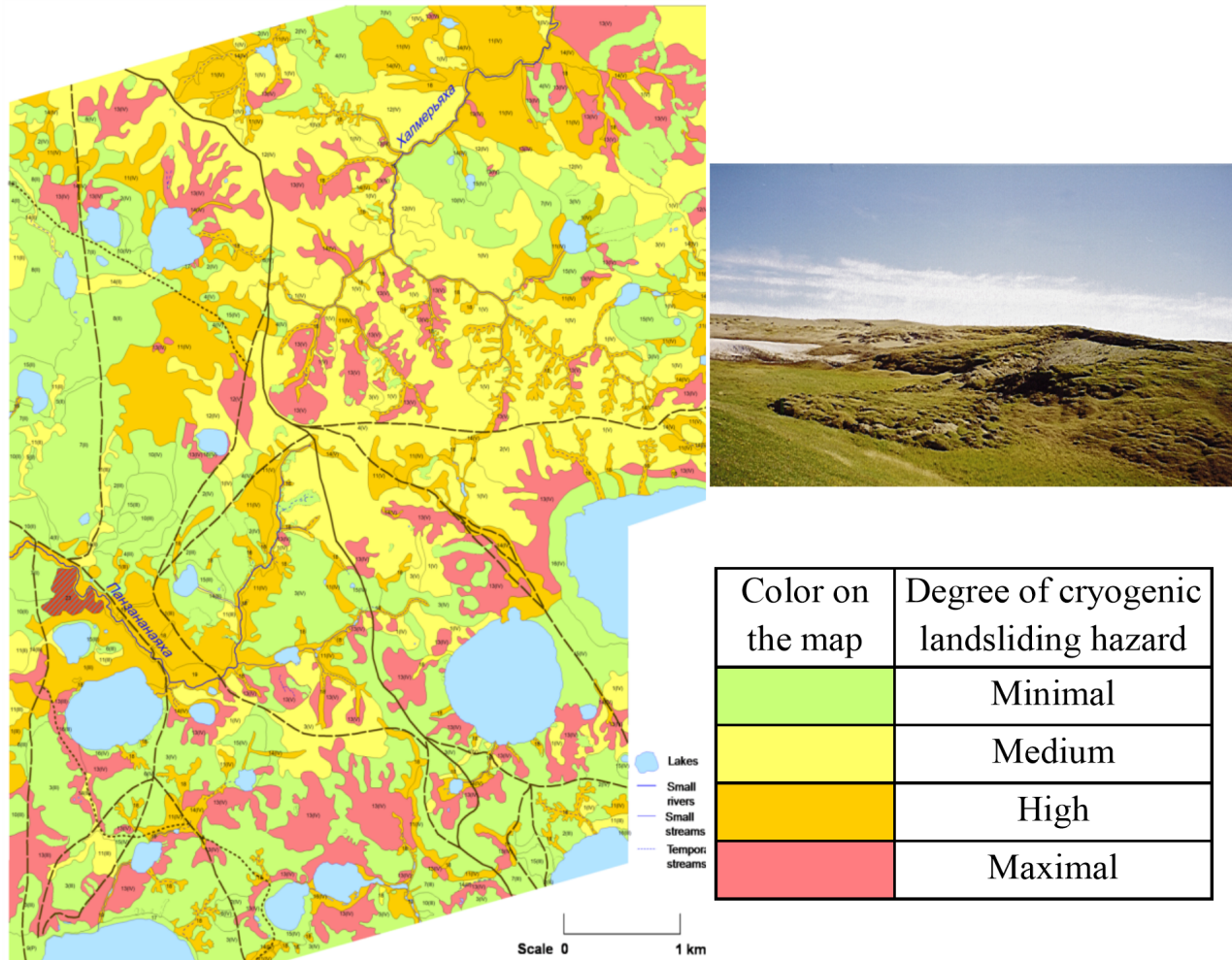
LEGEND CRYOGENIC PROCESSES

- | | | | |
|-----|--|---|---|
| ▶▶▶ | Thermoabrasion | | Landslide cirques |
| | Tabular ground ice exposures | | Active layer detachment slides of 1989: |
| ▽ | Thermoerosion gullies | | The largest single slides |
| ⊗ | Thermokarst | ▽ | The average single slides |
| | Polygonal peatbogs | ▽ | Clusters of average slides |
| # | Polygonal cracking | • | Clusters of small slides |
| ↻ | Wind-blown sands | | |
| ▼ | Water level decrease low terraces and khacvraic (drain lakes) form | | |

