
INTRODUCTION

This study analyzes change in tundra vegetation over a 22-year period as measured by NDVI (Normalized Difference Vegetation Index) in the area of Arctic Alaska. The area analyzed consists 630 km2 in the Toolik Flats and the Toolik Range, where the vegetation is predominantly krumholz wedge, dwarf-shrub tundra, and dwarf-shrub tundra.

METHODS

- Six Landsat scenes (TM and ETM), 10 years each, were compared: 1985, 1993, 1995, 2004, and 2007. All scenes had similar cloud cover and were collected during the peak of the growing season.
- Radiance and reflectance were calculated from the satellite data. The band reflectance was calculated from the satellite data using a light-dark pixel-based feature. NDVI was calculated from the normalized reflectance of Bands 3 and 4. Areas of cloud or shadow and bands were masked to the lines of the Landsat 7 scanner line were masked.
- Trends in NDVI were calculated on pixel basis using linear regression analysis, and tested for significance. Pixels with p < 0.05 were mapped.

NDVI trends were analyzed by elevation, flat and mesic using data from a series of remote-sensing data (Hansen 2003). Vegetation types, surface physiognomy, surface geology, and geological history were analyzed using recently published maps (Hymel & Miller 2008).

RESULTS

- Average NDVI of the study area increased significantly over the time period, at a rate of 0.0036 NDVI units/year (Fig. 3 and 5), showing a 3.2% increase in NDVI over the 22 years.
- The strongest increase in NDVI was on rolling and rolling terrains (Fig. 3C and 5). The greatest decrease in NDVI was on rolling and rolling terrains (Fig. 3C and 5).
- The 9th and 10th increase in NDVI was on rolling and rolling terrains (Fig. 3C and 5). This was the land cover category with the greatest changes in NDVI over the 22-year period. Of the most common vegetation types, dwarf-shrub tundra increased the most drastically, and non-lichen covered tundra (most non-lichenic tundra or NMT) showed a very small trend.
- The forest growth areas in the study area had higher levels of NDVI values (Fig. 4). The most recent advance of each generation had the largest increase in NDVI.
- The rate of greening increased with slope angle (Fig. 7). Greasing also decreased with elevation, meaning that areas with high elevations and lower NDVI had the lowest increase in NDVI. The forest vegetation category, which included river terraces with dense vegetation, showed the highest increase in NDVI, having a smaller average rate of greening than higher elevation categories.

CONCLUSIONS

The method provided a robust time series comparison of vegetation, which identified significant trends in areas of known degradation. The increase in NDVI in the study area was less than one half the rate for the entire United States (Fig. 8). The rate for the Arctic (average 0.0042/year) is higher than for the overall United States (average 0.0036/year). The study area includes higher elevations and steeper slope angles in the southern portion than in the northern portion. High-resolution satellite imagery would allow for additional analysis in areas of interest. The degradation of the high-latitude landscape has been well-documented, and it is critical to understand the changes occurring in the Arctic.

Climate data during this time period (1985-2007) from within the study area show a trend increase in temperature, with no significant increase in precipitation. Any change in climate, which could be either warming or precipitation, will affect the vegetation in the region and provide additional information.

ACKNOWLEDGEMENTS

This work is a contribution of the University of Alaska M.S. project by Jendri K. Miller (Merrill, 2007). The support was partially by NDV as part of the National Science Foundation, Office of Polar Programs (OPP) award 0638555, Alaska AG-17861, and National Science Foundation, Office of Polar Programs (OPP) award 0638555.

REFERENCES

[References and acknowledgments provided]