The Yukon-Kuskokwim Delta (YKD) region is one of the most biologically productive areas of the tundra biome and supports one of the largest indigenous human populations in the Arctic. Much of the YKD lies near sea level, and the region’s warm, thin permafrost is highly susceptible to thaw at temperatures above 0°C. Seal kill, tree-line, and changes in the frequency and intensity of storms make coastal ecosystems and infrastructure especially vulnerable. Multi-scale satellite records, coupled with a network of long-term monitoring plots, offer a means of characterizing disturbance processes, the scale at which they operate, and how they manifest in changes to vegetation and habitat. At the regional scale, Normalized Difference Vegetation Index (NDVI) trends have been idiosyncratic relative to circumpolar trends, with coarse-scale approaches needed to move from description of “big picture” spatial patterns to understanding of underlying drivers and impacts to ecosystem services. Long-term field plots in YKD coastal areas (late-1990s-present) are ideal for characterizing changes to the region’s most biologically productive habitats and subsistence areas. These plots indicate a range of vegetation responses across gradients of landscape age; salt-tolerant vegetation has been resilient on younger delta deposits, whereas changes are accelerating on older deposits underlain by permafrost. The LandSat record generally corroborates the browning observed by AVHRR in the YKD coastal zone; plausible mechanisms include regional climate trends such as increased summer cloudiness and winter plant mortality due to thinner snowpacks. Landsat-scale drivers include coastal flooding, salt-kil of vegetation, and permafrost degradation. However, greening is evident in upland areas (Nalato Hills, loolik Hills) and on the modern Yukon Delta. Independent lines of evidence indicate that these areas are experiencing very rapid shrub expansion.

**Key Points**

1. The Y-K Delta is poised for rapid change due to its proximity to basic environmental thresholds: sea-level rise and the freezing point (permafrost degradation).
2. In contrast to greening trends seen across much of the arctic, AVHRR time-series indicates strong declines in vegetation productivity on the Y-K Delta.
4. Browning is most pronounced on outer delta, suggesting influence of Bering Sea; greening in interior uplands and the modern Yukon Delta are consistent with observed shrub expansion.
5. Long-term field data are rare in the Arctic but offer a means to validate and interpret these spectral trends
6. Multi-scale approaches are needed to move from description of “big picture” spatial patterns, to understanding of underlying drivers and impacts to ecosystem services.

**Acknowledgments**

This work was funded by NASA’s Arctic Ecosystem Vulnerability Experiment, contract NNH16CP09C. We thank Chukchi residents James Ayaphuy, Greg Bates, and Andrew Bevacqua for their help on the Y-K Delta. We also thank Rachel Loeherlin (USGS) and Ryan Chick at the USA Field camp on the Tukok River.

**Permafrost Mapping with LiDAR**

Topography on the outer delta is extremely flat, but the development of permafrost beneath older sediments generates 1–2 m of heave and creates extensive permafrost plateaus that rise abruptly above younger deposits. The flat topography, and fairly uniform ground-ice conditions make it possible to map permafrost extent using LIDAR (white areas, center). A LIDAR flight-line collected in 2009 provides baseline data for permafrost extent, which can be updated following future collections.

**Ecosystem dynamics near the village of Newtok are influenced by coastal, fluvial, and permafrost processes.** "Hotspots" of LandSat spectral trend (1999–2015; far right) include outbank erosion and point bar accretion along rivers, lake drainage and plant colonization, and succession in older drained basins.

**AVHRR time-series**

Coarse-scale (12.5 km) AVHRR time-series indicate widespread NDVI decline on the YKD since 1982, especially near the period since 1999 (above). "Browning" is most pronounced in the early summer (below) There is evidence that this browning is linked to regional climate drivers, such as an increase in summer cloudiness, but interpretation of NDVI trends is complicated by abundant surface water on the YKD. Also, the region’s wide coastal zone is subject to abrupt, nonlinear dynamics after episodic storms, flooding, and salt-kil of vegetation, while interior uplands have one of the most active fire regimes anywhere in the Arctic. Drivers and impacts of ecological change on the Yukon-Kuskokwim Delta, Alaska

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**Background**

- southernmost part of tundra biome
- MAAT -2°C
- 70% below 30 m elevation
- 35 villages
- ~30,000 Yup’ik people
- exceptional breeding habitat for waterbirds

**Y-K Delta has been underrepresented in studies of arctic environmental change despite high societal value**

- vulnerable because of proximity to basic environmental thresholds: sea-level elevation and freezing point (permafrost thaw)

**Field monitoring**

- Salt-killed dwarf shrub after 2005 storm, later lichen expansion
- Salt-killed meadow after 2005 storm, later Carex seminervia expansion
- Bank erosion along the Manokwirik tidal river
- Smothering of halophytic sedges after 2005 storm, no recovery

**Literature Cited**