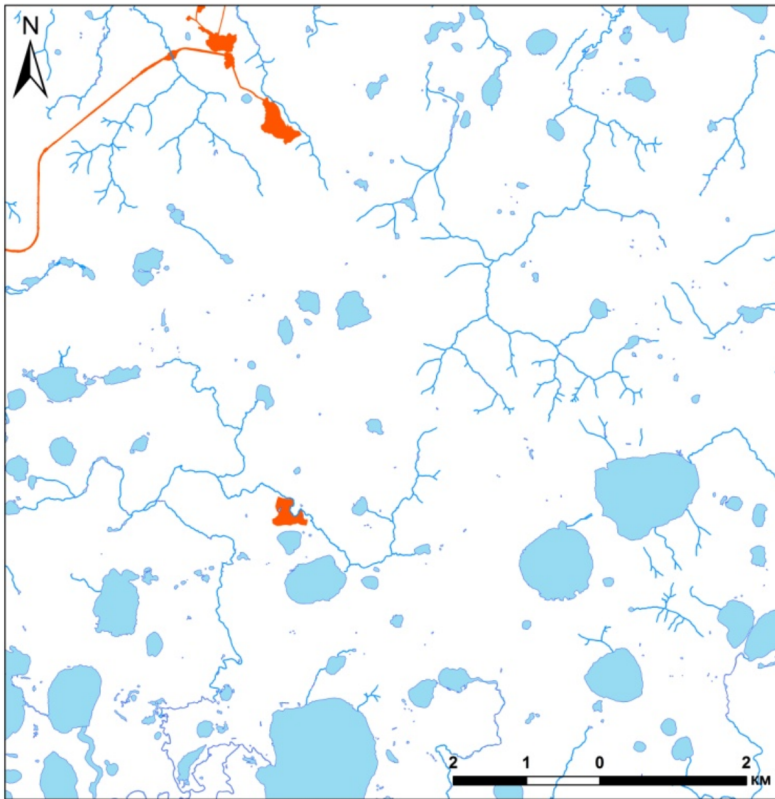
STATIONARY OBJECTS

- | | | | |
|---|---|---|--------------------------------|
| | Boreholes | | Active-layer monitoring sites: |
| • | Points of landslide studies | C | CALM grid 100×100 m |
| + | Points of complex studies at 1,5-km long Transect | L | LCLUC grids 50×50 m |

