Application of Global Land Survey data to land-cover mapping: Yamal Peninsula, Russia

H.A. Maier and D.A. Walker. Alaska Geobotany Center, University of Alaska Fairbanks, Fairbanks, AK. http://www.geobotany.org/

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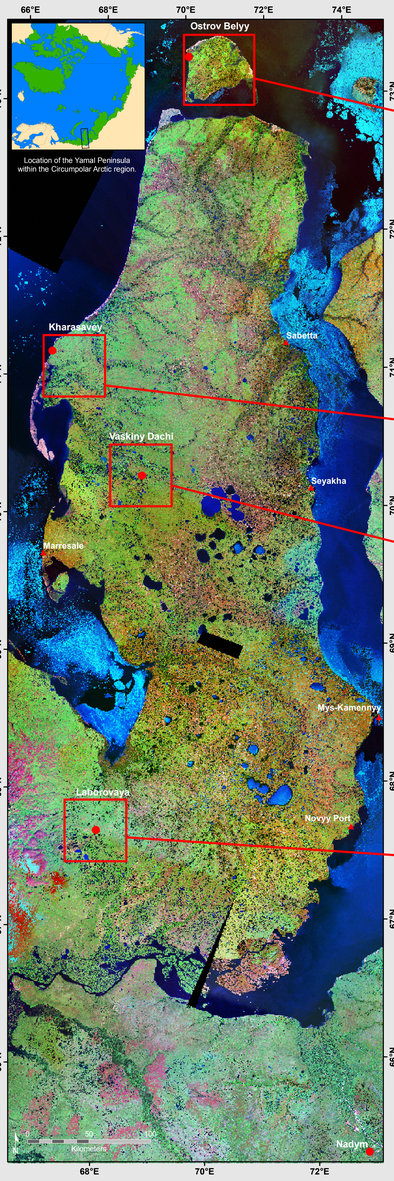
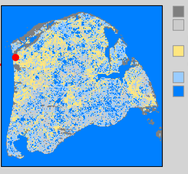
Landsat TM orthorectified mosaic false-color image



False color image of the Yamal Peninsula created from Landsat TM Orthorectified Mosaics (acquired 1986-1995). The false color composite displays Landsat TM bands 7 (2080-2350 nm; Mid-Infrared), 4 (760-900 nm; Near-infrared), and 2 (520-600; green) as red, green and blue channels. Vegetated areas are displayed as shades of green. Water is displayed as black and dark blue. Barren areas are displayes as shades of magenta and pink. Study regions area indicated by red squares (approximately 50x50 km). Field sites are indicated by the red dots within the study regions (red boxes).

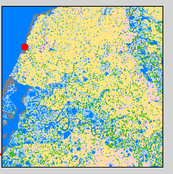
Landcover of study regions approximately 50x50 km

Ostrov Belyy



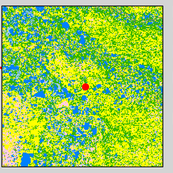
- Barren
- Dry cryptogamic-crust, prostrate dwarf-shrub tundra
- Moist graminoid, prostrate dwarf-shrub tundra
- Wet graminoid, moss tundra
- Water

Kharasavey



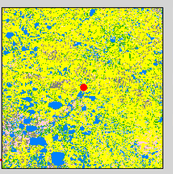
- Barren
- Dry prostrate dwarf-shrub, lichen tundra
- Moist graminoid, prostrate dwarf-shrub tundra
- Moist to wet shrub tundra and riparian shrublands
- Wet graminoid, moss tundra
- Water

Vaskiny Dachi



- Barren
- Dry prostrate dwarf-shrub, lichen tundra
- Moist graminoid, erect dwarf-shrub tundra
- Moist to wet shrub tundra and riparian shrublands
- Wet graminoid, moss tundra
- Water

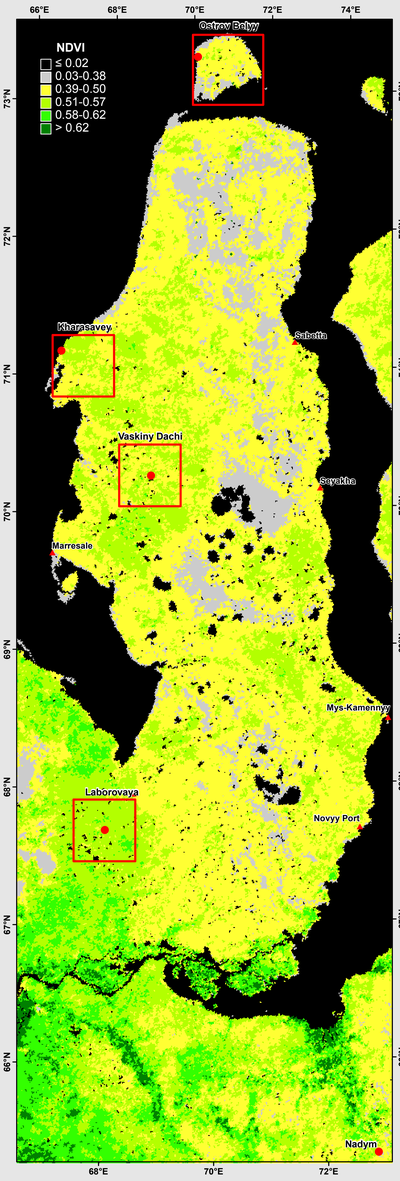
Laborovaya



- Barren
- Dry prostrate dwarf-shrub, lichen tundra
- Moist graminoid, erect dwarf-shrub tundra
- Moist to wet shrub tundra and riparian shrublands
- Wet graminoid, moss tundra
- Water

