Environmental and anthropogenic factors explain plant species richness across Western Siberia tundra

How is plant species richness distributed at community level in Western Siberian tundra?

- Western Siberian tundra communities are changing rapidly due to climate change, fossil fuels extraction and reindeer herding.
- We present macroecological models for species richness of Western Siberian tundra communities. We used General Linear Model, General Additive Model, Random Forest, and Gradient boosting to predict species richness as a response variable of environmental factors.
- The research is based on the Western Siberian part of Russian section of Arctic Vegetation Archive (http://avarus.space) ~ 1438 Braun-Blanquet plots (2005-2018 years) (Fig.2).
- We estimated the role of anthropogenic factors using distance from infrastructure derived from Open Street Maps as a proxy for human influence.
- We tested two mapping options: using actual distance to infrastructure raster (Fig.3) and a hypothetical zero human influence raster (distance to infrastructure was set to maximum value) (Fig.4).
- Both “environmental only” and “actual distance to infrastructure” ensemble of models show similar level and share the same patterns of model disagreement. (Fig. 6, 7). In contrast, “zero human influence” show much higher uncertainty (up to 40 species), especially in Southern and Western Gydan and Southern Yamal.

Table 1: Predictors

Predictor	Original resolution, m	Predictive power, TSR %
Mean Ground Temperature (2000-2016) PANGAEA	1000	19
Penman humidity (max)	1000	16
Mean temperature of driest quarter	1000	14
Potential evapotranspiration (min)	1000	13
Distance to infrastructure (OSM)	1000	11
Growing degree days above 5°C	1000	11
Penman humidity (range)	1000	11
(log transformed) slope (ArcticDEM)	10	10
Cloud area fraction	1000	7
Mean wind speed	100	5

Table 2: Model performance

Model	Spearman correlation	Mean Absolute Error	Root Mean Square Error
GLM	0.53	8.4	10.8
Random Forest	0.59	8.1	10.3
GAM	0.59	8.0	10.2
GBM	0.60	7.9	10.1