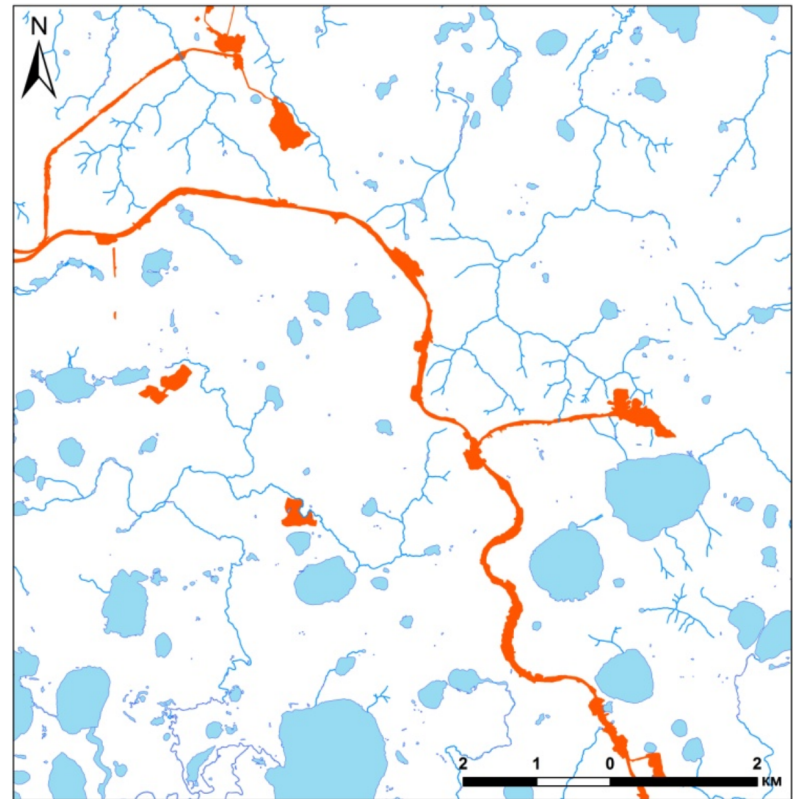
Landslide hazard map of Vaskiny Dachi



Infrastructure extent in 2010 compared to 2009 due to railway construction



2009



2010

Technogenic surface disturbances

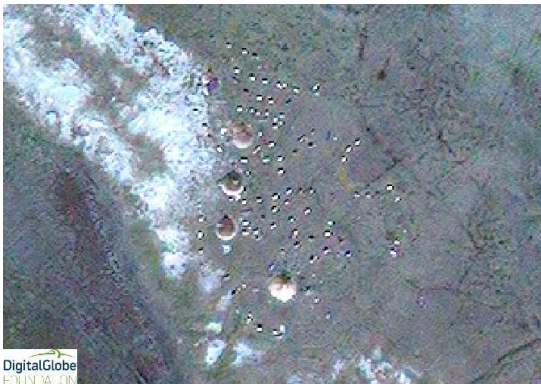
1



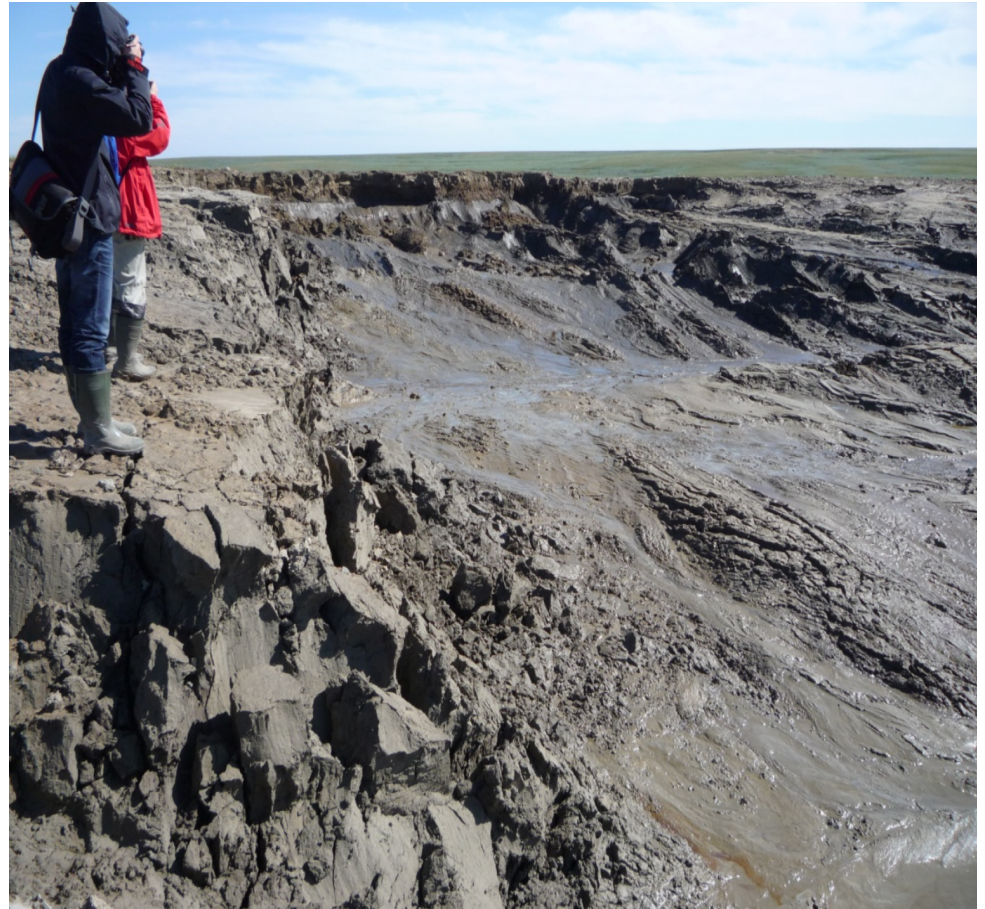
2



3

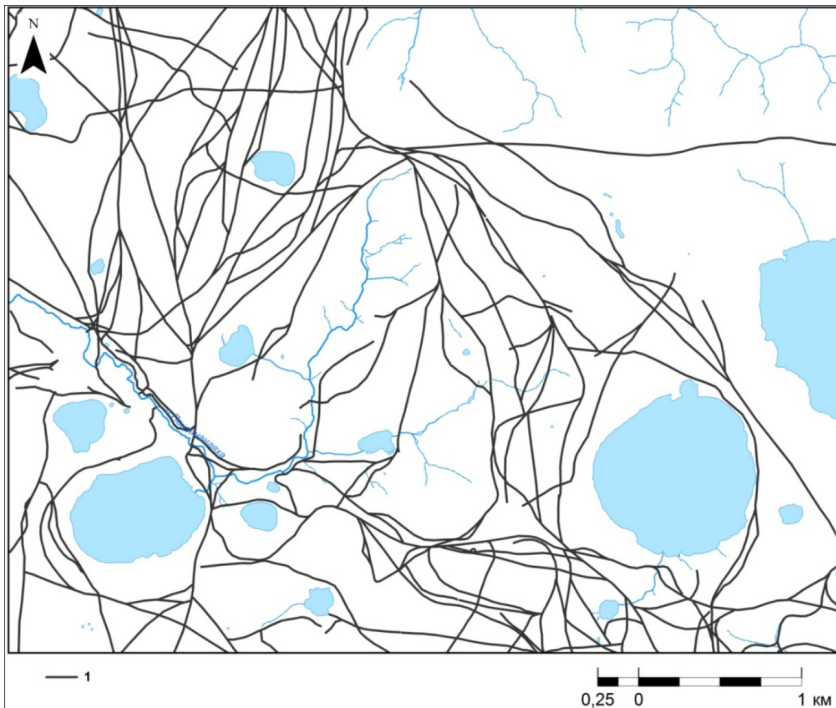


Technogenic thermocirque started
due to embankment construction

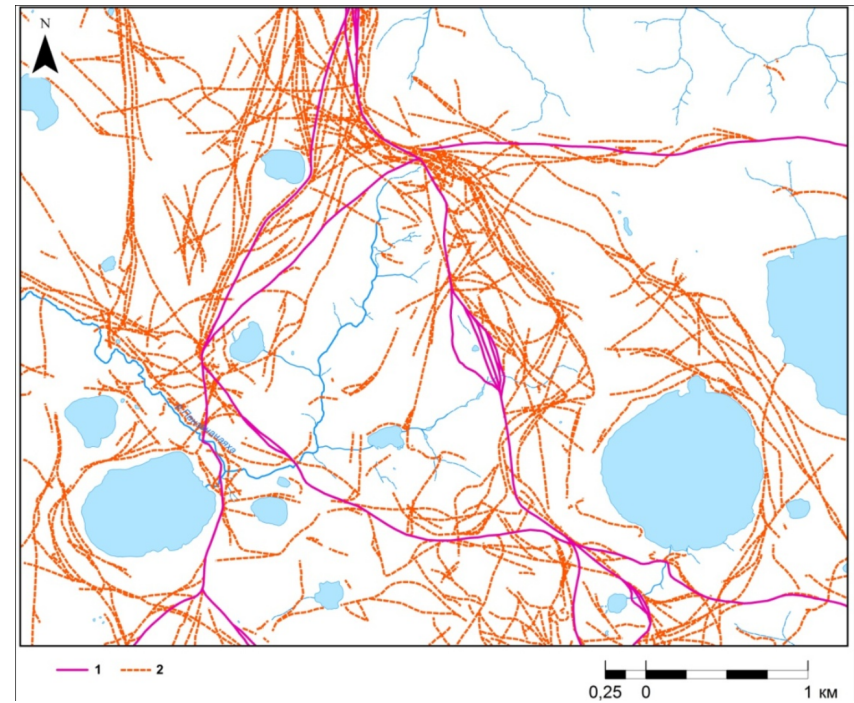


1, railway and quarry; 2, off-road vehicle tracks, 3, reindeer trampling

Vehicle track network growth due to investigations for railway construction, and natural recovery



