Mapping and monitoring of arctic vegetation using NaturaSat software

Maria Sibikova*, Donald Skip Walker#, Martha Raynolds#, Olivia Hobgood#, Amy Breen#, Jana Peirce#, Jozef Sibik*

*Plant Science and biodiversity Center SAS, Bratislava, Slovakia, maria.sibikova@savba.sk
#Alaska Geobotany Center, University of Fairbanks, AL, US

Introduction

The NaturaSat software integrates knowledge of botany fieldwork scientists, nature protection managers, mathematicians and software developers focusing on habitats exploration. The software is already in use in Central Europe, allowing extraction of the habitat borders with pixel accuracy of the Sentinel-2 optical data, classification of plant communities in segmented areas by satellite image characteristics and monitoring their area and quality dynamic changes. The first application in Arctic region is presented with case study areas - Toolik Lake and Prudhoe Bay

Workflow

of the NaturaSat software development:

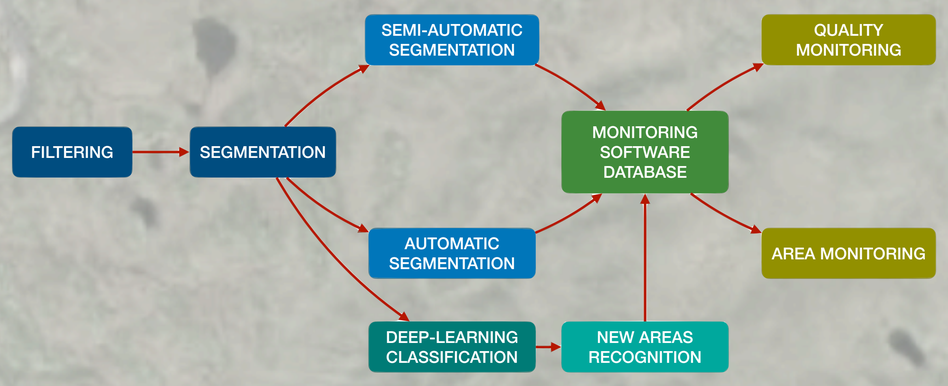


Fig. 1. The Toolik Lake area visualized by Senttinel-2 data

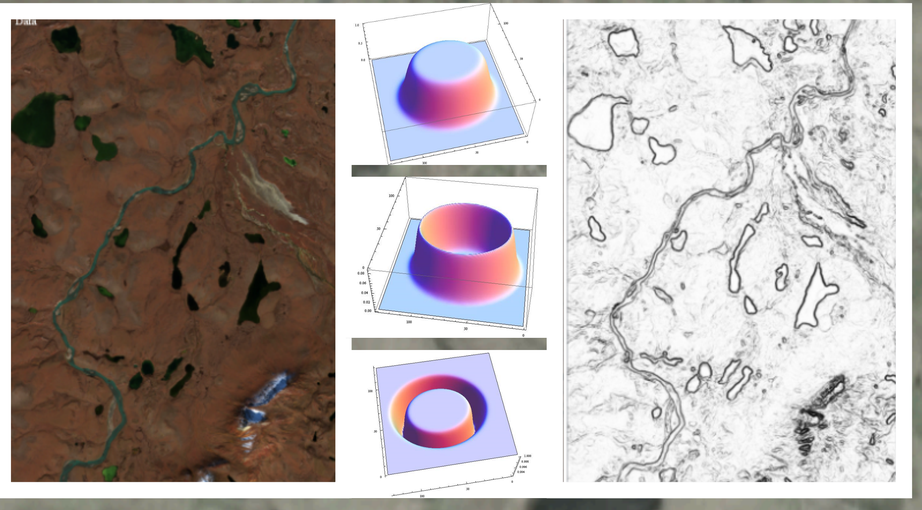


Fig. 3. Original data (a), image intensity function (b), norm of the gradient (c), edge detector (d) and its vizualization (e)

Semi-automatic segmentation

In the case of the semi-automatic segmentation, the user selects a straight line that is located along the desired habitat boundary edge, and the curve is automatically adjusted to the habitat boundary by the edge attracting term.