Resulting map ensembles. Spatial resolution = 1000 m

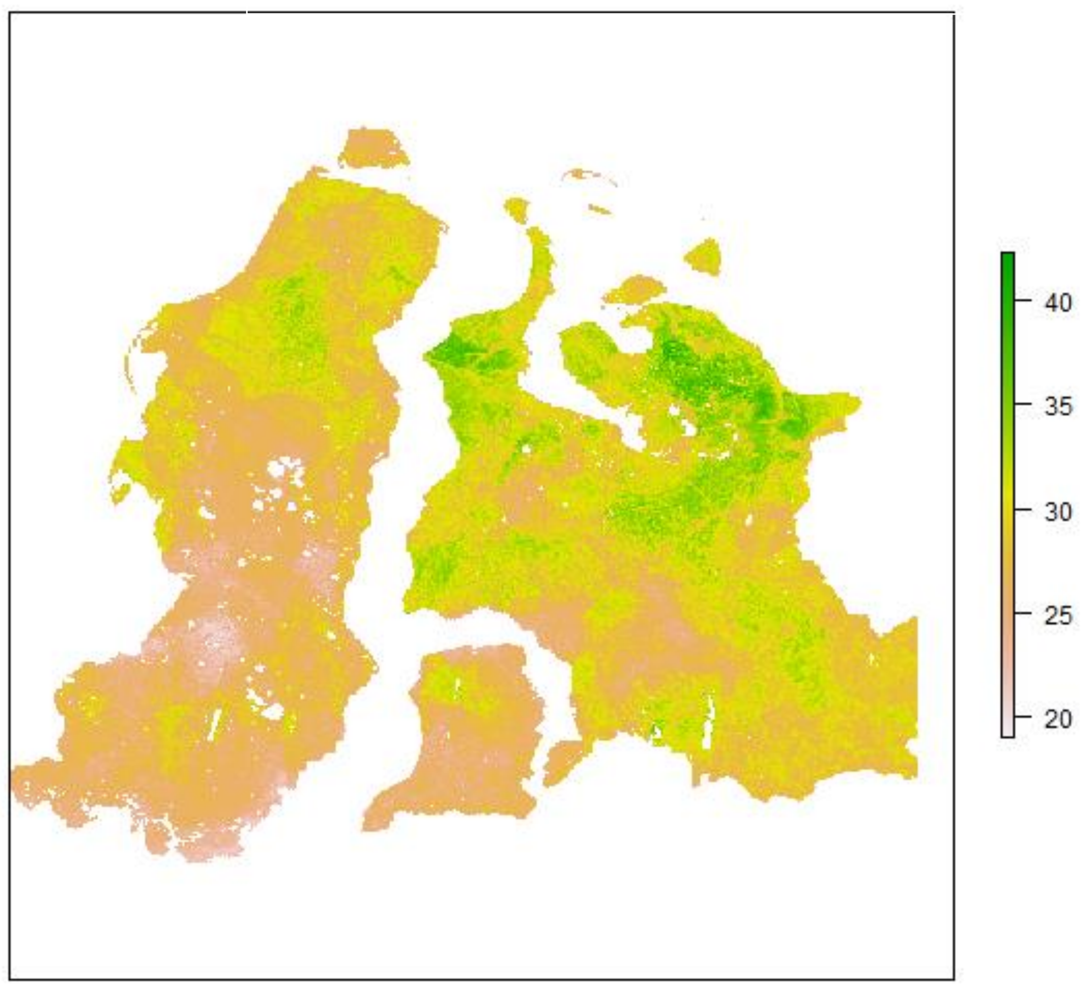

Fig 3: Actual distance to infrastructure used

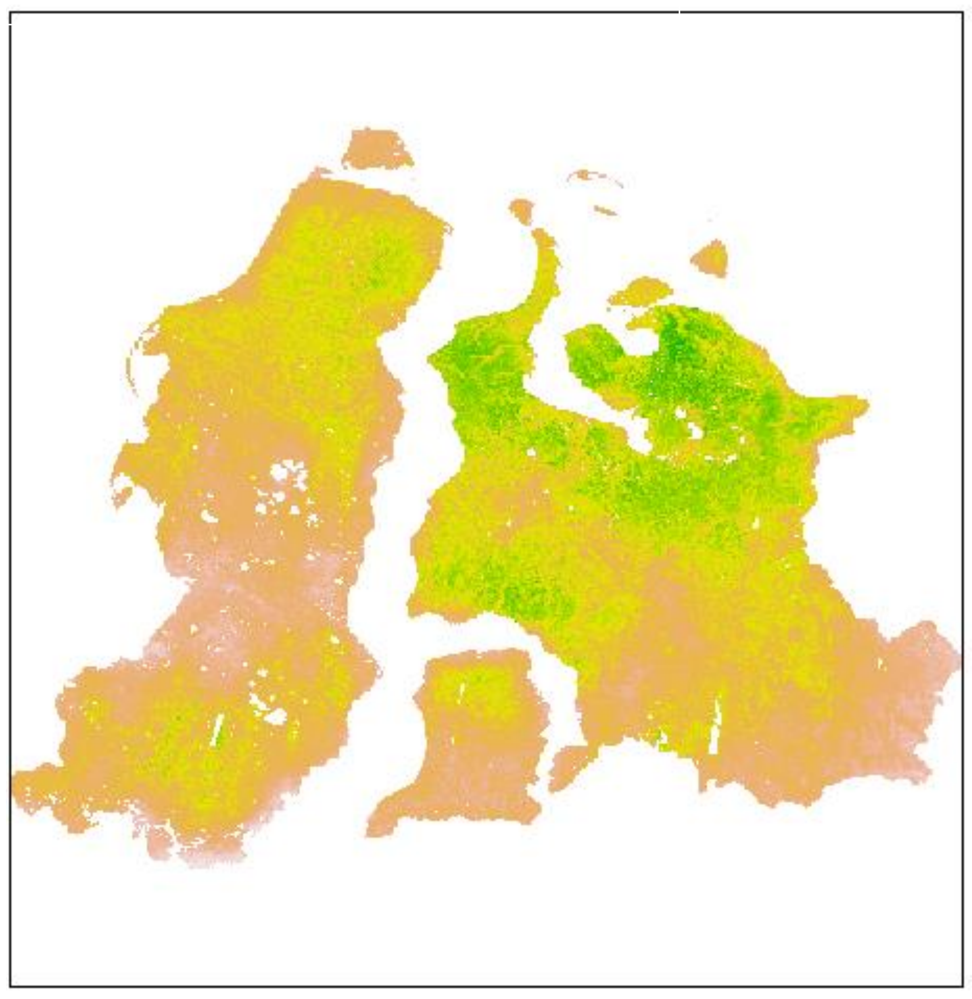

