Arctic coastal ecosystem mapping using high resolution optical satellite imagery

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ABSTRACT

Increased ship traffic and industrial exploration in the north is increasing the risk of environmental emergencies, specifically oil spills. Up-to-date spatial information will be helpful to emergency management in northern regions. The objective of this study is to evaluate the potential of the use of high resolution optical satellite imagery for coastal mapping. In this study, procedures for delineating the coastlines, mapping the coastal land cover, identifying texture patterns using local binary pattern (LBP) are developed. The performances of the segmentation, maximum likelihood classifier (MLC) and random forests (RF) classifier are evaluated. The developed methods were applied for coastal land cover mapping in four study sites in the Arctic, two sites in Coronation Gulf, Nunavut and two sites in Tuktoyaktuk, Northwest Territories using Pleiades satellite data. Results demonstrated that the developed semi-automatic method for extraction of coastline and water body has achieved accuracy of 98% in four arctic coastal areas. The extracted coastlines were more accurate than the existing coastline provided by the government Canada. Land cover classes investigated in the study areas included tundra, ice-wedge-polygons, inundated low lying tundra, marsh, beach of mixed sediment, beach of sand/mud, beach of mixed sediment and wood, beach of drift wood, beach of peat, bedrock, man-made and water. Results from pixel based MLC, pixel based RF, segment based MLC, and segment based RF were compared. In terms of overall mapping accuracy achieved in four study areas, RF outperformed MLC. In particular, segment based RF results were the best results in all four study areas, and achieved 88% overall accuracy for mapping 12 classes in Study Area 1, achieved 76% overall accuracy for mapping 12 classes in Study Area 2, achieved 90% overall accuracy for mapping 7 classes in Study Area 3, and 86% overall accuracy for mapping 6 classes in Study Area 4. Preliminary results indicated that LBP analysis is useful in identifying unique texture patterns of ice-wedge-polygons in the Arctic. Therefore, it demonstrated that the developed methods for delineating both coastline and water body and coastal land cover using high resolution optical data could be used to provide up-to-date information of coastal changes in the Arctic.