1990

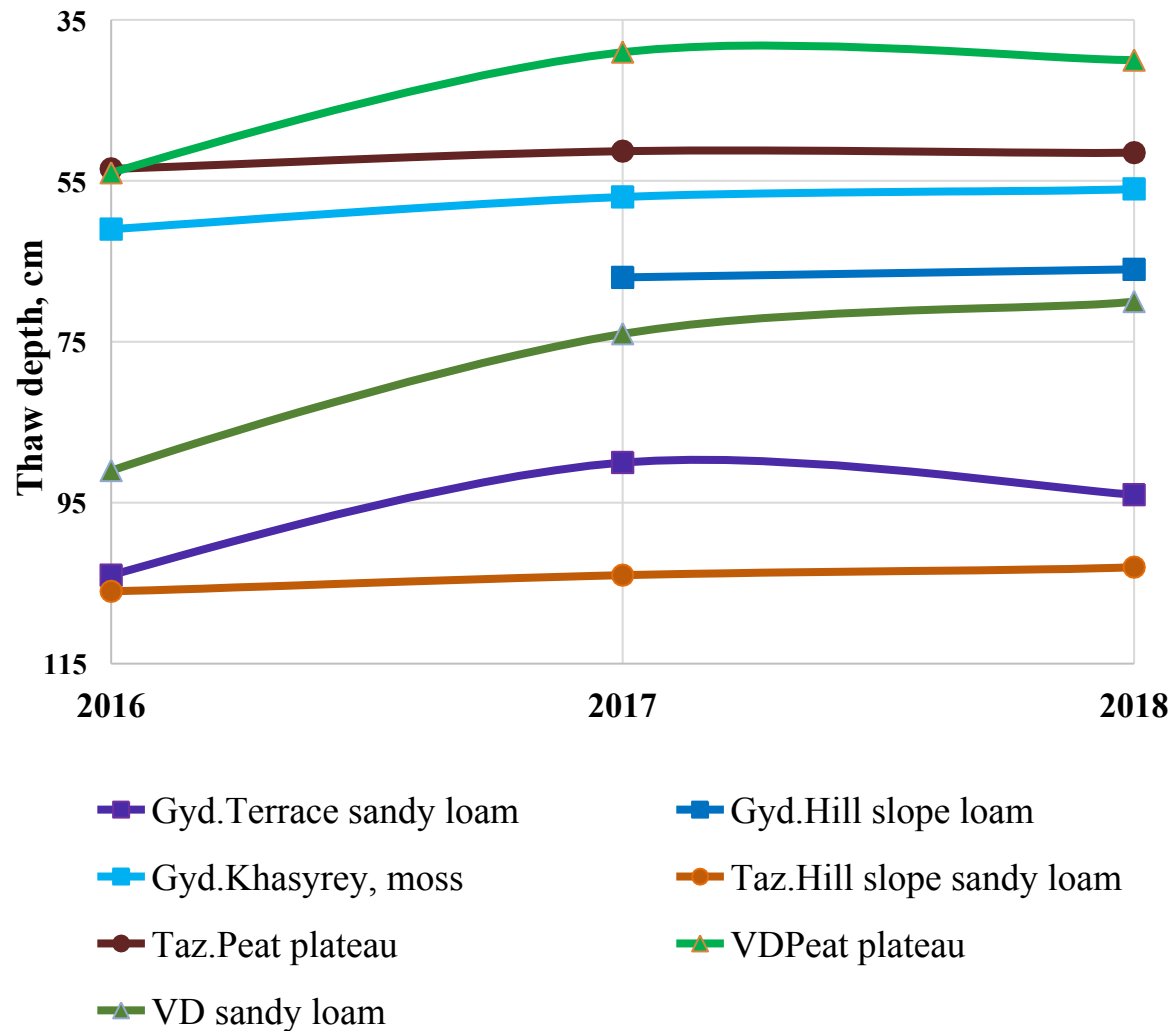


2009

After 2012

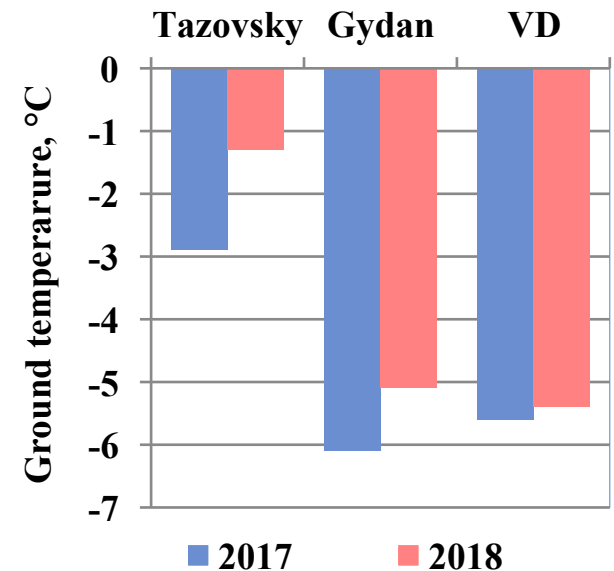
- Monitoring, continued activities
 - Active layer thickness continued, sites added: VD peat, Gas-Sale transect, Gyda transect, across disturbances transects
 - Active-layer wetness, extended to all gridnodes
 - Ground temperature, boreholes added: CALM 10 m deep, VD shrubs, Gas-Sale borehole, Gyda borehole.
 - Vegetation coverage of bare surfaces continued at VD
 - Seasonal frost heave/subsidence at VD continued, points added
- Monitoring, new activities
 - Thermocirque growth at VD
 - Gas-emission crater evolution
 - Lake bathymetry and chemistry (dissolved methane and colored organic matter)
 - Snow depth, structure and chemistry across Yamal
- Mapping based on very high spatial resolution images and stereo pairs
 - DEMs
 - Landscape, geomorphic maps
 - Dynamics of cryogenic processes maps
 - Prediction maps
 - Snow water equivalent maps

