

# Yamal LCLUC Synthesis: Comparison of infrastructure development and consequences to social-ecological systems in the Bovanenkovo Gas Field, Russia and the Prudhoe Bay Oilfield, Alaska

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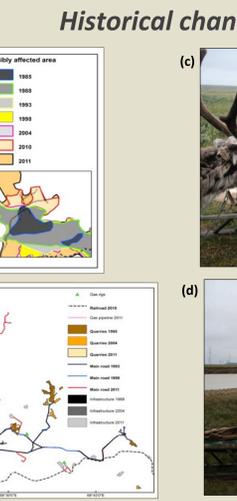
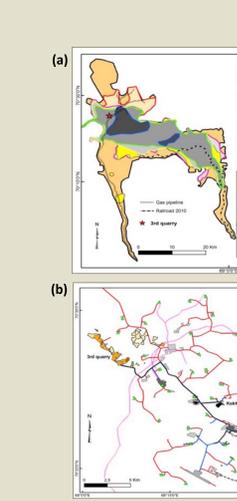
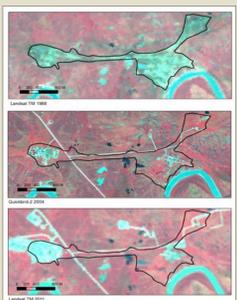
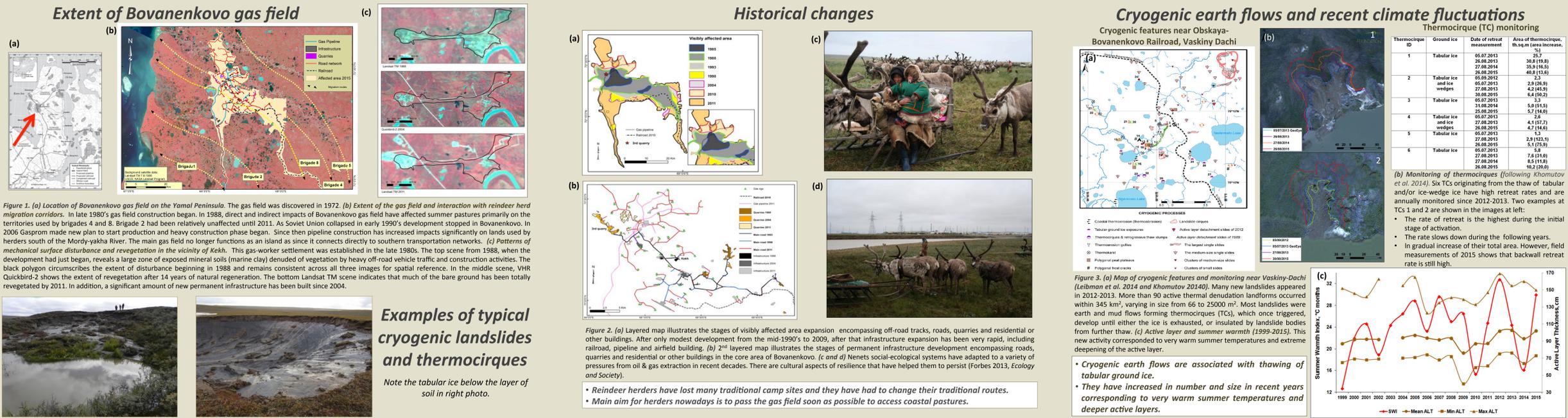
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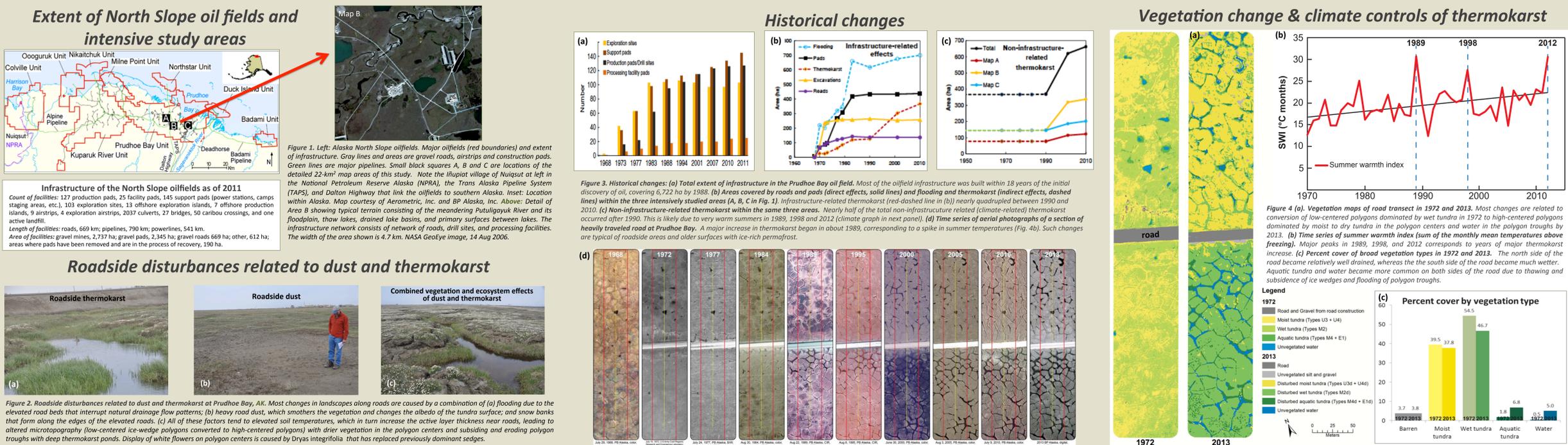
## Abstract