An unsupervised classification for Kharasavey, Vaskiny Dachi and Laborovaya was performed on bands 1-3 of the Landsat TM Orthorectified Mosaic image (TM bands 7, 4, 3) using the Iso Cluster and Maximum Likelihood algorithms (ArcGIS 9.3 software). Ostrov Belyy was mapped according to the procedure described below. Pixels were grouped into 35 clusters based on their spectral similarity. Each area was treated separately because of large variation in acquisition dates across regions. Each cluster was assigned to one of 7 land-cover classes with names and colors modified from those of the Circumpolar Arctic Vegetation Map (Walker et al. 2005). The five landcover classes displayed for Ostrov Belyy were simplified from the eight, ETM+ derived landcover classes described for Ostrov Belyy landcover map below.

Normalized Difference Vegetation Index from AVHRR 1-km data



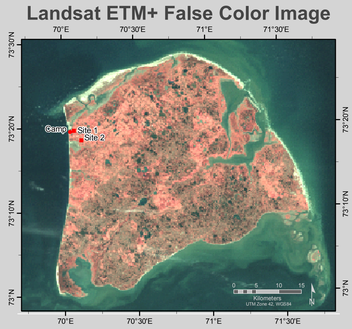
The Normalized Difference Vegetation Index (NDVI) is an index of photosynthetic capacity that can be related to plant biomass. NDVI is calculated as: NDVI = (NIR – R)/(NIR + R); where NIR and R are the spectral reflectance values of the near-infrared and red bands, respectively. The NDVI values displayed below were obtained from the CAVM (Walker et al., 2005) and were originally derrived from 1 km AVHRR imagery using bands 1 (red, 580-680 nm) and 2 (near-infrared, 725-1100 nm). Water and barrens are generally displayed as black and sparsely vegetated areas are displayed in gray. Vegetation density increases with darker shades of green. Live biomass values were scaled linearly with NDVI from 0 g/m^{-2} to >500 g/m^{-2}, based on biomass information from (Walker et al. 2009), low biomass values occur in the dry areas, intermediate values in moist areas, and highest values in the wet tundra areas.

Conclusions

- GLS orthorectified mosaic imagery provides high spatial resolution data for the entire Yamal Region
- Images have been orthorectified and equalized allowing high resolution imagery, covering a large extent to be easily incorporated into research projects.
- The large variation in acquisition dates of individual scenes (May-September), however, prevented making a consistent landcover map of the entire Yamal Peninsula. Separate landcover classifications were developed for each of the study regions.
- The variation in acquisition dates also prevented making a consistent NDVI map from the GLS data. For this we a 1-km AVHRR dataset produced by the USGS for making the Circumpolar Arctic Vegetation Map.

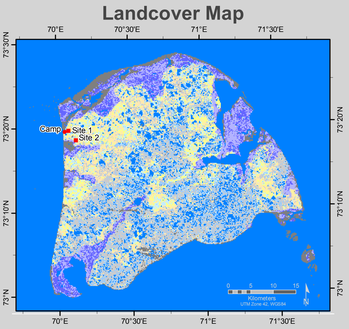
Ostrov Belyy (White Island), Yamal Peninsula region, Russia: Landsat ETM+ false color image, land-cover map, and NDVI map

Landsat ETM+ False Color Image



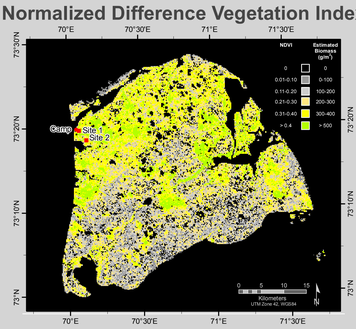
The pan-sharpened false color image of Ostrov Belyy (left) was created from a Landsat ETM+ scene (USGS 2000; 15 Aug 2000; Path 168, Row 8). The false color composite displays Landsat bands 4 (750-900 nm), 3 (630-690 nm) and 2 (525-605 nm) as red, green and blue channels. The image was sharpened to a resolution of 15 m using the panchromatic band (band 7) and a Simple Mean algorithm (ArcGIS 9.3). Vegetated areas are displayed as shades of red. The brightest reds generally indicate the most densely vegetated areas and the duller reds the least vegetated areas. Water is displayed as black and sparsely vegetated or barren areas as light colors. The mosaic of landsat scenes for the Yamal (lower right) was created from the USGS Landsat TM Orthorectified Mosaics data collection (acquired 1986-1995) and shows the location of Ostrov Belyy.