Active layer and ground temperature Gydan transect



Mean annual air temperature

	2017	2018
Marre-Sale	-5,8	-5,9
Tazovsky	-7,0	-6,5
Gydan	-9,3	-9,5



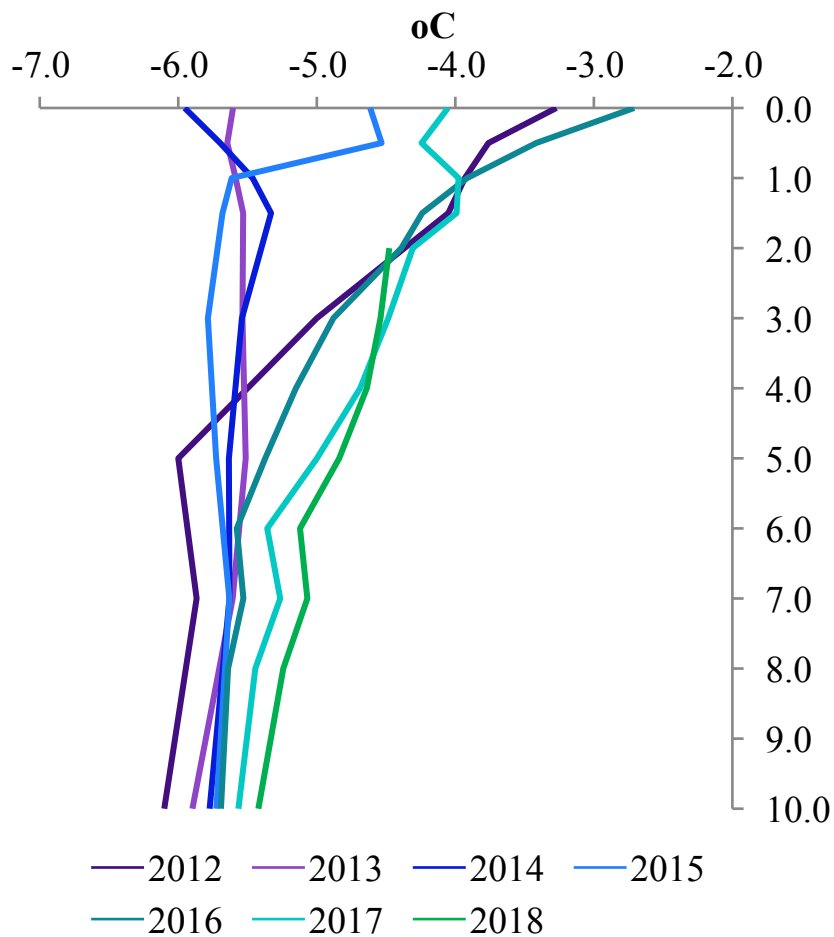
Mean annual air temperature

W/station	2017	2018
