The Yamal LCLUC Study: Vegetation Analysis and Mapping along a 900-km Arctic transect

D.A. Walker[1], H.E. Epstein[2], H. A. Maier[1], G.V. Frost[2], M.K. Raynolds[1], U.S. Bhatt[1], J. Comiso[3], R. Daanen[1], D.S. Drozdov[4], B. Forbes[5], A.A. Gubarkov[4], G. Jia[6], E. Kaarlejarvi[5], O. Khitun[7], A.V. Khomutov[4], P. Kuss[8], M.O. Leibman[4], G. Matyshak[9], N.G. Moskalenko[4], P. Orekhov[4], J.E. Pinzon[3], V.E. Romanovsky[2], C.J. Tucker[3], N.G. Ukraintseva[4], Q. Yu[2]

1. University of Alaska Fairbanks, AK, USA; 2. University of Virginia, Charlottsville, VA, USA; 3. NASA Goddard, Greenbelt, MD, USA; 4. Earth Cryosphere Laboratory, Moscow and Tyumen, Russia; 5. Arctic Centre, University of Lapland, Rovaniemi, Finland; 6. Institute of Atmospheric Physics, Beijing, China; 7. Komarov Botanical Institute, St. Petersburg, Russia; 8. University of Bern, Switzerland; 9. Moscow State University, Russia

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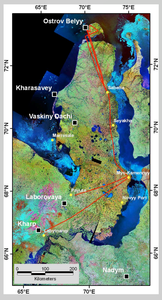
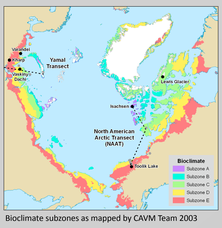
- Examines the roles of climate, substrate and disturbance on NDVI.
- Ground observations along the Yamal transect.
- Hierarchy of mapping and NDVI analyses.



Yamal Transect. Black squares are study locations. Red line is 2010 helicopter route.

One of two transects through all 5 Arctic bioclimate subzones



Bioclimate subzones as mapped by CAVM Team 2003

Sub-Zone	Mean July Temp	Shrubs
A	1-3 °C	none
B	3-5 °C	prostrate dwarf-shrubs (<5 cm)
C	5-7 °C	hemi-prostrate dwarfshrubs (5-15cm)
D	7-9 °C	erect dwarf-shrubs (15-40 cm)
E	9-12 °C	low-shrubs (40-200 cm)

What changes along the tundra bioclimate gradient?

- 10° C increase in the Mean July temperature.
- 10-fold increase in zonal biomass
- 10-fold increase in productivity
- 5 to 10-fold increase in vascular-plant diversity

Tundra study locations (Forest-tundra sites at Kharp and Nadym not included)

Ostrov Belyy (White Island)

Arctic tundra, bioclimate subzone B (High Arctic tundra)

Loamy tundra complexes in the northwest

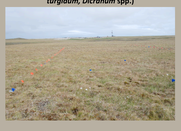
Site 1: Moist loamy tundra (*Carex bigelowii, Calamagrostis holmii, Salix polaris, Hylocomium splendens*)

Site 2: Dry sandy tundra (*Gymnomitrion corallioides, Salix nummularia, Sphaerophorus globosus, Racomitrion lanuginosum*)

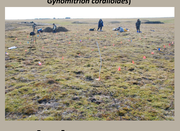
Kharasavey

Arctic tundra, bioclimate subzone C (Arctic tundra)

Site 1: Loamy tundra (*Carex bigelowii, Calamagrostis holmii, Salix polaris, Hylocomium splendens, Aulacomnium turgidum, Dicranum spp.*)



Site 2b: Sandy tundra (*Salix nummularia, Luzula confusa, Dicranum elongatum, Spaerophorus globosus, Gynomitrion corralioides*)

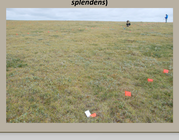


Kharasavey tundra from the air

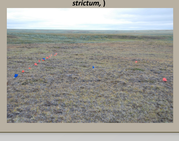
Vaskiny Dachi

Arctic tundra, bioclimate subzone D (northern hypoarctic tundra)

Site 1: Loamy, grazed (*Carex bigelowii, Betula nana, Salix polaris, Aulacomnium turgidum, Hylocomium splendens*)



Site 3: Sandy, alluvial terrace (*Ledum decumbens, Salix nummularia, Carex bigelowii, Sphaerophorus globosus, Gymnomitrion corralioides, Polytrichum strictum,)*



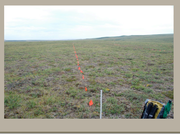
Cryogenic landslides near VD
Eroded marine terraces

Laborovaya

Arctic tundra, bioclimate subzone E (southern hypoarctic tundra)

Site 1, Loamy (*Betula nana, Salix phylicifolia, Vaccinium uliginosum. V. vitis idaea, Carex bigelowii, Dicranum spp.)*

Site 2: Sandy (*Betula nana, Carex bigelowii, Vaccinium uliginosum, Cladonia spp., Sphaerophorus globosus, Flavocetraria nivalis, Polytrichum strictum, Dicranum elongatum*)