Landcover Map



An unsupervised classification was performed on bands 1-7 of the Landsat image using the Iso Cluster and Maximum Likelihood algorithms (ArcGIS 9.3 software). Pixels were grouped into 15 clusters based on their spectral similarity. Each cluster was then assigned to one of 9 land-cover classes with names and colors modified from those of the Circumpolar Arctic Vegetation Map (Walker et al. 2005). Salt marshes near the coast (laydas, violet colors on the map) were delineated by drawing polygons around these areas (photo interpretation) on the false-color image and then reclassifying the pixels within the layda regions. Plant species and soils information in the legend is based on field surveys (17-30 Jul 2009) in the vicinity of the base camp near the Popov Hydrometeorological Polar Station in the northwest corner of the map (Walker et al. 2009) and supplemented with photos taken during helicopter based aerial transects that were flown across the island during arrival and departure from the base camp.

Normalized Difference Vegetation Index



The Normalized Difference Vegetation Index (NDVI) was calculated from band 3 (630-690 nm) and band 4 (750-900 nm) of the Landsat image. NDVI is an index of vegetation photosynthetic capacity that can be related to plant biomass. The values were calculated as: NDVI = (NIR – R)/(NIR + R); where NIR and R are the spectral reflectance values of the near-infrared (band 4) and red (band 3) bands, respectively. Water and barrens are generally displayed as black and sparsely vegetated areas are displayed in gray. Vegetation density increases with darker shades of green. Live biomass values were scaled linearly with NDVI from 0 g/m^{-2} to >500 g/m^{-2}, based on biomass information from (Walker et al. 2009). Low biomass value occur in the dry sandy areas, intermediate values in mesic loamy zonal areas and highest values in the moist to wet tundra sites.

Conclusions

The small island of Ostrov Belyy was contained within the extent of a single Landsat ETM+ scene allowing for the creation of excellent landcover, NDVI and biomass maps. The map will be used in planning for a wildlife refuge covering

Landcover Classes

1. **Barrens, sparsely vegetated and clouds**
   Includes barren coastal beaches, floodplains, mud flats, and sandy blowouts. Also a few clouds.
2. **Dry, cryptogamic-crust, prostrate dwarf-shrub tundra**
   Well-drained, sandy uplands, often with networks of small non-sorted polygons, on streams bluffs, and raised microsites between small lakes especially in the central and southern parts of the island.
3. **Moist, graminoid, prostrate dwarf-shrub, moss tundra (drier facies, tan; wetter facies, light yellow)**
   Xeromesic plant communities, mostly along stream bluffs with well-drained soils. Moderately drained, mainly loamy uplands, sometimes with non-sorted circles, mainly in the northwestern part of the island and scattered elsewhere.
4. **Wet, graminoid, moss tundra**
   Sites with saturated soils but generally not summer-long standing water.
5. **Aquatic, herbaceous marsh**
   Vegetated margins of lakes and areas with water up to about 50 cm deep.
6. **Moist to wet, brackish, graminoid marsh (brackish laydas)**
   Coastal areas and estuaries that are less frequently inundated by salt water.
7. **Wet saline, graminoid marsh (saline laydas)**
   Coastal areas that are frequently inundated by salt water, especially along the northern coast, and estuaries of several streams.
8. **Water**
   Includes ocean, lakes, and other mainly unvegetated bodies of water.

Detailed descriptions of the plant communities in each landcover class are in Walker et al. 2009.

References:
Maier, H.A. and Walker, D.A. 2010. Ostrov Belyy (White Island), Yamal Peninsula region, Russia: Landsat ETM+ false color image, land-cover map, and NDVI map (1:200K scale). Poster presented at the Second Yamal Land-Cover Land-Use Change Workshop. Rovaniemi, Finland. 8-10 Mar 2010.

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Credits:
Funding was provided by the NASA Land Cover Land-Use Change program, grant no. NNG6GE00A.

Data Sources:
Landsat TM Orthorectified Mosaics data collection. USGS Earth Resources Observation and Science Center (EROS). Scenes: N-42-65_LOC (Starting Date: 19860827, Ending Date: 19950928) and N-42-70_LOC (Starting Date: 19860820, Ending Date: 19930628). Online_Linkage: *http://earthexplorer.usgs.gov*

Landsat_ETM - Path: 168 Row: 8 for Scene: LE71680082000228SGS00. USGS Earth Resources Observation and Science Center (EROS). 2000. *http://earthexplorer.usgs.gov/.*

Circumpolar Arctic Vegetation Map. CAVM Team. 2003. Circumpolar Arctic Vegetation Map. (1:7,500,000 scale), Conservation of Arctic Flora and Fauna (CAFF) Map No. 1. U.S. Fish and Wildlife Service, Anchorage, Alaska.