Customizing the classification of Arctic wetlands for an improved analysis of their carbon and energy cycles

Kseniia Ivanova[1]*

INTRODUCTION

Wetlands play an important role in the carbon balance of the Arctic and cover more than 60 % of the area. While most climate models **distinguish only one or two types of wetlands**, biogeographical approaches define **at least ten types of wetlands** in the Arctic.

The main aim of this study is **to improve the representation of wetland ecology** in carbon upscaling studies in the Arctic. This requires finding the balance between the diversity of wetlands in the Arctic and variability in responses to climate forcing. On the one hand, a larger number of classes allows a more precise description of the conditions and characteristics of the fluxes within each class. On the other hand, more classes also mean less information per class, and thus more gaps that need to be interpolated.

MAIN AIM

Simple classification: aim at low number of wetland types

Consider variability in main environmental parameters

Optimized classification scheme

Focus on CO_2 and CH_4 fluxes (as well as variability)

Reflect variability in vegetation structure and composition

All classes identifiable with remote sensing data

DATA COLLECTION

Database:

78 articles

778 observations:
- CO_2 – 531
- CH_4 – 403

Data for 1988 – 2019

All seasons

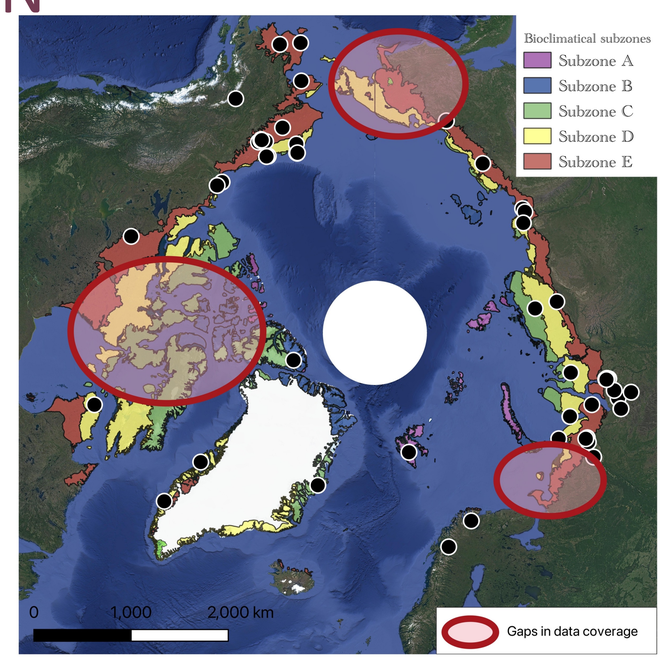


Fig. 1. Data coverage in the database on the satellite map (google.com). Colors indicate different tundra subzones by Walker et al., 2014.

CLUSTERING

The goal is to group similar objects into clusters based on input parameters, in order to identify classes of wetlands that can be distinguished based on their individual combination of environmental parameters, carbon fluxes, and vegetation.

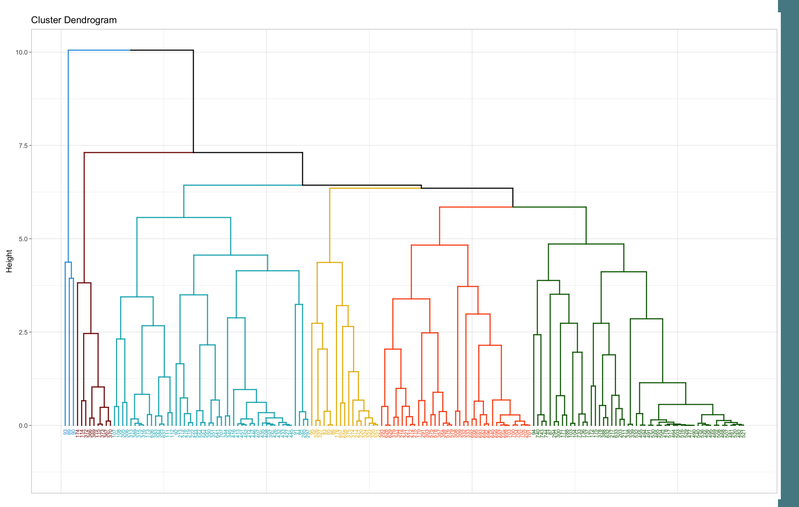


Fig. 2. Cluster dendrogram. The colors indicate different clusters.

