FIRST APPLICATIONS OF AIRBORNE LIDAR FOR ARCTIC COASTAL MAPPING: POTENTIAL CONTRIBUTIONS TO BUILDING COMMUNITY RESILIENCE UNDER CLIMATE CHANGE

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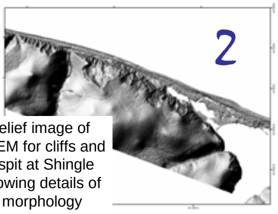
Abstract

Airborne scanning laser altimetry (LiDAR) systems provide a capability for rapid acquisition of topographic data. These systems collect laser range data from a swath of pulse-illuminated points beneath the aircraft flight line. The latest systems retain range and intensity information from multiple returns on each pulse, enabling the discrimination of vertically separated surface reflections and surface properties. The resulting horizontal and vertical coordinates are suitable for the production of high-resolution digital surface models showing vegetation, buildings, and other 'off-ground' features and digital elevation models (DEMs) of the bare ground topography.

This presentation focuses on recent applications of topographic LiDAR in northern coastal research. We propose a vision for more widespread acquisition of LiDAR data and complementary high-resolution imagery for Arctic coastal communities and nearby valued habitat.

Landsat mosaic of study area in Mackenzie Delta region of western Arctic Canada

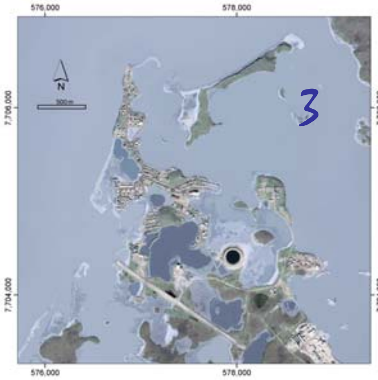


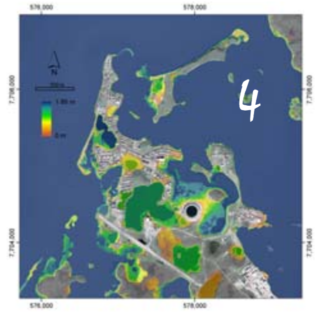
Shaded-relief image of LiDAR DEM for cliffs and proximal spit at Shingle Point, showing details of erosional morphology

LiDAR-derived DEMs are valuable tools for mapping flood risk and other hazard conditions in northern communities. The production of accurate flood-risk maps depends on high-quality LiDAR data, good knowledge of the local geoid, and appropriate ground-based validation surveys using high-resolution GPS. To address these issues, we have undertaken geodetic and topographic surveys in the Mackenzie Delta region and combined our results with traditional knowledge of past events to produce robust flood models for residents and land managers.

Tuktoyaktuk and Aklavik

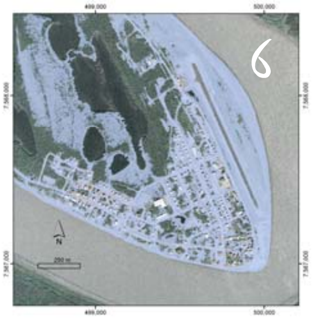
We have evaluated flooding hazards using LiDAR data for the communities of Tuktoyaktuk (3+4) and Aklavik (5+6) (Northwest Territories) and the seasonal coastal community of Shingle Point (7-9) (Yukon), all within the Inuvialuit Settlement Region of western Arctic Canada.

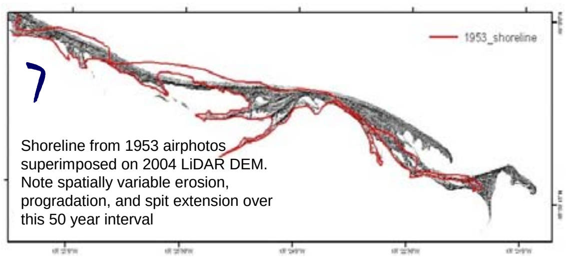




Flood extent (3) and flood depth (4) at Tuktoyaktuk, simulated by flooding the LiDAR DEM for a storm surge equivalent to the September 1993 event (2.51 m CD) with a projected sea-level rise of 0.31 m

Flood extent (6) at Aklavik (5) during high spring flooding, as experienced 5 June 1992, simulated by flooding the LiDAR DEM, validated by RTK ground surveys and traditional knowledge.

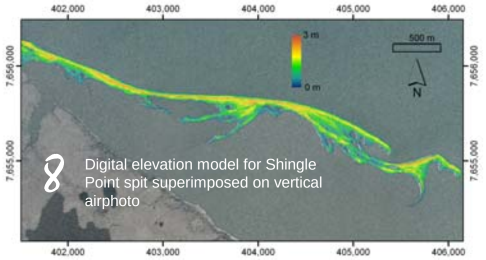




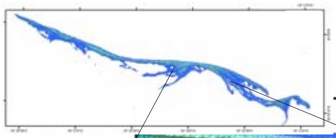
Shoreline from 1953 airphotos superimposed on 2004 LiDAR DEM. Note spatially variable erosion, progradation, and spit extension over this 50 year interval

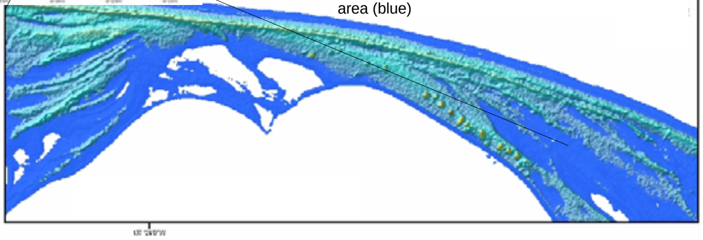
Shingle Point

Shingle Point spit is a seasonal occupation community west of the Mackenzie Delta on the Yukon coast (1). The spit has a history of storm breaching, spit extension, and pro-gradation. On occasion it is necessary to evacuate the seasonal community due to storm-surge flooding.



Digital elevation model for Shingle Point spit superimposed on vertical airphoto





Flooding of seasonal community on Shingle Point spit by a modest storm-surge water level of ~1 m (orthometric). Shaded-relief image and flooded area (blue)

Summary and Conclusions

Accurate representations of past and future flooding levels, extent, and depth are critical for community planning, engineering design, and the development of robust strategies for adaptation to climate change. Aerial photography and high-resolution satellite imagery have been available for community visualization and planning for some time now and detailed topographic surveys have been completed in most communities. Residents of these communities have a well-developed cultural affinity for the landscape and good appreciation of local hazards. Additional detail and understanding available from LiDAR-derived digital elevation models, combined with other data, can provide a solid foundation for development of adaptive choices to build community resilience in the face of environmental change.

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