Fig 4: Zero-human influence model ensemble

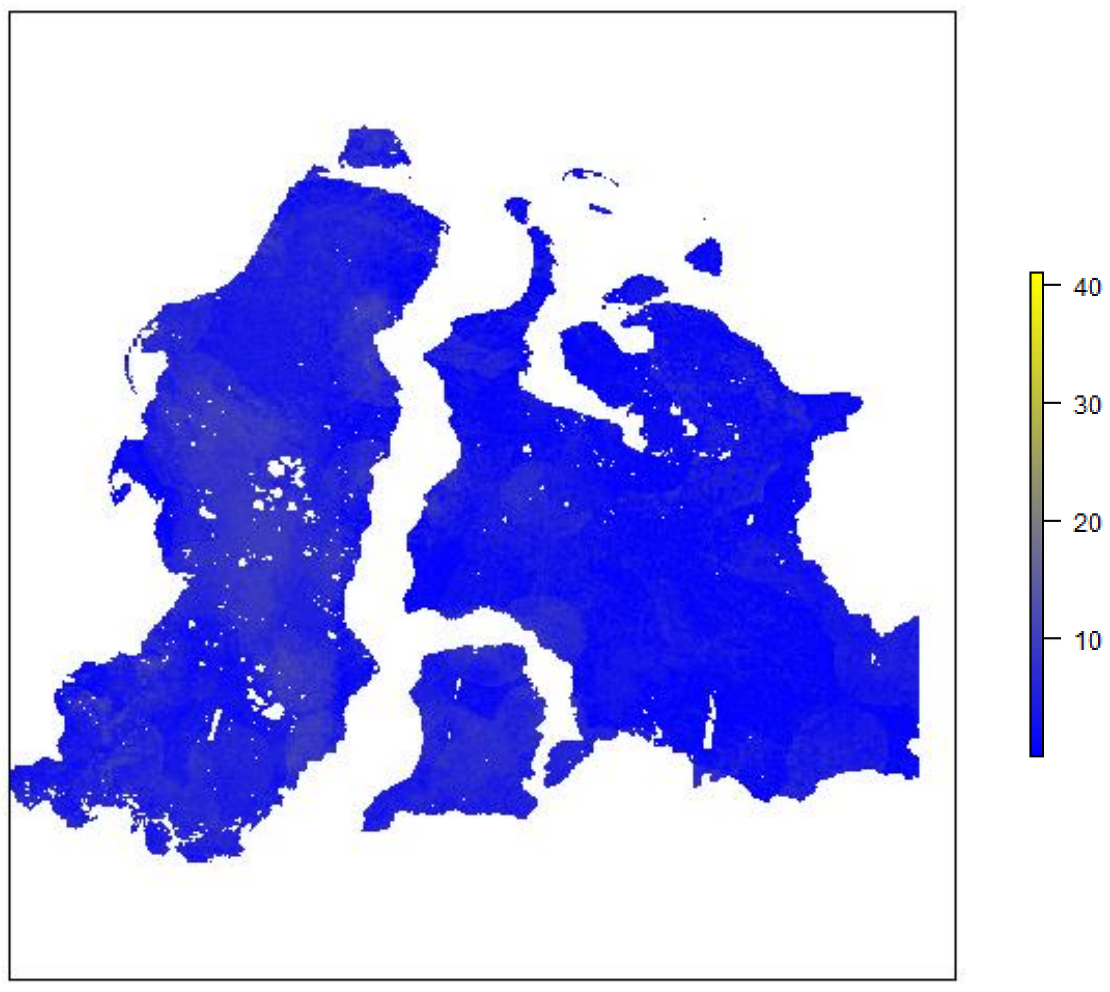

Fig 5: Models disagreement map (“actual distance to infrastructure”)