Marre-Sale	-5,8	-5,9
Tazovsky	-7,0	-6,5
Gydan	-9,3	-9,5

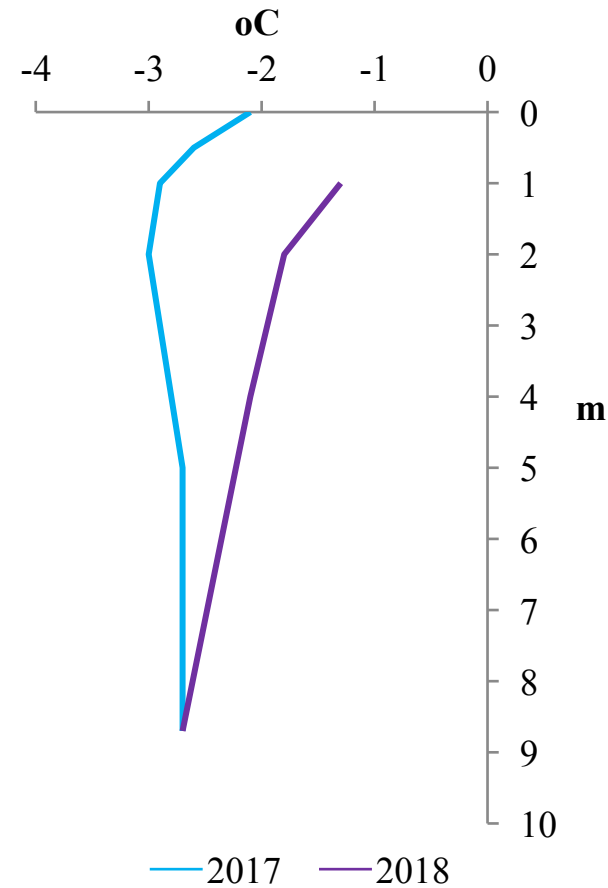
West-East



South-North



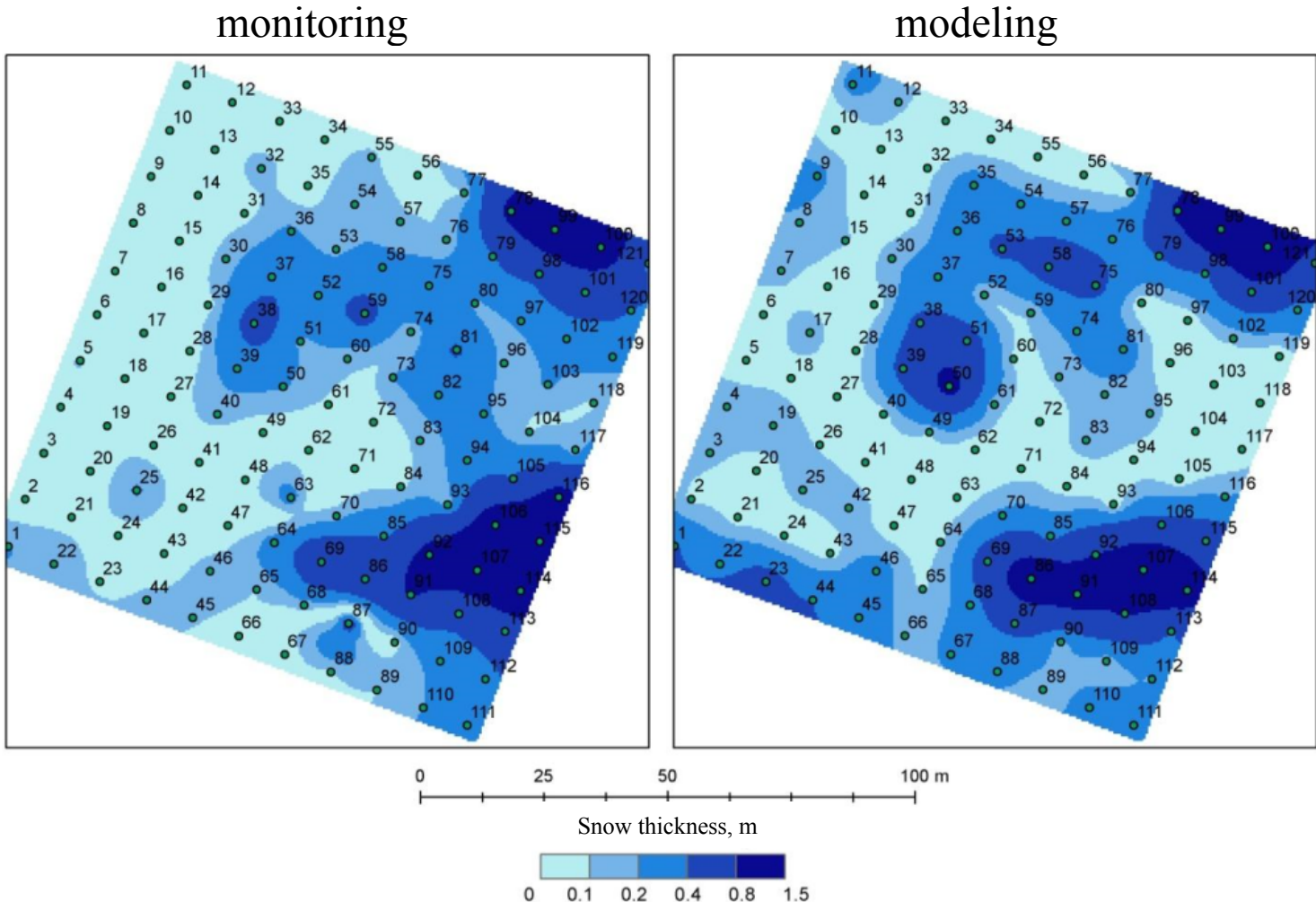
VD-CALM 10m



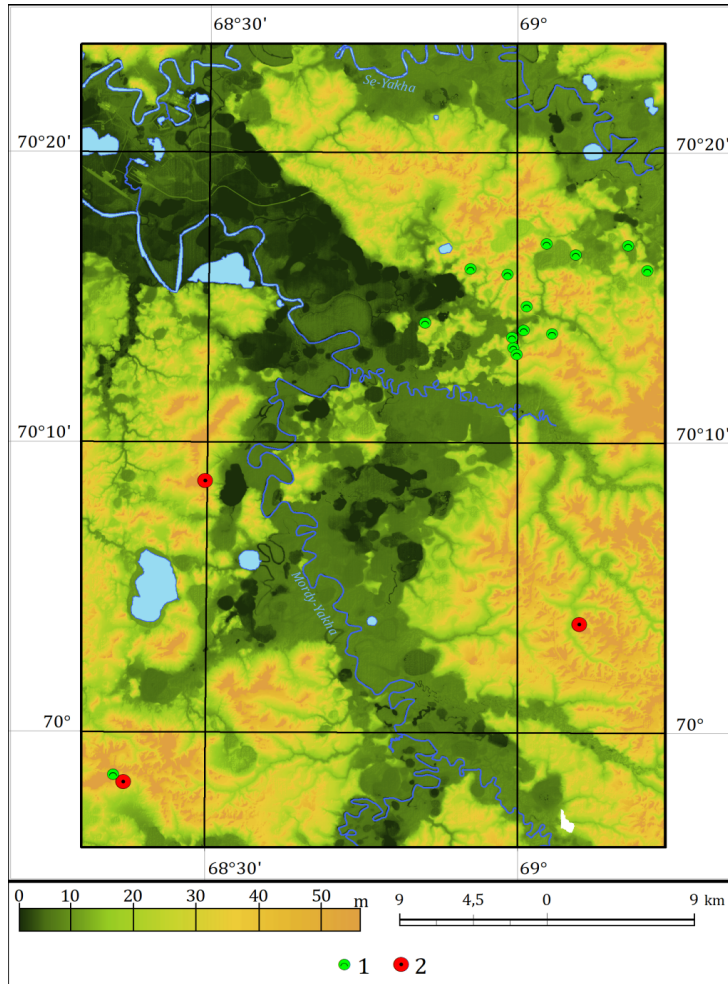
Tazovsky 8,7 m