Many areas of the Arctic are undergoing rapid permafrost and ecosystem transitions resulting from a combination of industrial development and climate change as summer sea ice retreats and abundant Arctic natural resources become more accessible for extraction. The Bovanenkovo Gas Field (BGF) in Russia and the Prudhoe Bay Oilfield (PBO) in Alaska are among the oldest and most extensive industrial complexes in the Arctic, and both are situated in areas with extensive ice-rich permafrost. Case studies of the two hydrocarbon fields provide an overview of the socio-ecological conditions, rates of hydrocarbon development, and perceptions of change by local cultures in these two remote Arctic areas.

**Bovanenkovo gas field, Yamal Peninsula Russia:** Highly erodible sands and the presence of massive tabular ground ice near the surface contributes to landslides and thermo-denudation of slopes. A large set of cryogenic landslides occurred in Bovanenkovo region in Central Yamal peninsula, Arctic Russia in late 1980's. Mega size Bovanenkovo gas field was found in 1970's and in 2012 production began after large infrastructure construction. In central Yamal peninsula both natural and anthropogenic changes has occurred during the past 40 years. These range from physical obstructions, such as roads, railways, and pipelines, to direct and indirect ecological impacts, such as changes in vegetation and hydrology. Analysis summarized from Kumpula et al. (2011), Kumpula et al. (2012), Khomutov & Leibman (2010), Khomutov et al. (2012) and Leibman et al. (2014).



**Prudhoe Bay oilfield, Alaska:** Thermokarst in the form ice-wedge degradation, is expanding along ice-wedges adjacent to roads and in areas away from roads. Between 1990 and 2001, coincident with strong atmospheric warming during the 1990s, natural thermokarst resulted in conversion of low-centered ice-wedge polygons to high-centered polygons, more active lakeshore erosion and increased landscape and habitat heterogeneity. These geocological changes have local and regional consequences to wildlife habitat, land-use, and infrastructure. Analysis summarized from Reynolds et al. (2014), Walker et al. (1980, 2014), Romanovsky et al. (2012), Kanevskiy et al. (2013).



**Conclusions**

- Differences in the underlying surficial geology (BGF: hilly, with mainly marine clays overlaid by alluvial sands and peat; PBO: flat alluvial gravel overlaid by loess and peat) have resulted in very different permafrost conditions and hazards (BGF: mainly tabular ground ice in the uplands, with extensive cryogenic landslides and thermocirques on slopes; PBO: ice-rich loess with extensive thaw lakes, and ice-wedge polygons with extensive thawing of ice-wedges forming thermokarst ponds).
- A recent series of warm summers has triggered a major increase in thermokarst in the PBO and thermocirques near the BGF.
- The small both fields were discovered at about the same time (PBO: 1968; BGF: 1972). The PBO infrastructure network developed rapidly and by 1977 was connected to the rest of Alaska by the Dalton Highway and the Trans-Alaska Pipeline, which permitted additional development of adjacent oilfields, and export of the oil to the ice-free port at Valdez. The BGF development proceeded much slower. Transport of gas out of the region still awaits construction of pipeline linkages to other gas fields on the Yamal and points further south in Russia and Europe.
- Populations of indigenous people in both areas have benefited economically from resource development, but with major social consequences. Most threatening to both groups is restricted free access by hunters and herders through their traditional lands.
- Future mega-expansion of infrastructure in both areas, combined with climate-induced changes to local landscapes and permafrost present unprecedented challenges to local communities. The shear scale of the proposed hydrocarbon developments in the next few decades could overwhelm the ability of the local communities to adapt to the changing conditions.
- Successful adaptive management will require full engagement of local people and governments with industry and national governing agencies.