Vegetation data

Toolik Lake Area Vegetation map (Walker & Maier 2008, Fig. 2) was imported to NaturaSat. Original habitats borders were compared with recent segmented areas. Transects of vegetation plots in Prudhoe Bay Area was used for software calibration.

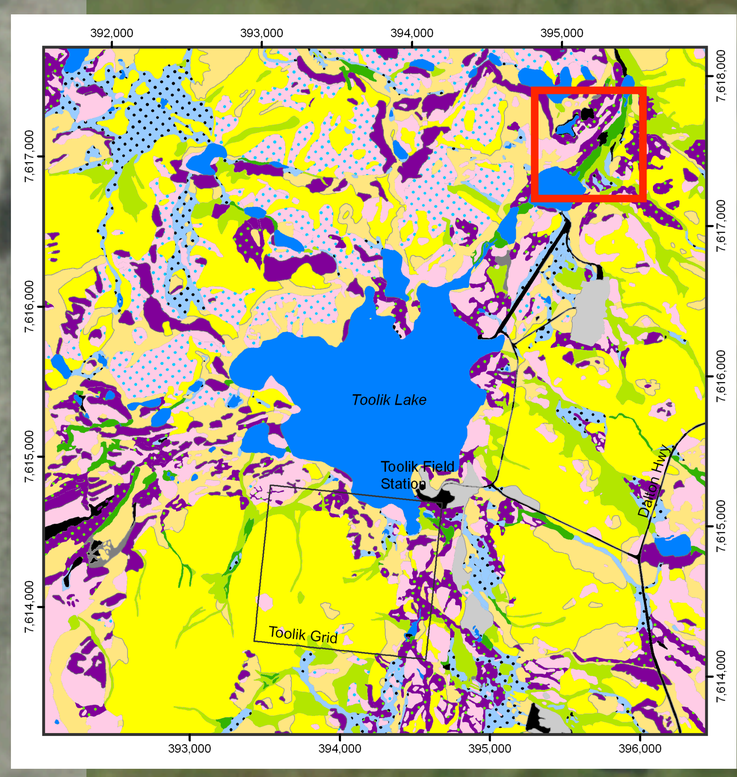
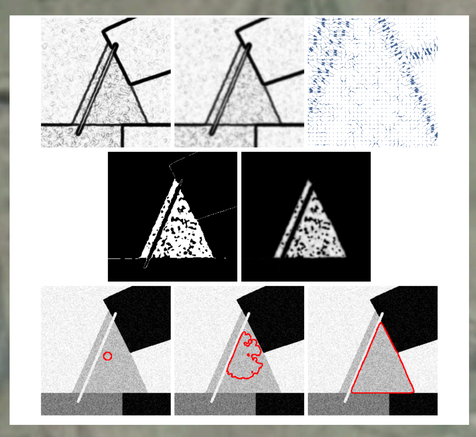


Fig. 2. The Toolik Lake Area Vegetation map (Walker & Maier 2008)



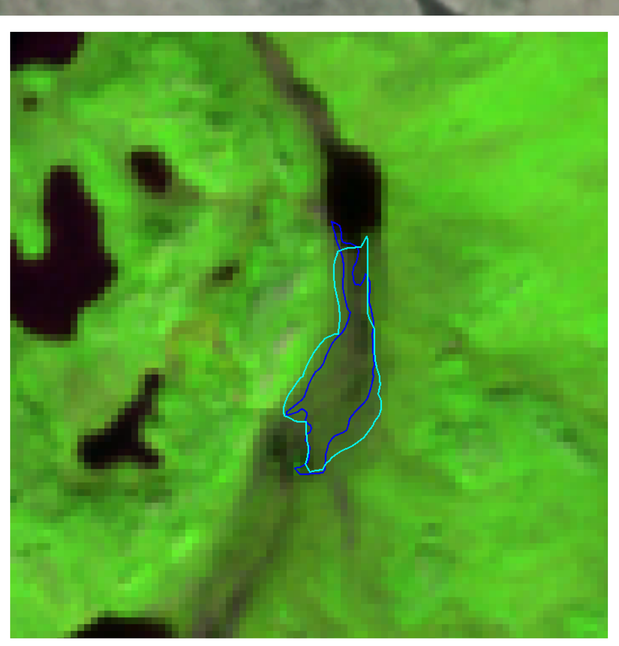
Automatic segmentation

The segmentation model is based on the evolving closed planar curve approach. In the fully-automatic segmentation the user selects a point inside the habitat or the habitat occurrence indicating point is chosen as the center of the circle which is then evolved by the curve evolution model.