Snow depth measured and modeled

VD CALM grid



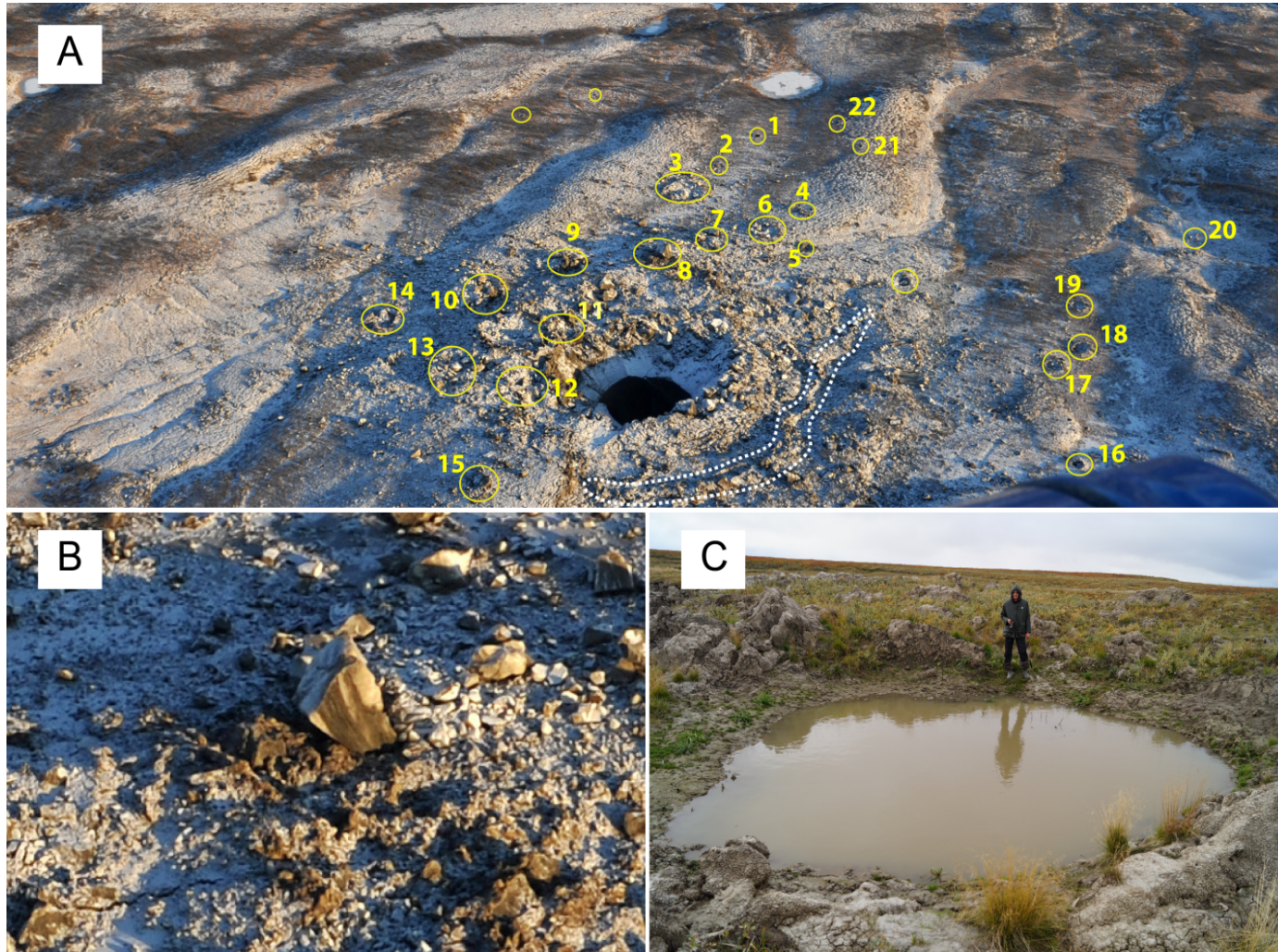
After 2012



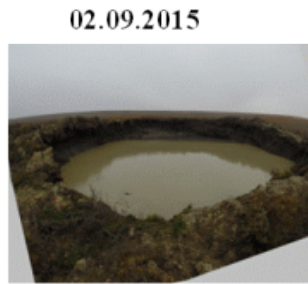
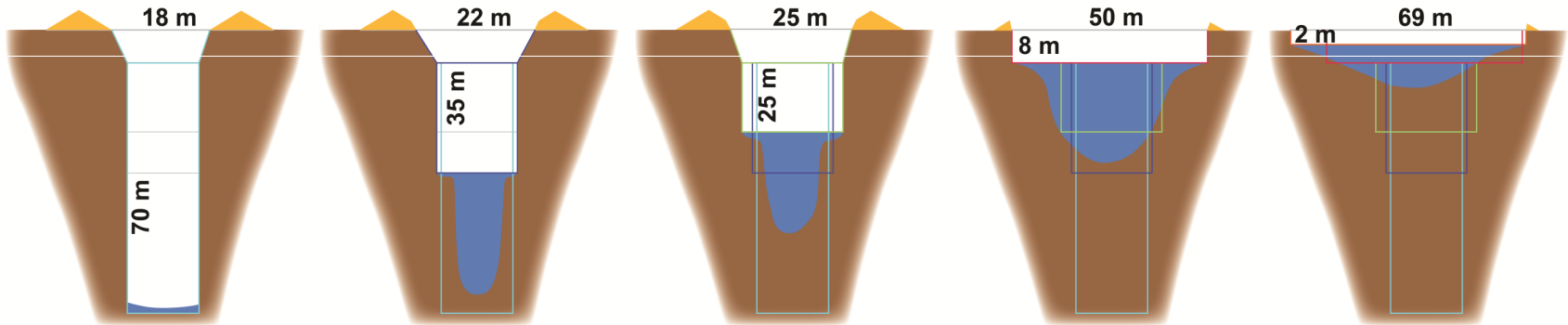
- 1, thermocirque/cluster of thermocirques;
2, gas-emission crater.