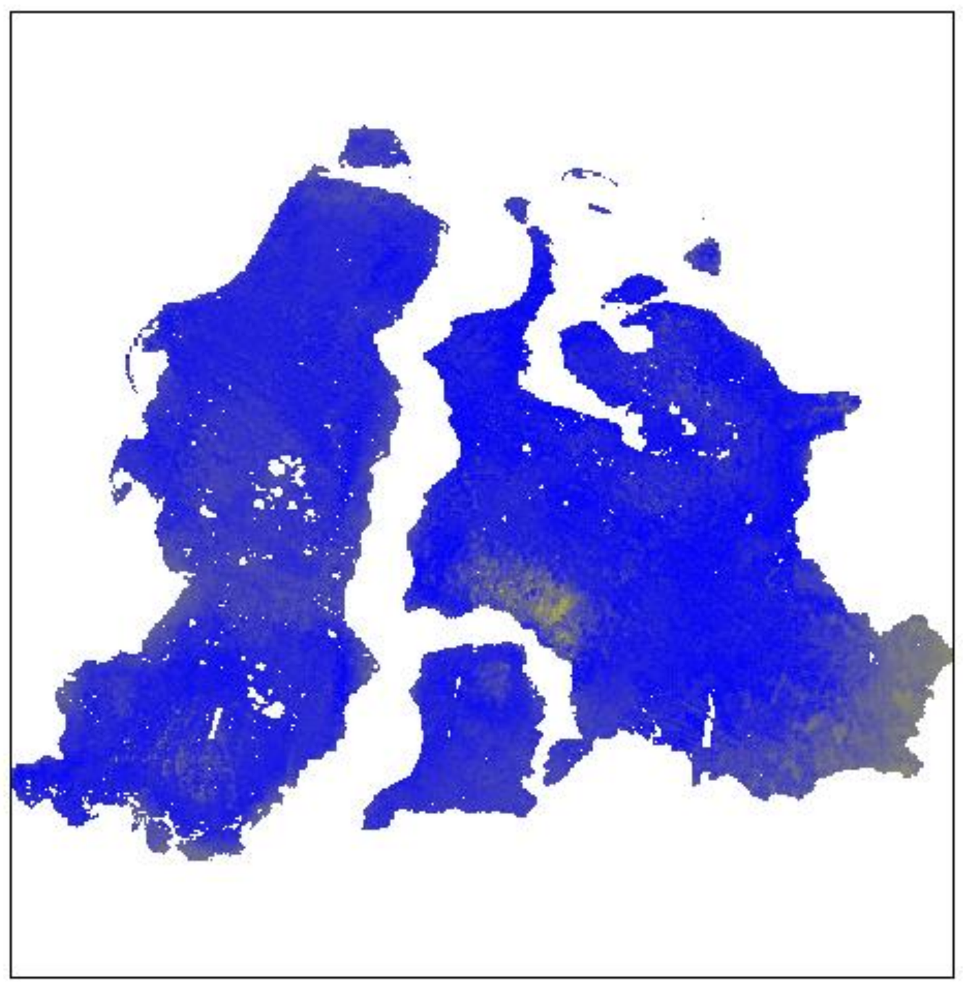

Fig 6: Models disagreement map (“zero human influence”)