PARAMETERS

Moisture type

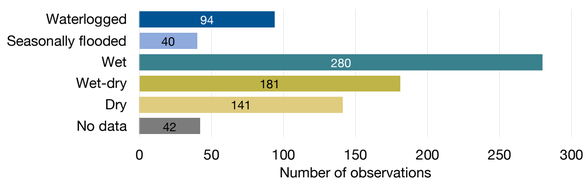


Fig. 3. Data distribution by different moisture types.

The five types of moisture were chosen as they reflect the diversity of moisture conditions in Arctic wetlands, can be determined based on available data for almost all studies, and can also be used in climate models in the future.

Water table level and its change during the vegetation season

Consideration of the water table level and its changes is crucial when accounting for CH_4 emissions from Arctic wetlands. An increase in water table level leads to an increase in anaerobic soil volume, resulting in a rise in methane emissions.

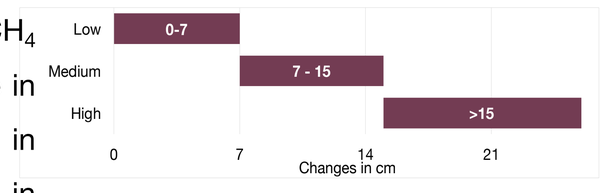


Fig. 4. Categories of change in the position of water level.

Preliminary types of wetlands

As a basis for further classification of Arctic wetlands and for initial data analysis (mean values, group dispersion), the wetland classification of the Arctic by Minayeva et al (2017) was used, with subsequent modifications based on the analysis of literature on GHG emissions. This classification was found to satisfy the majority of parameters (see "Main aim") but does not account for CO_2 or CH_4 emissions yet.

- Drained depression (Khasyrei)
- Fens with *Eriophorum*
- High- and low-centered polygonal tundra
- Near lake depression
- Palsa mires
- Peat plateaus
- Raised bogs, Sphagnum hollow
- Salt marshes
- Sedge meadows

pH
Active layer depth
Soil temperature

Vegetation (Presence of certain plant groups)

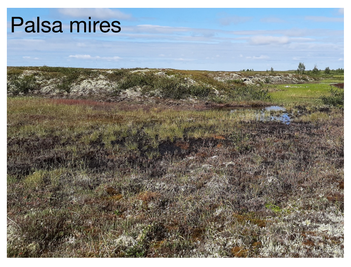
1. ***Sphagnum*** mosses (only hygrophytic). Wet or waterlogged environments with low nutrient availability and a low pH.
2. ***Eriophorum* spp.**. grow well in soils that are moist but not waterlogged, with a neutral to slightly acidic pH, and moderate to high soil fertility.
3. Group of ***Carex* spp.** that can be found in areas with a shallow water table or standing water.

   Species: *Carex aquatilis, C. rotundata, C. rostrata, C. chordorrhiza, C. wiluica, C. capitata, C. globularis, C. limosa., Arctophila fulva.*
4. **Cushion-forming lichens** indicate dry conditions.

Next steps:

- Exploring alternative methods for reflecting vegetation based on the limited descriptions provided by authors
- Figuring out if it is needed to use other groups or combinations of species in order to improve the accuracy of the vegetation classification.
- Search for the best combination of input parameters for statistical analysis.

Few examples of preliminary wetland types:



Photos: Ivanova K.

Funding

The authors acknowledge funding from the European Research Council (ERC synergy project Q-Arctic, grant agreement no. 951288).

Affiliations:
[1] 'Integrating surface-atmosphere Exchange Processes Across Scales - Modeling and Monitoring (IPAS), Department Biogeochemical Systems. Max Planck Institute for Biogeochemistry

//*email: kivanova@bgc-jena.mpg.de