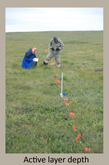
Zonal site, Polar Ural foothills

Data collected

Transects

NDVI and LAI

Species cover



Active layer depth

Plots

Species cover estimates, site factors

Biomass

N-factor

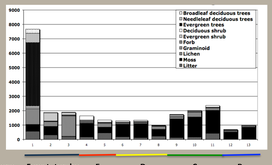
Soils

Soil pit profile descriptions

Top mineral horizon collected for chemical and physical analysis

Vegetation analysis

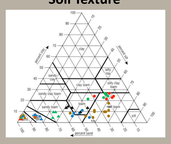
Biomass (g m^2)



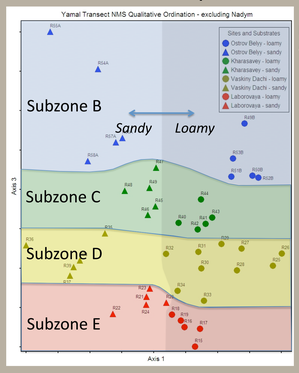
Subzone Forest -tundra E D C B

Zonal sites show little variation across the peninsula, except in subzone E.

Soil Texture



Ordination based on plant-species similarity of study plots



Interpretation:

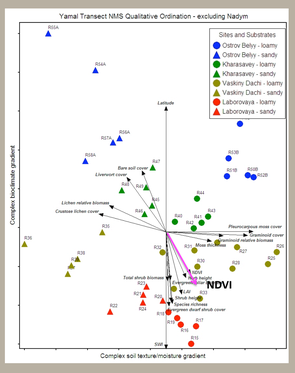
Axes of ordination strongly related to bioclimate and soil texture gradients

Horizonal axis: Sand to Loams

Vertical axis: Warm to cold

JJ Frost et al. 2010, Yamal LCLUC Workshop.

NDVI correlations



- NDVI shows significant relationships to both gradients.
- Some plant variables have clear correlations with complex soil texture gradient [e.g. pleurocarpous mosses and graminoids (+) and crustose lichens (-)].
- Others are more clearly correlated with the latitude gradient [e.g. bare soil cover (+); evergreen shrubs, species richness, herb height (-)].

Land-cover and NDVI analysis

Land-cover mapping with 30-m Landsat TM data

GLS-1990 mosaic

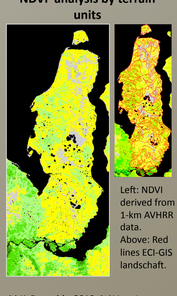
Land-cover maps

- Landsat mosaic provides intermediate-resolution terrain information of the whole peninsula.
- Mosaic is composed of many scenes with different acquisition dates (May to September). Difficult to get consistent land-cover classification or MaxNDVI for the whole peninsula.
- Land-cover maps produced separately for each LCLUC location.
- Next step: combine all decadal and mid-decadal mosaics to get one coverage displaying MaxNDVI for all pixels.

Maier and Walker. 2010. 2nd Yamal LCLUC Workshop.

Analysis of AVHRR-NDVI with terrain map units

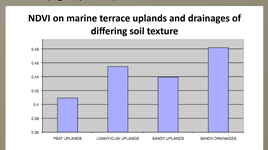
NDVI analysis by terrain units



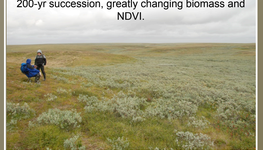
Left: NDVI derived from 1-km AVHRR data.
Above: Red lines ECI-GIS landschaft.

M.K. Raynolds. 2010. 2nd Yamal LCLUC Workshop

- NDVI of zonal uplands does not vary much across the climate gradient.
- Loamy uplands have higher NDVI than sandy uplands. Landschaft does not delineate some known sandy areas (e.g. O. Belyy).
- Broad river channels have highest NDVI (graph below) despite large amount of lakes in the valleys.
- 1-km data are not fine enough to resolve the greening patterns within the highly eroded upland areas (right: photos).



Landslides and cryogenic erosion



Photos by D.A. Walker

- Large effect of landslides on spatial patterns of greenness in many areas.
- Without quantitative measures of the rate of change, it is hard to determine if this is a factor with respect to recent temporal greening trends (Bhatt et al. 2010, in review).
- Need temporal series of high-resolution satellite images and/or photos in landslide areas to assess the rate of change.

References:

Bhatt, U.S., et al., 2010 in revision, Panarctic trend and variability in the land-ocean margins of sea-ice concentrations, land-surface temperatures, and tundra vegetation greenness: Earth Interactions.

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Walker, D.A., et al., 2009, Spatial and temporal patterns of greenness on the Yamal Peninsula, Russia: interactions of ecological and social factors affecting the Arctic normalized vegetation index: Environmental Research Letters, v. 4, p. doi:10.1088/1748-9326/4/4/045004.

http://www.geobotany.uaf.edu/yamal/