Fig. 4. First row: the visualization of smoothed edge detector and the vector field, second row: the homogenity function, third row: the initial segmentation curve and its time evolution until the final segmentation

.

Fig. 5. Automatic segmentation of tall shrub tundra near Toolik lake



Spatio-temporal monitoring

The quality monitoring of habitats is based on comparing optical band values inside the same segmented area on different dates. Area monitoring is based on comparison of Hausdorff distance of two curves. Presented areas (Fig. 7) are tall shrub tundra with area 1.7 ha in 2008, and same habitat with area 2.5 ha in 2022.

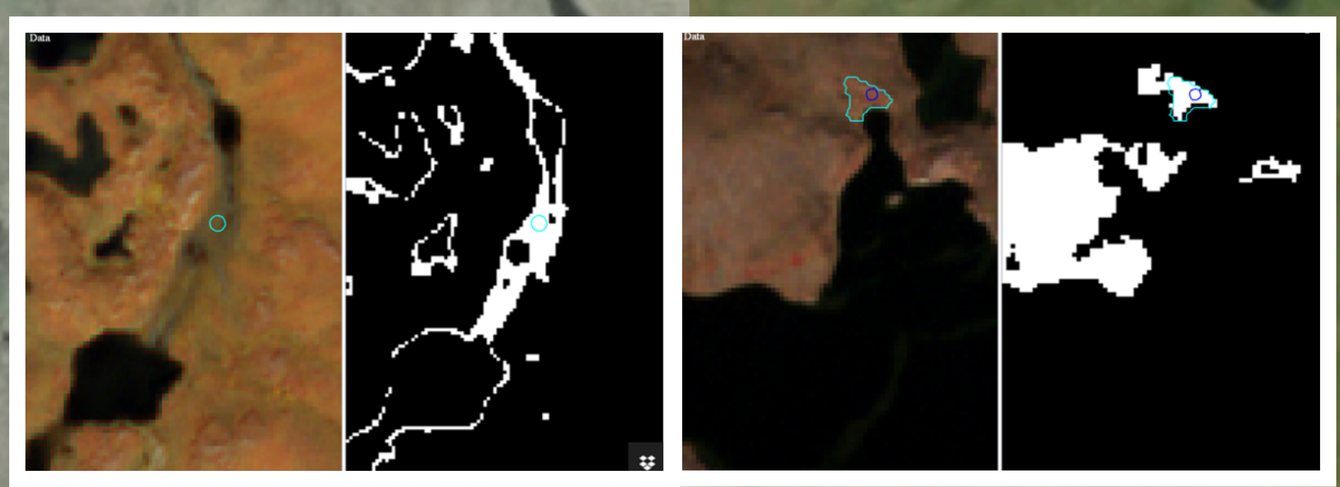


Fig. 6. Initial segmentation circle of tall shrub tundra and its homogenous area (left), and Initial segmentation circle of moist graminoid tundra and its homogenous area (right) near Toolik lake

Fig. 7. Tall shrub tundra area (dark-blue) from 2008, and recent segmentation (light-blue)

Acknowledgement: We appreciate the international support provided by the NASA Pre-ABoVE program (Award No. NNX13AM20G, NNX14AD90G), National Science Foundation (NSF) Arctic Science, Engineering and Education for Sustainability program (ArcSEES Award No. 1263854, 1928237), NSF Funding for this project was provided also by the National Aeronautics and Space Administration (NASA) Land Cover and Land Use Change Program (Award Nos. NNG6GE00A, NNX09AK56G, NNX14AD90G), ESA No. 4000140486/23/NL/SC/rp, and VEGA 2/0097/22.