MAPPING CANADIAN WETLANDS USING L-BAND RADAR SATELLITE IMAGERY

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1. INTRODUCTION

It is believed that the direct impacts of global warming will be most felt in the Earth's high latitudes in various forms. The regions thought to be sensitive to climate change include patchy Arctic wetlands on continuous permafrost and wetlands along the southern limit of permafrost in the Subarctic. The effects in these areas could take on a number of complex forms, and could cause wetlands to switch between carbon sources and sinks in so-far unquantified ways. Establishment of high-resolution maps of northern wetland extent and distribution is therefore an essential goal for estimating sources, sinks, and net fluxes of CO_2 and CH_4 as well as providing a baseline against which to compare future changes.

Previously, we have developed a robust algorithm for mapping boreal wetlands using L-band satellite radar imagery, and in particular have used the method to produce a complete vegetated wetlands map of Alaska using the JERS radar data [1]. In this work, we apply this algorithm to produce a static map of Canadian wetlands from the 1997-98 era JERS radar data at 100-m resolution, to be followed in the future by the 2007-era ALOS/PALSAR maps.

2. METHODOLOGY

In the Canadian classification system, wetlands generally refer to waterlogged land-cover types, include peatlands (bogs and fens), flooded vegetation (marshes and swamps), and shallow open waters. We use this system to generate the wetlands map of Canada. For the non-open-water classes, we translate them into vegetated wetland types of emergent, scrub/shrub, and forested.

Our classification is based on 1997-1998 JERS data taken from the summer and winter mosaics produced by the Global Boreal Forest Mapping (GBFM) project. The data are HH polarized and provide 100 m resolution. The classification also uses a texture image, which provides a measure of SAR brightness variability, for each of the two backscatter images. Each texture image is calculated as the coefficient of variation for a high-resolution (12.5 m) version of the backscatter image within a 100 m processing window consistent with the other data layer resolutions.

The other data layers beside SAR imagery and image texture are summer and winter image collection dates, a digital elevation model (DEM), a slope model, an open water mask, a proximity to water map, and geographic latitude. The image collection dates are used to help compensate for temporal differences between swaths. The DEM of Canada, which accounts for local terrain altitude, is taken from a publicly available resource; it is assembled into a mosaic, reprojected and resampled to the JERS resolution. The slope model, which provides local orientation of the terrain surface, is calculated from the DEM. In addition to serving as an input to the classification algorithm, the slope model is also used to mask out regions of high slope (i.e., greater than 3 degrees), which are unlikely to be wetlands and could suffer from geometric errors since the GBFM mosaics are not orthorectified. The open water mask, which is used to exclude regions of open water from the classification, is derived from the summer mosaic alone. It also provides the basis for calculating the proximity to water map for non-water pixels.

The classification algorithm used here is based on a decision-tree classifier known as "Random Forests" [2]. The algorithm classifies by randomly generating a large number of decision trees based upon training data of known characteristics, implementing the decision trees, and setting each pixel's classification code equal to the class selected by the most decision trees. The algorithm relies on ground reference data to train the classifier, and later to validate its results. Our wetlands training data are assembled from a variety of sources, including the National Wetlands Inventory (for areas in the vicinity of US borders), BOREAS data bases, and several other focused study sites.

3. RESULTS AND CONCLUSIONS

The classification algorithm discussed above, based on the Random Forests methodology, is currently being applied to generate the first-ever vegetated wetlands map of Canada. The map is being constructed “from outside in” such that initially, the regions within several hundred kilometers of US borders are being processed. The reason is that substantially more training and validation data are available in both Alaska and the continental US than are available in Canada. For the interior and northern regions of Canada, the ground reference data are sparse, but still available to the extent needed to construct the wetlands classification rules.

The results of the classification for the regions completed will be shown at the presentation. Given that our method yielded an overall aggregate accuracy of 89.5% in Alaska, we hope and expect that our classification will ultimately produce an accurate map of Canadian wetlands.

5. REFERENCES

[1] Whitcomb et al., “Mapping vegetated wetlands of Alaska using L-band radar satellite imagery,” C. J. Remote Sensing, 2008, in press.

[2] Breiman, L., 2001. Random forests. Machine Learning, 45, 5–32. Open source software at www.stat.berkeley.edu/~breiman/randomforests.