Geomorphic impact of GEC



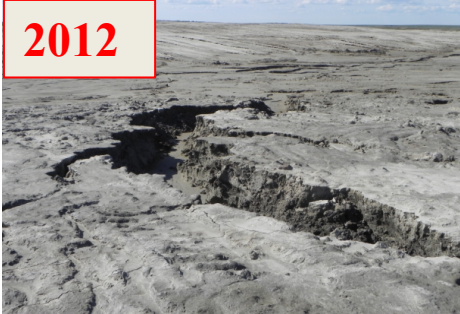
Evolution of GEC



Technogenic impact/recovery

Yamal, quarry

2012



2015



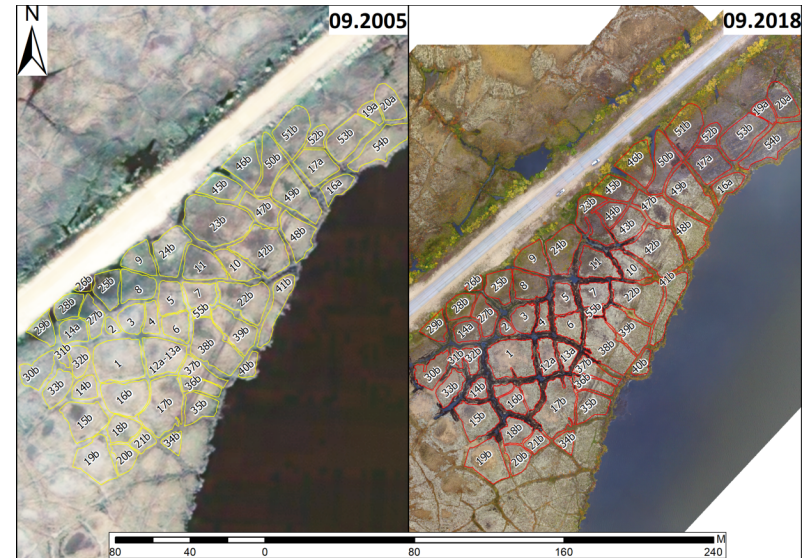
2017



Yamal, tracks

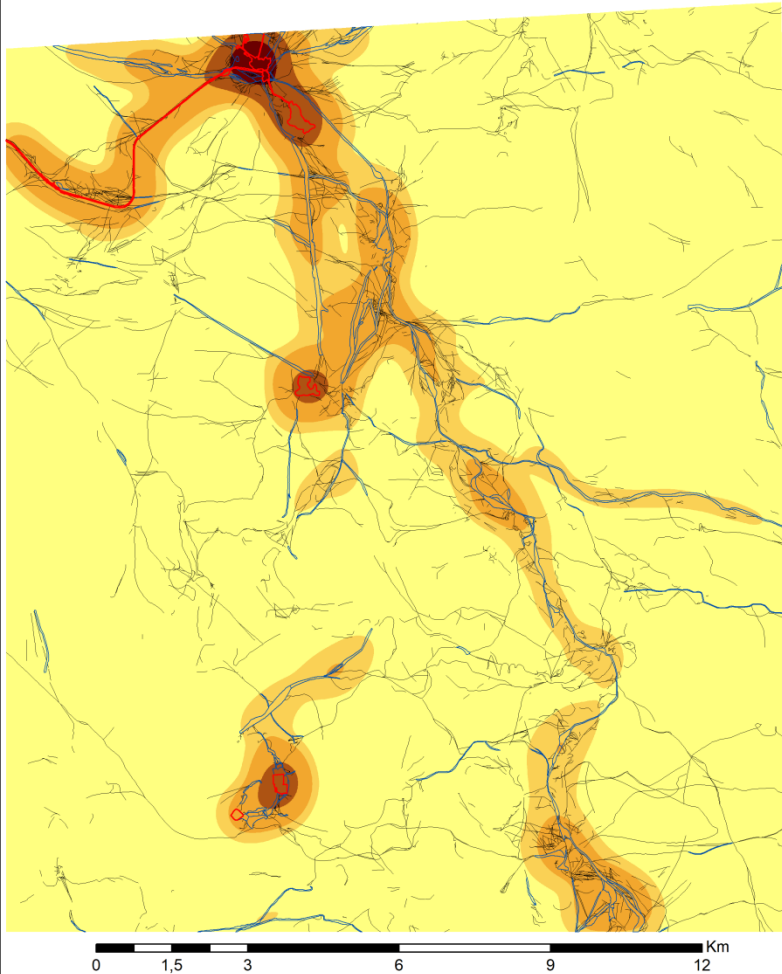


Tazovsky, road, peat plateau

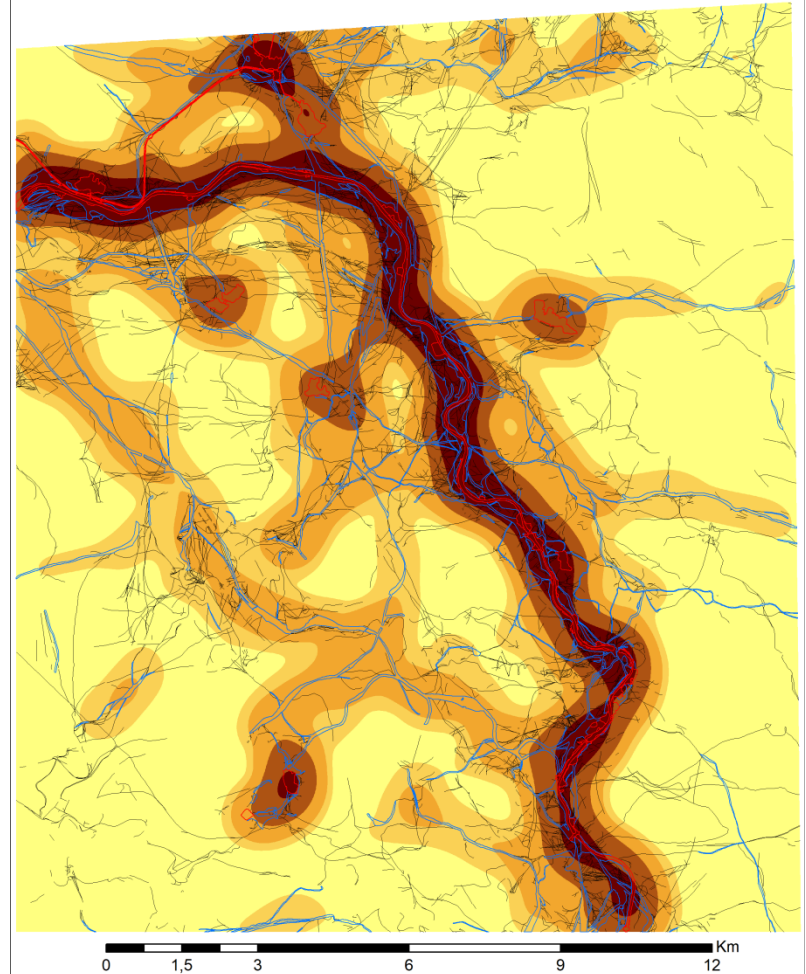


Density of impact

2009



2013



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