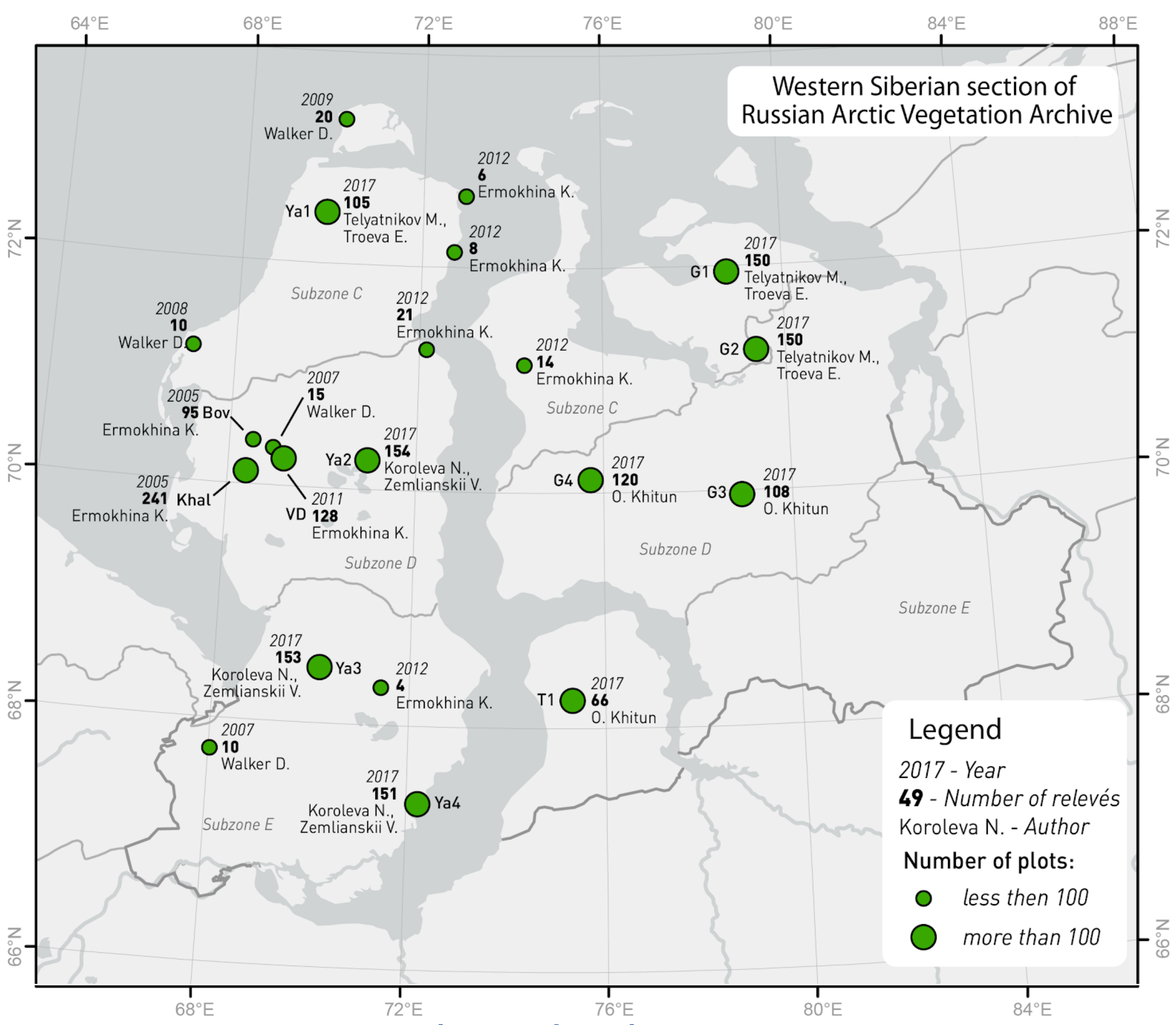

Fig.2:Plot data

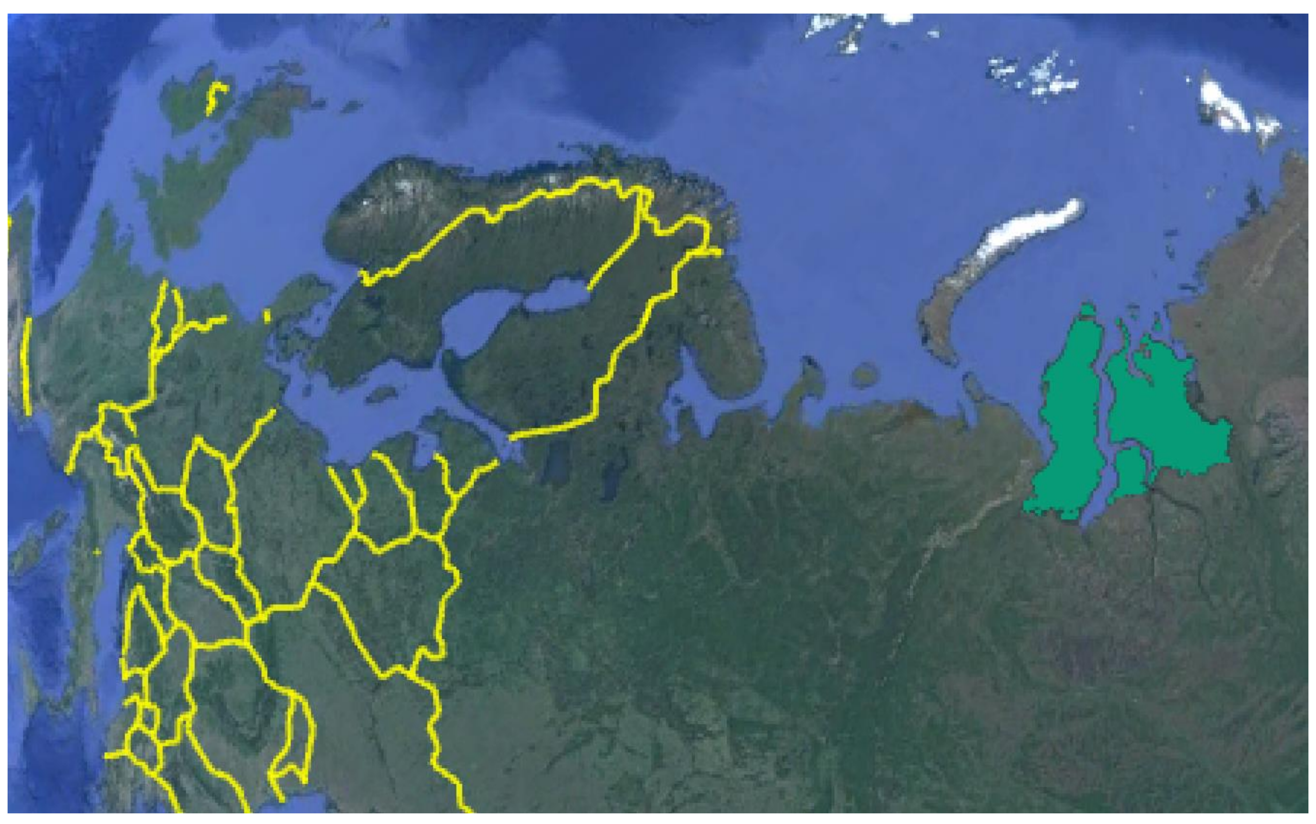

Fig.1: Research area on Google Earth

Discussion

- Clear gradient in species richness from South-West to North-East.
- Climate factors such as ground temperature and precipitation play a key role in shaping community species richness while topographic relief plays a secondary role.
- The decrease in species richness in the southern part of the region might be a result of reindeer herding and gas extraction.
- Areas disturbed by human activity are characterized by relatively high model uncertainty.

Authors

Presented by:
Vitalii Zemlianskii
vitalii.zemlianskii@ieu.uzh.ch

Philipp Brun
philipp.brun@wsl.ch
Ksenia Ermokhina
diankina@gmail.com
Niklaus Zimmermann
niklaus.zimmermann@wsl.ch
Gabriela Schaepman-Strub
gabriela.schaepman@ieu.uzh.ch

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